MAKING CARBON COUNT: GLOBAL CLIMATE CHANGE AND LOCAL CLIMATE GOVERNANCE IN THE UNITED STATES

by

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ABSTRACT

In the absence of federally-mandated climate change regulations in the United States, many municipalities have begun to design and implement their own climate mitigation and adaptation programs during the past decade. These include programs such as the US Mayors Climate Protection Agreement, where more than 1,000 cities have pledged to meet Kyoto Protocol greenhouse gas (GHG) reductions targets within their own jurisdictions, as well as efforts to integrate climate information (e.g. tree-ring reconstructions of streamflow) into resource planning efforts to better assess the effects of climate change on water supplies. Using three related case studies in these areas, this dissertation examines the emergence and spread of local climate change programs in the US, with an emphasis on how government institutions work to make climate governable, and the potential effects these practices have on social life and the production and circulation of scientific knowledge. Central findings of the dissertation include: 1) Cities, through the use of everyday and routine political mechanisms that they have available to them, have become key sites of government action on climate change. In the process, local governments have been able to reaffirm, and in some cases expand, their influence within the public sector of environmental policy; 2) Carbon is the political currency of local climate change programs. Through the creation of GHG inventories (i.e. “carbon territories”) and the production of carbon-relevant citizens, climate has become the object of urban environmental governance; and 3) Climate science is utilized in complex and contradictory ways in climate mitigation and adaptation programs. Several framings of climate science have been constructed by local governments as a means to justify action

on climate change, while resource managers have begun to incorporate paleoclimate data into water resources planning. In both cases, the use of science has advanced political action on climate change, but the reliance and privilege of scientific discourses may preclude other “non-expert” communities from participating in the debate. This also demonstrates the “science effect,” where the practices of science and the state are constructed as separate and distinct, when they are, in fact, coproduced through the practices of climate governance.

INTRODUCTION

> "In the context of an increasingly urbanized globe…cities have become crucial sites in the propagation of neoliberal projects…Yet, cities are much more than zones of ideological and institutional experimentation in this era of market-oriented politics; they are also preeminent sites of resistance and struggle; they are places in which progressive alternative visions are being forged both beyond and outside restricted modalities of neoliberalism." (Leitner, Peck, and Sheppard 2007, ix)

It is becoming increasingly accepted that global climate change represents one of the most pressing social and ecological challenges facing society today. Yet, despite ongoing negotiations about climate policy taking place through the United Nations Framework Convention on Climate Change (UNFCC), much debate and disagreement exists amongst the world's national governments about how best to abate rising greenhouse gas (GHG) levels and the predicted impacts of climate change. Outside of the international arena of climate politics, however, cities around the world have begun to create and implement their own climate mitigation and adaptation policies. In the United States this has been particularly significant, as no formal government-led GHG reduction strategy is currently in place. Instead, local governments throughout the US are forging ahead of federal legislation by conducting GHG inventories, designing protocols to reduce GHG emissions, and developing adaptation plans to prepare for the potential impacts of climate change. This dissertation asks: How and why have sub-national climate change programs emerged in the United States, and with what implications for environmental governance?

This research examines the emergence and spread of local climate change programs in the United States, with an emphasis on how government institutions work to make climate governable, and the potential effects these practices have on social life and

the production and circulation of scientific knowledge. Furthermore, as expressed by the quote provided at the opening of this chapter, this research also explores how municipal climate programs do (and do not) rearticulate neoliberal policies for environmental management, including increased acceptance and implementation of market-based mechanisms for climate regulation (such as carbon trading and offset exchanges that have become favored mechanisms at the international scale). Do cities represent sites of resistance and struggle over the inequalities of climate mitigation and adaptation policies? Or, are local governments working to sustain global economic development and the contradictions of the carbon-intensive economy?

This research comes out of a personal interest in how we can appreciate urban spaces as ones imbued with their own environmentally significant qualities and characteristics. As urbanization has transformed "natural" landscapes all over the world into places of concrete, high rise buildings, and fast moving automobiles, cities are often seen as facilitating the ultimate separation of nature and society. My research, however, seeks to help transform this narrative of urban destruction into one where urban spaces become a "metabolic system" (Gandy 2002) of their own, which has the potential to provide the possibilities and potentiality for more socially and ecologically just practices to take place. Upon hearing in 2005 that hundreds of cities in the United States had adopted the US Mayors Climate Protection Agreement (MCPA), I began to explore municipal climate governance as a means by which concerned policy-makers and communities in the US might be able to promote alternatives visions of climate policy, particularly in the absence of federal leadership on climate change at the time. When I

first traveled to Seattle, Washington—a "pioneer" city in creating municipal responses to global climate change—during the summer of 2007, I was surprised to learn that the City's local government had been working to reduce their own GHG emissions and encourage other cities to do the same for more than a decade. Political and public consciousness that the City of Seattle could "lead the way in the fight against global warming" (Seattle Mayor Greg Nickels, quoted in Cornwall 2007), suggested that local communities can engage global environmental concerns, despite widely held notions that these problems are exclusively the domain of national and international communities. I was surprised to learn, moreover, that although this avenue for progressive climate action has been occurring in places like Seattle for several years, little was known about what motivates local communities to address climate change, nor the effects that local climate policies have on the urban landscape and the lives of the people who live there.

This dissertation provides five papers exploring these questions about municipal climate policy and the integration of climate science into local climate mitigation and adaptation programs. Three separate, but related, studies make up the data for this research, including: 1) A multi-city survey of all cities in the Pacific Northwest that have joined two of the country's most prominent municipal climate programs; 2) An in-depth analysis of Seattle's climate mitigation policies; and 3) An examination of science-policy engagements surrounding climate variability and change within the water sector in the western United States. These case studies are discussed in detail as part of the "Present Study" chapter of this dissertation.

Throughout the introductory chapters of this dissertation, I distinguish between two primary areas of research as, first, "*urban climate governance*," which consists of the Seattle study and multi-city survey, and, second, "*sustainable water management*," which includes the water resource study in the western US. All of the case studies utilized in this dissertation reflect my wider engagement with nature-society theory and assemblage geographies, which attempt to examine human-environment interactions as the product of context-specific associations of people and objects that make up socio-ecological life.

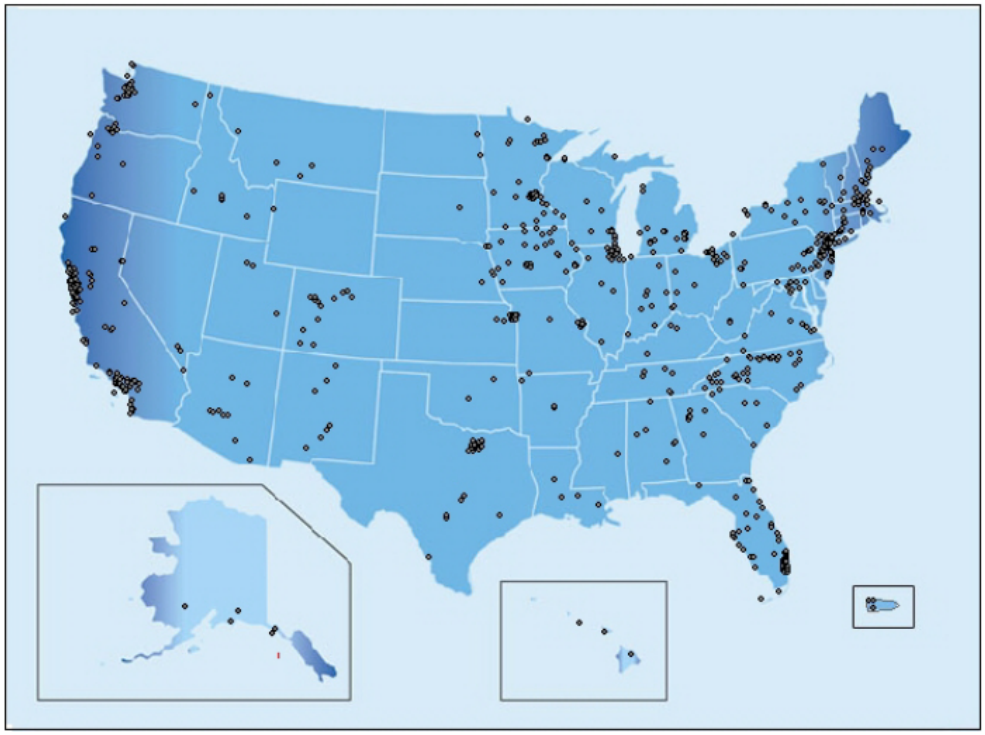
Research Problem and Context

Urban Climate Governance

On June 13, 2005, under the leadership of Seattle Mayor Greg Nickels, the US Mayors Climate Protection Agreement (MCPA) was unanimously endorsed by the United States Conference of Mayors. Cities that choose to participate in the MCPA "strive to meet or beat the Kyoto Protocol targets in their own communities, through actions ranging from anti-sprawl land-use policies, to urban forest restoration projects, to public information campaigns" (US Conference of Mayors 2009b). As of October 2009, just over four years after the MCPA was originally endorsed, more than 1,000 cities whose populations represent nearly 87 million U.S. citizens have adopted the agreement. The result has been a fundamental shift in the way climate change mitigation is addressed in the US, which is through a network of local governments and city jurisdictions, rather than nationally-centered climate regulations. Participating cities represent a wide range of socio-political

contexts, as MCPA signatories come from all fifty states, consist of large and small cities, and include both Republican and Democratic administrations (See Figure 1).

FIGURE 1: MAP OF CITIES PARTICIPATING IN THE US MAYORS CLIMATE PROTECTION AGREEMENT (MCPA)



(US Conference of Mayors 2009a)

Seattle, Washington is one of the most active local governments in this effort to address climate change through urban policy. Seattle's first formal Resolution (No. 28547) about climate change, which recognized "the crisis of global warming… [and] its effects upon our region," was adopted in June of 1992, five years before the international

community negotiated the Kyoto Protocol. This proclamation was followed by a series of Ordinances (Nos. 118597, 119176, 119467, 119830, and 120031) that authorized Seattle's participation in the Cities for Climate Protection Program (CCP), where the City aggressively pursued energy efficiency programs and GHG monitoring efforts within the context of local energy production. Seattle's "Earth Day" Resolution (No. 30144), adopted on April 10, 2000, strengthened this commitment to climate mitigation in the energy sector by requiring that Seattle City Light, the region's electricity provider, meet the City's electricity needs with *no net greenhouse gas emissions*. Through a combination of using low-carbon energy sources (90% of Seattle's electricity is generated through hydro-power plants), implementing energy conservation efforts, and purchasing carbon offsets, Seattle reached its goal of becoming carbon neutral in November of 2005 (Stiffler 2005, Seattle City Light 2009).

Further efforts to implement climate mitigation outside of the energy sector in Seattle began in July 2001. Resolution 30316 committed Seattle to the "long range goal of stabilizing atmospheric concentrations of greenhouse gases," including a city-wide plan to reduce Seattle's GHG emissions 7%-40% below 1990 levels by 2010. These GHG commitments also required that the City begin assessing and monitoring its GHG emissions through the use of carbon inventories. More recently, under the administration of Seattle's current Mayor, Greg Nickels, Seattle has made climate mitigation a central feature of its environmental priorities agenda. In addition to creating and implementing the US Mayors Climate Protection Agreement (a multi-city climate program previously described), Mayor Nickels also created a Green Ribbon Commission on Climate Change,

which included the membership of eighteen local and regional leaders from government, business, and the non-profit sectors to provide recommendations for how the City could meet its GHG reduction goals. Information from this executive committee was used to create Seattle's Climate Action Plan and to develop and assess community and government GHG inventories.

Currently, Seattle has successfully achieved an 11% reduction in per capita emissions for residents of Seattle in 2005, relative to 1990 levels (City of Seattle 2007) and is in the process of developing and implementing several community outreach programs in an effort to continue to meet its long-range GHG reduction goal of 80% below 1990 levels by 2050 (City of Seattle 2009). Because of the efforts discussed here, Seattle has become a key institution in the creation of urban climate policy, and an example for municipal governments interested in addressing climate change more broadly.

In what might be thought of as a *"post-Kyoto era*" (Olmstead and Stavins 2006) then, the amount and type of actors, agents, places, institutions, and organizations participating in some form of climate governance has changed dramatically during the past several decades. From government programs like the one underway in Seattle, to the network of cities participating in the MCPA, the emergence and persistence of locally-based climate programs is directly challenging mainstream notions that "global" climate change is effectively and adequately addressed only at the national and international level. This dissertation examines how local systems of governance engage issues that are frequently viewed as the global domain of national and international communities, along

with the interactions of science and policy embedded in these debates. The network of local state institutions involved in the MCPA have moved ahead of federally-mandated legislation, crafting their own political practices and regulatory mechanisms related to climate change. Yet, little is known about the contexts within which these locally-situated, state-based climate movements emerge, nor how they gain traction beyond the site of their original creation. The research presented here on urban climate governance directly addresses these questions through an examination of Seattle's Climate Action Plan and the US Mayors Climate Protection Agreement (see Appendices A, B, and C).

Sustainable Water Management

At the same time that local governments are grappling with how best to reduce their GHG emissions, many resource managers in the US are becoming increasingly concerned about the effects that climate change might have on one of our most basic needs—clean and reliable water supplies. In the western US, specifically, growing populations and over-allocated water resources are forcing water mangers to seek out new forms of information to plan for the impacts of climate variability and change on the region's water sources (Woodhouse and Lukas 2006). A variety of pertinent climate-related data and research do exist, but this scientific information *must* be made accessible and relevant for decision-makers in order for it to be useful in planning efforts. This requires that climate scientists, resource managers, and policy-makers are effectively working together to connect scientific knowledge to planning and policy in urban areas, which includes participation of many types of experts with different knowledge backgrounds and

outcome goals. Increasingly, these interactions and partnerships are being recognized as a process that is much more complex than simply passing information from one group to another (Jacobs and Pulwarty 2003).

Potential influences of climate on water resources in the western US include changes in water sources (e.g. ground or surface water) or amount of water supplies, increased frequency or intensity of drought, and modification of urban runoff and flooding regimes. Two main ways that climate science is currently being incorporated into water management is through the use of seasonal climate forecasts and streamflow reconstructions, both of which can be useful tools for water managers in planning for and assessing the impacts of climate on water supplies and system reliability. Seasonal climate forecasts can assist water managers in planning for and responding to variations in water supplies, while tree-ring data provide information on streamflow variability over multiple centuries, giving water managers a much better understanding of the range of natural variability for a particular watershed than is available from direct observations.

In many of these cases where water managers have attempted to use scientific information, however, significant barriers to use of climate data must be overcome for it to be useful in water management. Differing levels of climate knowledge, planning capacities, and willingness to incorporate climate data into water management have led to significant variations in the use of climate information by resource mangers (Jacobs et al. 2007). With respect to the production of scientific knowledge, researchers must also understand that “better science” does not always lead to better management and decision-making (Tribbiua and Moser 2008). Instead, significant gaps may exist between what

data decision-makers are aware of, knowledge about how to use scientific data, and what information may actually be necessary to address a particular management concern. At the same time, differences in background, professional training, and organizational mandates often places emphasis on different outcome goals for scientists and decision-makers, producing significant barriers for meaningful and sustained interactions between researchers and resource managers (Janse 2008, White et al. 2008).

This dissertation research examines science-policy engagements surrounding climate adaptation at the local level to better understand how scientific and research communities can work together to address the challenges of climate change. In the western US, climate scientists and water managers have engaged in collaborative efforts to deal with water resource concerns, and this research evaluates these interactions to determine how scientific information has been integrated into water resource planning, and with what effects on the potential for the creation of meaningful climate adaptation programs (see Appendix D).

Together, the case studies presented in this dissertation examine the emergence of local climate governance, through both urban climate mitigation programs and water resource adaptation efforts, to provide a framework for understanding the significance and potentiality of locally-based climate action in the US. By understanding the ways that locally-situated actors and institutions have come to address social and physical processes often deemed as being “out of their control,” the possibilities for real change become visible. So too, knowing more about the character of these programs and science-policy

engagements will lead to fuller understandings of their potential social and ecological effects. While much of the current scholarship in social sciences focuses on the global arena of climate policy, my work shows how the ecology of global climate change intersects with local communities and politics. In particular, this research agenda elicits the following research questions, centered on two theoretical areas of inquiry:

1. **The State-Nature Relationship**: What are the geographies and expressions of state power emergent in municipal climate change mitigation programs? How do municipal governments make climate governable at the local level in the US, and with what implications for social life?

2. **Coproduction of Science and Policy**: How is climate science used in debates about urban governance, and with what implications for the production and circulation of environmental knowledge in political discourses? What is the nature of science-policy interactions in climate adaptations efforts, and what major factors contribute to more or less successful engagements of scientists and decision-makers?

The following section situates these specific questions about urban climate governance and sustainable water management within a broader theoretical context. While each of the appended studies provides a literature review specific to the questions and data included therein, some general (yet brief) theoretical framings common to multiple studies are provided here. First, by integrating literatures on neoliberal environmental

governance, critical state theory, and governmentality, my research on urban climate governance attempts to better understand the nature of state practice emergent in new forms of climate policy (Appendix A and B). Finally, using a brief review of science-policy studies, including how scientific information is framed by decision-makers in the making of environmental policy, my research examines how climate science is used in debates about urban governance (Appendix C) and practices of sustainable water management (Appendix D).

Literature Review

Neoliberal Environmental Governance and the State

Agrawal and Lemos (2007, 36) argue that due to an increase of neoliberal economic reforms since World War II , the state "is steadily becoming less important" for regulating environmental concerns. McCarthy and Prudham (2004, 276) define neoliberalism as "a market increasingly wide in its geographic scope, comprehensive as the governing mechanism for allocating all goods and services, and central as a metaphor for organizing and evaluating institutional performance," indicating that market-based environmental regulations (such as cap-and-trade), instead of government-led programs, have become the favored mechanisms of environmental policy. Indeed, ideas related to this "shrinking state" have permeated much of political ecology research during the past several years, resulting in a plethora of work that defines the rise of environmental "governance" and its distinctiveness from past forms of state-centered "government" (Lemos and Agrawal 2006). Recent work in political geography and state theory,

however, offers a critique of political research that posits the state as separate from society, as well as claims that the retreat of top-down, nationally-centered policies necessarily diminishes the state in contemporary forms of governance. This scholarship emphasizes the mundane practices and relations of "the state" in everyday life (Gupta 1995, Marston 2004, Painter 2006), the uneven and often incoherent spatiality of the state (Coleman 2007, Secor 2007), and how the state is constituted through complex networks of various actors and institutions (Mitchell 2002). Many researchers, furthermore, have also demonstrated that neoliberal regulations are often highly uneven and widely contested, requiring sustained observations of how and where neoliberal environmental policies play out (Bakker 2005, Mansfield 2004, McCarthy 2005, McCarthy and Prudham 2004, Robertson 2007).

Given this trajectory of research regarding neoliberal environmental governance, it is reasonable to expect that state responses and roles in negotiating complex socioecological systems, like climate change, are uneven and complex as well. My research illuminates the role of the state in environmental governance by examining how and why political spaces (both as state territories and local jurisdictions, as well as places such as county offices and city council chambers) and practices (including the everyday actions of community activists, scientist, and other state actors, rather than more spectacular displays of governance seen in large international conference of parties) have changed in the post-Kyoto era. It is here that I argue the state can be seen as an active institution in environmental governance, along with a better understanding of the

implications and possibilities for social and ecological justice that local climate programs may hold.

But, it must be noted that critical social science has also demonstrated that state power operates in diffuse ways within and among the populations over which it governs. Drawing on Foucault's (1991) notion of governmentality, Agrawal (2005) explores the idea of "environmentality," or how technologies of governance that actively engage populations in environmental management produce new "environmental subjects" that understand their environment in ways complementary to the goals of modern government. In this regard, my research examines how the emergence of new forms and techniques of environmental governance, like those utilized by the City of Seattle, are (or are not) engendering new environmental subjects surrounding climate change. Specifically, more remains to be understood about how everyday state practices of climate governance produce new environmental subjects that discipline themselves and their actions in ways pursuant to the goals of state institutions.

The State-Nature Relationship

Using examples ranging from scientific forestry to urban planning, Scott (1998) argues that the state-nature relationship is one premised upon simplification and legibility, where easily reproducible laws regarding social and ecological systems have led to disastrous and unplanned results. Scott's argument, though a critical framing of the role of nature in the state, has been critiqued for characterizing the state as somehow separate from the social and physical systems it governs (Robbins and Rice 2007). As a result, scholars

now call for an increasing level of engagement with how we theorize "the state" in governance, by examining "how the techniques, discourses, and everyday practices of environmental governance actually operate" (McCarthy 2007, 188). Drawing on the work of Mitchell (1999), this research conceptualizes the state not as an independent "container" of social relations (Taylor 2003), but as the *effect* of everyday practices of planning, information exchange, and expertise. In essence, this perspective shifts our analysis away from monolithic understandings of the state that are driven only by economic and social elites (e.g. Miliband 1969) to one of "stateness" that is "the result of complex networks of prosaic practices of making, unmaking, and remaking by actors within and outside of state institutions" (Painter 2006, 770).

Drawing on these theories, I argue that by studying the "mundane" practices of elected officials, state workers, community members, and scientific researchers we can begin to see the true nitty-gritty of what constitutes the state-nature nexus. In the case of local climate governance specifically, more needs to be understood about the everyday decisions, encounters, and practices that make up a vast network of cities adopting and implementing global climate change policy in the US, which occur outside of the large public displays or international climate meetings. It is through these intimate and everyday practices that the spaces of political action emerge and persist—in city council chambers and mayors' offices that sign the MCPA, in local sustainability conferences where government engineers learn about the effects of climate change on their communities, and through personal communications between elected officials urging each other to become part of the growing number of cities joining the MCPA.

In this regard, Bulkeley and Betsill (2003) have examined the Cities for Climate Protection program (CCP), which they argue operates through transnational networks of multi-level governance where climate mitigation information and technologies are not implemented in a top-down manner, but instead operate within and across local, regional, and global political arenas. The project proposed here builds on this research to "move beyond the framework of the international political processes within which the climate change issue is frequently discussed, to illuminate how climate protection is sought across a myriad of different sites" (Bulkeley and Moser 2007, 1). Whereas this and other work has emphasized the ways networked forms of multi-city climate governance constitute "a new sphere of authority, which is not defined or contained by reference to a particular territory" (Bulkeley 2005, 895), I conduct an in-depth case study of a single political site (Seattle) to further illuminate the specific and situated practice by which the state-nature relationship is constructed through networks of government workers, climate researchers, and other community individuals, both within and beyond the jurisdictions of individual participating cities.

Coproduction of Science and Policy

Political Ecology offers critical insights into the relationship between physical and social systems, including how environmental change is part of larger systems of production and consumption, whose knowledge "counts" in environmental regulation, and how constructed imaginaries about "nature" often have negative socioecological effects (Bryant 1992, Castree and Braun 2001, Eden 1998, Escobar 1998, Robbins 2004,

Zimmerer 1994). In the process, the production of environmental knowledge has come to be understood as "the product not merely of scientific practices, but also of research cultures and of negotiations between science and policy" (Eden 1998, 425). Science studies scholars further argue that separating political and scientific components of environmental research and regulation, though often demanded by modern institutions of governance, is a misguided approach to understanding complex environmental issues (Hess 1997, Jasanoff 1990, Latour 1987). Instead, these scholars recognize that engagements between decision-makers and research scientists are at the heart of producing environmental science and policy outcomes and norms (Forsyth 2003).

My research, by examining the various actors and organizations of municipal climate governance, looks explicitly at relationships between localized political movements and scientific understandings of climate change. In many cases, government workers and elected-officials have become *de facto* climate scientists as they discuss the issue in public and private forums. Examining how these power and knowledge networks are constructed and contested, as well as the complex web of institutions, people, and places involved, is essential for understanding how and why the state emerges as an actor in climate governance at the municipal level in the US.

But the translation of science to policy is not a straightforward process. Research has shown that barriers often exist in the integration of science and natural resource management. This includes how issues of "accessibility, credibility, understandability, relevance, and timing of research" (Pagano et al. 2001) can affect the ability of decision-makers to determine how (and what type) of climate data may be useful for managing

environmental resources. More specifically, climate scientists must be able to communicate and share information with decision-makers and planners at appropriate temporal and spatial scales for management purposes, while management agencies must have the capacity, knowledge, and willingness to appropriately incorporate scientific information into decision-making (Gamble at al. 2003). Salience, credibility, and legitimacy of scientific knowledge must also be achieved, where decision-makers evaluate the perceived usefulness, accuracy, and transparency of scientific information (Cash et al. 2003). The way that these standards are assessed by users of scientific information will greatly affect the use of that information.

To better understand how science is integrated into planning and policy, models have been developed to both assess how science is used in decision-making and improve incorporation of scientific information in resource management. Lemos and Morehouse (2005) propose an iterative model for the integration of scientific knowledge in decision-making, which explicitly recognizes that science and policy are *coproduced* through interactions of researchers, decision-makers, and the public. In the coproduction of science and policy, there is "an actual re-shaping of both groups' perceptions, behavior, and agendas that occurs as a function of their interaction" (Lemos and Morehouse 2005), leading to more integrated and sustained interactions between producers and users of scientific information. If an interactive research process is in place, useful integration of scientific information into environmental management may be achieved.

Critical Geographies of Nature and Society

Central to this research is the integration of critical social theory and human-environment interactions. Specifically, this includes an examination of how non-humans do work on social practices and how social life works to produce that which is natural. This work attempts to bring social and physical geography into closer conversation through explorations of the situated places in which humans, environments, and objects are brought into relation via environmental policy. By engaging these aspects of nature-society theory, in combination with my other more applied research on climate governance, I work to uncover how environmental policies construct both the possibilities and limitations for more just and equitable social relations.

To do this, I draw on the ontological and epistemological framings provided by the "site ontology," which requires "sustained attention to the intimate and divergent relations between bodies, objects, orders and spaces" (Marston et al 2005). This includes the ways that people and objects "hang together" through a variety of social practices that constitute wider social relations and event spaces, as well as how those processes are made more extensive through increasing connectedness of political sites. Most importantly, this research framework gives prominence to the social site, rather than the abstract institutional or scalar form of its occurrence, as the key ontological and methodological concern.

Fundamental to this line of inquiry is a discussion of the spatial ontologies which underlay the creation of environmental policy. I argue that mainstream notions of "global climate governance" are, in fact, both captive to and the product of scalar imaginaries that

presuppose a vertical scaffolding of political sites through which climate regulation should occur. What is seen in the *everyday practice* of climate governance, however, is a series of site specific and highly localized relations that constitute climate governance. Through these ontological framings, more importantly, we actually discover that there is no "global" space for climate governance, but only a series of local encounters of people and objects, collectively shaping and reshaping the discourses and regulatory mechanisms of climate change. Just as Gibson-Graham (1996 and 2006) call attention to non-capitalisms and alternative economies in the face of "global capitalism," a critical examination of the spatial ontologies and scalar imaginaries associated with climate governance opens up and legitimates new and existing spaces of political action, which may offer more viable opportunities to sustain environmental movements by focusing on their extensiveness and connectedness, rather than a constructed and contested scale of their occurrence (see Marston 2000).

Contributions of the Dissertation

As climate change produces new social and ecological conditions for urban life, my research highlights the potential opportunities and challenges for including climate mitigation and adaptation in urban sustainability programs, and the ways that science is utilized during debates about resource management. Unlike research on international and national climate policy, which frequently abstracts social and political processes to the global scale, my work focuses on the everyday (often mundane) practices of local

governments to obtain a better understanding of how environmental policies affect, and are affected by, our lived experiences and routine practices.

First, my research contributes to political geographic research on new articulations of state power—one where local governments directly engage global environmental politics. This work also challenges claims that globalized environmental concerns and the rise of neoliberal environmental policies are diminishing the capacity of governments and the importance of territorial state practice. Furthermore, this research pushes scholarship on global environmental governance to consider how climate policies are mapped onto the urban landscape and the bodies of the people who live there. Knowing how and why climate is of interest to local governments, and the potential effects that it has on urban residents, is of increasing importance as more municipalities are placing climate change at the center of their sustainability agendas.

Second, this research critically examines the relationship between climate science and policy. As much of the focus has been on the US's use of "uncertainty" science during the Bush administration, I show how different framings of science utilized in debates about urban governance in Seattle produce alternative political practices. The case study of water managers and climate scientists in the western US suggests that science and policy can be effectively integrated in adaptation efforts, though several social and political barriers do still exist in these collaborations. As climate scientists and decision-makers incorporate scientific knowledge into planning and policy, my work shows the potential benefits of such an approach, along with the major obstacles that still remain. Together, both of these contributions articulate and illustrate the relations

between the state, society, and science that are emergent in modern environmental governance.

Explanation of the Dissertation Format

This dissertation consists of five appended articles. Appendix A, entitled "Picking the Low Hanging Fruit?: State Transformation, State Practice, and Subnational Climate Governance in the United States," will be submitted to *Environment and Planning A.* This paper reports the results of a multi-city survey of municipalities that are participating in the US Mayors Climate Protection Agreement or are members of the International Council on Local Environmental Initiatives (ICLEI) in the Pacific Northwest. The research presented in this paper examines the political mechanisms being employed by cities involved in urban climate governance to meet GHG reduction goals, and claims that through local climate change programs, municipal governments are working to extend their influence over the public sector of environmental policy, though primarily in areas over which they have direct control.

Appendix B includes a paper under review at the *Annals of the Association of American Geographers* special issue on climate change, entitled "Territorializing Carbon: Governing Climate in Seattle, Washington." Using information collected during a four month residency in Seattle, this paper shows how climate comes to be the object of urban governance via the use of GHG inventories. It also demonstrates that as Seattle's government has worked to reach its climate mitigation goals, it has also begun to enroll its residents as a new type of carbon-relevant citizen in the process.

The third paper, “Climate Policy and the ‘Science Effect’: The Science of Consensus, Calculation, and Security in Seattle, Washington” (Appendix C) will be submitted to the *Transactions of the Institute of British Geographers*. This paper also reports findings from an in-depth study of Seattle’s climate programs, specifically, the ways in which climate science has been framed and utilized in the pursuit of climate policies. It is argued that although these uses of science have resulted in alternative political practices surrounding climate change than those seen in the federal government, they privilege the use of scientific inquiry and knowledge, which may preclude non-expert groups from participating in political processes. This process has also required that policy-makers and research scientists construct their work as autonomous spheres of practice, when they are, in fact, coproduced through the work of climate governance.

Appendix D, “Science and Decision-Making: Water Management and Tree Ring Data in the Western United States” (co-authored with Connie Woodhouse and Jeffrey Lukas) has been published in the *Journal of the American Water Resources Association*. Using interviews and surveys of water managers throughout the western US, this paper describes how paleoclimate data have been incorporated into water resource management and what social and institutional factors affect the process of integrating science and policy more broadly. I was responsible for the majority of the data collection and analysis associated with this manuscript, as well as 85% of the paper writing.

The following chapter provides an overview of the research methods and data collected for the five papers described here. An overview of the major findings of the research is also provided.

PRESENT STUDY

The full methods, results, and conclusions of this study are presented in the papers appended to this dissertation. The following is a summary of the three case studies included in the appendices and a summary of the most important findings in the documents.

Methods and Data Collected

This dissertation utilizes a mixed method approach that employs both qualitative and quantitative techniques. In the following sections, I describe the methods used in each of three case studies, along with an overview of the data collected. A summary of the conclusions of the research is provided in the final section of this chapter.

Study I: Survey of MCPA and ICLEI Cities in the Northwestern United States

During July and August of 2009, an online survey of local governments that are designing and implementing local climate change programs was administer via email to 88 jurisdictions throughout the Pacific Northwest region on the United States. The response rate of the survey was 33% (n=29) and full survey results are reported and analyzed in Appendix A. This region was selected for the study area based upon my experience researching local climate change programs in Seattle, Washington (described below), and the opportunity to design and implement the survey collaboratively with a Climate Protection Advisor in the City of Seattle's Office of Sustainability and the

Environment and the Pacific Northwest Regional Manager of ICLEI Local Governments for Sustainability. Both of these individuals have extensive experience working with local governments on the design and implementation of local climate mitigation programs. This collaborative effort in creating and circulating the survey ensured that the survey would be distributed to the individual primarily responsible for climate or environmental programs in each municipality (contact information was provided by collaborative partners). Furthermore, working with representatives from Seattle and ICLEI allowed me to incorporate their knowledge about local climate initiatives into the survey questions and answer choices. For the purposes of this survey, the Pacific Northwest was defined as containing: Alaska, Hawaii, Idaho, Montana, Oregon, and Washington (based upon ICLEI's region designation).

The survey utilized a combination of closed and open ended questions about why each municipality has adopted a climate-related or GHG reduction goal, what mechanisms are being used to meet emissions reduction goals, the informational resources consulted during the process, as well as the educational backgrounds of those involved in the adoption and implementation of the program. These questions (provided in Appendix G) were designed to examine state practice and power emergent in new forms of subnational climate governance. Because the survey sought information about how and why local governments choose to join climate programs, the survey was only sent to jurisdictions that are active in local climate governance. Information about why some jurisdictions choose *not* to include climate change in their environmental policies was not part of the study design. Furthermore, to maintain confidentiality, the names of

participating cities are not provided, and only summary results of city size and region are disclosed. All survey participants were required to review and accept a confidentiality agreement before completing the survey.

Study II: In-Depth Analysis of Seattle's Climate Governance

From July to September 2008, I resided in Seattle, Washington to conduct an in-depth analysis of the City's climate change programs. A follow-up research trip was also conducted for one week in April of 2009. As part of my extended residency in Seattle, I collected data regarding the historical development of the City of Seattle's interest in climate change, including who is involved, why people are interested in addressing climate at the local level, and how these ideas are communicated and shared with others in the community. Methods utilized during my time in Seattle include, interviews, observation, participation, and archival research.

Interviews: While in Seattle during 2008, I interviewed thirty-three individuals whose jobs were related the City's climate change policies or the production of information and knowledge about climate impacts and adaptation programs. Interviews were conducted with elected politicians, city and county workers, university and private researchers, and community organizations in the Seattle area (a full list of interviewees is provided in Table 1). Where possible, individuals involved in the original creation of the MCPA, and other climate-related programs were interviewed. Interview participants were identified using publically available information about city and county departments,

TABLE 1: LIST OF INTERVIEWS CONDUCTED IN SEATTLE

ID	Sex	Affiliation	Recorded
1	M	scientific researcher	Y
2	M	scientific researcher	Y
3	M	scientific researcher	Y
4	M	scientific researcher	Y
5	F	scientific researcher	Y
6	M	scientific researcher	Y
7	Group interview (1 M, 2F)	scientific researcher	Y
8	M	city worker	Y
9	M	city worker	Y
10	F	city worker	Y
11	M	city worker	Y
12	M	city worker	Y
13	F	city worker	N
14	F	city worker	Y
15	F	city worker	Y
16	F	city worker	Y
17	M	city worker	Y
18	M	city worker	N
19	F	city worker	N
20	F	county worker	Y
21	Group Interview (2 M, 2F)	county worker	Y
22	M	county worker	Y
23	M	county worker	Y
24	M	county worker	Y
25	M	county worker	Y
26	F	Non-profit environmental group	Y
27	M	Municipal Lobbying Organization	Y
28	M	Municipal Lobbying Organization	N
29	F	University of Washington	Y
30	M	Former Elected Official	Y
31	F	Former Elected Official	Y
32	F	Former Elected Official	Y
33	M	Community Activist	Y

references from interviewees, and through my affiliation with the Climate Impacts Group (CIG) at the University of Washington in Seattle.

During interviews, I utilized a semi-structured format that allowed me to "investigate complex behaviors and motivations," while also collecting "a diversity of meaning, opinion, and experiences" through one-on-one discussion (Dunn 2005, 80). A semi-structured interview format also ensured that a specific set of topics were addressed in each interview, but allowed flexibility to accommodate new topics that emerged during individual conversation. As part of the interviews and analysis, I examined how state workers and research scientists have positioned themselves in climate governance debates, what institutional and knowledge networks are formed around the issue of climate, and how individuals involved understand the relationship between their locally-based political practices and jurisdictional authority with respect to global systems of climate change. Sample interview questions utilized include: Why/How did your organization become involved in climate change regulation? What information is exchanged/utilized/involved? What personal or institutional relationships have facilitated the creation and endurance of local climate programs in Seattle?

All interviews were transcribed, coded, and analyzed using narrative and discourse analysis. Both narrative and discourse analysis are concerned with the ways in which people understand and represent life, rather than capturing "true" or "accurate" accounts of reality. Narrative analysis was utilized to determine how people "generate plausible accounts of the world" (Silverman 2003, 340). The ways in which people construct stories about their actions and activities provide insight into how they

participate in and make sense of the world. Discourse analysis draws on post-structural theories of power and knowledge to examine how individual's language and narratives both structure and reflect their understandings of world. Furthermore, discourse analysis examines the "regulatory frameworks" within which these discourses and practices are "produced, circulated, and communicated," as well as how these frameworks are maintained, altered, and reproduced through time (Waitt 2005, 165). Uncovering the creation and transformation of collective understandings in local climate governance, particularly how and why climate change has become a problem for local government, helped illuminate the shifting geographies of emergent in local climate regulation.

Because the group of individuals working on climate change mitigation and adaption in Seattle is relatively small, no information that may lead to their identification is provided here or on the appended papers. Only general references to "government workers" or "research scientists," for example, are used in writing of the research results. Maintaining strict confidentiality throughout the data collection, analysis, and dissemination stages allowed interviewees to speak openly about their experiences, without concern that their statements may be directly attributed to them.

Observation and Participation: During my time in Seattle, I also conducted observation of departmental activities within the City of Seattle's Office of Sustainability and Environment, regional research organizations, and of the activities and daily lives of Seattle residents. Observation activities included being allowed to listen and watch inter-departmental meetings in City government and attending two research presentations by scientific researchers on the impacts of climate change in the Pacific Northwest region.

During observation, I paid close attention to the interactions between individuals and organizations (including government, research, and community groups), as well as interactions internal to each organization. Observation methods allowed me to contextualize and enhance information gathered during interviews, enabling me to gain a deeper understanding of how diverse groups of individuals negotiate complex political and socio-ecological terrains.

Participation was also undertaken as part of this study. This included assisting a Seattle City worker (in the Office of Sustainability and Environment) in analyzing the results of an internal survey distributed to City departments about the impacts of climate change on their operations. As part of this effort, I provided a summary of the surveys collected that will be utilized in creating a City-wide adaptation response plan. This provided me with the opportunity to see how data are collected and decisions made within one of the City's most important departments for designing and implementing climate-related policies.

Archival Research: The collection of archives, including City of Seattle documents, memos, and other texts, was performed to provide a longer historical context of the information collected during interviews and through observation. The full text of fifteen resolutions and ordinances (dating from 1992 to 2008) was obtained from a City website, except for one resolution that was obtained from City microfilm (See Table 2). Other collected archives included notes, emails, and letters from former members of the City Council, which were made available through the City's public records office at City Hall.

TABLE 2: CLIMATE-RELATED RESOLUTIONS AND ORDINANCES IN SEATTLE

Number	Subject Matter	Date Passed	Presiding Mayor
Resolution 28546	The Crisis of Global Warming	June 8, 1992	Norman Rice
Ordinance 118597	Cities for Climate Protection Campaign	May 27, 1997	Norman Rice
Ordinance 119176	Cities for Climate Protection Campaign	October 5, 1998	Paul Schell
Ordinance 119467	Cities for Climate Protection Campaign	May 10, 1999	Paul Schell
Ordinance 119830	Cities for Climate Protection Campaign	January 10, 2000	Paul Schell
Resolution 30144	GHG Reduction Targets	April 10, 2000	Paul Schell
Ordinance 120031	Cities for Climate Protection Campaign	July 10, 2000	Paul Schell
Resolution 30256	GHG Mitigation from Electricity Generation	October 30, 2000	Paul Schell
Resolution 30316	Setting GHG Reduction Goal, GHG Inventories	July 23, 2001	Paul Schell
Resolution 30359	"No Net Emissions" from Electricity Generation	July 23, 2001	Paul Schell
Ordinance 121062	Purchase of Carbon Offsets for Electricity Generation	January 27, 2003	Greg Nickels
Resolution 30791	Payment for Carbon Offsets for Electricity Generation	August 15, 2005	Greg Nickels
Ordinance 122565	Purchase of Carbon Offsets for Electricity Generation	November 19, 2007	Greg Nickels
Ordinance 122574	Requirement for Assessing GHGs in SEPA Review	December 3, 2007	Greg Nickels
Ordinance 122876	Funding for the "Climate Action Now" Program	December 8, 2008	Greg Nickels

Study III: Water Resource Management and Climate Adaptation in the Western United States

To determine why water managers seek out tree-ring data and how it is utilized in planning efforts, both interview and survey methods were utilized. Four semi-structured

interviews were conducted with nine individuals associated with three different water utilities in Colorado during January 2008 (see Table 3). Interviews consisted of open-ended questions about how water managers incorporate tree-ring data into water management, what social and institutional barriers or challenges in using tree-ring data exist, and how satisfied people were with the climate information provided by climate scientists. Qualitative analysis was performed on the interviews to produce a general summary of each individual organization's background and use of tree-ring data and to decipher general topics or themes that occurred in multiple interviews.

TABLE 3: SUMMARY OF INTERVIEWS OF WATER PROVIDERS

Water Provider	**Number of Interviews**	**Comments**
Organization A	One group interview with three water managers/engineers	Private water utility serving a large urban area.
Organization B	One group interview with two water engineers from consulting firms and one interview with a water supply manager	City-owned water utility serving a mid-sized urban area.
Organization C	One group interview with three water managers/engineers	Publically owned water conservation district

To protect the confidentiality of interviewees, pseudonyms were used for each of the three water utilities (e.g., Organization "A"). As with the interviews conducted in Seattle, this research design allows interviewees to speak openly about their collaborations with scientists, without concern that their statements would be attributed to them or their organization.

An online survey was also administered to all individuals (n=71) that participated in one of seven technical workshops for water managers conducted by climate scientists during 2006 and 2007. Survey questions queried respondents about their professional occupation, their use of paleoclimatic information in water resources planning, and how tree-ring data have been integrated into the operations or decision making of the organizations. Appendix D reports the full reports of the survey, which had a response rate of 39%. A full list of survey questions is provided in Appendix H.

Summary of the Research

Hundreds of cities in the US have adopted new GHG reduction goals during the past several years, yet little is known about how they affect the practices of sustainable development or notions of urban citizenship. Municipalities of all types are conducting GHG emissions inventories, incorporating mitigation strategies into existing operations, and creating new community engagement programs to reach GHG reduction goals. My research shows that these local governments—through the use of GHG inventories and emissions monitoring—are producing new carbon territories as the means to incorporate climate into their sustainability policies. The creation and quantification of bounded and ordered spaces of carbon producing activities enables local governments to regulate, administer, and monitor policies on climate change. These practices work to engender changes in the behaviors of residents to reach GHG reduction goals through the making of carbon-relevant citizens. Though these climate-related programs are executed through some of the most mundane and routine aspects of urban governance, such as

transportation planning and urban development, they are becoming central mechanisms by which local governments expand their influence within the public sector of environmental policy and over the everyday practices of urban residents. I also argue that the proximity (and familiarity) of these programs to people's everyday lives may provide new opportunities for participatory governance or the contestation of neoliberal environmental policies.

At the same time that local governments are working to create effective climate mitigation and adaptation policies, urban resource managers are creating new planning practices to address the potential impacts of climate change on water resources. My research examines how and why water managers seek out and utilize new forms of scientific information in planning for climate change, and the effect that this has on the practice of sustainable resource management. This research shows that climate science and policy exist not as separate spheres of knowledge and practice, but are co-produced as scientists and decision-makers work to collectively define environmental problems and the information necessary to address them. As urban water managers and climate scientists work together, the practices of both science and policy are transformed, in ways that may have the potential to improve science-policy engagements. These decision-making communities, however, are often limited to small number of government workers and scientific experts, showing that much work remains to make these processes more inclusive and democratic than they currently tend to be.

Though specific findings are presented in each of the five appended research papers, three general themes can be deciphered from the research as a whole. These include:

1. Cities are key sites of government action on climate change. Despite a lack of action by the federal government in the US, municipal governments throughout the country have begun to design and implement climate mitigation and adaptation programs, without any mandate to do so. Though the political mechanisms utilized in these efforts are some of the most mundane of municipal governance, they allow local governments to reaffirm, and in some cases expand, their influence within the public sector of urban development.

2. Carbon is the political currency of local climate change programs. Through the creation of GHG inventories and the construction of carbon-relevant citizens, climate has become the object of urban environmental governance. The creation of carbon territories allows local governments to directly engage the "global" arena of climate politics, showing that state institutions are an active and important aspect of contemporary climate governance.

3. Climate science is utilized in complex and contradictory ways in climate mitigation and adaptation programs. Despite the widely publicized use of "uncertainty" in science during the Bush administration, other framings of science

have been constructed during the same time as a means to justify action on climate change. Similarly, water managers in the western US have begun to incorporate paleoclimate data into water resources planning and to assess the reliability of water supplies. In both cases, the use of science has advanced political action on climate change, but the reliance and privilege of scientific discourses may preclude other 'non-expert' communities from participating in the debate. This also demonstrates the "science effect," where the practices of science and the state are constructed as separate and distinct, when they are, in fact, coproduced through the practices of climate governance.

These broad themes are found throughout the five appended papers. Each of the appended papers discusses its specific the theoretical framework and empirical findings in detail.

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APPENDIX A. PICKING THE LOW HANGING FRUIT?: STATE TRANSFORMATION, STATE PRACTICE, AND SUBNATIONAL CLIMATE GOVERNANCE IN THE UNITED STATES

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Abstract: Subnational climate change programs—particularly at the city and county level in the United States—have become increasingly prevalent during the past several years. Two of the most widely adopted programs by local governments include the U.S. Mayors Climate Protection Agreement (nearly 1,000 U.S. cities have signed on) and the Cities for Climate Protection Agreement (with more than 1,000 local jurisdictions worldwide). While much of the existing literature on government participation in local climate programs has focused on institutional barriers to action and socio-ecological motivators for participation, this paper examines the expressions of state power embedded in the emergence of these programs. Integrating literatures on state transformation and urban governance, everyday state practices, and neoliberal environmental policy, this paper argues that local governments have become key sites of state power related to climate change. Furthermore, these programs are doing much more than "picking the low hanging fruit" of environmental policy, but rather, they represent new articulations of state practice aimed at the expansion of state capacity, though primarily within the public sector of environmental policy.

Introduction

In February 2005, amidst staunch denial about the urgency of climate change at the national level in the United States, Seattle Mayor, Greg Nickels, announced that his city would voluntary meet Kyoto Protocol targets of reducing greenhouse gases (GHGs) 7% below 1990 levels by 2012. Mayor Nickels also urged other local governments to take action on climate change by creating the U.S. Mayors Climate Protection Agreement (MCPA), where participating cities "strive to meet or beat the Kyoto Protocol targets in their own communities" using land use regulations, environmental policies, and community engagement programs (U.S. Conference of Mayors 2009). As of August 2009, more than 969 cities, whose populations represent more than 85 million U.S. citizens, have adopted the agreement. Other programs have also been created to engage local governments in climate action, such as the Cities for Climate Protection Program (CCP) with 1,179 participating jurisdictions from more than 30 countries worldwide.[1] MCPA signatories and CCP participants—which come from all states, consist of large and small cities, and include jurisdictions with both Democratic and Republican leadership—are drawing sharp contrast to the lack of action by the federal government in the U.S. during the Bush administration. Even as President Obama is working to pass federal cap-and-trade legislation and other climate-related programs to reverse the position of Bush-era climate politics, the question remains, why do local governments that are not required to calculate, monitor, or reduce GHGs, choose to do so?

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1 The CCP was created by the International Council on Local Environmental Initiatives (ICLEI) in 1993 (ICLEI 2009a).

This paper examines this question in the context of changing geographies of state power and the everyday political mechanisms frequently utilized to achieve government control. Importantly, local climate change programs are often characterized as grabbing the "low hanging fruit" of climate policy—those political changes which come with the least resistance and can be easily incorporated into exiting goals and policies (Slocum 2004). [2] Furthermore, cities that do implement local climate change policies are often thought of acting outside of their own best interests because the full range of the causes and consequences of climate change exist far beyond any one local government's control (Engel and Saleska 2005). While these assertions capture some aspects of local climate governance, this paper argues that there is also value in taking a more nuanced view of nature of state practice in contemporary environmental governance. In programs like the MCPA, networks of local governments, rather than nationally-centered regulations, have become the primary facilitators of state-led climate regulation in the U.S. Municipalities participating in climate policy do not fit a traditional model of governance—one where action cascades between international, national, and local scales of governance in a hierarchical fashion (Bulkely 2005). Instead, they directly engage what is often considered a "global" political arena via locally situated policies and actors. While these programs have achieved increased notoriety in public policy circles during the past several years, researchers have only begun to unravel how and why local governments become sites of political action related to climate. Furthermore, little is known about the actual expressions of formal state power that make up sub-national climate programs and

2 This expression was used during interviews with several city workers and non-profit organizations to express the idea that many GHG reducing activities are easily implemented by local governments.

the technologies of government that are most frequently implemented to reach their stated goals.

Using survey data collected from city and county governments about how and why they have adopted climate-related programs, the aforementioned aspects of state practice in local climate governance are further explored here. This includes how climate change programs are incorporated into government operations, the degree to which the inclusion of climate in local governance does or does not transform state functions, and the types of the political mechanisms that are utilized in climate protection programs. It is argued that locally-based climate programs represent new articulations of state power, ones where local governments are reaffirming, and in some cases expanding, their influence within the public sector of environmental governance. At the same time, however, the contradiction of such an approach is that these "public" programs are necessarily aimed at individual involvement and personal choice related to GHG reduction activities, rather than large scale reforms through urban development. These findings suggest that local climate governance does not represent fundamental challenges for urban capital, and indeed, may be intended to facilitate it.

This study is situated within debates about state transformation, state practice, and neoliberal environmental governance. A brief review of these topics is therefore provided in the next section, followed by a discussion of the survey method. Then, a results section discusses how and why local governments design and implement climate change policies, and the paper concludes with a discussion of the implications of the survey findings for how we understand the nature of state practice in subnational climate governance.

State Transformations: Neoliberal Environmental Governance and the City

Globalization and neoliberalism—two of the most ubiquitous, yet contentious, concepts in contemporary social science—have redefined the ways environmental governance has been understood and examined during the past several decades. The rise of transnational networks of people and places, along with a growing emphasis on global environmental concerns, has propelled state institutions into a global arena of political action (Biermann and Dingwerth 2004, Shaw 1997). At the same time, an increase in market-based environmental policies and a decrease in state-centered environmental management have meant that states are no longer the primary institutions of environmental management (Agrawal and Lemos 2007). A general consensus has emerged that these policies have qualitatively (and perhaps quantitatively) transformed state spaces and institutions, but far less agreement has been achieved on exactly how. Similarly, scholars have examined the rise of neoliberal environmental governance, but have only begun to consider its emergence within the context of shifting geographies of state practice emergent in new forms of urban governance.

Brenner (2004, 2) argues that urban regions have become the "key sites of contemporary state institutional and spatial restructuring" since the 1970s. In contrast to scholars that claim globalization is weakening state institutions, particularly at the national level, Brenner claims that the state has been fundamentally transformed by globalized forms of capital and capitalist development. Rather than a "hollowing out" (Jessop 2002) of national state power in the face of increased economic and social integration worldwide, scalar hierarchies of governance are being reworked into new

configurations of state institutions operating within and between subnational, national, and international scales of governance. Like Agnew's notion of the "territorial trap" (1994), Brenner's formulation of a "rescaled" statehood calls into serious question persistent fetishizations of national territories as the primary foundation of state spatiality and practice. Moreover, this rescaling of state institutions works to "*intensify* [uneven geographical development] through the deployment of urban locational policies designed to strengthen the place-specific socioeconomic assets of strategic, globally linked city-regions" (Brenner 2004, 16 emphasis in original), reinforcing the dialect of territorializing and deterritorializing effects of global capitalist development on state spaces.

Other scholars of state theory, however, have called into question the existence of a coherent and autonomous institution, "the state," that exists in opposition and separation from "society." Rather, Mitchell (1999, 83) argues that this separation of state and society is "a line drawn internally, within the network of institutional mechanisms through which a certain social and political order is maintained." The appearance of a unified state structure (drawing on Foucault 1991), Mitchell argues, is actually the "effect" of the everyday functions of disciplining and ordering populations. These functions—the heart of state practice—include the "mundane processes of spatial organization, temporal arrangement, functional specification, supervision and surveillance, and representation" (Mitchell 1999, 95). An examination of this "prosaic" or "everyday" state (Painter 2006), rather than that of more spectacular state practices, sheds light on the ways that state power is constituted by everyday social relations and practice.

The most fundamental and influential expressions of state power are, indeed, perhaps those that we notice the least.

When considered along with Brenner's "rescaling" of the state, Mitchell's analysis of the "state effect" suggests that the key to understanding state practice and spatiality is to uncover *where and how* the everyday bureaucratic ordering of nature and society take place, in relation to the territorial dialectics of urban capitalist development. In the case of climate governance, for example, the causes and consequences of climate change, along with the potential contradictions for urban development, are being negotiated in city halls, council chambers, court rooms, and local government planning departments. Globalized environmental concerns related to climate change have become locally situated problems for state institutions and local governments. But why has this come to be? In the absence of federal regulations in the U.S. on climate change, why have local governments stepped up to the regulatory plate?

Perhaps the answer lies in the nature of neoliberal environmental governance. At the same time that cities have become key sites of governance, state institutions have become caught in a web of market-based reforms to regulation. While the contents and meaning of "neoliberalism" have been vigorously debated (e.g. Peck and Tickel 2002), neoliberal environmental governance has come to mean the ways that extending "the reach of commodity circulation [relies] on the re-working of environmental governance and on entrenching the commodification of nature" (Heynen et al. 2007, 3). From the enclosure of many of the worlds common resources such as fisheries and wildlife (Mansfield 2007, Robbins and Luginbuhl 2007) to the commodification of wetlands and

carbon capturing trees (Robertson 2004, Bumpus and Liverman 2008), it is increasingly the role of markets and capital to determine where and how natural resources and amenities are created, sustained, and distributed. Nature-society relations, more broadly, have been reworked by neoliberalism to include public and private divisions, commodified and valued forms of nature, and market-based notions of environmental justice during the past several decades.

The deep irony of neoliberal environmental governance, however, is that at the same time that these processes replace government institutions with those of the market, the marketization of governance becomes increasingly reliant on the state to create and reinforce the conditions necessary for private regulations. Peluso (2007, 89) argues that this contradiction "requires some nuance in how states are understood." The "*destructively creative* social order" of neoliberalism (Peck and Tickell 2007, 33, emphasis in original) is to undo those state functions that impede capitalist development, and to replace them with new state functions that help to expand and consolidate market-led regulatory mechanisms. As such, neoliberalism does not dismantle the state, but instead, it reconfigures it. "Entrepreneurial cities" (Hall and Hubbard 1996), competing for a piece of the economic development pie, are at the heart of these negotiations between state, society, market, and the environment.

Exploring New Articulations of State Practice: The Question of Local Climate Governance

Climate governance, like other forms of environmental regulation, has been examined in the context of these emerging and expanding neoliberal policies. Bailey (2007, 440), for example, has shown that the European Union's emissions trading scheme reconfigures the spatial and scalar implementation of environmental policies by "intensifying and producing new patterns of interaction between supranational, national and non-state actors." Rather than simply setting aside state institutions in favor of market-based emissions trading schemes, governments have become increasingly important in negotiating and facilitating the new carbon economy (Bailey and Maresh 2009). Similarly, Bumpus and Liverman (2008, 145) show that carbon offsets "may be seen as a case of neoliberal environmental governance in which the management of an environmental problem is partly devolved to the market and to the individual, but in which the state eventually establishes the rules under which markets operate." As a result, the ways that local governments enable or constrain capitalist development, protect ecological goods and services, distribute environmental externalities, and privatize access to common resources, sets the stage for the limitations and potentialities of neoliberal environmental governance.

When it comes to the politics of subnational climate governance specifically, we are not without a starting place. Several studies have attempted to uncover how and why local governments adopt climate-related policies. Zahran et al. (2008) use statistical modeling and GIS mapping to determine what sociospatial factors explain participation

patterns in the CCP. They find that communities with high risks associated with climate change (e.g. coastal communities or areas with high incidences of extreme weather events), low climate stress (e.g. lower levels of carbon emissions per capita, less carbon intensive industries), and high opportunity (e.g. number of environmental organizations and percent of population college educated) are the most likely to participate in the CCP. Pitt and Randolph (2009) also show that significant institutional, organizational, and methodological barriers exist in climate protection planning at the local level, such as insufficient data for emissions inventories or a lack of funding and expertise to implement programs. These obstacles demonstrate that even as some communities feel the push to address climate change at the local, still other factors may inhibit full success. Where these studies highlight the motivations and barriers for local climate action, the survey presented here examines the technologies of government utilized to reduce GHGs in the communities that choose to adopt climate programs.

With respect to the nature of state practice in local climate governance, Aall et al. (2007) classify local action on climate policy into six categories, which range from "business as usual," where actions related to climate do little to change actual urban environmental regulation, to local climate programs that employ "sticks and carrots" to curb CO_2 emissions. The general characterization of much of this literature is that local governments are "picking the low hanging fruit" by implementing climate-related policies that do not fundamentally change the nature of urban environmental governance. Less is known, however, about whether these practices and policies represent a

fundamental change in state power or spatiality. What is the relationship between new approaches to climate governance and the state practices necessary to facilitate them?

Given that networks of local governments have been shown to be legitimate aspects of global climate governance, it is essential that we understand the ways that state institutions voluntarily impose climate regulations on themselves. Does the emergence of these programs signal a fundamental shift in state-society or state-market relations, or are states working to reinforce capitalist development via climate governance? How are spaces of authority defined and created by local governments, and with what effect on urban governance? Is there the potential that these programs may challenge or transform the neoliberalzation of contemporary environmental governance, or do they further entrench dominant interest within the urban landscape? The following section provides an empirical examination of these questions, followed by a discussion of the results.

Research Objectives and Methodology

To uncover the nature of state practice and power emergent in new forms of subnational climate governance, a survey of local governments that are voluntarily designing and implementing climate change programs was conducted during July and August 2009. Given the framework specified regarding state transformations and neoliberal environmental governance in the preceding sections, three objectives guide this research and analysis:

1. **Determine if the emergence of subnational climate programs affect the nature of state practice at the local level in the United States.** Do local governments require new state capacity or authority to implement climate change programs? How do local governments incorporate climate change into the regulatory practices of urban governance?

2. **Examine the expressions of state power emergent in subnational climate governance.** Who or what are the targets for local climate change programs, and how are they selected? What are the potential implications of these choices?

3. **Examine the potentiality of these movements to challenge (or rework) neoliberal governance.** To what degree do new practices of climate governance by local governments challenge citizens, firms, and capital to modify existing practices within the wider carbon economy?

Using an online survey program, a questionnaire was distributed (via email) to 88 jurisdictions that are currently participating in local climate change programs throughout the Northwestern US.[3] The survey was designed and distributed in collaboration with a representative of the Northwest division of the International Council for Local Environmental Initiatives (ICLEI) and the City of Seattle's Climate Protection Advisor.

3 The Northwestern US was selected as the study area based on the author's experience working in the Seattle region and the researcher's relationships with regional collaborators that could provide her with appropriate contact information for local governments.

Because of this collaborative effort, questions and answer choices reflect and incorporate existing knowledge from ICLEI and the City of Seattle about local climate initiatives, based on their extensive interaction with local governments that are working to address climate change. The survey was designed to elicit information about how and why local governments choose to join climate programs, and as such, the survey was only sent to jurisdictions that are active in local climate governance. The survey was not designed to provide information about why some jurisdictions choose not to include climate change in their environmental policies.

Email recipients and addresses were obtained from ICLEI and the City of Seattle's databases, ensuring that the survey would be sent to the individual primarily responsible for environmental and/or climate initiatives in each jurisdiction. The entire population of survey recipients included all cities and counties in the Northwest that are ICLEI members or signatories of the MCPA. Using ICLEI's Northwest regional designation, the survey recipients included jurisdictions from six states: Alaska (n=8), Hawaii (n=5), Idaho (n=10), Montana (n=3), Oregon (n=16), and Washington (n=46). Of the 88 total jurisdictions, 33 jurisdictions were both ICLEI members and MCPA signatories, 26 were ICLEI members only, and 29 were signatories of the MCPA only.

The full survey included 16 questions, but only 10 that were directly relevant for this research. The other 6 questions elicited information relevant to ICLEI and the City of Seattle's organizational operations. Of the 10 questions discussed here, three asked for information about the background of the respondent, one question asked about the frequency with which the respondent utilized different types of climate and GHG

emissions data, one question required that the respondent rank a series of statement in order of importance about why the jurisdiction had joined ICLEI and/or the MCPA, and five questions asked about climate-related actions occurring within the jurisdiction.

After filtering out four surveys with incomplete responses, the response rate for the survey was 33% (n=29). The completed surveys do represent a range of jurisdictions and demographics. Table 1 shows the characteristics of respondents by jurisdiction type, population size, and MCPA signatory status.

Table 1: Profile of Jurisdictions that Responded to Survey

City	79%
County	21%
Population with over 100,000 (“large jurisdiction”)	38%
Population between 10,000 and 100,000 (“mid-sized jurisdiction”)	38%
Population under 10,000 (“small jurisdiction”)	24%
Jurisdictions that have signed the MCPA	66%
Jurisdictions that have not signed the MCPA (ICLEI members only)	34%

Responses from the entire population of survey respondents provide a general description of how and why local governments are designing and implementing policies related to climate mitigation and adaptation. Three sections of survey results follow, including: 1) how climate change is incorporated into local government, 2) what local governments are doing to reach their GHG reduction goals, and 3) why local governments choose to adopt climate-related policies.

Results I: How is climate change incorporated into local government?

Of primary importance for understanding the nature of state practice embedded in local climate governance is obtaining information about how cities and counties formalize their climate-related goals, who is responsible for their design and implementation, and what types of information are consulted during the process. Knowing more about how climate change is incorporated into local government practice also illuminates that ways that state institutions exert power over the urban landscape, along with the forms of expertise needed to do so.

In response to "How has your jurisdiction formalized its climate-related actions and/or policies," more than half of all cities have adopted a GHG reduction goal (52%) (See Table 2). Approximately one-third have adopted a climate action plan (32%), included language related to climate change in their comprehensive plan (36%), or required an energy efficiency component in their comprehensive plan (28%). These findings indicate that increasingly formalized standards and regulations, via adopted ordinances and resolutions, are being utilized by local governments to engage in GHG mitigation activities. Only a small percentage of jurisdictions have created a climate adaptation plan (8%), showing that mitigation is still the primary focus of the work local governments are currently doing.

Table 2: How Jurisdictions Have Formalized Their Climate-Related Actions or Policies
(Respondents could select more than one answer)

Adopted a Climate Action Plan	32%
Created a Climate Adaptation Plan	8%
Adopted a GHG Reduction Goal	**52%**
Included Language Related to Climate in our Comprehensive Plan	36%
An Energy Efficiency Component in our Comprehensive Plan	28%
None of the Above	16%

With respect to GHG emissions, respondents were also asked if they have conducted a GHG inventory, and if so, if the extent (i.e. operational boundaries) of the inventory is for government operations, the community at large, or both (see Table 3). Half of all jurisdiction have conducted a GHG inventory for *both* government operations and the community at large, showing that many local governments are assessing their emissions at the full scale of their jurisdiction, not just those areas directly related to government activities. Another 21% have conducted a GHG inventory, but only for government buildings, vehicles, and operations, while 29% of local governments have not yet completed an emissions inventory. The responses to this question show that *counting carbon*—that is, knowing the extent of a local government's contribution to global atmospheric GHGs—does represent an important aspect of state knowledge and practice in subnational climate governance. To the extent that most local governments would not have collected or calculated information related to GHG before adopting local climate change programs and GHG reduction goals, new forms of knowledge about and monitoring of GHGs are likely needed within the majority of local governments surveyed.

Table 3: Responses to "Has your government conducted a GHG inventory?"

We have conducted an inventory for government operations AND the community at large	**50%**
We have conducted an inventory for government operations ONLY	21%
We have conducted an inventory for the community ONLY	0%
We have not yet completed an inventory	29%

Data were also collected on what types of information is being used in the design and creation of climate-related programs and policies (Table 4). Respondents were asked how often they consulted a variety of types of information—ranging from highly scientific data to government and non-governmental data sources. Though very few respondents indicated that they "frequently" consult scientific information (7%), a total of 81% of respondents said that they "rarely" or "sometime" consult scientific papers about climate change (such as peer reviewed journal articles or Intergovernmental Panel on Climate Change (IPCC) Reports). Similarly, local governments appear to be utilizing other sources of scientific information at an even higher rate, where a total of 69% of jurisdictions "sometimes" or "frequently" consult secondary sources of scientific information (such as newspaper and websites). Only 27% of respondents, however, "sometimes" or "frequently" have discussions with research scientists or environmental experts in their area.

Federal government information about GHG are most often "rarely" (45%) or "sometimes" (41%) consulted by local governments, while state and regional government information about emissions and impacts were generally consulted "sometimes" (57%) or "frequently" (21%). Overwhelmingly, the most frequently utilized information was that provided by non-for-profit groups, where 97% of jurisdictions "sometimes" or "frequently" consult that information.

Table 4: Frequency that Jurisdictions Consult different Forms of Information

	Never	Rarely (1-4 times a year)	Sometimes (monthly or by-monthly)	Frequently (multiple times a month)
Scientific research papers about climate change (e.g. IPCC reports or peer-reviewed academic journal articles).	14%	**45%**	35%	7%
Secondary sources that summarize scientific reports on climate change (e.g. newspaper, magazine articles and web resources).	10%	21%	**38%**	31%
Discussions (in person, phone, email) with research scientists or environmental experts within my own government or regional research centers/universities.	24%	**48%**	24%	3%
Federal government sources about greenhouse gas emissions and trends (e.g. Department of Energy or Environmental Protection Agency sources).	0%	**45%**	41%	14%
State and regional government resources about climate change impacts or emissions (e.g. Department of Ecology).	11%	11%	**57%**	21%
Information provided by not-for-profit groups (e.g. US Conference of Mayors or ICLEI)	0%	3%	45%	**52%**

These responses indicate that primary and secondary sources of scientific information are relevant to local governments, and perhaps are being incorporated in the design and implementation of local climate programs, though it is primarily through written reports rather than one-on-one discussions with actual scientists. Again, the range of information being utilized by local governments, including scientific information and government resources, suggests that local jurisdictions do seek out new forms of information related to climate. As such, some new forms of expertise are associated with these climate programs, but as indicated above, this knowledge is being used to

implement a wide range of regulatory mechanisms through many already existing government departments.

The educational background of respondents (see Table 5), however, indicates that there is a great deal of variation in the formal training and educational specializations of individuals facilitating local government action on climate change. The highest percentage of respondents have a background in public policy or government (27%), while 15% of respondents have background in each of city planning, physical science, and liberal arts/social science. Other areas of educational training include architecture, educations, business, law, and the arts.

Table 5: Educational Background

City Planning	15%
Public Policy / Government	**27%**
Architecture	4%
Physical Science	15%
Liberal Arts / Social Science	15%
Education	4%
Business	12%
Humanities	0%
Engineering	0%
Law	4%
Arts	4%

"Other" responses included: "Environmental Planner" (n=1), "Environment" (n=1) Sustainable Development (n=1), Accounting (n=1), and Economics (n=1)

Furthermore, responses to the question "What is your job title?" (Table 6) indicate that the highest percentage of jurisdictions (38%) have individuals within a department responsible for environmental activities in charge of climate programs, followed by

planning and development departments (21%). Only a very small percentage (7%) of communities implementing climate-related programs are doing so through individuals specifically charged with “climate change” responsibilities.

Table 6: Responses to “What is your job title?”

General Area of Job Title	Responses
Elected Official / City Administrator	14%
Environment / Energy / Sustainability	**38%**
Planning / Development / Public Works	21%
Special Projects	10%
Climate Change	7%
Other	10%

Note: respondents were asked to provide their job title.
Responses were then aggregated into the above categories.

These findings gathered from Tables 3 though 6 suggests that there is not one particular knowledge community or technically trained group of individuals dominating the design and implementation of local climate initiatives, but rather, a wide range of perspectives are involved in the process. So too, these initiatives are being folded into the activities of environmental protection, planning, and administrative departments, even as new types of information about GHG are being collected and monitored in many local governments. The high proportion of positive responses to a variety of environmental policy mechanisms suggests that there is considerable action to formalize climate goals at the local level, but it is occurring through several currently available regulatory options (i.e. inventories, standards, commitments). At the same time, measuring and quantifying carbon emissions does appear to be a central aspect of much of local government action on climate change, showing that some new activities and operations are likely to accompany these regulatory methods. It is important to note, moreover, that what is

included in a GHG inventory and how a jurisdiction's activities are attributed to the official jurisdiction boundary, can vary widely between local governments. While there are many inventorying tools and protocols, such as ICLEI Local Government GHG Protocol Project, there is no universal standard or requirement for how GHG inventories are conducted by local governments at this time. Despite these potential barriers or sources of confusion, local governments are moving forward in determining their GHG emissions and adopting new environmental policies to reduce them.

Results II: What are local governments doing related to climate?

To obtain a better picture of what regulatory mechanisms local governments are using to reach GHG reductions goals, and the specific technologies of government embedded in the adoption of these climate programs, respondents were also asked about specific transportation, urban design, and government operation activities that they currently (or plan to) implement in their community to meet climate-related commitments (Tables 7 through 9). These questions were designed to find out how local governments plan to meet their greenhouse gas reductions goals and other climate-related targets.

Table 7 shows that the most popular GHG reduction mechanisms in the transportation sector are those related to increasing walking and biking as a form of alternative transportation. Specifically, 76% of jurisdictions are making improvements to pedestrian paths and sidewalks, and 72% of jurisdictions are increasing or improving bike routes. Still, a majority of jurisdictions (55%) are working to increase public transportation routes, while 46% of respondents indicated that they are working to

increase driving efficiency, using measures such as traffic light timing. Only a fifth of cities are implementing more aggressive road pricing policies, suggesting that only a few cities have begun to use economic disincentives (i.e. "sticks") for drivers to reduce trips or miles traveled. Furthermore, these findings suggest that the focus of transportation programs to reduce GHGs is on changing individual transportation behaviors (i.e. providing more public transportation options to get people out of their cars), rather than sending new pricing signals about the cost of automobile travel.

Table 7: Responses to "Which of the following transportation programs are you currently (or expect will be) incorporated into your jurisdiction's climate-related policies?"

Increasing public transit routes or options (light rail, streetcar, etc.)	**55%**
Increasing or improving bike-friendly routes or dedicated bike paths	**72%**
Improving pedestrian paths or sidewalks	**76%**
Implementing driving or parking charges (e.g. "road pricing")	21%
Implementing driving efficiency measures (e.g. traffic light timing)	46%

Note: In Tables 6 through 8 responses that received more than 50% positive rate are highlighted

With respect to the built environment and urban development (Table 8), the survey shows that local governments are overwhelmingly targeting *government* buildings for energy efficiency upgrades, and more specifically, *new* government buildings. 71% of local governments are requiring efficiency standards for new government buildings and 52% of jurisdictions that are requiring upgrades for existing government buildings. Local governments are also making changes to existing building codes to encourage more compact development (64%), but whether these requirements are compulsory in nature is not known from this survey. Finally, less than one-third of jurisdictions are requiring

efficiency standard in *new private* buildings (32%) and only 37% are requiring more green space in urban design. These findings indicating that most of the GHG reducing mechanisms for urban development are targeted at government buildings—or more specifically, items over which local governments have direct control.

Table 8: Responses to "Which of the following urban design / neighborhood development programs are you currently (or expect will be) incorporated into your jurisdiction's climate-related policies?"

Requiring efficiency (or green) standards for CURRENT GOVERNMENT buildings	**52%**
Requiring efficiency (or green) standards for NEW GOVERNMENT buildings	**71%**
Requiring efficiency (or green) standards for NEW PRIVATE buildings	32%
Revising or changing building codes to encourage more compact buildings and/or developments	**64%**
Revising or changing jurisdiction codes to require more green space and/or urban forest cover	37%

Table 9 shows responses to a question about possible government operations and programs that jurisdictions are implementing to reduce GHGs. Three-quarters of respondents have created programs that increase the amount of alternative fuels being used in city vehicle fleets (75%), but less than half of all jurisdictions (43%) have begun offering alternative sources of energy to their residents. Additionally, many jurisdictions are creating new programs aimed at involving the wider community and other levels of government in climate-related efforts, which includes 66% of jurisdictions that have or are in the process of creating community action programs and 50% of jurisdictions that actively lobby other levels of government for actions or funds related to climate change. There has been less engagement of the business community by local governments, however, as only 35% of respondents are specifically providing incentives for businesses to reduce their GHGs. Perhaps most surprisingly, more than one-third (41%) of

responding jurisdictions are purchasing voluntary offsets to reduce their GHGs and 50% have begun to assess and plan for potential climate impacts within the community. Again, results here suggest that many of the jurisdictions are implementing changes in areas over which they have direct and complete control (i.e. city vehicle fleets and alternative energy sources), but far less regulatory methods include those that extend into private economic development.

Table 9: Responses to "Which of the following programs related to government operations programs are you currently (or expect will be) incorporated into your jurisdiction's climate-related policies?"

Implementing fuel efficiency or alternative fuels programs for city/county vehicle fleets	**75%**
Offering alternative energy sources to electric utility customers	43%
Assessing and/or creating a community-wide response to predicted climate impacts	**50%**
Creating new community action programs to engage local residents in actions to reduce GHGs	**66%**
Providing incentives to the business community to reduce their GHGs	35%
Purchasing voluntary offsets to reduce our jurisdiction's carbon footprint	41%
Lobbying other government agencies and/or levels of government for actions/funds related to climate change.	**50%**

Results III: Why do jurisdictions implement climate change mitigation and/or adaptation programs?

The survey was also designed to find out more about why local governments voluntarily implement climate policies and GHG reduction goals, without any mandate to do so. To determine motivations for local government action, a series of five statements about why the respondent's jurisdiction has joined a local climate change program were provided, and the respondent was then asked to rank their importance from least to most (See Table 10). The statements were created and selected based on available literature *and* knowledge about local government participation in ICLEI and the MCPA from the ICLEI

and City of Seattle collaborators. Additionally, having respondents rank the statements, rather than state a level of agreement, was based on previous experience where survey respondents "strongly agreed" or "agreed" with all statements provided. Forcing respondents to rank the statements allows for a relative comparison of the "most" and "least" motivating factors. Furthermore, respondents were able to mark the statement as "not applicable" if they did not feel it was a reason for their jurisdiction's involvement in local climate change programs.

Though there is considerable variation across the ranking of the five statements, some general trends do emerge. With the highest proportion of "Most Important" rankings (48%), the statement "There is strong consensus about the causes and consequences of climate change in the scientific community, so we are showing leadership on this issue by taking action at the local level" is the primary motivation for local government action. The second two most important motivating factors were economic, having to do with cost savings associated with GHG reducing activities and the ability of communities to market themselves as "climate-friendly" or "green." Conversely, with the highest percentage of "Least Important" rankings (42%), the statement "Federal regulation on climate change is inevitable, and implementing greenhouse gas reduction programs now, in advance of legislation, will provide our jurisdiction with an advantage when this legislation is passed" was shown to be little of a motivating factor. The impact of climate change on government operations or service delivery (such as the ability for cities to provide adequate water supplies) was shown to be moderately important, but no one ranked this statement as the "most important"

reason. Only one respondent indicated that one of the responses was “not applicable,” supporting the claim that all of these reasons are motivating factors to local governments.

Table 10: Responses to “Please rank the following five statements about why your jurisdiction is implementing (or working to implement) climate change mitigation and/or adaptation programs in order of importance (1 = most important, 5 = least important, using each number only once).”

	1 (Most Important)	2	3	4	5 (Least Important)	NA
We are implementing climate-related policies because the impacts of climate change are affecting (or will affect) our government operations and our ability to deliver services to our residents.	0%	26%	30%	**33%**	11%	0%
Reducing our community’s greenhouse gas emissions makes economic sense. The cost of inaction far exceeds the cost of action.	15%	**42%**	19%	15%	8%	0%
Implementing climate change policies will help our community remain competitive in urban development as we market our City/County as "green" or "climate-friendly."	**25%**	21%	17%	17%	17%	4%
There is strong consensus about the causes and consequences of climate change in the scientific community, so we are showing leadership on this issue by taking action at the local level.	**48%**	14%	10%	14%	14%	0%
Federal regulation on climate change is inevitable. Implementing greenhouse gas reduction programs now, in advance of legislation, will provide our jurisdiction with an advantage when this legislation is passed.	10%	7%	28%	14%	**41%**	0%

Overall, responses to the question about why local governments choose to implement climate-related programs, suggests that local governments understand climate science to be in a relative state of “consensus.” Rather than seeing climate science as a barrier to action, local governments actually see it is a motivating factor for taking action. Furthermore, this often comes from a sense of frustration about inaction at other levels of government, prompting local governments to take action themselves as a form of “leadership.” As is seen in other environmental programs (energy efficiency standards,

for example), actions related to reducing GHGs are also framed in economic terms. Attracting development as a "green" community or saving money by reducing GHGs (i.e. better energy efficiency) costs ranks high among motivating factors for local governments. Fear of federal regulations, however, and to a lesser degree worries about service delivery due to climate impacts, are not currently the most important reasons for adopting local climate initiatives. These findings suggest that local governments are taking a "go at it alone" approach, motivated by economic interests and ethical concerns, more than fears of compulsory regulations or disruptions in city services. As such, local government action takes more of a "grass roots" configuration, than that of a heavy "top-down" type of governing.

A Harvest of Low Hanging Fruit: State Power and State Capacity in Subnational Climate Governance

The imprint of neoliberal environmental governance, including the transformation of urban areas as key sites of state practice, resonates loudly with the emergence of subnational climate governance. State restructuring and neoliberal practices related to climate have been firmly mapped on to the urban landscape, and ultimately, the infrastructure that supports it and the bodies within it. The survey findings presented in this paper suggest that local governments are reaffirming and expanding their reach into the everyday functions of urban governance (i.e. transportation, land use, development) as part of local climate programs, based on notions of an inactive federal government, scientific consensus about climate change, and the benefits of "green" development. The

survey presented here shows that more than 70% of all local governments that responded to the survey have conducted some type of greenhouse gas inventory, and that more than half of all jurisdictions have adopted a GHG reduction goal.

Moreover, the targets of these programs are largely those over which local governments have direct control (i.e. alternative fuels in city vehicle fleets and energy efficiency standards for government buildings), rather than those that directly engage and challenge urban capital development. This work is being done by utilizing already existing regulatory mechanisms and departmental functions that work through citizen's individual behaviors and choices, rather than compulsory regulations on firms and capital. There is also evidence that some governments are starting to engage the wider community through outreach programs, interactions with other levels of government, and regulations encouraging green development and more walking or biking within the community. Less than a third of cities, however, have begun to implement more compulsory regulations on individuals and businesses, such as road pricing or energy efficiency requirements for private buildings.

Overwhelmingly, this analysis indicates that local governments have become primary sites of climate governance and negotiation of the state-nature nexus related to carbon management. An examination of these "transformations" of state power—where state responsibilities for climate governance are being assumed by local governments via a variety of regulatory mechanisms available to them—shows that climate programs and policies are being folded in to already existing departments and practices of the local state. Transportation choices, building codes, sustainability departments, and city vehicle

fleets have become the mechanisms by which cities and counties are attempting to reach GHG reduction goals.

Through the process of incorporating climate change into the everyday operations of urban governance, local governments have substantially increased their capacity and reach related to climate change. Though these activities for which local governments have long been responsible (i.e. transportation and urban design), it is the centralization of these action around issues of climate change that facilitates a re-articulation of state power. The results of this survey demonstrate that climate governance can (and does) occur outside of national and international agreements, where a lack of federal action has created distinct "policy room" for state and local governments to step in (Rabe 2007). Increasingly, "global" environmental problems like climate change, once thought to demand a correspondingly top-down "global" environmental solution, are being addressed by other means of governing within and between formal state institutions.

It is important to note, however, that these expressions of state power are occurring primarily within the *public sector* of urban governance, and very few local governments have expanded their reach into the private sector. As local governments have increased their involvement in transportation and community development, these programs will increasingly require that *individuals adopt new behaviors for their success*. As local governments reduce GHGs in areas over which they have control, they will increasingly have to rely on the choices of private citizens and industry to continue to meet their goals. This is evident, moreover, in the finding that two-thirds of the local jurisdictions surveyed stated that they are creating community outreach programs,

compared to only 35% of communities that are doing the same within the private sector (Table 8). The everyday state, it seems, is simultaneously reasserting state functions in relation to climate change, and running into the ultimate limitations of neoliberal governance. The reality that local climate programs have not significantly challenged economic development or private consumption points to the inevitable limitations of the "green capital" approach to environmental protection and justice. As local governments claim that scientific consensus requires action and leadership from government institutions, it is still framed within the parameters of a neoliberal urban landscape.

This expansion of state capacity and increased penetration into the everyday lives of residents through the formalization of climate related goals and policies, manifests itself in the most routine and mundane of everyday life. While state institutions have taken advantage of the opportunity to reassert, and often extend, their influence over public domains of environmental governance in the name of climate mitigation, it is in ways that are ever more familiar and accessible to everyday people. Transportation planning and urban development resonate with the lived experiences of community residents, perhaps providing a new pathway into public participation in government authority and climate governance. As state spaces are being restructured and state practices reorganized, it is essential to remember that "space is simultaneously an object of contestation and part and parcel of political strategy" (Leitner et al. 2007, 19), meaning that the proximity of these programs to everyday life may provide new opportunities for contestation of neoliberal governance. As Miller (2007, 224) states "downscaling decision making to the municipal scale and below bring decision making close to the

level of everyday life-world institutions such as schools and neighborhoods, has the potential to stimulate citizen participation."

In sum, this survey shows that state power *is* being transformed by the emergence of local climate action, as local governments are reaffirming and increasing their capacity to influence "public" aspects of GHG producing activities. This is ultimately bound up within the need for private citizens to change their behaviors, showing the contradictory nature of neoliberal governance where a decrease in "command and control" regulations on corporations has resulted in the need for individuals to take action on their behalf. Perhaps most importantly for our understanding of the state in neoliberal environment governance is that the harvest of low hanging fruit, local governments have found, is certainly ripe for the picking.

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APPENDIX B: CLIMATE, CARBON, AND TERRITORY: GREENHOUSE GAS MITIGATION IN SEATTLE, WASHINGTON

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Abstract: Hundreds of local governments in the United States have adopted greenhouse gas (GHG) reduction goals during the past several years, requiring critical examinations of the role of the state in climate governance and the effects of these programs on urban citizenship. Using a study of Seattle, Washington, a city at the forefront of implementing climate regulations through formal government institutions, this article examines how and why climate is incorporated into local environmental policy. By deliberately connecting the causes and consequences of global climate change to the local community, Seattle has been able to use climate as a conceptual resource for urban environmental policy via the climatization of the urban environment. Furthermore, a key mechanism for making climate governable in Seattle is the carbonization of urban governance, where a relationship between the production of GHG emissions and specific urban activities is established through the use of carbon inventories and emissions monitoring. These practices facilitate the act of territorialization, where material natures and state institutions are co-constituted through the production of carbon territories. A key effect of these practices is that Seattle has begun to enroll its residents as a new type of carbon-relevant citizen in the regulation of global climate, while also reaffirming its ability to regulate infrastructural design, commercial activities, and community development. These findings are discussed with respect to their implications for how we

understand state practice in climate governance, as well as the relationship between “the state” and “nature” in environmental politics.

Key words: *climate governance, state practice, territorialization, urban environment*

During the past several years in the United States, something of a revolution has quietly taken place in climate governance. Many regions, states, and cities have forged ahead of the federal government by designing and implementing their own climate regulations, including greenhouse gas (GHG) reduction targets (Lutsey and Sperling 2008). Increasingly, some of these sub-national mitigation programs can claim great successes. The City of Seattle, Washington for example, has achieved an 11percent reduction in per capita GHG emissions for 2005 relative to 1990 levels (City of Seattle 2007). This begs the question, why are some city governments inventorying carbon emissions and setting GHG reductions goals without being mandated to do so? Furthermore, how is climate incorporated into urban environmental policy, and with what implications for social life and the role of the state in climate governance?

Using an in-depth study of Seattle's climate mitigation efforts, I argue that through the *territorialization* of carbon—the active creation and quantification of bounded and ordered spaces of carbon producing activities, and simultaneous reproduction of local government jurisdictional capacities—Seattle is able to regulate, administer, and monitor policies on climate change. Using GHG inventories that attribute portions of the global carbon cycle to its local jurisdiction, Seattle exercises state power through territorial claims to material natures (i.e. GHGs) that do not necessarily reside within its boundaries, while also reconstituting and reaffirming the City's governmental boundaries and functions. This has resulted in a new logic of environmental governance centered on the creation of carbon-relevant citizens (i.e. environmental subjects) who are enrolled in the process of governing global climate. I outline and describe this process as

occurring through three stages, including the *climatization* of the urban environment, the *carbonization* of urban governance, and the *territorializtion* of carbon in Seattle. In an era when many environmental issues are viewed as problems that reach far beyond the capacities of individual state institutions, government programs like the one in Seattle are demanding new examinations about the relationship between state territories and material natures emergent in climate governance.

Theoretical Framings: The Nature of the State in Climate Governance

The diversity of perspectives on how to understand and investigate political strategies related to climate change in current scholarship are drawing attention to the difficulty of theorizing modern state practice in relation to material natures. Because of the character of climate change, an environmental problem whose consequences are not confined to the same spaces as their causes, it is often argued that climate change challenges the capacities of states to protect their citizens due to increased interdependence of nation-states in mitigating emissions (Biermann and Dingwerth 2004). Political geographers, furthermore, have examined the ways that many state functions predicated on the importance of territory and sovereignty are (or are not) being challenged by the intensification of economic and social globalization and the rise of environmental concerns that cross territorial boundaries (e.g. Brenner 2004, Elden 2005).

In places like Seattle, however, local governments are asserting themselves as active institutions in the making of climate policy, despite neoliberal reforms that have favored market-led environmental regulations during the past several decades. Drawing

on formulations of “the state” that emphasize the mundane practices and relations of the state in everyday life (Marston 2004, Painter 2006) and the uneven and complex spatiality of the state (Coleman 2007, Secor 2007), it becomes evident that state power is expressed in diverse ways through many sites of governance, even in the execution of neoliberal policies. These theoretical orientations suggest that a more nuanced look at state practice, particularly as it occurs through the most routine and everyday activities of local governments, may shed light on the state-nature relationship being forged through new sub-national climate change programs.

In their discussion of the state-nature relationship, Whitehead, Jones, and Jones (2007) show that the physical environment is brought into relation with modern state institutions through a two-fold process: 1) the *centralization* of knowledge about nature using technologies of government that standardize, simplify, and abstract forms of nature, and 2) the *territorialization* of nature where legible and bounded spaces are utilized in the regulation and administration of state policies related to the environment. A central aspect of this state-nature relation is what Scott (1998) calls “state projects of legibility and simplification,” where complex natures are made legible to state institutions using several techniques, including mapping of territories and standardization of measures. Stripple (2008) has further argued that states work to “border” climate change though a series of territorializing discourses about allocations of GHG reductions targets and accounting of carbon sinks among national territories, drawing a firm link between statecraft, territoriality, and climate change in environmental policy.

In this regard, Betsill and Bulkeley (2006, 152) have argued about the Cities for Climate Protection Program, that "political power and authority not only lie within nation-states, but can accrue to transnational networks operating through a different form of territoriality," suggesting that subnational climate programs are reframing (and perhaps, reclaiming) state practices that are often attributed to national governments as they engage with climate policy. Furthermore, in an effort to illustrate the relationship between municipal climate programs, state institutions, and climate change, some scholars argue that the rise of sub-national actors in climate regulation exemplifies the creation of new forms of "multi-level governance," where action on climate change occurs within and between international, national, regional, and local scales of authority (Bulkeley and Betsill 2006).

Importantly, this growing body of literature on local climate governance points to the diversity of actors and sites through which climate mitigation is occurring (Bulkeley and Moser 2007), the complex (and non-hierarchical) scalar associations of multiple levels of governments produced as "local" institutions engage the "global" political arena of climate mitigation (Bulkeley 2005) and how local governments create climate-related policies through complex negotiations with various interests groups, non-human actants, and their citizens (Rutland and Aylett 2008). Building on this body of research that critically opens up what constitutes global climate governance, and how climate policies and willing citizens are constructed through political discourse and practice, this paper attempts to more explicitly illustrate the relationship between the state and material nature (i.e. climate change) embedded in these accounts. This includes the specific and

contingent relationship between the state and carbon that is embedded in territorial practices of the state, and the ways that these state practices provide the impetus for engaging urban citizens in mitigation efforts. While existing literature on local climate governance destabilizes widely-held notions that national territories are (and should be) the primary mechanism by which climate is governed, specific illustrations of the territorial practices that are occurring in these sub-national climate programs are still needed. This paper provides an explicit account of the relationship between climate and territory, as it has become articulated around carbon molecules and the creation of GHG inventories in Seattle.

Moreover, whereas increasing amounts of work shows the importance of "framing" climate issues in terms of local co-benefits around economic advantages and public health (e.g. Koehn 2008), and the type of communities involved in climate mitigation (e.g. Zahran et al. 2008), scholars are only beginning to elucidate the wider role of the state in governing climate. As action federal action on climate change has been stalled in the US, local governments have been able to take advantage of this "policy room" (Rabe 2007) to use climate-related policies as a mechanism for garnering support for a wide variety of urban policies, indicating that climate change programs provide a unique opportunity for local governments to pursue and achieve diverse goals at the local level.

But Agrawal (2005), drawing on the work of Michel Foucault, has also shown that expressions of state power related to the environment are often accompanied by the internalization of state objectives by citizen subjects. That is, a central part of state power

is the making of *environmental subjects* that come to care for the environment in ways complementary to the goals of modern government. In an examination of the governmentality of Portland's climate policies, Rutland and Aylett (2008, 631) argue that "when individuals come to view themselves and their goals according to the same metrics as the state, and base their actions on these metrics, they become part of the network of self-regulating actors that is at the heart of the practice of governmentality." Given this connection between climate policy and individual action, it becomes important, particularly in the context of emerging climate institutions, to better understand how spaces of political authority are organized and controlled through everyday (often mundane and routine) state practices and subject formation related to collection of information and regulation of the physical environment. The remainder of this article explores these issues using the case study of Seattle's climate governance.

Governing Climate in Seattle, Washington

To explain how and why Seattle includes climate as part of its urban governance strategies, and the effect that this has on the City's residents, I argue that climate has come to be the target of urban governance in Seattle via a three-fold process. First, the urban environment is *climatized*—that is, environmental policy in the city of Seattle has become centrally organized around issues related to the causes and consequences of climate change, making climate a key conceptual resource in environmental management. Second, urban governance must be *carbonized,* where all aspects of local government work are made carbon-relevant through the use of GHG accounting tools. Carbon, as part

of geographically inventoried emissions of GHGs that are created by activities that fall within the City's jurisdictional influence, becomes a governable aspect of the environment. Finally, carbon is *territorialized*—such that the authority of Seattle's government to address myriad social and environmental concerns is by virtue of its defined and delineated spaces of carbon production and responsibility, which serves to simultaneously reproduce Seattle's jurisdictional borders and authority. This tripartite set of conceptualizations has allowed Seattle's government to reaffirm its ability to regulate infrastructural design, commercial activities, and neighborhood development through formal and informal regulatory means that act directly on the City's citizens and enroll them in the process of mitigation. Though these transformations have been divided into three stages for the purpose of this analysis, they do occur concurrently and are intimately connected. These findings are based on a two-year study of the role of the state in Seattle's municipal climate action, where information was collected via archival research, sustained observation of city activities, and interviews with city workers during 2007 and 2008.

The Climatization of Seattle's Urban Environment

Through a gradual, yet deliberate, process of formal and informal political action during the past two decades, Seattle's urban environment has become centered on issues of climate change. Global climate change—its causes, consequences, and solutions—has become ever more local in Seattle, while local action on climate change has become more global in its political relevance. The process first began in 1992, with the passage of

Resolution 28546, where the city "recognize[ed] the crisis of global warming…its effects upon our region, and urg[ed] the United States government to adopt measures designed to reduce emissions which contribute to global warming." [1] At a time when environmental issues like global climate change were firmly the domain of national and international communities, Seattle was working to link this global issue to the local community.

Five years later, Ordinance 118579 (adopted in May 1997) allowed for Seattle's participation in the Cities for Climate Protection (CCP) Campaign, where the Seattle's electricity provider, Seattle City Light (SCL) would accept $43,000 from the International Council for Local Environmental Initiatives (ICLEI) to develop a local action plan to conduct a GHG audit and set a GHG reduction target for the utility. Seattle renewed its participation in the CCP program four more times (1998, 1999, and twice in 2000), for a total of $101,000 in additional funding from ICLEI. Each time, the ordinances make reference to the ways Seattle is attempting to "incorporate global climate change issues into City planning and educational efforts," again making formal links between local activities and global climate change, while also asserting that the solutions for climate mitigation lie within local government and community actions, rather than solely the national or international sphere. The City's partnership with ICLEI proved to be important in the making of Seattle's climate policies, including how and why the City's climate programs became framed in terms of energy production.

In July of 2001, Seattle committed to the "long-range goal of stabilizing atmospheric concentrations of greenhouse gases," (Resolution 30316) including reduction of the City's GHGs by 7-40% below 1990 levels by 2010. This resolution also

claims that "many of the critical components of a local action plan for climate protection are already in place or under development in Seattle," directly linking many aspects of Seattle's existing urban landscape, such as the built environment and urban forests, to climate change. The resolution also requires that Seattle's Office of Sustainability and Environment (OSE) coordinate the City's GHG reduction initiatives, including defining and conducting a GHG inventory, developing and coordinating a plan to reduce GHG, and assessing available projects and policies for meeting GHG reduction goals. A former elected official, who played a key role in implementing many of these early climate resolutions, provided the following statement about why she wanted to address climate change at the local level in Seattle: [2]

> "…I care a lot about our human impacts on the environment, and global climate change in particular, and wanting local governments to be a model. At that time it was very frustrating what was happening at the national level… so that's what motivated me. And I also felt as though we needed to create more livable cities too…And that is from solid waste, transportation, to climate change."

This statement shows that the motivation for local action on climate change in Seattle came from at least two places, 1) a desire to show leadership to the federal government and other cities on the issue of climate change, and 2) the need to develop a narrative about environmental policy through which several other urban programs could be organized.

More recently, the climatization of Seattle has taken place at an extraordinary rate under the administration of Mayor Greg Nickels (2001-2009), including the creation of a Green Ribbon Commission to provide expert and community opinions on the creation and implementation of the City's Climate Action Plan, along with the formalization of

climate change positions within the OSE. Since putting climate change at the center of his environmental agenda, which occurred after recognition in late 2004 that climate change could have a dramatic effect of the City's water supplies (Grist 2005), Nickels targeted specific sectors for climate mitigation, including transportation emissions and energy efficiency. These areas are now central components of the City's Climate Action Plan, and climate is the central concern of the City's environmental programs. As a City worker stated:

> "Before local action on global warming was … one of the many things that we were working on. Now, it's like our number one priority and we're allocating something like seventy percent of our overall resources to it. Climate change disruption and the local response thereto has become the organizing principle or the framework for sustainable development work in the city and in my office."

Climate has become a discursive, conceptual, and material resource for municipal action in a variety of areas in Seattle, and an organizing principal in the execution of urban environmental governance. The City's green building program, for example, has become a central feature of Seattle's action plan to meet its GHG reductions goals, and GHG emissions are considered when evaluating transportation options in Seattle. The impetus for climatizing the urban environment in Seattle comes from the desire to show leadership on the issue to other governments, the ability of local climate programs to serve as an umbrella for several other urban issues (e.g. transportation planning and energy conservation), and fear of failure in providing key urban services to its residents because of the impacts of climate change (e.g. reliable water supplies). These efforts have also proven to be a unique opportunity for Seattle to reaffirm and rearticulate local

government capacity in a variety of areas, as the solutions for global climate change are shown to exist within local environmental governance.

The Carbonization of Urban Governance

Using standards for city operations to meet GHG reductions internally, while also creating extensive carbon and GHG inventories for the wider community, nearly all aspects of urban governance in Seattle have become geographically defined and quantitatively tallied in terms of carbon (or more generally GHG) emissions and reduction potential. Nearly all elements of traditional city work and life—providing transportation options, overseeing community development, and supplying services and utilities—have been made carbon-relevant during the past decade in Seattle.

In 2000, Seattle adopted the "Earth Day" Resolution (30144), which required that SCL provide electricity with "no net greenhouse gas emissions." This meant that emissions from portions of Seattle's power supply (the Klamath Falls Project) and other operational activities (such as SCL automobiles and buildings) had to be mitigated through the use of conservation efforts, and where mitigation was not possible, the City would purchase carbon offsets. The City estimated that 272,727 tons of CO^2 would need to be offset annually at a cost of $1.4 million a year (Resolution 30256). Using offset project guidelines (Resolution 30359) several projects have allowed the SCL to reach its goal of being a "climate neutral," such as allowing cruise ships to plug into Seattle's shore power supply at port, rather than burning diesel fuel (Port of Seattle 2005). Because the City of Seattle's power supply is 90% hydropower—an energy supply with virtually

no GHG emissions—achieving climate neutrality has been easier for Seattle than many other cities that rely more heavily on carbon-based electricity. The "no net emissions" policy did, however, formally recognize the role that government plays in environmental protection related to climate change through their everyday operations, service delivery, and regulatory authorities.

As part of its Climate Action Plan to reach the City's GHG reduction goals,[3] the City has formally quantified and geographically accounted for its carbon emissions through the use of GHG inventories. Deciding what is included in a carbon inventory requires that the City actively define its carbon jurisdiction because much GHG related activity can cross the defined boundaries (e.g. an airport located inside city boundaries that serves several regional jurisdictions), or can be attributed to different spatial extents that those of the defined community (e.g. electricity production or waste disposal for a city that actually occurs outside city limits), (City of Seattle 2007). As one City employee said about Seattle's community GHG inventory:

> "The carbon foot-printing process for a geographic area as small as even a city is extremely complex. We spent a lot of time on that. We engaged the Green Ribbon Commission very deeply in making a lot of those policy judgment calls that go into defining your bubble and what's in and what's out..."

The inventorying and monitoring process requires that Seattle collect and assess a significant amount of information about City activities in terms of their carbon emissions. Seattle has been keeping track of data related to energy use for decades (e.g. the City keeps records on energy usage), but much of these data are now assessed in new ways to make them relevant for tracking GHG inventories (e.g. energy use now used as a measure

of GHG emissions). In the process of designing and implementing these carbon-related policies, Seattle has worked to construct climate as an object of urban governance via subjective emissions accounting strategies and complex negotiations with various interest groups in Seattle, which are neither objective nor inevitable (see also Rutland and Aylett 2008).

Together, these ordinances and resolutions related to GHG reduction, offsetting, and inventorying have allowed climate to become a governable aspect of the urban environment in Seattle. In the process, nearly all aspects of Seattle's urban environment have become *carbon relevant*, forming the basis for environmental policy within the City of Seattle and a fundamental aspect of the Seattle's wider forms of urban governance. This first began with efforts to make Seattle's electricity provider "carbon neutral," which required precise accounting of GHG emissions for energy production, and subsequently spread to other areas of urban governance, including land use and transportation planning. The importance of Seattle's carbonizing activities, particularly as they have emerged within and spread beyond the energy sector, is that GHG inventories allow the City to examine and monitor activities over which they have direct control (i.e. energy production) *and* those activities over which they do not directly control (i.e. people's transportation choices). This phenomenon sets the stage for Seattle's attempts to engage its local residents in climate policy, which is discussed in detail in the following section.

Territorializing Carbon in Seattle, Washington

Through the use of GHG inventories and centralization of local environmental policies around issues of climate change, Seattle has constructed political authority related to the climate through the territorialization of carbon. GHG molecules, though part of the global atmosphere, are assigned to Seattle's jurisdiction by spatially referencing them to transportation, energy production and consumption, and other GHG producing activities that occur within the City. Though it may seem that climate change represents an unterritorializable form of material nature because once emitted, emissions become part of a globally mixed atmosphere, the City of Seattle has created new strategies for incorporating GHGs into its territory. This analysis suggests that a re-articulation of territorialization with respect to climate change is occurring in Seattle, one that is not concerned with defining a territorially-based "inside" and "outside," but with the attribution of material nature to specific places and activities that are within the boundaries of state institutions.

Because of the territorialization of carbon, Seattle has been able to reassert, and in many ways recast, its ability to regulate infrastructural aspects of the city (i.e. transportation structures) and social and economic practices (i.e. urban development). This process is fundamental to understanding how state power is exerted over diverse physical landscapes and social practices. Notably, this characterization of climate governance also illustrates the ways that state practices and material natures are *co-constituted* via territorializing actions of the local state. As climate is made governable by assigning GHGs to the local community, and the material nature of climate is rendered

visible to state institutions via carbon governance, Seattle also reproduces its jurisdictional borders and governing capacity. As the problem of climate change becomes increasingly important in discourses of environmental security, carbon represents the key relation between the state and nature emergent in new government programs related to climate.

Importantly, however, this territorialization of carbon has facilitated, indeed *required,* that Seattle develop strategies to engage citizens in the effort to reduce GHGs. As a city worker stated:

> "… there's just the cold hard facts and the cold hard numbers which say that as a city government we have reduced our climate pollution 60 % since 1990. That's huge, but we are not going to get there unless people start taking action. The reality is we as a city have stood up and said we're going to do this thing…we can't do it without the community…we can't literally push people onto the bus…we are going to have to rely on some of those behavioral changes…."

To meet their GHG reduction goals the city *must* motivate its residents. This is not easy task, however, and requires that the local government develop a suite of strategies to influence what have now been deemed carbon-related activities of the wider community. Seattle has created a series of programs to engage various areas of urban activity, targeted at individuals, neighborhoods, and businesses, and their corresponding spaces of carbon responsibility. Seattle "Climate Action Now" is a community outreach program that helps residents understand and reduce their carbon footprints through home-based energy conservation programs, disseminates of information on climate change, and encourages residents to utilize alternative forms of transportation. The Neighborhood Climate Protection Fund allows neighborhoods to apply for small grants to execute

climate related activities and projects in their own neighborhoods, and the Seattle Climate Partnership has been created to engage businesses by providing resources for local companies to assess and reduce their GHG emissions.

All of these programs, based on the ability of the City to regulate climate through the territorialization of global carbon, are creating a new form of carbon governmentality, where individuals are expected take on the responsibilities themselves of reducing their carbon footprint in accordance with the goals of the state. Get on a bus, turn down your thermostat, ride your bike to work—*be a good carbon citizen*. In Seattle, this effort is predicated upon distinct and historically contingent territorial practices occurring via carbon and through the local state. While some scholarship characterizes climate change as having the potential to dramatically undermine the capacity of governments to protect their citizens, this analysis suggests that states are actively working to manage the challenges of climate change through both territorial and bio-political means, which rely on individual action to address climate change, rather than larger structural changes in capitalist development (see also Grove *forthcoming*). The question emerges, as states increase their capacity to govern climate via territorial practices that have been executed by governments for centuries, do they run the risk of simply reproducing the socio-economic conditions that enabled the problem of climate change to occur in the first place?

Carbon Territories: The Everyday State and the Logic of Urban Governance

An examination of how the Seattle has made climate governable reveals that it is through *carbon* that climate can be made relevant to the practices of the state. The production of carbon territories and territorial ordering of climate via carbon is a central way that states can exercise political power related to climate. Whereas other scholarship on local climate governance has destabilized the primacy of hierarchical forms of environmental governance centered on national and international governments, this paper further elucidates the ways that local government institutions work to incorporate GHGs into territorial state practices, and are themselves, reproduced in the process. Furthermore, as carbon territories enable governments to define and reduce their GHG emissions, urban citizens are necessarily enrolled in the process as carbon-relevant individuals who are expected to reduce their individual carbon footprints. Through these territorial practices frequently attributed to the nation-state, local governments are constructing new claims regarding who has the political authority to regulate GHG emissions, and where state practices related to climate change can and should play out.

Furthermore, throughout the City of Seattle, climate and carbon are becoming the centralizing concept of urban environmental governance. Carbon matches the territorial logic of the state, precisely because it is measurable and quantifiable. The policies and practices related to the territorialization of carbon require increasing quantification, measurement, and verification of carbon-related activities, as Seattle moves from a "sustainability" paradigm of urban environmental governance to a climate-centered one. This ability to make climate legible, via the carbonization of urban governance, is

perhaps why climate change is beginning to replace the concept of sustainability that has been so elusive in urban environmental governance for the past several decades. Though the actual practices of urban governance (i.e. transportation and land-use planning) have not changed significantly, the ways they are framed and evaluated are now *territorially relevant* and *globally significant.*

This analysis of the role of the state in climate governance also complements other research that claims that the state is still an important aspect of neoliberal environmental governance (e.g. Mansfield 2007), rather than a lame duck or shrinking institution. There is distinct room for state governments to take action related to climate, which is often in the most mundane of state activities—transportation, building codes, neighborhood development—rather than that of highly visible national and international agreements. With respect to climate governance, the state does not simply control and regulate material natures that happen to reside within state borders—the materiality of GHGs does not allow for it. Instead, the state actively produces a discourse about the materiality of climate as being referenced to carbon producing activities in its jurisdiction that make it governable. As the state begins to reach the limits of its coercive power in climate mitigation (activities it can directly control), it works to achieve the consent of its residents to help accomplish its goals through programs that encourage residents to change their behavior. Most importantly, we see that making climate compatible with state practice through the creation of carbon territories also sets the stage for the making of willing citizens in the fight against global warming. In the process, however, it seems increasingly likely that state interventions in climate mitigation, which rely on the

engagement of individuals to reach climate-related goals via territorially defined authority, may be reproducing the same political practices under which the problem of climate change was permitted to proliferate in the first place.

Notes

[1] Full text of Seattle's Ordinances and Resolutions is at: http://clerk.ci.seattle.wa.us/~public/cbory.htm

[2] Names and affiliations are not provided with interview quotes to maintain confidentiality of interviewees. Quotes are from interviews with city workers whose jobs are directly related to the design and/or implementation of Seattle's Climate Action Plan or other climate-related initiatives.

[3] The City's GHG reduction goals are 7% below 1990 levels by 2012, 30% below 1990 by 2024, and 80% below 1990 by 2050.

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APPENDIX C: CLIMATE POLICY AND THE 'SCIENCE EFFECT': THE SCIENCE OF CONSENSUS, CALCULATION, AND SECURITY IN SEATTLE, WASHINGTON

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Abstract

This paper examines the use of climate science in debates about urban governance to better understand the relationship between environmental knowledge and political action surrounding climate change. Though claims about uncertainty in scientific inquiry on climate change were used to preclude action at the federal level in the United States during the Bush administration, several other discourses of science have proliferated at other sites in the US during the same time. Using a case study of the City of Seattle, one of the first cities in the US to design and implement a greenhouse gas reduction goal, this paper identifies and examines three other scientifically-based discourses on climate change that underlie climate policy. These include a science of *consensus*, a science of *calculation*, and a science of *security*. A discussion of the discursive features, key policy elements, and motivating factors are provided for each of the three characterizations of climate science utilized in Seattle's urban environmental policy. In each case, scientific objectivity and formal expertise remain a key feature of the relationship between science and policy, giving rise to the "science effect," where political practice and scientific inquiry are made to appear separate, when, indeed, they intimately connected and co-produced.

Introduction: Uncertainty Science and the Federal Government in the US

In his now infamous decision to withdraw the United States from the Kyoto Protocol shortly after taking office in 2001, then president, George W. Bush, refused to implement national greenhouse gas (GHG) regulations due to a lack of scientific understanding about the magnitude or scope of climate change. References to scientific uncertainties pepper Bush's public comments on climate change, including those in the following passage from a June 11, 2001 speech:

> "We do not know how much effect natural fluctuations in climate may have had on warming. We do not know how much our climate could, or will change in the future. We do not know how fast change will occur, or even how some of our actions could impact it. For example, our useful efforts to reduce sulfur emissions may have actually increased warming, because sulfate particles reflect sunlight, bouncing it back into space. And, finally, no one can say with any certainty what constitutes a dangerous level of warming, and therefore what level must be avoided."
>
> (George W. Bush, Quoted in Lind and Tamas 2007, p. 101)

This discourse about *uncertainty* in science, in combination with the assertion that GHG mitigation would overburden the US economy, is the hallmark of Bush-era climate politics and a legacy of international proportions that still follows the US today. Furthermore, it serves as an important and highly visible reminder that scientific information is frequently politicized in ways that scientists may have never intended.

But climate science has been utilized in much more diverse ways than is suggested by a look at the federal government in the US during the Bush administration. The City of Seattle, for example, has been using climate science as justification for their GHG reduction goals and as an informational resource to better understand the impacts that climate change may have upon the region. Yet, surprisingly little scholarship has

systematically examined scientific debates about climate change occurring outside of the federal government in the US. Geographers have yet to identify and interrogate the forms of knowledge that underlie the diversity of claims to "know" various aspects of climate change—the atmosphere, carbon emissions, adaptation and impacts—that are integrated into urban-scale debates on climate change. Beneath the shadow of high profile science-policy engagements in the national arena of climate politics in the US, other government institutions have been creating and circulating their own systems of knowledge about climate change for more than a decade.

This paper examines Seattle government's emergent and diverse utilizations of climate-related science in debates about urban climate governance from the 1990s to present. Since the City of Seattle first recognized the importance of climate change for environmental and economic health in 1992, to more recent attempts to formalize greenhouse gas (GHG) mitigation procedures in 2007, Seattle has evoked and utilized climate science in at least three ways. These framings of scientific information include a science of *consensus*, a science of *calculation*, and a science of *security*, each of which are described and reviewed within the context of current scholarship on critical science-policy studies. All three of these scientific discourses, and the political practices they engender, have been central mechanisms in shaping Seattle's urban environmental policy, which is now centered on climate mitigation and adaptation efforts. Furthermore, these discursive framings rely heavily on a widely-held understanding that scientific inquiry can produce verifiable and reproducible information about the world. The result, therefore, is the "science effect," where the practices of science and the state are

constructed as separate and distinct, when they are, in fact, coproduced through the practices of climate governance in Seattle. To illustrate these findings, the following sections include an overview of social science perspectives on knowledge and policy, a presentation of the Seattle case study methods and results, and a discussion of the "science effect" that these interactions of science and decision-making help to produce.

Scientific Knowledge, Environmental Policy, and Climate Change

Geographers and other social scientists have firmly established the link between scientific knowledge (both 'expert' and 'non-expert'), political practice, and environmental outcomes (Bryant and Bailey 1997, Forsyth 2003, Robbins 2004, Zimmerer and Bassett 2003). Practices of scientific inquiry and the making of environmental policy are intimately connected in matrix of knowledge and practice that are enmeshed in complex power relations. As Sally Eden (1998) states, environmental knowledge is "the product not merely of scientific practices but also of research cultures and negotiations between science and policy, between science and its publics and between claims to authority," showing that many individuals and institutions engage in the practice of making environmental discourses. The result, therefore, is that knowledge claims about the physical environment, particularly as they are employed through policy discourses, are never truly neutral. Even where science seeks to uncover "facts" about the physical environment, the knowledge it produces is disseminated and deployed in a socio-political context.

Nowhere is the relationship between scientific knowledge and political practice more contentious than in the politics of climate change. As climate mitigation and adaptation become increasingly important in global environmental governance, the proliferation of political discourses about the science of climate is remarkable. From the scientific claims of the Intergovernmental Panel on Climate Change (IPCC 2007) that "warming of the climate system is unequivocal" to the US Chamber of Commerce's request to have the US Environmental Protection Agency hold a "trial" about the science of global warming (Tankersley 2009), many institutions and organizations are working to shape the ways that climate change science is understood and the range of political actions that may (or may not) be implemented to address climate change. This includes debates about the type of political mechanism needed to reduce GHGs (regulations, markets, etc.), the level at which climate policies should be implemented (international, national, subnational), and the targets and standards most appropriate to reach desired goals (GHG reduction goals and monitoring).

But, the politics of climate change knowledge are complex. Research has shown that US media stories on climate change include more coverage of climate skeptics than countries such as Germany (Grundmann 2007), for example, and that balanced reporting practices in the US contribute significantly to misunderstandings about IPCC consensus science among US residents (Boykoff 2008). This suggests that increased exposure to minority views about the science of climate change in the US has likely influenced public and policy opinions about climate change. Blennow and Persson (2009), furthermore, find that the strength of a person's belief in climate change and adaptive capacity greatly

influenced their willingness to implement climate adaptation measures, indicating that personal opinions of climate change, in addition to government policies, have the potential to influences actions related to climate change. Even where decision-makers have worked to integrate climate science into management practices, there is increasing evidence that "better science" does not always lead to more effective resource planning (Tribbia and Moser 2008). These studies illustrate that people's understandings of climate change science are negotiated in multiple spaces (from the home to the nation's capital) and through multiple sources (from media coverage to personal action). The socio-political context of how and where environmental knowledge is consumed, it seems, is as important as the practice of scientific inquiry itself.

Coproduction of Science and Policy, Green Governmentality, and the "Science Effect"

More recently, these complex and varied interactions between science and policy have led many scholars to see scientific inquiry and political practice as *coproduced*. Rather than existing as separate spheres of practice, where information between science and policy is delivered in a linear fashion, the coproduction model claims that "knowledge making is incorporated into governance, and governance influences the making and use of knowledge" (Chilvers and Evans 2009, 355). This approach goes beyond an examination of how science is "politicized," to an examination of how "science and politics co-evolve dynamically" (Forsyth 2003, 104). This has become particularly relevant as political and scientific agendas related to climate change are increasingly intertwined. Given the unique challenges of climate governance, a critical approach to

science-policy studies that recognizes the complex relationship between knowledge and action is needed to produce accurate reflections of what is occurring, as well as potential avenues for appropriate solutions.

Furthermore, the notion of *green governmentality* has become a central aspect of critical science-policy studies and a framework for analyzing the relations of scientific discourses and political outcomes. Broadly defined as they condition by which "the modern administrative state, mega science and big business….[are central to] the administration of life itself—individuals, population and the natural environment" (Backstrand and Lovebrand 2006, 54), green governmentality draws attention to the relationship between modern state practice, knowledge production, and individual conduct. This work extends Michel Foucault's (1991) writings on governmentality (where the circulation of power is shown to be increasingly targeted toward individual bodies through the proliferation of modern forms of expertise) to the ways in which "scientific" knowledge about the natural world has become a central feature in the exercise of political power. Lovbrand, Stripple, and Wilman (2009, 8 emphasis added) provide the following observation to this effect:

> "Rather than approaching the work of science as a detached reflection of reality, the governmentality concept helps us think of science as a socially embedded practice *interwoven into the fabric of rule and authority*. When approaching government as a domain of cognition, the forms of knowledge that conceptualize the object to be governed are central to the analysis"

Through this statement, the authors draw attention to the ways that scientific practice produces the nature and categories of objects to be governed. As formal

scientific inquiry becomes the basis for political action aimed at a variety of places (from government to the body), it also becomes the platform upon which social order is maintained and contested. This influences the available field upon which social and political practice play out in far-reaching ways, including questions about *what* we are governing, *who* should define the mechanisms, and *how* policies should be implemented.

Drawing on these notions of green governmentality, Whitehead (2009) provides insights into the relationship between scientific knowledge and systems of government that may be emergent in climate change policy through a historical case study of air pollution policy in Britain. Specifically, Whitehead (p. 2) argues that "knowledge intensive and scientifically-grounded systems of air pollution government" signify the rise of "government with science" that characterizes modern environmental management. Defining, quantifying, and monitoring atmospheric pollution requires that multiple experts—those from science, community, and government—work to collectively define legitimate and relevant knowledge about air quality. Furthermore, these science-policy negotiations are embedded in a world of non-human actants—weather patterns, biogeochemical systems, and land and oceans—that set the stage for what technologies of government are employed and produce the conditions under which substances become pollutants. This has come to be the stage upon which climate change science and policy are being integrated into the practices of modern government, and the making of the "science effect" more broadly. Whitehead (2009, 220), expanding on the work of Timothy Mitchell (2006) provides the following analysis of the science and the state in modern environmental governance (emphasis in original):

> "…I would argue that the history of British air pollution government has been a history shaped by both *State effects* and *science effects.* While these effects cannot hide the complex interdependencies of State and science, they have, at different times, been use to shape the legitimate extent and moments of (in)action of both government and scientific communities…[U]nderstanding how the artificial construction of the autonomous zones of State and science shape emergent forms of atmospheric action, and senses of responsibility for air government, has never been more important" (emphasis in original).

Indeed, Whitehead identifies the ultimate illusion of science-policy interactions through what he calls state and science "effects." That is, though they are intrinsically enmeshed through practices of inquiry and governing that constitute one another, science and the state must *appear* as autonomous spheres of practice. For climate to be a legitimate "object of government with science" (Whitehead 2009, 228), state practice must be based on objective and sound scientific facts. At the same time, however, for science to be objective and autonomous, it must produce a boundary between itself and the state. In doing so, governments can select to represent science in the ways most appropriate for its desired outcomes, while the scientific community can maintain a research agenda that supports or refutes current political practice. This phenomenon of modern government is explored in the context of Seattle's use of climate science in environmental policy.

But the question still remains: are all claims about the nature of the world equally valid, or are some more "true" than others? Given the notoriety of climate skeptics in the US, how can we distinguish between different interpretations of climate science, and those that truly misrepresent scientific information? Social constructionist theories have been utilized to make sense of this complex relationship between the physical environment, scientific inquiry, and political practice. Hacking (1999, 2) states that social

construction reminds us that "meanings are not fixed and inevitable…they are the product of historical events, social forces, and ideology." In other words, even understandings of the world that we see as self-evident or factual, are, indeed, the product of social struggles about meaning-making. Social constructionist viewpoints have also been applied to climate change. Demeritt (2001, 301), for example, claims that "the technical aspects of science have constructed the problem of global warming for us in materially and politically significant ways," showing that the social practice of science has created specific knowledge claims about global warming. Demeritt *does not refute the existence of climate change*, but instead he wishes to show how discoveries of scientific facts are mediated by social relations and norms (Demeritt discusses global climate models, specifically). Similarly, as scientific information about climate change proliferates, policy-makers and other individuals must make sense of the information through their own scientific framings, where "material realities gain meaning through social interaction" (Pettenger 2007, 6). The distinction that is important here, therefore, is that although it is through discursive framings of information that people make sense of scientific information (which is itself socially-situated), not all political claims based on science are equally meaningful. Even as ideas like global warming are socially constructed, some framings make better use of the scientific evidence than others. The key question for consideration is: What kind of politics result from what kind of discursive framings, and with what effect on the relations between the state and science? The following section explores these relations of science and policy, as they are articulated through urban governance in Seattle, Washington.

Science and Policy in Urban Governance: The Case of Seattle, Washington

Science and policy are negotiated in an infinite number of places and among an ever increasing number of people and organizations operating in a rapidly changing environment. Debates about climate change are occurring within multiple levels of government, between various community groups, and among wide-ranging socio-political contexts, providing the opportunity for new and diverging understandings of the relationship between scientific expertise and environmental governance. Using the example of Seattle, Washington, a city that has outspokenly challenged the federal government's stance on climate change, this section examines three separate science-policy framings. In each case, the discourse of science used by Seattle provides justification for action based on objective and verifiable scientific inquiries, illustrating the dialectical nature of science and policy relations embedded in the "science effect."

Information for this article is from more than thirty interviews with city and county workers, research scientists, and community activists conducted during 2008 and 2009. Furthermore, an extended residency in Seattle during 2008 allowed for observation of City operations related to climate change and the collection of archival materials from former elected-officials involved in the design of Seattle's Climate Action Plan. To protect the confidentiality of interviewees, no identifying information is provided. Interview quotes are attributed only to "city workers" or "research scientists," for example.

Why Seattle?

Largely thought of as a "pioneer city" in local climate governance, the City's first resolution on global warming was passed in 1992. In 2006, Seattle formally adopted and began implementing its Climate Action Plan. Based on the recommendations of the City's Green Ribbon Commission on Climate Change, which included eighteen commercial, governmental, and non-profit community leaders, the plan targeted transportation choices, urban development, and energy production as key areas to reduce GHG emissions (City of Seattle 2009). More recently, the City can boast an 8% reduction in GHGs in 2005 relative to 1990 levels (City of Seattle 2007) and the creation of several community outreach programs to educate Seattle residents on ways to reduce their energy consumption. Being home to active politicians, research scientists, and community residents has meant that the creation and contestation of social and scientific discourses around climate has been occurring in Seattle for many decades. So too, this has required that decisions-makers and research scientists negotiate a complex science-policy divide.

Climate Science and Policy in Seattle: Consensus, Calculation, and Security

Table 1 (below) outlines three prominent science-policy discourses that have emerged within and been disseminated throughout Seattle regarding climate change since the 1990s. While the table presents three distinct discursive characterizations of the science of climate change, there are elements that do occur within multiple discursive characterizations simultaneously. In each of the three cases, the discourse is characterized by its key features, policy elements, and the factors often attributed to its successful

adoption and circulation. Discussions and examples of each of the three discourses are provided below.

Table 1: Science-Policy Discourses in Seattle (1990-present)

Characterization of Climate Science and Policy	**Key Features of the Discourse**	**Key Policy Elements**	**Motivating Factors**
Science of Consensus ***A "synergistic" proposition***	Legitimacy Credibility	Mitigation Goals and Targets	Exposure Experience
Science of Calculation ***"leadership" and "leverage"***	Enclosure via Quantification and Verification	GHG Inventories and Monitoring	Leadership Action
Science of Security ***"fear of failure"***	Non-Stationarity Variability	Risk Assessment Impact Adaptation	Precaution Preparation

A Science of Consensus: The "Synergistic" Proposition

> "The world's leading climate scientists have documented a clear global warming trend and the unmistakable impacts of human activities on that trend…Global warning of the magnitude now predicted by the scientific community will cause extremely costly disruption of human and natural systems throughout the world…[and scientists at the University of Washington project] significant harm to the Pacific Northwest due to changes in weather patterns attributable to global warming."
>
> (City of Seattle, Resolution 30316, July 23, 2001)

Only three months after George Bush withdrew the United States from the Kyoto Protocol, the City of Seattle began constructing a much different narrative about climate change science. Referencing both the IPCC and a regional research group located at the University of Washington (the Joint Institute for the Study of Atmosphere and Oceans),

Resolution 30316 (quoted above) firmly proclaimed the urgent need to reduce greenhouse gas emissions based on available scientific evidence that suggests the potential for irreversible impacts on both human and ecological systems. Scientific synthesis reports from the IPCC and other peer-reviewed sources, along with a discussion of the co-benefits of climate mitigation ranging from energy security to green development, were utilized as justification for requiring the creation of a GHG inventory and a plan that would reduce Settle's GHG emissions by at least 7% below 1990 levels by 2010. Clearly, the "best available science" was evoking a dramatically different political response in Seattle from that at the national level in the US at that time.

Six years later, the City of Seattle strengthened its climate policies, yet again, by requiring that an evaluation of climate impacts and GHG emissions be incorporated into the City's environmental review process (part of the State Environmental Policy Act (SEPA)). Justification for these actions, including formal review procedures for new urban developments, is based upon the existence of *consensus* science about the causes and consequences of climate change. Ordinance 122547 states that:

> "The International Union of Concerned Scientists, the Intergovernmental Panel on Climate Change and numerous other international organizations have reached *consensus* that climate change is being negatively affected by human behavior and governmental policy… [and] the November 2007 report of the Intergovernmental Panel on Climate Change showed new and stronger evidence that many risks cited in the panel's first three reports this year are actually greater than projected" (City of Seattle, December 3, 2007).

Using reference to internationally known scientific communities, in addition to other to local climatologists that have "urged more aggressive steps to aggress greenhouse gas pollutants locally and regionally," the City of Seattle passed Ordinance 122547 requiring

that climate impacts be evaluated in all public and private development proposals. Framing climate as an issue about which consensus about the severity of climate change has been achieved in both international and local communities, provides the basis for incorporation of mitigation efforts in routine review procedures. Similarly, when the City requested funding for programs to encourage community residents to reduce their carbon footprints, claims to consensus science were used as justification for those efforts. When creating a subfund for Seattle's Climate Action Now (Seattle "CAN") program, for example, the Seattle City Council proclaimed:

> "…there is now unprecedented *consensus* among international scientists that the earth's average annual temperature is rising and that human activities are increasing the release of greenhouse gases into the atmosphere that contribute to global warming."
> (City of Seattle, Ordinance 122876, December 11, 2008)

Collectively, the language in these resolutions and ordinances reflects a discourse of climate science, based upon the findings of scientific experts, that ends the debate on whether climate change is occurring, while opening up a debate about how the city will create and achieve *mitigation goals and targets*. As a city worker stated in a 2008 interview: "One nice thing in Seattle is that we've totally stopped having the conversation about whether climate change is real. We don't need to talk about that anymore," suggesting that scientific information on climate clearly indicates the need for government action on the issue.

But, creating this sense of legitimacy and credibility of climate science has not occurred spontaneously. Instead, the integration of consensus science in urban policy has been the product of direct and indirect interactions between climate scientists and

regional decision-makers in Seattle. The Climate Impacts Group (CIG), a National Oceanic and Atmospheric Administration (NOAA) funded research center located at the University of Washington, for example, has been producing regionally-relevant climate science since the 1990s. Scientists working as part of CIG frequently describe the process of effective scientific outreach as one of *exposure* and *experience*. Repeated and frequent discussions of regionally significant climate science about the impacts of climate change, combined with an increase in awareness that climate variability can be the result of global climatic oscillations, were important factors in achieving credibility and relevancy of climate science. A scientist from CIG stated:

> "I think there was just this kind of blanketing of information that we [CIG] put out to people for a number of years before you started to get this desire for more information. That desire has targeted different issues through time driven by events, basically, that were either politically or culturally significant, but also climate events. So, the big El Nino of '97-'98 was surely a huge boost for our credibility."

As residents and policy-makers are repeatedly exposed to climate science, including an experience of the effects that climate change may have via climate evens like El Nino, scientific information has taken on new meaning and significance. Widespread media coverage of a strong El Nino event in the Pacific Northwest during 1997-1998 made it widely known that the region should expect drier conditions throughout the fall and winter, with potential effects on water supplies and salmon populations (Henderson 1997). Regional scientists, like the one quoted above, indicate that the 1997-1998 El Nino event captured the attention of the community in ways that made climate science much more relevant to people's everyday lives.

Mayor Greg Nickels, furthermore, frequently refers to a lack of snow pack in the winter of 2004-2005, and the potential threats to the region's water supply that can result from lower than normal snowfall, as the impetus for him to create the US Mayors Climate Protection Agreement (Grist 2005). Indeed, even as Mayor Nickels was sympathetic to environmental causes before the 2004-2005 winter drought, it was the direct experience of what could occur with climate change that prompted political action. A CIG scientist describes the phenomena in the following way:

> "The science is compelling, so that helped people understand, and it's something that you don't have to wait 'til the 2020's to see the effects. You get a bad snowpack year and they get a preview. They get a sense of what's going to happen."

With widespread consensus about the urgency and severity of climate change throughout the Seattle community, elected officials and city workers began framing the need for climate mitigation activities as a "synergistic" proposition, by claiming that the actions necessary to reduce GHGs are also those that improve the quality of life and environmental health of urban communities. As an employee working on Seattle's climate protection program stated in reference to creating a comprehensive climate mitigation strategy:

> "I think we realized pretty early on that the vast majority of the things that we needed to do to reduce our contribution to global warming or to the resilience to climate disruption impacts were the same things that we need to do for other purposes anyway. Things that we should do to improve quality of life which is already the job of the government—reducing traffic congestion and reducing traffic itself to clean up the air, promoting bicycling to promote health, reducing diesel emissions because they're the number one source of toxic air pollution. All these things that have *synergy* with carbon footprint reduction also provide all these community benefits."

This *synergistic* approach to climate governance has likely made political action in Seattle much more palatable and widely accepted than it otherwise might have been. In Seattle, unlike official policy at the federal level in the US, a science of consensus has been utilized to invoke and justify political action on climate change, including the creation of GHG mitigation goals and a win-win proposition for action. This occurs not because Seattle has access to different scientific evidence than the federal government, nor because the City is has more scientifically experienced staff. Instead, the political will to incorporate climate change in to urban governance comes from distinct and site-specific experiences of climate and weather that evoke concern and understanding about the potential impacts of climate change.

A Science of Calculation: "Leadership" and "Leverage"

> "The fact that the mayor has been taking such a national leadership role [on climate change] has really helped inspire people to feel like they need to be leaders and there are going to be eyes all over our community saying how the heck is Seattle doing it."
>
> (Quote from an interview with City of Seattle employee)

Translating the desire for climate mitigation into actual action has required the formation, integration, and dissemination of new forms of scientific expertise about GHG emissions in Seattle. Specifically, the creation and verification of GHG inventories, as a way to assess and monitor Seattle's climate mitigation goals, has required a science of *calculation* to define and determine what portion of world's GHG emission fall under the purview of Seattle government. Because the atmosphere is often viewed as a common

resource, or perhaps more accurately, a global "carbon dump" (Lohmann 2005), municipal climate mitigation efforts require that Seattle determine its share GHGs, so that the emission reductions they do achieve can be attributed to their jurisdiction. In essence, climate mitigation strategies are meaningless unless institutions (such as governments and corporations) are able to lay claim to portions atmospheric GHGs, and then work to reduce them.

To do this, the science GHG calculation has become central feature of climate governance in Seattle. GHG inventories assess the amount of emission produced by activities that occur directly within a city's jurisdiction (e.g. energy use in buildings), emissions that occur within city boundaries but are also associated with activities that occur outside of the specific jurisdiction (e.g. car travel to and from work across jurisdiction boundaries), and those that may occur outside of the jurisdiction, but are produced directly for activities relevant to the jurisdiction (e.g. energy production for a city that occurs outside of its boundary) (City of Seattle 2007). Because of the spatially complex dynamic of GHG inventories, the City of Seattle has spent a considerable amount of time ensuring that their own GHG inventory is based upon the most accurate and up-to-date emissions accounting science. The 2005 Inventory of Seattle's Greenhouse Gas Emissions, for example, provides the following statement about creating the inventory protocol:

> "While there is a standard protocol for corporate inventories, there is no standard protocol for local community greenhouse gas inventories. Therefore [the] inventories presented here are guided by protocols developed for national and corporate inventories, specifically the Greenhouse Gas (GHG) Protocol… and the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC Guideline). The GHG

> Protocol was developed with a multi-stakeholder, consensus-based process by the World Business Council for Sustainable Development and World Resources Institute. The IPCC Guideline was developed in the early to mid-1990s by the Intergovernmental Panel on Climate Change (IPCC)."

Initially, these emissions inventorying efforts required a significant amount of input from local and regional "experts" to make decisions about what should and should not be included in Seattle's GHG inventory. Many of these experts were from the City's Green Ribbon Commission on climate change, a group of Seattle-based individuals from a cross-section of economic and political organizations, while others were scientists and engineers from local research and advocacy groups. A city worker stated about GHG inventorying process during an interview in 2008:

> **"**[We had a] series of meetings, different expertise, it's fair to say, well staffed. these were high powered people and we wanted to use their time efficiently. So, we didn't spend a lot of time blue sky brainstorming. For example the carbon footprint we would bring graphs of it to them and answer questions and ask their advice on things like should the airport be in or out, should we do it by car emissions… we identified the key issues that are complex at the local level. all these issues that are now going to be, we hope, sort of decided upon in a consistent way…"

Obtaining the "best" information about how to conduct a GHG inventory has provided a scientific basis of legitimacy and accuracy needed for the inventory to be accepted by the wider community. Without the backing of national GHG standards and local community experts, the legitimacy of a GHG inventory might be compromised.

The result of this science of calculation in Seattle has been the act of *enclosing* the global atmosphere. The practice of enclosure can be defined as "the capture of common resources and exclusion of the communities to which they are linked" (Heynen and

Robbins 2005, 5). Similarly, enclosure of the global atmospheric commons, it turns out, is central to Seattle's climate policy. The science of calculation works to enclose the global carbon dump, and attribute a scientifically verifiable amount of global carbon molecules to the City of Seattle. This has required new material and discursive practices to engender a sense of ownership over odorless, colorless GHGs that the City has been producing for decades.

Furthermore, in Seattle, it has become essential that the City of Seattle be able to quantify and calculate GHG emissions based upon standardized information. In 2008, for example, the City formalized a GHG quantification requirement for new developments during the environmental review process, which applied standard GHG calculations to all new development. A city worker provided the following statement about the quantification of GHG emissions in this review process:

> "As of…March 31st, we implemented a requirement for disclosure, that basically said every project that undergoes SEPA review has to at least quantify what the life cycle greenhouse gas impacts will be….So we have a worksheet where they fill in some simple numbers and it calculates the operational impacts of heating air conditioning etc., as well as the transportation, the indirect impacts of the project, and the embodied energy like construction and materials used, etc"

Importantly, Seattle has not taken on these efforts to inventory and reduce their GHG emissions without larger motivation. During interviews with city works, and in public statements by elected officials, references to *leadership* and *leverage* are often provided as the motivation for conducting and monitoring GHG emissions in Seattle. An essential component of Seattle's GHG inventorying efforts is the desire to provide a

progressive and cutting-edge example of environmental stewardship to the wider Seattle community and other government institutions. Mayor Nickels, for example, was able to leverage his position within the Conference of Mayors (the organizing and lobbying organization for cities of 30,000 people) to gain attention for Seattle's climate-related efforts. A City worker stated about the importance of showing leadership on climate issues when evaluating GHG emission in Seattle by saying

> "The mayor is very active in the US Conference of Mayors…He saw that as a huge *leverage* point and knew that if you could rally the whole US Conference of Mayors as an institution, they represent 1100 cities across the country, that would have more power… he's proven to be absolutely correct about this, he foresaw the power in the juxtaposition that would be created from all that grassroots *leadership* [on climate change] coming from cities, and the lack thereof at the federal level in terms of refusal to sign the Kyoto protocol."

Through the creation of the US Mayors Climate Protection Agreement, where participating cities pledges to "meet or beat" the Kyoto Protocol, the science of calculation has become a prominent feature of Seattle's outreach efforts. Communities all over the country have begun to inventory and monitor their GHG emissions in an effort to mitigate climate change largely because of the example Seattle (and other pioneer cities) have provided. For governments to claim GHG reductions, and meet GHG reduction goals that they set for themselves, they must engage in the act of enclosure for the global atmosphere. In Seattle, and other communities following their example, the desire to show leadership on climate issues has been shown to be a primary motivator.

A Science of Security: "Fear of Failure"

> "Preparing for climate change's impacts is necessary because scientists believe that the impacts expected over the next century are generally irreversible. In short, they are irreversible because existing atmospheric concentrations of greenhouse gases are sufficient to produce climatic impacts for at least the next 100 years. While cities can ward off catastrophic climate change by reducing climate pollution, cities will also need to adapt to the climate changes of the next century by developing adaptation policies that ensure cities are resilient to the projected climate impacts."
>
> (Senior City of Seattle Staff Briefing Memo (Draft), September 2008).

Seattle's achievements in climate mitigation have been widely recognized and praised, but the City's climate-related efforts have not stopped there. More recently, Seattle has undertaken an aggressive climate adaptation planning effort to alleviate and avoid some of the dangerous impacts of climate change that are predicted to affect the region in the coming decades. From rising sea levels, to more summer days over 90 degrees, the potential social and ecological impacts of a changing climate in the Seattle region could be very widespread. This has prompted the City of Seattle to engage in a new *science of security* to ensure that the City's people and infrastructure can withstand the unavoidable consequences of climate change that many scientists suggest we are already committed to.

In the early 2000s, Seattle's water provider, Seattle Public Utilities (SPU), began working in conjunction with the Climate Impacts Group (CIG) at the University of Washington to assess the impacts of climate change on the region's water supply. Using a combination of General Circulation Models (GCMs), hydrologic models, and water supply models, climate scientists and water managers in Seattle determined that rising temperatures and global warming would affect the amount and timing of snowmelt in the

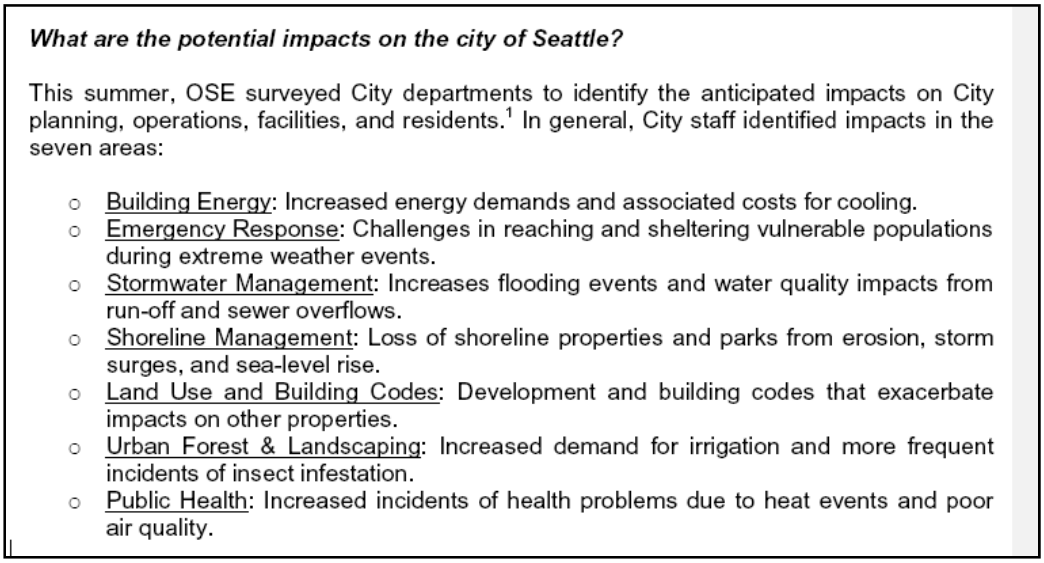
Pacific Northwest region. SPU, therefore, has begun to evaluate current reservoir storage and drought management plans to determine if they accommodate potential decreases and changes in water supply (Wiley and Palmer 2008). Concerns about the City's ability to provide sufficient water to the region have been at the heart of these new science-policy relationships.

The City of Seattle, more recently, has expanded its adaptation efforts to include other municipal departments, including those related to housing, recreation, government operations, electricity service, and entertainment. As part of an internal survey distributed to eleven different city departments during the summer of 2008, information was collected about the potential vulnerabilities City agencies expect may arise due to climate change.[4] In order for the participants to determine the effect that climate change might have on the day-to-day activities, the survey included a scientific overview of predicted climate impacts for temperature, precipitation, and sea level rise. Though the City of Seattle is still in the process of formalizing their climate adaptation plan, preliminary results from the internal survey suggest that nearly all City departments will have to plan for climate change. Departments and agencies that work with vulnerable populations (e.g. the elderly), for example, will need to have excessive heat day procedures to ensure that those without air conditioners can survive increasing summer temperatures. Similarly, coastal roads and buildings may face increased erosion and loss of seafront. Figure 1, taken from a Adaptation Planning Briefing Memo used by a City worker in the Office of

[4] A "Climate Change Impacts Questionnaire" was distributed to the following department/agencies in Seattle municipal government: Dept. of Parks and Recreation, Fleets and Facilities, Dept. of Neighborhoods, Dept. of Planning and Development, Libraries, Department of Executive Administration, Seattle housing Authority, Office of Housing, Human Service, the Seattle Center, and City Light. The survey was administered by the Office of Sustainability and Environment.

Sustainability and Environment, shows the entire list of municipal vulnerabilities compiled by the City of Seattle as a result of the internal impacts survey. Of central importance is a concern for the security of human life, ecological health, and infrastructural resilience.

Figure 1: Information about Climate Impacts from Departmental Briefing Memo



What are the potential impacts on the city of Seattle?

This summer, OSE surveyed City departments to identify the anticipated impacts on City planning, operations, facilities, and residents.[1] In general, City staff identified impacts in the seven areas:

- Building Energy: Increased energy demands and associated costs for cooling.
- Emergency Response: Challenges in reaching and sheltering vulnerable populations during extreme weather events.
- Stormwater Management: Increases flooding events and water quality impacts from run-off and sewer overflows.
- Shoreline Management: Loss of shoreline properties and parks from erosion, storm surges, and sea-level rise.
- Land Use and Building Codes: Development and building codes that exacerbate impacts on other properties.
- Urban Forest & Landscaping: Increased demand for irrigation and more frequent incidents of insect infestation.
- Public Health: Increased incidents of health problems due to heat events and poor air quality.

Moreover, these assessments of climate impacts point to the real, and increasing, potential for climate change to disrupt municipal service delivery. Seattle may face challenges in providing clean and plentiful water supplies or difficulties protecting people and infrastructure against sea level rise. During interviews with government workers and regional scientists, this potential disruption of government responsibilities, and the desire to prevent such disruptions before they occur, has been described as a motivating factor for integrating a science of security into urban governance. As a researcher from CIG

stated about the rise in scientific assessments of the impacts of climate change on resource management during an interview in 2008:

> "Yeah, to me maybe a lot of this does stem back to economic concerns, but it's been an interesting process for me to become aware of what appears motivates people that are in the resource agencies. One of those things is the *fear of failure* to deliver what is expected… you never turn on the tap and there is no water, for example."

This "fear of failure" among workers in Seattle government has resulted in two fundamental shifts in urban management: the concept of a *non-stationary* environment, and the need for *risk management* planning. Though much of urban planning has assumed constant weather and climate conditions based on observations from the past several decades, climate adaptation planning requires that municipal governments integrate new and changing environmental scenarios into current and future planning procedures. As a CIG scientists stated about the need for new shoreline planning based on potential changes in sea level:

> "The thing I found [in working with the City] was that most of our current laws and regulations are planned for a static shoreline, so they are setbacks and protective measures in place, but based on the concept that there will be variability in tides and things like that, but that the shoreline itself isn't going to change. The long-term planning aspect of updating some of these distances and setbacks based on a migrating shoreline [due to climate change] is not in existence in the regulatory and legal structure at this point."

Though, as pointed out in the quote above, Seattle does not officially have a plan in place to deal with sea level rise, they are in the process of creating one. This effort, in fact, has resulted in the creation and assessment of new city-wide metrics and risk assessments to incorporate a changing climate into urban management. In planning for sea level rise, for example, Seattle's Office of Sustainability and Environment is working

to create new "risk tolerance" guidelines for sea level rise when planning and assessing city developments near the shoreline (see Figure 2). These are created with a sense of *precaution* and *preparation* for impending impacts of climate change that the world has committed to.

Figure 2: Reproduction of "Risk Tolerance" Guidelines Provided by the City of Seattle to Department Heads

Risk Tolerance	SLR by 2050	SLR by 2100	Description of Risk Tolerance Factors
High	3"	6"	Facility has a relatively short life span (10-20 years) and/or can be easily/cost-effectively modified to accommodate higher SLR. Little risk to facility from storm surges.
Medium	6"	13"	Facility has medium life span (30-50 years) and/or could be modified with a moderate investment. Facility is may be affected by significant storm surges.
Low	22"	50"	Facility has very long life span (>50 years) and/or could only be modified with significant investment. Facility is likely to be damaged with storm surges or high tides.

The framing of climate-related science in terms of socio-ecological security has integrated a risk management approach into government operations more broadly. As a CIG researcher said about her experience describing climate impacts to government institutions:

> "… as individuals we have to make decisions about whether we get earthquake insurance or not, whether we bike with our helmet on or not. we always have to make decisions… putting it [climate adaptation] in the context of risk management, it's something that, some governments are already dealing with…you're not asking for money to study this or to retrofit that on the basis of a green issue but rather as a risk issue."

Indeed, a science of security has become the central framework for adaptation planning in Seattle government. Risk assessment and workable metrics are the primary political mechanisms utilized in current efforts. The use of regionally-specific climate science, furthermore, is a key component in the making of workable and relevant adaption policy. In Seattle, it seems, a *"fear of failure"* to deliver services has prompted decision-makers to begin creating and implementing new forms of adaptation planning.

Discussion and Conclusion: Examining the 'Science Effect'

In Seattle, the science of climate change has been framed in three distinct and important ways. First, a science of *consensus* has been used as justification for implementation of climate mitigation goals and targets. Repeated exposure to regionally-specific climate science, combined with an impactful experience of an El Nino event in the late 1990s, contributed to this discourse of science taking hold amongst decision-makers in the Seattle community and the legitimacy of climate science more broadly. Secondly, a science of *calculation* has been employed by City workers in Seattle, as they work to assess and verify their contribution to global GHG concentrations. In effect, this practice works to enclose the global atmosphere by engendering a sense of ownership and responsibility over globally-mixed carbon molecules. Notions of leadership and leverage have been the motivation for this action, which is otherwise not mandated by any formal policy from the federal government. Lastly, a science of *security* is emerging in the Seattle area. City employees are diligently working to assess community risks to climate impacts because of a fear of failure to not be able to deliver reliable services, such as

water and protection of vulnerable populations. Preparation for potential impacts and precautionary principals are guiding this effort. The results case study presented here demonstrate that climate science has been framed in multiple and diverse ways during debates about urban governance in the Seattle area.

But how are these close relations of science and policy negotiated within the science and policy communities at large? Clearly, science and policy are being co-produced within Seattle's efforts at climate governance. As policy-makers begin to assert that climate change as an issue of central and urgent concern, the practice of scientific inquiry is legitimated and advanced. More regionally-specific science is needed; newer and more community-relevant GHG emission data are required; the creation of site-specific risk assessment metrics becomes imperative. Simultaneously, as new facts about the nature of climate change are produced and circulated by the scientific community, new policy practices can be employed by government workers trying to mitigate GHG emissions and prepare for climate impacts.

But, even as evidence that "science [is] a socially embedded practice interwoven into the fabric of rule and authority" (Lovebrand et al. 2009, 8) is provided by this analysis of science-policy interactions, political action has occurred in Seattle because of widespread agreement that the scientific basis for these political actions is verifiable and reliable. In essence, the role of the *state* is to sort through the best available knowledge, while the role of *science* is to present the facts in the most objective and accurate way possible. As a CIG scientist said about his interactions with policy-makers in the Puget

Sound Region regarding the estimation of possible sea level rise provided in a regional scientific report:

> "If you want a rough guide to how bad it [sea level rise] could really be over the next 100 years, here it is. At one point she [a coastal engineer] said, 'You're frustrating me. Why don't you just tell me the answer?' You know better than that. *You're not a politician*. So that's an example of how we were asked."

This statement suggests that the role of scientists should end at the door of the decision-maker. Even though the practices of resource managers and city workers legitimate and reinforce the importance of science, scientists cannot (and should not) act as policy advisors. The presentation of science and policy as autonomous spheres of practice, even though they are widely understood and accepted as intimately intertwined, is the heart of the "science effect."

The importance of this phenomenon is twofold. First, the nature of the "science effect" is one where scientific fact serves as the basis for political action, meaning that scientists are expected to appear politically neutral and objective in the presentation of their results. In each of the three framings of science utilized for mitigation and adaptation in Seattle, references to expert knowledge are foundational to their legitimacy. This means that because formal knowledge is used to legitimate environmental policies, and it *must* appear separate and autonomous from political influence. This has the effect of putting climate scientists in a very difficult position, where they must balance the need to present objective information, despite their desire to help provide pertinent information needed for political action. This extended quote from a regional research scientist in Seattle captures this sentiment:

> "I try to be very clear about the fact that we cannot predict the future specifically or precisely, but we see the direction that we're headed, and that direction has some pretty clear consequences. …*Its really important for your credibility* to keep that clear because we have a year like this, the west coast as a whole has experienced something very significant drought, yet in the Pacific Northwest we had this incredible snowpack... It is something that you can't point at and say 'this can't happen because global warming is underway and is going to make this impossible.' But you say 'well, we've had an exceptional year. It's a pretty local phenomenon or regional phenomenon if you look at the country as a whole. But it's still possible that if the winds blowing the right way and if you get the right kind of circulation set up, it's likely to be less and less a part of our future,' *And that's just the way you have to be.*"

Importantly, I do not wish to claim that this is an inappropriate relationship. Indeed, good environmental policies are based on sound scientific information. Rather, the point here is that the "science effect" necessities a careful distinction between what is scientific *fact* and what is the *perception* of politicians. Scientists, it seems, walk the line of science and policy with great caution.

Second, because of the need for objective and reliable scientific basis in climate policy, only those that produce or utilize this type of information are relevant for political practice. The City *must* go to great lengths to justify their environmental policies by relying on a formal scientific basis. As Whitehead (2009, 217) states about government workers in Britain during the early 1900s, "state officials, responsible for the day-to-day government of the atmosphere, were routinely caught between scientific commitment to objective observation and a governmental commitment to paternal supervision and guidance." In Seattle, city workers and elected officials have become particularly skillful at this action of objectively verifying political practice that is often based on morally relevant grounds. Furthermore, even where community members are engaged in decision-making processes, the "science effect" can intimidate "non-experts" from voicing their

opinion. When groups like the Green Ribbon Commission are consulted, for example, their opinions must be translated into objective items of action, the causes and consequences of which can be independently verified.

Importantly, the three framings of science in Seattle presented here have forged a progressive response to climate change. Seattle has successfully reduced their greenhouse gas emissions and is aggressively working to plan for predicted climate impacts. This is a notable achievement, indeed. At the same time, however, Seattle's experience illustrates the dialectical and contentious relationship between the state and science—one where scientists and policy-makers, though deeply integrated through the production and circulation of environmental knowledge, must appear to remain separate for legitimacy. But even when scientists wish to engage the political arena, entrenched ideologies embedded in the "science effect" can often suggest that those scientists are no longer truly objective.

Recently, some organizations have begun to integrate science and policy more aggressively. These efforts are working to recast the relationship between science and policy embedded in the "science effect," though much work still remains to be done. The National Oceanic and Atmospheric Administration (NOAA), for example, has created eight regionally focuses scientific outreach centers (referred to as Regional Integrated Sciences and Assessment (RISA) programs). Researchers in these programs, including the scientists quoted above in this section, specifically work at the interface of science and policy as part of the RISA mission. As demonstrated by the quotes from scientists provided here, however, these efforts often run up against the dialectical nature of science

and the state in modern environmental governance. What is continually seen in the personal interactions and experiences of climate scientist and decision-makers is collective engagement of complex socio-ecological issues, but what is reflected in institutional arrangements of their engagements, however, is one of separation and independence.

Perhaps, the example provided by the City of Seattle and regional climate scientists can provide the basis for understanding science and policy as co-constitutive. Efforts to break down the divide, moreover, should not be seen as an attack on either, but rather as a pathway to more comprehensive and collective efforts in addressing pressing environmental concerns. At the same time, this may provide room for more democratic negotiations of environmental policy, where many forms of expertise, from community experiences to scientific inquiry, are incorporated into the making of climate policy.

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APPENDIX D: SCIENCE AND DECISION MAKING: WATER MANAGEMENT AND TREE-RING DATA IN THE WESTERN UNITED STATES

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Abstract: Growing populations, limited resources, and sustained drought are placing increased pressure on already over-allocated water supplies in the western United States, prompting some water managers to seek out and utilize new forms of climate data in their planning efforts. One source of information that is now being considered by water resource management is extended hydrologic records from tree-ring data. Scientists with the Western Water Assessment (WWA) have been providing reconstructions of streamflow (i.e., paleoclimate data) to water managers in Colorado and other western states (Arizona, New Mexico, and Wyoming), and presenting technical workshops explaining the applications of tree-ring data for water management for the past eight years. Little is known, however, about what has resulted from these engagements between scientists and water managers. Using in-depth interviews and a survey questionnaire, we attempt to address this lack of information by examining the outcomes of the interactions between WWA scientists and western water managers to better understand how paleoclimate data has been translated to water resource management. This assessment includes an analysis of what prompts water managers to seek out tree-

ring data, how paleoclimate data are utilized by water managers in both quantitative and qualitative ways, and how tree-ring data are interpreted in the context of organization mandates and histories. We situate this study within a framework that examines the coproduction of science and policy, where scientists and resource managers collectively define and examine research and planning needs, the activities of which are embedded within wider social and political contexts. These findings have broader applications for understanding science-policy interactions related to climate and climate change in resource management, and point to the potential benefits of reflexive interactions of scientists and decision makers.

Key Terms: tree-rings, paleohydrology, water management, coproduction

Introduction: Evaluating Science-Policy Engagements in the Western United States

Growing populations, limited resources, and sustained drought have placed increased pressure on already over-allocated water resources throughout the western United States (Fulp, 2005). As a result, some water managers have begun to seek out and utilize paleoclimate information to better understand the effects that climate variability may have on water supplies and system reliability (Woodhouse and Lukas, 2006). A plethora of potentially useful data for water managers does exist, but this scientific information must be made accessible and relevant for decision makers in order for it to be useful in water planning. This also requires that climate scientists, resource managers, and decision makers are effectively working together to connect scientific knowledge to planning and policy in water management. Interactions and partnerships between scientists and decision makers, however, are increasingly recognized as a process that is much more complex than simply passing information from science "producers" to science "users" (e.g., Jacobs and Pulwarty, 2003; Vogel et al., 2007). Rather, effective science-policy interactions must be understood as multidirectional, requiring participation from many experts with different knowledge backgrounds and outcome goals.

To better understand what makes science-policy partnerships more or less effective, we conducted an assessment of collaborations from 2000 to 2007 between paleoclimatologists from the Western Water Assessment (WWA) and water providers in Arizona, Colorado, New Mexico, and Wyoming to determine if and how tree-ring based reconstructions of hydrology have been useful and applicable to water resource planning and management. Partnerships between scientists and management personnel, along with

a series of technical workshops, have been the mechanisms for the translation of scientific results into information for water resource applications in the efforts we examine here. Interviews were used to assess the outcomes of ongoing and established research partnerships with three water utilities in Colorado, and survey information was elicited from the entire population of attendees from seven workshops conducted in four western states to determine if and how scientific information presented in the technical workshops has been incorporated into water resource planning.

In the following sections, we first provide an overview of the key challenges to the integration of science and decision making, and then we describe the coproduction of science and policy as a framework for assessing interactions between scientists and resource managers. A short introduction to tree-ring based reconstructions of streamflow and the history of their application to water management follows. We then describe the research questions and methods used to assess the use of reconstructions of streamflow by water management agencies, targeting the factors and events that have prompted water managers to seek out climate-related information, the ways that tree-ring data are interpreted in the organizational context of water supply agencies, and issues of credibility and acceptance of tree-ring data. The results are organized into four main topics (corresponding to four research questions): (1) why water managers seek out paleoclimate data, (2) the use of paleoclimate data, (3) the importance of institutional characteristics and water users, and (4) data challenges and considerations. Finally, we advocate science-policy models that promote interactive, iterative, and reflexive partnerships between scientists and decision makers, while also considering the larger

social context within which climate data are both produced and used in resource management.

Integration of Science and Decision Making: Key Challenges and Opportunities

During the past decade, researchers have begun to examine what barriers exist in the translation of science to water management and policy. This research has documented that the "accessibility, credibility, understandability, relevance, and timing" of research (Pagano et al., 2001, p. 1148) can affect the ability of decision makers to determine how, and what type, of climate data may be useful for managing water resources. More specifically, scientists must be able to communicate and share information with decision makers and planners at appropriate temporal and spatial scales for management purposes, while water management agencies must have the capacity, knowledge, and willingness to appropriately incorporate scientific information into decision making (Gamble et al., 2003).

With respect to the production of scientific knowledge, researchers must also understand that "better science" does not necessarily lead to better management and decision making (Tribbia and Moser, 2008; McNie, 2007). Instead, gaps may exist between what data decision makers are aware of, their knowledge about how to use that data, and what information may actually be necessary to address a particular management concern. At the same time, differences in background, professional training, and organizational mandates often places emphasis on different outcome goals for scientists and decision makers, producing significant barriers for meaningful and sustained

interactions between researchers and resource managers (Janse, 2008; White et al., 2008). Social practice and institutional norms can also affect the creation and utilization of scientific knowledge, including the influence of priorities and procedures of scientific funding institutions on research activities and the preference for technological solutions to environmental concerns among the resource management community (Jasanoff, 1990).

To examine and address many of these issues, conceptual frameworks have been developed to better understand how science is used in decision making and to improve the integration of scientific information in resource management. Fundamentally, this approach begins from the standpoint that "science" and "policy" exist not as separate spheres of knowledge and practice, but instead, they are coproduced through engagements of researchers, decision makers, and the public (Lemos and Morehouse, 2005). Coproduction refers to the “collaborative process of knowledge production that involves multiple disciplines and stakeholders of other sectors of society” (Pohl, 2008, p. 47), and the process of interactive and iterative “stakeholder” involvement procedures that collectively shape research agendas with both scientists and policy makers (Lemos and Morehouse, 2005).

Most importantly, the coproduction of science and policy approach places emphasis on the interactive, and often blurry, relationship between society and scientific expertise in resource management. As Vogel et al., 2007, p. 351 state:

> “Interestingly, when scientists and practitioners begin working together…both the science and the practice change, and sometimes in unexpected or unintended ways. For example, practitioners and policy makers become more than mere recipients of scientific knowledge but begin to help configure research agendas…Such outcomes can, however, blur the "traditional" roles of scientist and practitioners, as the producer, user, and brokering roles become more fluid and less compartmentalized. Knowledge thus flows in

> many directions and the distinction between "pure" and "applied" or Modes I and II science can no longer be clearly made."

As the above quote shows, it is increasingly being accepted that there is no "linear process" of delivering scientific information to decision makers, nor a definite distinction between the practices of science and policy (Vogel et al., 2007; White et al., 2008). Instead, in science-policy engagements there is "an actual re-shaping of both groups' perceptions, behavior, and agendas that occurs as a function of their interaction" (Lemos and Morehouse, 2005, p. 61), leading to more integrated and sustained interactions between producers and users of scientific information. If an interactive research process is in place, useful integration of scientific information into water resource planning may be achieved.

We use this coproduction framework in our assessment and discussion of the partnerships between paleoclimate researchers and water managers in the western U.S. paying close attention to how science and policy are (or are not) integrated in these efforts and what social and technical factors influence the use of scientific information. Although the emphasis of this paper is primarily an assessment of how science has influenced the practice of water planning, input from water managers to scientists was central to the formation of partnerships between water providers and WWA researchers during the study period, including what types of scientific data were created for water resource applications (Woodhouse and Lukas, 2006). Without the influence and input of water managers in shaping the scientists' research and delivery of information, these science-policy partnerships would not have occurred.

A Brief Overview of Tree-Ring Data and Water Resource Management

Gaged streamflow records are the basis for water resource management where surface water is the primary water supply. In the western U.S., very few gage records are 100 years or longer, and even the longest records contain a limited number of sustained severe droughts, the events that are most challenging to water management. Recent drought conditions in the western U.S. have made it increasingly clear that the range of variability in the gage records may not be fully representative of true long-term variability. Information on long-term natural hydrologic variability over multiple centuries can be obtained from tree rings in moisture-sensitive trees (e.g., tree species whose ring widths correlate well with variations in moisture availability), offering a proxy method to determine streamflow over periods much longer than the available gage records (also referred to as "paleoclimate data" in this paper). The close association between water-year streamflow and annual tree growth, linked by the regional climate, is particularly strong in the southwestern and intermountain western U.S. making it possible to create high quality reconstructions of annual streamflow for gages such as on the mainstem Colorado River, its upper and lower basin tributaries (Stockton and Jacoby, 1976; Smith and Stockton, 1981; Meko and Graybill, 1995; Hidalgo et al., 2000; Woodhouse et al., 2006: Meko et al., 2007), the South Platte River (Woodhouse and Lukas, 2006), and the Sacramento River (Meko et al., 2001).

Increased availability and awareness of tree-ring data during the past decade has prompted a growing number of water managers to seek out tree-ring data for use in a variety of applications, ranging from general assessments of long-term hydrologic

variability to numerical inputs into water supply models (Woodhouse and Lukas, 2006). Although the number of water managers using tree-ring data, and to some extent, the ways they are using the tree-ring data, has increased in the past several years, the application of tree-ring data to resource management is not new: the use of these data in water resource management extends back to the 1930s in the western U.S. (see Table 1).

Table 1: Brief Overview of Applications of Tree-Ring Data to Water Resource Management

Hardman and Reil (1936)	Truckee River, possible applications to water resource management; agricultural regions of the Truckee River basin.
Schulman (1942)	Report for the Los Angeles Bureau of Power and Light, assessment of reliable power generation from Colorado River.
Potts (1962)	For Denver Water Board, annual S. Platte flow, droughts for estimating future storage requirements.
Earle and Fritts (1986) and Meko *et al*. (2001)	Sacramento River reconstructions for the California Department of Water Resources.
Smith and Stockton (1981)	Salt and Verde Rivers reconstructions for the U.S. Army Corps of Engineers.
Young and others (1995)	Hydrologic, economic, social impacts of Colorado River drought.

While this brief overview of the history of tree-ring applications for water resources documents the usefulness of tree-ring data to water management, these applications have been relatively isolated (Woodhouse and Lukas, 2006). Increased demand on water supplies due to population growth and new recreational and environmental uses, along with a decrease in supply resulting from persistent drought

conditions since about 1999, have converged throughout many parts of the western U.S. during the past decade. This has resulted in an increase in research on the applications of tree-ring data in resource management and greater attention to the adequacy and reliability of water supplies for both municipal and rural water agencies and providers. This paper documents efforts to introduce these data to water managers, and is the first evaluation of the outcomes of these efforts to utilize tree-ring data in water management.

WWA Researchers and Water Managers in the Western U.S.: Established and Emerging Collaborations

Researchers from the WWA, a joint program of the National Oceanic and Atmospheric Administration (NOAA) and the University of Colorado (including the second and third authors of this paper) found that increased pressure on western U.S. water resources and growing interest in the long-term frequency and severity of drought conditions, were conducive to the introduction and acceptance of new sources of scientific information to water managers. WWA is one of nine NOAA funded Regional Integrated Sciences and Assessment (RISA) programs that have undertaken this effort of engaging decision makers in the production and delivery of science. Starting in 2000, WWA scientists developed several partnerships with Colorado Front Range water managers to collaboratively investigate ways that tree-ring data, including streamflow reconstructions, could be incorporated into water resource management. This also included the creation of specific streamflow reconstructions in the watersheds of water providers. Collaborations

with three “established research partners” are the subjects for the in-depth interviews in this assessment project.

Based on the positive outcomes of these initial partnerships and broader interest within the larger community (including local and state water planners, municipal water engineers, consultants, and other water-related agency management), WWA researchers began to share the results of this work with the larger community through a series of technical workshops in 2006. The main goals of these workshops were to explain the methodologies for creating streamflow reconstructions from tree-rings and explore how these reconstructions could be used in water resource. Water managers, decision makers, and climate scientists also gave brief presentations on their experiences incorporating the tree-ring information in resource management, planning, and policy. Seven of these workshops were held in 2006 and 2007 in Boulder, Alamosa, and Durango, Colorado; Cheyenne, Wyoming; Albuquerque, New Mexico; and two in Tucson, Arizona. During the workshops, discussions between scientists and water managers helped participants collectively define and understand challenges of water management in the region and how tree-ring data could be used to address those challenges.

The workshops were accompanied by the development of a web resource, TreeFlow, to provide access to the tree-ring data and information about applications of the data. Feedback received in surveys completed at the conclusion of each workshop indicated that water managers found the training and information about applications useful, but no formal follow-up or post-workshop evaluation was performed at that time. In early 2008, survey data were collected from participants in these workshops as part of

this assessment project. The results of this independent evaluation (from both interviews and surveys) are reported and analyzed here.

It should be noted that the workshop survey respondents are probably biased in a positive manner toward using paleoclimate data and other climate information in water management, relative to the entire population of water practitioners. The way the invitation lists for the workshops were assembled from existing contacts and networks, and the choice of invitees to attend or not, will likely tend to select individuals already interested in, and inclined to see positive value in, the paleoclimate data. So we make no claim that the survey respondents are representative of the water community at large in their attitudes toward, and use of, the paleoclimate data.

Although the results of this evaluation are applicable throughout the western U.S. because many states face similar water management issues in the region, interview and survey respondents were only from the following states: Arizona, Colorado, New Mexico, and Wyoming. Together, the partnerships between WWA researchers and water utilities in Colorado, along with the workshop that began thereafter, occurred from 2000 to 2008, and serve as the study period for this evaluation.

Research Questions and Methods

The fundamental goal of this project is to evaluate the outcomes of interactions between WWA scientists and water managers in the western U.S., including how water managers and utility directors are using tree-ring data in hydrologic models of water supply,

resource planning, and decision making. Four specific research questions guided this project:

1. What motivates the acceptance and use of scientific information for planning in water resource management?

2. How have tree-ring data been used by water managers, and has this influenced organizational procedures or plans related to climate variability and uncertainty?

3. What is the relationship between institutional characteristics of water supply organizations and the use of tree-ring data in water resource management?

4. What data challenges still exist in the incorporation of tree-ring data in water management?

Data collected regarding these questions have allowed us to better consider the coproduction of scientific knowledge for decision making, including (1) why tree-ring information becomes relevant for resource planning, (2) how tree-ring data is actually used in water resource management and the influence of this information on water management plans and assessments of water supplies, (3) what institutional factors influence the way tree-ring data is used in water management and drought planning, and (4) the challenges that still exist in using tree-ring data in water management. Given the increased pressures on water supplies throughout the western U.S., finding ways to improve communication and interactions between climate scientists and water managers has the potential to help address many pressing concerns related to water supply in the region.

Research Phase One: Interviews With Established Research Partners

Four semistructured interviews were conducted with nine individuals associated with three different water utilities in Colorado during January 2008 (see Table 2 for summary of interviews). Each interview was approximately 1 hour long, consisting of open-ended interview questions designed to elicit information regarding the integration of tree-ring data into water management by each organization, the institutional context within which tree-ring data have been used, and each organization's general satisfaction with the tree-ring data and other information they were provided by WWA researchers. Qualitative analysis was performed on the interviews to produce a general summary of each individual organization's background and use of tree-ring data and to decipher general topics or themes that occurred in multiple interviews. Although the number of utilities included in this evaluation is small (n = 3), it represents the entire population of water utilities that have had sustained interactions (over a period of several years) with WWA researchers to generate tree-ring reconstructions of streamflow for gages specific to those utilities, and apply them to water planning.

Table 2: Summary of Interview Participants

Water Provider	**Number of Interviews**	**Comments**
Organization A	1 group interview with 3 water managers/engineers	Private water utility serving a large urban area.
Organization B	1 group interview with 2 water engineers from consulting firms and 1 interview with a water supply manager	City-owned water utility serving a mid-sized urban area.

Organization C	1 group interview with 3 water managers/engineers	Publically owned water conservation district, which is currently experiencing a transition from agricultural to urban water uses. A water board determines how much of each contractee's water quota will be delivered each year based on snow pack, runoff, and estimated diversions.

All of the water providers we interviewed are located in Colorado's Front Range, a semiarid region where snow-fed surface water is the main water supply. Furthermore, these three water utilities represent a range of organizational characteristics for water providers in the western U.S. We use pseudonyms for these utilities (e.g., Organization "A") to maintain the confidentiality of interviewees. This research design was chosen to allow interviewees to speak openly about their collaborations with scientists, without concern that their statements would be attributed to them or their organization.

Research Phase Two: Surveys of Technical Workshop Participants

We also evaluated the outcomes of seven technical workshops for water managers conducted by WWA researchers during 2006 and 2007. A written survey, administered via the internet, was distributed to all previous workshop participants to determine if and how they have utilized the paleoclimatic information provided in the workshops. The survey was sent to 71 individuals, from a wide variety of public and private water entities. The response rate for the internet survey was 40% (n = 29); one response was subsequently removed from the survey due to inconsistent responses to several questions, leaving a total of 28 responses (39% of those contacted) which were tabulated and

analyzed. It is possible that there is a bias in the survey responses because the workshop participants who have had more interactions with the researchers, and have been using the tree-ring data, may have been more likely to respond to the survey (all responses were anonymous, so we cannot test for this bias). So the survey responses may overstate the positive outcomes of the workshop and use of the tree-ring data, but do serve as an important indicator of how paleoclimate data have been used by water managers.

The workshop survey population offers a much larger and more diverse set of responses than was obtained from the interviews. The relationship between the researchers and most of these individuals and organizations has not extended beyond the contact at the workshop they attended. The survey questions were designed to elicit basic background information on workshop participants, if and how tree-ring data have been integrated into the operations or decision making of the organizations, what information from the workshops has been most or least useful, and what other paleoclimatic data might be of use. Table 3 contains a summary of the occupational background of survey respondents, to provide information about the segment of the water management community that provided responses to the survey questions. The majority of workshop participants self-identify as being in water planning or operations (56 and 41%, respectively), followed by research, consulting, and municipal government.

Both methods, interviews and surveys, were designed to address all four stated research questions, and thus, examples from both interviews and surveys are used in the following results sections. The full interview questions and survey questions/responses have been provided as Appendix S1-S3 (see Supporting Information). Only the portions

of the interviews and surveys that most directly and clearly address the specific research are specifically discussed as part of this paper.

Table 3: Survey Responses to the Question "In What Area(s) do you Work?"
(Respondents could select more than one answer)

Planning	56 %
Operations	41 %
Research	26 %
Water Conservation District	15 %
Water Conservancy District	0 %
Private Consulting	26 %
City Government	26 %
County/State Government	15 %
Federal Government	16 %

Results (1): Why Water Managers Seek Out Tree-Ring Data

Both the interview and survey data provide insight into what has prompted water managers to seek out paleoclimate data and information. The most prominent motivating factor that was specifically mentioned by interview and survey respondents to questions about why they choose to seek out tree-ring data was the occurrence and persistence of an extreme event – drought. Dry conditions began around 1999 or 2000 in many western states and persisted for several years, with extreme meteorological and hydrological drought in 2002 (often referred to as the "2002 drought" in Colorado). Organization C, for example, began to use tree-ring data in water resource planning after the 2002 drought drastically reduced the amount of water they were able to provide to contracted water users. Historically, Organization C provides at least 50% of individual water quotas to users, though in 2002 they were only able to provide 30%, a level unprecedented in their

history as a water conservation district. In response to a question about why they began collaborating with WWA researchers on tree-ring based streamflow reconstructions, an engineer from Organization C stated:

> "We hadn't seen anything like that [the 2002 drought]…So we were contemplating a 30% quota, which was just unheard of and a lot of us here were really pretty worried about 30% of a full allotment…We were water supply limited for the first time." (January 16, 2008, personal communication)

Droughts and low flows were very instrumental in motivating Organization A, B, and C's interest in collaborating with WWA researchers to reconstruct streamflows over longer time periods than had been available through the gaged record.

Through survey responses, we did find that drought was not the only factor motivating water managers to consult paleoclimate data in planning efforts. The survey respondents were allowed to provide an open-ended response to the question "What initially prompted your interest in tree-rings or the use of tree-ring data?" The answers were wide-ranging, but frequently referred to the need to better forecast variability and/or assess the reliability of water supplies, the desire to improve planning for future water supplies, and uncertainties related to the potential frequency and severity of sustained drought conditions over longer time scales. Other responses included exposure to paleoclimate data in their own research or studies (e.g., graduate research projects), media exposure to climate data, or desire to acquire additional knowledge of paleoclimate data for personal or professional use. Importantly, our interview and survey responses indicate that there is wide interest in paleoclimate data among water managers for many

applications, meaning that there are many potential entry points for scientists to make paleoclimate data relevant for water management.

Results (2): How Water Managers Use Tree-Ring Data

Interviews and survey data show that paleoclimate data are used in both quantitative and qualitative assessments. Table 4 shows that 14% of survey respondents have begun to use tree-ring data in their work when they had not being doing so before, and an additional 14% of respondents that were already using tree-ring data now recognize additional applications of tree-ring data. Almost all workshop attendees (96%) agreed that the workshops provided them with a better understanding of how streamflows are reconstructed from tree-rings, while more than 70% have a better understanding of the range of natural variability that exists in streamflows from the reconstructions. A large portion of survey respondents (68%) recognize the potential usefulness of tree-ring data, a reflection of the understanding for applications of climate data they gained at the workshops.

Importantly, the interaction of scientists and decision makers during the workshops appears to have facilitated communications on the applications of tree-rings for water management, while also increasing the credibility of tree-rings for use in water resources planning (71% of survey respondents indicated that "tree-ring data are more credible to me and/or my organization"). Only a small number of the survey respondents (7%) have not used the information from the workshops.

Table 4: Survey Responses to the Question "What Outcomes Have Resulted from your Participation in the Tree-ring Technical Workshops?"
(Respondents could select more than one answer)

I have a better understanding of how streamflows are reconstructed from tree-rings	96%
I have a better understanding of the range of natural variability in streamflow	71%
I have a better understanding of how streamflow reconstructions can be used in water management	79%
Tree-ring data are more credible to me and/or my organization	71%
I realize the potential usefulness of tree-ring data to my organization	68%
I now use tree-ring data in my work	14%
I was already using tree-ring data, but now recognize additional applications	14%
I have not used the information I received [learned] at the workshop	7%

One of the most revealing results of the survey (Table 5) was that more than half of the respondents (54%) have used the tree-ring data to inform planning and decision making. Furthermore, approximately 50% of respondents have used the information they learned in the workshops to educate their boards, decision makers, and/or publics, while up to one-quarter of workshop participants are using tree-ring data in some form of quantitative analysis (e.g., water models). Less than 20% of the respondents have not used tree-ring data in their own organization (Table 5).

Table 5: Survey Responses to the Question "How Have Tree-Ring Data Been Used by You, Your Organization, or Organizations that you Consult for?"
(Respondents could select more than one answer)

To Broaden Understanding of Hydrologic Variability	75%
To Educate Users/Public	46%
To Educate Board and Other Decision-Makers	50%
As Input into a Water System Model or Other Model	25%
For Quantitative Analysis, but not in a Modeling Environment	14%
To Inform Planning and Decision-Making	54%
I have not Used Tree-Rings in my Organization	18%

Quantitative Use of Tree-Ring Data

All three water utilities that we interviewed are using tree-ring reconstructions of streamflow in a quantitative environment, incorporating the data into water system models. This allows these water providers to gain a better understanding of their system's reliability over a wider range of hydrologic variability, and assess the performance of drought management plans to accommodate those fluctuations. Organization A, for example, was using a 45-year instrumental record [1947-1991] and the 1950s drought without use restrictions as a worst-case scenario for water supply modeling and planning, prior to the acquisition of tree-ring data. The incorporation of streamflow reconstructions into Organization A's hydrologic model, however, revealed that the worst drought in the 360-year tree-ring record (in the 1840s) could have been accommodated by current drought management plans if severe use restrictions had been implemented. The

importance of this finding is that Organization A's system performed through the 1950s without water use restrictions, but could only get through the 1840s with restrictions. As a result, Organization A is now considering any changes that need to be made in their system and/or operations to get through a 1840s drought without use restrictions. Organization B also integrated the reconstructed flows into their water supply system model to assess their ability to meet demands under a broader range of conditions that presented in the gage record, and to develop a city drought plan with conservation thresholds.

Water managers at Organization C have also used data from tree-ring reconstructions to quantitatively assess water quotas that the organization would have set over the entire paleo streamflow record, under their current quota-setting guidelines. They were surprised to find that quotas lower than 50% of contracted water allotments (their lowest historical allotment prior to 2002) were not nearly as unusual as they assumed from the single occurrence (2002) of a below 50% allotment in approximately 50 years of system operation. This finding held a very important implication for Organization C's water allotees, who generally believed that they would always receive at least 50% of their water allotment, even in drought years. Organization C also has plans to use tree-ring data to construct a more sophisticated "quota-chronology" model over the entire paleo record to help identify "trigger-points" for their drought plan. They will be able to present the output from this model to water users to provide a better picture of what their water quotas might be under certain conditions. A water engineer from Organization C stated:

> "So, I did this little study, just to kind of look at – it wasn't very sophisticated. It just kind of ran through our project under some different quota-setting methodologies and I guess the result out of that study is that the 30% quotas really aren't that unusual when you have a longer time period to look at, based on the way that we set quotas at that time. We had a few public meetings just to knock on people's doors and say, "oh, by the way, you know that 50% you thought you might get, it's going to be 30%!" (January 16, 2008, personal communication)

Quantitative assessments of water supplies using paleoclimate data are providing important information about drought frequency and severity to water suppliers in the western U.S. How these insights will be incorporated into planning efforts and future water models, however, is still being considered and evaluated by many of these organizations.

Qualitative Use of Tree-Ring Data

As shown in Table 4, a large proportion of survey respondents (approximately 50%) have used the tree-ring information to educate water boards and/or publics about the range of hydrological variability and frequency and severity of droughts. This is also the case with the water utilities we interviewed. Tree-ring data have been used to educate Organization A's board about longer records of streamflow variability and to update drought plans. Organization A's board was happy to see that a longer record of streamflows from the tree-ring record could have been accommodated using current drought plans, and the tree-ring record also gave the water board a better sense of the frequency of drought and restriction events. A water manager from Organization A describes their process of using the tree-ring information for education of their high-level decision makers in the following statement:

> "So we took them [the board] through part of the planning process to re-educate or educate them on what our planning approach was – the 1950s drought, without restrictions, what we learned from using the tree-rings – and we got a really positive favorable response that made them feel a lot better to see a longer hydrological period." (January 14, 2008, personal communication)

Furthermore, all three organizations and a high proportion of survey respondents (75%) indicated that the tree-ring record was important for gaining a better understanding of hydrologic variability – including the sequences, spells, and persistence of drought (Table 5). Specifically, the tree-ring record has shown many of these water utilities that using the 1950s drought – or another 20th Century drought as the worst-case scenario – may not be adequate for testing water system reliability. The tree-ring record has also helped define breadth of uncertainty and helps place some bounds on expectations for the future, based on the past. These responses seem to indicate that the credibility of tree-rings for use in water management is increasing with better understanding of how these records are produced by scientists.

Results (3): Importance of Institutional Context and User Constituencies

Interviews with the three Colorado water utilities also indicated that organizational structure and history greatly affect how tree-ring data are incorporated into planning and operations. Organization B, for example, is located in an area with several climate research centers and has established relationships with climate scientists. Consultants that work with Organization B were interested in obtaining a better understanding of the magnitude of drought variability even before drought conditions of the 2000s, so they sought out tree-ring data to lengthen the time domain of water system models. A model

using tree-ring reconstructions was used to help develop Organization B's 2003 drought plan, which has been embraced by the city council and wider community that they serve (historically a very environmentally active community). Furthermore, Organization B is now in the process of using tree-ring data in conjunction with climate change model output in the next phase of planning. A consultant working for Organization B describes the initial motivation to seek out tree-ring data in the following statement:

> "And so, we had a limitation – an analytical problem in terms of only being able to look at the same historical trace [gaged flow record] over and over again. And people have done recombinations, you can do synthesized hydrology traces based on that, but early on I remember reading about the tree ring data that Stockton and Jacoby had done on the Colorado River Basin [in 1976]… and based on that they had cast some doubt as to…"gee, we might actually be having a relatively wet century here"…The next thing they [Organization B's City Council] saw is the drought plan in 2003…at that time, they heard about tree rings and they were fascinated." (January 15, 2008, personal communication)

Conversely, Organization C, a water provider with a more conservative approach to climate change than Organization B, would like to gain a more complete understanding of the tree-ring record as a way to begin assessing the impacts that variability beyond that seen in the gaged record (i.e., over past centuries) may have on their water supply. Organization C is also concerned with the perceptions of their water customers about climate change, so they are very cautious about including paleoclimate data in their current assessments of water supplies. This is primarily because they do not want to create fear that water supplies will decrease in the future and create the possibility that their water users – who currently buy and sell shares of delivery rights in an open market – would "hoard" water.

Survey respondents indicated that there are also social and technical barriers to the use of paleoclimate information (Table 6). Most frequently, these concerns about the use of tree-ring data are related to the perception of tree-ring data by stakeholders (37%) or difficulty incorporating tree-ring data into water models or decision making (30%). A smaller portion of individuals believe tree-ring data is still too uncertain/not credible (22%) or feel that the observed record is sufficient for their needs (15%).

Table 6: Survey Responses to the Question "Do you or individuals in your organization have any of the Following Concerns that Might Limit the use of Tree-Ring Data?"
(Respondents could select more than one answer)

Tree-ring data are too uncertain/not credible	22%
Stakeholders/public may not accept/understand use of tree-ring data	37%
Observed/gaged record is sufficient for our planning needs	15%
It is difficult to use tree-ring data in qualitative or quantitative assessments with gage data	22%
It is difficult to incorporate information related to tree-ring data into decision-making	30%
None of the Above	37%

Overall, the survey and interviews point to the important influence of social and political factors on how paleoclimate data are incorporated into water management (particularly aspects of water management related to water supplies and drought management). Just because managers understand the utility and applications of tree-ring data to their work does not necessarily guarantee that they will use it.

Results (4): Data Challenges and Considerations

Both interviewees and survey respondents indicated that using tree-ring information in decision making and planning can pose some distinct challenges, including the need for both spatial and temporal disaggregation of the tree-ring data to use it in modeling. Of survey respondents, 22% agreed with the statement: "It is difficult to use tree-ring data in qualitative or quantitative assessments with gage data" (Table 6). Organization A developed an "analog method" to disaggregate the annual reconstructed flow values for their water supply model requiring daily inputs at 450 nodes, matching each year in the reconstruction with a similar year in their model period. Engineers from Organization A, however, indicated that "giant leaps"– i.e., assumptions about the spatial and temporal representativeness of the "analog" data – have to be made in this procedure. One engineer from Organization A said:

> "So there's like 450 nodes that we have daily data for, so, using the tree-ring data unfortunately you have to make giant leaps…absolutely giant leaps…so what we did was we…we just went back and found the closest year in the '47 to '91 data that we had, so the year 1680 might have been closest to 1950. And so we used the daily data for 1950 for all the east slope nodes. So, it's a huge leap." (January 14, 2008, personal communication)

Organization A also indicated that they are interested in working with paleoclimate researchers to create ensemble reconstructions of streamflow to obtain a better understanding of the uncertainty of tree-ring records, particularly around extreme low-flow years. This might allow them to get a better sense of the firm yield (the maximum yield deliverable without failure during the gage period, Archfield and Vogel, 2005) of their water system using the tree-ring records. Organization B, however, indicated that

the most important factor to them in using tree-ring data, or any climate data, for drought planning is how well the parameters of the water model, and in particular water rights, are specified. They were less concerned with creating new or better streamflow reconstructions and were more interested in creating new applications of tree-ring data, such as analyses that combine past climate variability from tree-rings and projected future climate changes.

Concerns about public perceptions of the use of climate data in planning procedures poses other data concerns for water managers that wish to use tree-ring data in their planning efforts. Although Organization A has developed a strategy for disaggregating the tree-ring data spatially and temporally to provide the necessary input into their water system model, they are still using the 1950s drought for planning, in part because of Environmental Impact Statement (EIS) process requirements. They said that using tree-ring data in their water model might open the organization up to questions about how they determine their water supplies during public review procedures, which are derived from streamflow reconstructions. A water engineer from Organization A said:

> "Even if we have everything worked out on a [model] run and we are comfortable with it and have confidence in it, you can't really use that model run so easily for an EIS process because people go "well what happened in October of 1634…why in November this did this happen." (January 14, 2008, personal communication)

As a result, it appears that "data accuracy" in tree-ring applications means different things to different water providers. Some organizations want better reconstruction model skill (e.g., a reconstruction that captures low flows better), while other organizations are satisfied with the reconstruction quality and are more interested in using the data in better

water supply models (e.g., a model that handles complex water rights). In any case, acquiring and using tree-ring data has prompted that the organizations more closely examine their drought plans and consider a wider range of variability than is present in the instrumental record.

Discussion of Results and Concluding remarks

Paleoclimate researchers and water utilities in the western U.S. have embarked upon collaborative and productive partnerships for integrating tree-ring data into water management efforts. The science-policy engagements that we report on here took the form of specific research collaborations between scientists and water providers (e.g., creating specific streamflow reconstructions in consultation with a water utility) and the form of a more general workshop format where researchers and resource managers shared information and experiences related to the integration of paleoclimate data and water resource planning. Our findings show that deliberate and reflexive interactions between scientists and resource managers can improve the accessibility, understanding, and utilization of paleoclimate data in water management, while also providing important feedback to scientists about how their information can be made most relevant to decision makers. We also found that these engagements of scientists and decision makers do, in fact, increase the credibility of tree-ring data within individual organizations, though significant social and institutional barriers may still exist within the water utility itself, or among the utility's users, with respect to incorporation of paleoclimatic data into water planning efforts.

We did find that paleoclimate data can be made relevant to water resource management through many types of applications, from water model inputs to educational information on drought severity. Perhaps most significantly, our evaluation of partnerships between paleoclimate scientists and water managers reveals that these collaborations do change the practice of water management in many ways: in quantitative ways such as the inclusion of paleoclimate data in water models, and also qualitative ways including the use of tree-ring information in educational outreach to water utility boards and publics. All of the interviewed research partners and most of the workshop participants who responded to our survey state that they have a better understanding of the range of hydrological variability they may reasonably expect. This improved understanding has been integrated into water models, drought planning efforts, and educational outreach to utility directors and water users. The three water utilities we interviewed for this project have all re-examined their established practice of using the 1950s drought as the worst-case scenario, and they are beginning to incorporate paleoclimate data and streamflow reconstructions into drought management efforts and water supply models to address the finding that more severe droughts have occurred in the past.

This evaluation also reveals many aspects of science-policy interactions that can pose difficulty in meaningful integration of decision making and scientific research efforts. We found that the institutional context and history of a water utility impacts the approach to incorporating paleoclimate data into water management. In the case where there is a history of use of paleoclimate data and information, water utilities have been

able to aggressively pursue integration of paleoclimate information into resource planning. Conversely, other water managers have indicated that steps still need to be taken to make paleoclimate data more credible to their publics and board members. This is evidence that interactions between scientists and resource managers occur in complex social and political contexts that must be acknowledged and accounted for in effective partnerships.

Furthermore, our assessment demonstrates the usefulness of the coproduction framework for understanding and evaluating science-policy partnerships. Because environmental policies and planning efforts have important outcomes for the management of ecosystems and natural resources, it is essential that we know why decision makers consider and use scientific information, how it is communicated by scientists to decision makers (and vice versa), and what policies and planning procedures result. By recognizing that science and resource management exist not as separate spheres of practice, but instead are actively coproduced, science-policy partnerships can lead to better water management practice. Going beyond the "delivery" of scientific information, to recognizing its coproduction, can allow scientists and water managers to engage in conversations about planning and research practice. Through active engagement in the coproduction of science and policy, research scientists are afforded the opportunity to help with policy considerations, while resource managers can help define and create scientific research agendas. Furthermore, the role of society, as part of the science-policy engagement should be given more attention in future interactions between managers and research scientists. Given the complexity and severity of the environmental

problems facing the western U.S. and other parts of the country, we think these interactions are both necessary and timely. The lessons learned in this work are also broadly applicable to other scientific fields, and are relevant to planning for adaptation to climate change and its impacts on water resources.

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APPENDIX E: LIST OF SURVEY QUESTIONS (MCPA AND ICLEI CITIES)

Climate Protection Survey

1. What jurisdiction do you work for?

2. What is your job title?

3. What is your educational background? (please select the best answer)

- ◯ City Planning
- ◯ Public Policy / Government
- ◯ Architecture
- ◯ Physical Science
- ◯ Liberal Arts / Social Sciences
- ◯ Education
- ◯ Humanities
- ◯ Engineering
- ◯ Business
- ◯ Law
- ◯ Arts

Other (please specify)

4. Has your government conducted a greenhouse gas (GHG) Inventory? (please select the best answer)

- ◯ We have conducted a GHG inventory for government operations AND the community at large
- ◯ We have conducted a GHG inventory for government operations ONLY
- ◯ We have conducted a GHG inventory for the community at large ONLY
- ◯ We have not yet completed a GHG inventory

5. How has your jurisdiction formalized its climate-related actions and/or policies? (you may select all that apply)

- [ ] We have adopted a climate action plan
- [ ] We have created a climate adaptation plan
- [ ] We have adopted a GHG reduction goal
- [ ] We have included language related to climate change in our comprehensive plan
- [ ] We have an energy efficiency component in our comprehensive plan
- [ ] None of the Above

Other(s) not listed here (please specify)

6. Please rank the following five statements about why your jurisdiction is implementing (or working to implement) climate change mitigation and/or adaptation programs in order of importance (1 = most important, 5 = least important, using each number only once). Please select NA if the statement does not apply to your city/county.

	1 (most important)	2	3	4	5 (least important)	NA
We are implementing climate-related policies because the impacts of climate change are affecting (or will affect) our government operations and our ability to deliver services to our residents.	◯	◯	◯	◯	◯	◯
There is strong consensus about the causes and consequences of climate change in the scientific community, so we are showing leadership on this issue by taking action at the local level.	◯	◯	◯	◯	◯	◯
Federal regulation on climate change is inevitable. Implementing greenhouse gas reduction programs now, in advance of legislation, will provide our jurisdiction with an advantage when this legislation is passed.	◯	◯	◯	◯	◯	◯
Reducing our community's greenhouse gas emissions makes economic sense. The cost of inaction far exceeds the cost of action.	◯	◯	◯	◯	◯	◯
Implementing climate change policies will help our community remain competitive in urban development as we market our City/County as "green" or "climate-friendly."	◯	◯	◯	◯	◯	◯

You may also list other reasons your jurisdiction is implmenting climate programs here

7. Is your jurisdiction receiving formula allocations via the Energy Efficiency and Conservation Block Grant (EECBG)?

◯ Yes

◯ No

8. The EECBG funds will be used to advance/continue programs and policies that were ALREADY underway in my jurisdiction.

◯ Yes

◯ No

9. The EECBG funds will allow my jurisdiction to implement policies that have already been developed by our government, but have NOT YET BEGUN prior to EECBG funding.

◯ Yes

◯ No

10. My jurisdiction will be utilizing EECBG funds to develop NEW programs that were not previously part of our environmental programs or policies.

◯ Yes

◯ No

11. Will your jurisdiction be applying for competitive state EECBG funds?

◯ Yes

◯ No

12. How often do you (or others in your jurisdiction) consult the following sources of information when designing, implementing, or monitoring your climate-related programs and policies (including those that may be part of the EECBG)?

	Never Consult	Rarely Consult (1-4 times a year)	Sometimes Consult (monthly or by-monthly basis)	Frequently Consult (multiple times a month)
Scientific research papers about climate change (e.g. Intergovernmental Panel on Climate Change (IPCC) reports or peer-reviewed academic journal articles)	◯	◯	◯	◯
Secondary sources that summarize scientific reports on climate change (e.g. newspaper and magazine articles and web resources such as www.realclimate.org)	◯	◯	◯	◯
Discussions (in person, phone, email) with research scientists or environmental experts within my own government or regional research centers/universities.	◯	◯	◯	◯
Federal government sources about greenhouse gas emissions and trends (e.g. Department of Energy or Environmental Protection Agency sources).	◯	◯	◯	◯
State and regional government resources about climate change impacts or emissions (e.g. Department of Ecology, Clean Air Agency, or Puget Sound Regional Council).	◯	◯	◯	◯
Information provided by not-for-profit groups, such as the US Conference of Mayors, ICLEI-Local Governments for Sustainability, the Sierra Club, or Climate Solutions.	◯	◯	◯	◯

Please list other major sources of information that you use that are not listed here

13. Please indicate which of the following transportation programs are currently (or you expect will be) incorporated into your jurisdiction's climate-related policies and/or Energy Efficiency and Conservation Block Grant projects. (If applicable, you may select more than one column answer to each statement)

	Part of our climate or GHG reduction plan	Part of our EECBG plan or EECBG requested funding	Not currently part of either our climate plan or EECBG funding
Increasing public transit routes or options (light rail, streetcar, etc.)	☐	☐	☐
Increasing or improving bike-friendly routes or dedicated bike paths	☐	☐	☐
Improving pedestrian paths or sidewalks	☐	☐	☐
Implementing driving or parking charges (e.g. "road pricing")	☐	☐	☐
Implementing driving efficiency measures (e.g. traffic light timing)	☐	☐	☐

Other transport programs your jurisdiction is implmenting not listed here (please specify)

14. Please indicate which of the following urban design/neighborhood development programs are currently (or you expect will be) incorporated into your jurisdiction's climate-related policies and/or Energy Efficiency and Conservation Block Grant projects.
(If applicable, you may select more than one column answer to each statement)

	Part of our climate or GHG reduction plan	Part of our EECBG plan or EECBG requested funding	Not currently part of either our climate plan or EECBG funding
Requiring efficiency (or green) standards for CURRENT GOVERNMENT buildings	☐	☐	☐
Requiring efficiency (or green) standards for NEW GOVERNMENT buildings	☐	☐	☐
Requiring efficiency (or green) standards for NEW PRIVATE buildings	☐	☐	☐
Revising or changing building codes to encourage more compact buildings and/or developments	☐	☐	☐
Revising or changing jurisdiction codes to require more green space and/or urban forest cover	☐	☐	☐

Other urban design/neighborhood development programs your jurisdiction is implmenting not listed here (please specify)

15. Please indicate which of the following programs related to government operations are currently (or you expect will be) incorporated into your jurisdiction's climate-related policies and/or Energy Efficiency and Conservation Block Grant projects. (If applicable, you may select more than one column answer to each statement)

	Part of our climate or GHG reduction plan	Part of our EECBG plan or EECBG requested funding	Not currently part of either our climate plan or EECBG funding
Implementing fuel efficiency or alternative fuels programs for city/county vehicle fleets	☐	☐	☐
Offering alternative energy sources to electric utility customers	☐	☐	☐
Assessing and/or creating a community-wide response to predicted climate impacts (e.g. temperature or precipitations changes)	☐	☐	☐
Creating new community action programs to engage local residents in actions to reduce GHGs	☐	☐	☐
Providing incentives to the business community to reduce their GHGs	☐	☐	☐
Purchasing voluntary offsets to reduce our jurisdiction's carbon footprint	☐	☐	☐
Lobbying other government agencies and/or levels of government for actions/funds related to climate change.	☐	☐	☐

Other programs related to government operations that your jurisdiction is implmenting not listed here (please specify)

APPENDIX F: LIST OF SURVEY QUESTIONS (WATER MANAGERS)

1. In what areas do you work? (select all that apply)

- ☐ Planning
- ☐ Operations
- ☐ Research
- ☐ Water Conservation District
- ☐ Water Conservancy District
- ☐ Private Consulting
- ☐ City Government
- ☐ County/State Government
- ☐ Federal Government

Other (please specify)

2. What initially prompted your interest in tree rings or the use of tree ring data?

3. What outcomes have resulted from your participation in the tree-ring technical workshops? (select all that apply)

- ☐ I have a better understanding of how streamflows are reconstructed from tree rings
- ☐ I have a better understanding of the range of natural variability in streamflow
- ☐ I have a better understanding of how the streamflow reconstructions can be used in water management
- ☐ Tree ring data are more credible to me and/or my organization
- ☐ I realize the potential usefulness of tree-ring data to my organization
- ☐ I now use tree-ring data in my work
- ☐ I was already using tree-ring data, but now recognize additional applications
- ☐ I have not used the information I received [or learned] at the workshop
- ☐ Other

Please provide a brief description of your choices

4. How have tree-ring data been used by you, your organization, or organizations that you consult for? (select all that apply)

- [ ] To broaden understanding of hydrologic variability
- [ ] To educate users/public
- [ ] To educate board or other decision-makers
- [ ] As input into a water system model or other model
- [ ] For quantitative analysis, but not in a modeling environment
- [ ] To inform planning and decision-making
- [ ] I have not used tree ring data in my organization

Please provide a brief description of your choices

5. How do you, your organization, or organizations that you consult for ANTICIPATE using tree ring data in the future? (select all that apply)

- [ ] To broaden understanding of hydrologic variability
- [ ] To educate users/public
- [ ] To educate board or other decision-makers
- [ ] As input into a water system model or other model
- [ ] For quantitative analysis, but not in a modeling environment
- [ ] To inform planning and decision-making
- [ ] I do not have future plans for using tree ring data at this time

Please provide a brief description of your choices

6. Have you shared the information from the workshop with others inside or outside your organization?

- ◯ Yes, they have been very receptive
- ◯ Yes, they are interested, but have more questions
- ◯ Yes, but they are not very interested
- ◯ No, I have not shared the information

Other (please specify)

7. Do you or individuals in your organization have any of the following concerns that might limit use of tree ring data? (select all that apply)

- [ ] Tree ring data are too uncertain/not credible
- [ ] Stakeholders/public may not accept/understand use of tree ring data
- [ ] Observed/gaged record is sufficient for our planning needs
- [ ] It is difficult to use tree-ring data in qualitative or quantitative assessments with gage data
- [ ] It is difficult to incorporate information related to tree-ring data into decision-making
- [ ] None of the above

Other (please specify)

8. Would any of the following help you make better use of tree-ring data since you have attended the technical workshop (besides the specific data products and/or workshops discussed in the Durango, Cheyenne, and Albuquerque workshops that will be delivered in the next year)?

Because this survey is anonymous, we will not be able to identify you with a response to this question. We ask that you email Connie Woodhouse (conniew1@email.arizona.edu) or Jeff Lukas (Lukas@Colorado.edu) if you would like us to follow up with you regarding your additional needs.

- [ ] I need more tree-ring data (specific reconstructions, data sets)
- [ ] I need technical assistance using tree-ring data in models or other applications
- [ ] I need assistance communicating the tree-ring record to others in my organization
- [ ] I would like to see a follow-up workshop (describe below)
- [ ] I do not require any additional information at this time

Other (please specify)

9. Overall, how useful has the information you were presented in the WWA technical workshop been to you or your organization?

- ◯ Very useful
- ◯ Somewhat useful
- ◯ Not useful

Comments and Other Suggestions for Future WWA Workshops

10. Besides participating in technical workshop(s), what other interactions have you had with the Western Water Assessment (WWA), WWA tree-ring researchers (Connie Woodhouse and Jeff Lukas), or tree-ring data? (select all that apply)

- ☐ I have had interactions or meetings with WWA researchers
- ☐ I have received tree-ring data/products from WWA researchers directly, or through intermediaries
- ☐ I have downloaded WWA tree-ring data products from WWA or NOAA websites
- ☐ I have viewed information on the WWA tree-ring website
- ☐ I have had interactions with non-WWA tree-ring researchers
- ☐ None of the above

Other (please specify)

=