



Contents lists available at ScienceDirect

Environmental Science and Policy

journal homepage: www.elsevier.com/locate/envsci

Governing ecosystem adaptation: An investigation of adaptive capacity within environmental governance networks

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ARTICLE INFO

Keywords:

Adaptive capacity
governance network
ecosystem management

ABSTRACT

Climate change is impacting ecosystems in dynamic ways. In order to mitigate the risks brought about by these ecosystem changes, ecosystem management, which has historically focused on preservation and preventing change, must now be much more flexible and responsive. The capacity to adapt management approaches to current and future climate conditions is fundamentally a function of access to resources and social capital, both of which are considerably influenced by underlying socio-political conditions. While a growing body of research addresses the adaptive capacity of individuals, communities, and organizations, less research has investigated adaptive capacity within the arrangements of diverse public and private organizations that typically manage ecosystems, also known as governance networks. Furthermore, most research on adaptive capacity seeks to evaluate it deductively across a framework of high-level indicators without attending to the underlying conditions that contribute to the variation in these measures. To address these gaps, we conducted a case study analysis of three governance networks in the Pacific Northwestern US, investigating the socio-political conditions underlying key dimensions of adaptive capacity. Using a set of 49 interviews with actors engaged in ecosystem management across the three regions, we found evidence that adaptive capacity in the context of the governance networks was shaped by four key underlying socio-political conditions: political power, legal power, institutional support, and the extent of protected land. In so doing, this study advances understanding of adaptive capacity, moving toward an approach that answers to a call for greater attention to history, politics, and power dynamics.

1. Introduction

The effects of climate change on ecosystems have considerable impacts on the communities that steward and depend on the services these ecosystems provide. To mitigate these impacts, ecosystem management must be flexible and responsive; the entities engaged in management must have significant adaptive capacity. Because ecosystems often span across ownership boundaries, a wide range of public and private actors are implicated in ecosystem governance; usually, no single centralized governing entity has unilateral authority over management. This range of public and private stewards across different land ownership types engaged in ecosystem management is known as a governance network. As climate change alters the ecosystems that these governance networks manage, understanding their adaptive capacity is critical.

This paper focuses on adaptive capacity in the context of governance network ecosystem management. While the study of adaptive capacity is robust, much of the current research focuses on the individual and

household level (Siders, 2019) while less has examined the governance network level. Because it is often governance networks that manage ecosystems, this lacuna represents a barrier to understanding the ways in which ecosystem level adaptive capacity might be cultivated.

To evaluate adaptive capacity, studies often employ indicator frameworks to measure it across a range of dimensions. For example, the “Five Capitals” framework (Scoones, 1998) has served as the foundation for numerous analyses of adaptive capacity at the individual and household level. Such framework-driven analyses focus on high-level indicators, rather than underlying conditions, an approach that has borne critique from political ecologists in recent years (Taylor, 2014; Watts, 2015). These underlying conditions are especially relevant in assessing adaptive capacity in governance network ecosystem management: networks are shaped by unique historical contexts and complex relationships among actors, and indicator-driven assessments shed little light on, for example, why some networks are characterized by greater social capital than others. Thus, to better understand the nature of

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<https://doi.org/10.1016/j.envsci.2022.03.021>

Received 27 February 2021; Received in revised form 14 March 2022; Accepted 27 March 2022

Available online 19 April 2022

1462-9011/Published by Elsevier Ltd.

adaptive capacity in this context, it is necessary to examine the underlying socio-political conditions that produce this variance in adaptive capacity measures.

To address this gap in the literature, we examined the adaptive capacity of three governance networks engaged in ecosystem management in the rural Pacific Northwest, each of which had participated in creating a regional climate adaptation plan. We identified salient dimensions of governance network adaptive capacity and investigated the socio-political conditions underlying these dimensions. We used semi-structured interviews with key stakeholders engaged in the development of each adaptation plan to illuminate the conditions that contribute to the networks' adaptive capacity. Adaptive capacity in this context manifested as adaptation-oriented ecosystem management work. While our interviewees did not always conceptualize these efforts explicitly as climate adaptation work, these conservation and restoration projects indeed served climate adaptation purposes—enhancing riparian vegetation, for example, helps minimize the impact of storm-induced flooding. We found that adaptive capacity in this context was shaped by four socio-political conditions: political power, legal power, institutional support, and the extent of protected land. Revealing the influence of these underlying conditions represents an important step in responding to the critiques posed by political ecologists, and shifting our focus towards analysis of the processes that produce adaptive capacity.

2. Literature review

2.1. Adaptive capacity

Adaptive capacity in the context of climate change is commonly defined as: “the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences” (McCarthy et al., 2001; Siders, 2019). A common approach to investigating adaptive capacity involves creating a framework of indicators of distinct dimensions of adaptive capacity and using it generate quantitative measurements (e.g., Hirschfeld et al., 2020; Silas et al., 2020; Gupta et al., 2010; Nelson et al., 2010). The diversity of indicators that have been employed is tremendous: in a review, Siders (2019) found 158 distinct indicators across the literature. This approach, however, has borne criticism from political ecologists, who argue that treating adaptive capacity as static and quantifiable is misleading. While effective in evaluating the elements that contribute to adaptive capacity, this approach overlooks the underlying conditions responsible for variability in these measures – political ecologists argue that we must understand adaptive capacity as dynamic and socially structured, and interrogate the processes that produce it (Watts, 2015; Taylor, 2014). To begin to analyze the processes that produce these adaptive capacity measures, it is first necessary to assess the socio-political conditions underlying the variation in these measures – for example, the governmental policies that provide access to financial resources that support adaptive capacity.

Some studies in adaptive capacity have taken important steps toward analyzing these underlying socio-political conditions. Vásquez-León et al. (2003), in their investigation of the vulnerability of farmers and ranchers near the US-Mexico border, elucidate the political processes that have made wealthier white ranchers more resilient than small scale Hispanic farmers. Antwi-Agyei et al. (2015), in a study of two districts in Ghana, found that the complex land tenure system constrains the adaptive capacity of women and migrant farmers, and thus recommend policy changes that would provide these groups with greater security. And in a study of smallholder farmers in the Indian state of Odisha, Panda et al. (2013) found that crop insurance was a particularly effective method of increasing their adaptive capacity. While these studies represent a critical step in evaluating these underlying conditions more directly, they focus primarily on the individual level; in governance network ecosystem management, such analyses are far fewer.

2.2. Governance networks and ecosystem management

Governance network theory emerged from political science scholarship in the 1960s, (Klijn and Koppenjan, 2012), and in recent years, this approach has been employed in the study of ecosystem governance (e.g., Fischer et al., 2016; Fischer and Jasny, 2017; Lubell et al., 2016; Bodin et al., 2020). While holding no legal mandate or official authority to manage resources collaboratively, governance networks – which may be a coherent collaborative unit, or just a loosely connected set of actors – hold significant influence over management of a given ecosystem. A governance network managing an ecosystem may include federal, state, local and tribal government, conservation-oriented nonprofit institutions, land trusts, and private landowners – all actors that have some amount of leverage in local ecosystem management.

2.3. Adaptive capacity at the governance network level

The adaptive capacity of governance networks engaged in ecosystem management has received increasing attention in recent years. Both Petersen and Wellstead (2014) and Abrams et al. (2017) studied the pine beetle epidemic across the western US in the late 20th century, finding that emergent governance networks operating between the community and state level contributed both critical capacity and legitimacy to respond to the crisis. Fischer and Jasny (2017) examined interactions in a network of organizations involved in wildfire management in Oregon, finding that organizations tended to associate with others holding similar management goals, attitudes towards wildfire, and in similar geographic regions.

Several other studies have presented models to evaluate adaptive capacity in a similar, mid-range spatial scales. Engle and Lemos (2010) present a framework for the analysis of water governance networks in Brazil, and Folke et al. (2005) lay a groundwork for understanding adaptive capacity in socio-ecological systems, examining governance arrangements that are particularly conducive to cultivating adaptive capacity. And Gupta et al. (2010) present the adaptive capacity wheel, a framework for the analysis of adaptive capacity in institutions. These frameworks largely agree that important indicators at the governance level include information and knowledge, experience and expertise, transparency, trust, commitment, legitimacy, accountability, collaboration, flexibility and leadership (Clarvis and Engle, 2013). Literature in the theoretically adjacent fields of resilience and disaster risk reduction also demonstrates the importance of iteration and flexibility in building resilience in multi-level institutional arrangements (Garmestani, 2009; Seng, 2013). Finally, of particular note are two indicators that appear as relevant across scales. The first is social capital, the social resources that actors draw from when pursuing livelihood strategies (Scoones, 1998), which may encompass indicators such as trust and collaboration. The second is access to resources – financial and otherwise – which may provide an entity with the crucial funding and staffing capacity to enact adaptation strategies (Siders, 2019).

For the most part, however, existing frameworks do not examine the underlying conditions that shape these indicators of adaptive capacity, but instead, treat the indicators as static features of the system. Important questions thus remain: what might be responsible for the variation in adaptive capacity – as measured by these indicators – in different governance networks?

Thus, key gaps exist in our understanding of adaptive capacity: few studies have analyzed the ways in which underlying socio-political conditions contribute to variation in adaptive capacity, and few have examined adaptive capacity in the context of governance network ecosystem management. Addressing these gaps would contribute to a more robust understanding of how these variations in adaptive capacity arise – why is it, for example, that one governance network has greater social capital than another? We sought to address these gaps by conducting an analysis of three governance networks engaged in ecosystem management in the Pacific Northwestern US, investigating the socio-

political conditions underlying adaptive capacity in each region.

3. Study area and study sites

We conducted our study in the Pacific Northwestern United States, the region composed of the states of Washington, Oregon, and the northern part of California. Climate change presents a range of threats to the region's ecosystems. The region's average temperature has risen nearly two degrees Fahrenheit since 1900, and its forests now face increasing risks from wildfire, drought, insect and disease outbreaks, and changing precipitation regimes (Abatzoglou et al., 2014; May et al., 2018). Land in this region is a mosaic of public and private ownership: in each state, between 30% and 50% of land is federal, between 45% and 60% is privately owned, between 3% and 13% is state owned, and the remainder is held by local and tribal government (Vincent et al., 2020; Washington State Recreation and Conservation Office, 2014; Jung, 2022; Graves, 2016). Cross-boundary ecosystem management in the region is coordinated to varying extents by different types of governance networks, including watershed councils and forest collaboratives (Flitcroft et al., 2017; Davis et al., 2017; Habron, 2003).

We chose a multiple case study approach, selecting three study sites in which to examine the socio-political conditions underlying governance network adaptive capacity. This comparative approach allowed us to assess the ways in which differences in these conditions across sites generate differences in adaptive capacity, despite dealing with similar climate-related ecosystem management challenges.

3.1. Study site selection

We chose three case study locations in which adaptation plans had been developed at least five years prior. Choosing three sites allowed us to investigate each more thoroughly than would be possible with a greater number of sites given our resources, while providing insight into variation in adaptive capacity across the region, making our findings more generalizable than they would be with just one case study site. In each study site, a set of organizations had developed these adaptation plans in coordination with the Model Forest Policy Program (MFPP), a nonprofit organization devoted to assisting rural communities across the US adapt to the impacts of climate change (Model Forest Policy Program, 2020). These plans provided useful general background information on the region's climate-related concerns and the potential tools and strategies available to build resilience. And as documents written collaboratively by actors across each region engaged in ecosystem management, they helped establish the boundaries of the governance network in each region (in each region, the vast majority of governance network actors played some role in creating the adaptation plan). The full list of key actors in each of these governance networks is laid out in Table 1.

3.2. Study sites

3.2.1. Study site 1: Nisqually river watershed, Washington

The Nisqually River lies in northwestern Washington State, originating on the slopes of Mount Rainier, and emptying into Puget Sound. With its headwaters in a national park, and estuary in a national wildlife refuge, it is one of the most protected rivers in the Pacific Northwest. Land ownership across the remainder of the river corridor is divided between a state forest, land trust, military base, state and local government, private citizens and the Nisqually Tribe. During the mid-20th century, the river was the center of a consequential treaty rights battle centering on the Nisqually Tribe's right to fish on the river, which eventually resulted in a federal court decision (the Boldt Decision) allocating the tribes of Puget Sound 50% of the annual salmonid harvest (United States v. Washington, 1974; Wilkinson, 2006). This decision set the stage for the statewide Salmon Recovery Program in the mid-2000s and situated the Nisqually Tribe in a central role in resource

Table 1
Key governance network actors in each case study region. Actors here were either interviewed, or noted by interviewees as central to regional ecosystem management. Actors that were interviewed are denoted with an asterisk (note: this is not an exhaustive list of entities engaged in ecosystem management in each region; rather, it is a list of those that were particularly relevant to climate adaptation planning processes).

Case study region	Collaborative body	Federal actors	State actors	Local government	Native American tribes	Nonprofit organizations	Industry
Nisqually watershed	<ul style="list-style-type: none"> Nisqually River Council 	<ul style="list-style-type: none"> Nisqually Wildlife Refuge* Mount Rainier National Park* Joint Base Lewis-McChord 	<ul style="list-style-type: none"> Washington Dept of Fish and Wildlife* Washington Dept of Natural Resources* Puget Sound Partnership* Oregon Dept of Forestry 	<ul style="list-style-type: none"> Pierce County* Thurston County* Town of Eatonville* City of Yelm City of Ashland* City of Medford 	<ul style="list-style-type: none"> Nisqually Indian Tribe* 	<ul style="list-style-type: none"> Nisqually Land Trust* Nisqually River Foundation* 	<ul style="list-style-type: none"> Tacoma Public Utilities
Rogue basin	<ul style="list-style-type: none"> Southern Oregon Forest Restoration Collaborative 	<ul style="list-style-type: none"> Rogue River-Siskiyou National Forest* Bureau of Land Management* 	<ul style="list-style-type: none"> Oregon Dept of Forestry 	<ul style="list-style-type: none"> City of Ashland* City of Medford 	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> The Nature Conservancy* GEOS Institute* KS Wild* The Freshwater Trust* Lomakatsi Southern Oregon Climate Action Now* 	<ul style="list-style-type: none"> Southern Oregon Timber Industry Association*
Siskiyou county	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> Klamath, Six Rivers, and Shasta-Trinity National Forests* NOAA Fisheries* 	<ul style="list-style-type: none"> North Coast Water Board* State Dept of Fish and Wildlife* 	<ul style="list-style-type: none"> City of Mount Shasta* Siskiyou County* 	<ul style="list-style-type: none"> Karuk Tribe* 	<ul style="list-style-type: none"> Mount Shasta Bioregional Ecology Center* Siskiyou Land Trust* Scott River Watershed Council* Cal Trout* Klamath River Renewal Corporation* 	<ul style="list-style-type: none"> N/A

management. Recognizing the economic and ecological importance of the river, in the mid-1980s, the Washington State legislature created the Nisqually River Council (NRC) and the Nisqually Land Trust to ensure ecologically sound management. The NRC is now made up of stakeholders from federal agencies, state and local government, the Nisqually Tribe, and the land trust, and is regionally renowned for its exceptionally effective collaboration; indeed, it is seen as something of a gold standard for collaborative watershed management across the Northwest. In 2014, the NRC partnered with the Model Forest Policy Program to create a climate adaptation plan. This plan, the *Forest and Water Climate Adaptation: A Plan for the Nisqually Watershed*, outlines the region's key climate threats, centering on the accelerating shift from a snow-fed to a rain-fed system, leading to declining base-level stream flow and increased water temperature, along with hillside erosion and flash floods (Greene, 2014).

3.2.2. Study site 2: Rogue basin, Oregon

The Rogue Basin encompasses the region between the Klamath Mountains and the Cascades along the Rogue River in Southwest Oregon. It is the ancestral territory of a number of indigenous tribes, whose presence is now limited due to a brutal removal policy implemented in the late 1850s (Lewis, 2007). Over 60% of the total land in the basin is under federal control, and the population is quickly growing, especially along the wildland urban interface. The remainder of the region is mostly private land (largely industrial timberland), much of which exists in a “checkerboard” pattern with federal land, along with some state, county, and local government land. The Southern Oregon Forest Restoration Collaborative (SOFRC), established in 2007, is the governance network that served as the center of the analysis. Though federal, state, nonprofit and industry actors are engaged in SOFRC, collaborative management has faced considerable challenges, centering on divergent approaches to adaptive forest management (Fattig, 2013). SOFRC advocates for active forest management to restore ecosystem function and minimize the risk of uncharacteristically severe wildfires. Another local organization, the GEOS Institute, advocates for a more hands-off approach, arguing that “catastrophic” wildfires actually serve an important ecological function (DellaSala and Hanson, 2015). In 2013, SOFRC collaborated with MFPP to create a regional climate adaptation plan. *The Rogue Basin Action Plan for Resilient Watersheds and Forests in a Changing Climate* outlines several key climate threats, chief among them the threat of catastrophic wildfire, as well as reduced stream flows and increased water temperature, which could devastate both fisheries and the outdoor recreation sector (Myer, 2013).

3.2.3. Study site 3: Siskiyou county, California

Siskiyou County sits along California's northern border with Oregon, and contains three major watersheds, earning it the nickname of the “faucet” of Northern California. While the county is resource rich, it is struggling economically – though Mount Shasta, an outdoor recreation attraction, supports a considerable tourism industry, much of the county remains poor (Cook, 2014). The county is the ancestral territory of a number of indigenous groups, many of whom still reside in the region, including the Klamath, Karuk, Yurok, and Modoc on the western side, and the Shasta, Winnemem Wintu, Achumawi, and Atsugewi tribes on the eastern side (Cook, 2014). Around 60% of land in the county is national forest, and the remainder is split between private land (largely industrial timberland), county and local government land, and tribal land. Ecosystem management in Siskiyou is defined by a number of severe conflicts, including strife over the bottling of spring water near Mt. Shasta, and water allotment and management in the Klamath Basin (Little, 2018; Chaffin et al., 2016). In 2013, the Mount Shasta Bioregional Ecology Center collaborated with MFPP to create a climate adaptation plan, *Renew Siskiyou: A Roadmap to Resiliency*, which identifies two key threats: catastrophic wildfire and water stress (Cook, 2014). Unlike the other two case study regions, Siskiyou County lacks a single overarching collaborative resource management body; thus, the

governance network in this region is less defined, but this presents a fruitful contrast to the other case study regions.

4. Data collection and analysis

The primary source of data for this our cross-case comparison was a set of 49 semi-structured interviews. We conducted 16–17 interviews in each study site with the broad array of local actors engaged in ecosystem management, many of whom had taken part in the writing of the adaptation plan (Table 2). We identified the interviewees through snowball sampling, beginning with a representative of the nonprofit organization responsible for leading the adaptation plan, and moving out to representatives from other entities that were either involved in creating the plan or are otherwise engaged in regional ecosystem management activities. In preparation for these interviews, we read each region's climate adaptation plan, and reviewed court cases, legislation, and other secondary work on the history and ecosystem governance of each region. Interviewees were asked for their informed consent to participate in the study, which was designated as exempt by the University of Michigan Institutional Review Board.

Although we set out to learn about adaptive capacity and its underlying conditions and were aware of existing frameworks in theory, we did not presuppose any particular concepts were important to our informants. Our interview guide (Appendix A) began by asking interviewees about their engagement with the writing of the climate adaptation plan to better understand the process by which the plan came about. We then asked about the impacts of the plan, to assess the degree to which the plan had been implemented along with the unintended, peripheral impacts of the plan. The final questions addressed the state of ecosystem management in the region more generally, to better understand the context in which the plan had been written, asking about key projects, collaborations, and conflicts that have defined ecosystem management. Almost all interviews were conducted in person, averaging about one hour per interview.

Immediately following each interview, we developed analytical memos (Miles et al., 2014), summarizing our initial impressions; we then transcribed interviews verbatim to allow for detailed coding. In our first round of coding, we developed a set of categorical codes to distill the raw interview data into categories relating to each of the questions (Miles et al., 2014). Then, as we proceeded through the first round of coding, we developed a codebook, generating emergent codes to capture the underlying conditions that emerged as influential in each region, as well as two dimensions of adaptive capacity that were particularly important, (Appendix B). We conducted the coding with NVivo 12 data analysis software (QSR International Pty Ltd, 2018). Finally, we developed another set of analytical memos on these codes to further investigate the importance of each of the conditions in shaping adaptive capacity and the ways that these conditions interacted and shaped one another in each context.

5. Results

5.1. Introduction and summary of key findings

In our investigation of adaptive capacity in climate adaptation-focused ecosystem management in each of our study sites, we identified four key underlying conditions that contribute significantly to adaptive capacity in this context: political power, legal power, the support of higher-level governance institutions, and the extent of protected land (Table 3). These conditions are deeply intertwined – for example, proximity to political power served as an important lever by which a governance network could gain the support of state and federal governance institutions. We also identified two particularly salient dimensions of adaptive capacity—social capital and access to resources—that help illustrate the ways in which these underlying conditions (Figs 1–4) shape adaptive capacity (Fig. 5).

Table 2
Number and type of stakeholders interviewed by site.

Case study region	Stakeholder type							Total
	Non-Profit Organization	Federal Agency	State Gov.	County/Local Gov.	Indigenous Tribe	Industry Representative	Private Citizen	
Nisqually Watershed, WA	5	4	2	3	1	0	2	17
Rogue Basin, OR	7	4	1	3	0	1	0	16
Siskiyou County, CA	8	3	0	3	2	0	0	16

5.2. Relevant dimensions of adaptive capacity

While, as discussed in Section 2.3, the adaptive capacity literature abounds with potential indicators, two indicators emerged as particularly relevant across the three case study regions: social capital, and access to resources. When asked about the factors contributing to success in implementing adaptation-oriented resource management projects, interviewees consistently described the strong relationships and trust among governance network actors. These social resources are commonly referred to as social capital. The value of social capital was especially clear in the Nisqually Watershed: the Nisqually River Council's success in collaborative resource management work is extensive, and nearly every interviewee attributed much of this success to the exceptionally strong relationships among stakeholders. Social capital appeared less robust in the Rogue Basin – while a collaborative ecosystem governance body was present, it was much less stable, and much more conflict-prone. In Siskiyou County, social capital was very underdeveloped, as no overarching collaborative governance body even existed. The other salient dimension of adaptive capacity was access to resources, in the form of both financial and staffing capacity. While in the Nisqually Watershed, the NRC had access to a steady stream of state funding for adaptation-oriented conservation work and the staffing to implement it, interviewees in the Rogue Basin and Siskiyou County cited the lack of adequate access to funding as a critical impediment to such work. Both social capital and access to resources were thus crucial in defining the adaptive capacity of each of the study sites in the study region – in each case, their relative robustness had a considerable impact on the ability for actors engaged in ecosystem management to effectively adjust management strategies in response to climate impacts. These dimensions of adaptive capacity were in turn shaped considerably by four key underlying socio-political conditions (Table 3), examined in the next sections.

5.3. Socio-political conditions shaping adaptive capacity

5.3.1. Political power

Nisqually Watershed: High (Politically Well-Connected).

Rogue Basin: Moderate (Moderately Politically Connected).

Siskiyou County: Low (Politically Isolated).

In all three governance networks, interviews indicated that proximity to political power played a considerable role in shaping adaptive capacity. In the Nisqually Watershed, powerful allies in both state and federal government were instrumental in the NRC's robust success in watershed restoration initiatives. Indeed, the NRC was formed by state legislation, and interviewees identified several state and federal representatives in both political parties that had served as long term allies, ensuring that funding for their work remained consistent. In describing the unique composition and strength of the coalition supporting their work, one member described it as “not like your usual sort of green coalition...it's definitely homegrown”. For the past thirty years, the reliable support of these political champions has ensured the continuous access to both state and federal funding for restoration initiatives, and has incubated a collaborative management environment defined by exceptionally strong relationships among stakeholders.

In the Rogue Basin, interviewees described SOFRC's connections to

political power as significant, though not quite as robust. Two state legislators have been champions of both climate change mitigation and wildfire prevention through active management. And at the federal level, Senator Ron Wyden secured millions of dollars from the 2009 stimulus package for the Ashland Forest Resiliency Project, which has served as a pilot project for the *Rogue Basin Strategy* (Metlen et al., 2017), a basin-wide forest management plan aiming to reduce the probability of catastrophic wildfires. Interviewees underscored the importance of this pilot project in demonstrating the feasibility and effectiveness of adaptation-oriented forest management – its success, many felt, made the eventual broader-scale implementation of the *Rogue Basin Strategy* much more likely.

In Siskiyou County, on the other hand, many interviewees expressed a sense of utter isolation from the levers of political power. Many noted that they did not have any allies in the state or federal government championing adaptation-oriented management efforts, severely limiting potential sources of funding for this work. This, some felt, contributed to their inability to effect change in channels besides litigation: without political champions advocating for collaborative management work, litigation was the only available lever to prevent maladaptive management behavior. One key exception to this phenomenon, however, were the actors engaged in the Klamath River dam removal campaign. While the original agreement failed to secure federal funding, the states of California and Oregon, recognizing the singular importance of this collaborative effort, stepped in and provided the funding.

Thus, across the study region, proximity to political power contributed significantly to each governance network's social capital and access to resources. Having close allies in the state and federal government was instrumental in creating and sustaining sources of funding for adaptation-oriented ecosystem management, and in the case of the Nisqually Watershed, early support from these allies created the collaborative management body in which strong relationships among network actors were forged. Without such allies, collaborative management efforts faltered.

5.3.2. Legal power

Nisqually Watershed: High (Robust Legal Tools).

Rogue Basin: Low (Few Legal Tools).

Siskiyou County: Low (Few Legal Tools).

Interviews also provided evidence that the legal landscape defining ecosystem management contributed considerably to adaptive capacity. This is especially evident in the Nisqually Watershed, where the success of conservation initiatives is founded upon the unique legal power set out by the Boldt Decision (United States v. Washington, 1974). “You simply cannot overstate the importance of [the Boldt] decision” said one former employee of Mount Rainier National Park. One of the most sweeping decisions in the history of resource management in the Pacific Northwest, it mandated that 50% of annual catch of the Puget Sound salmonid fisheries be allocated to the Indigenous tribes of Washington State, providing tribes with unprecedented leverage in ecosystem management (United States v. Washington, 1974; Brown, 1994). This proved instrumental in advancing collaborative adaptation-oriented conservation efforts in the Nisqually Watershed, laying the groundwork for the creation of the Salmon Recovery Program, which has provided millions in state and federal funding for habitat restoration

Table 3
The four key socio-political conditions underlying adaptive capacity across the three case study regions.

Socio-political conditions	
Case Study Region	Land Protection: The extent of protected land, and the manner in which it was arranged
<p>Political Power: Connections with political actors that would yield their power to support the aims of governance network actors</p> <p>High (Politically Well-Connected) The NRC was born out of political action at the state level, and several current state and federal legislators were cited as champions of their work</p>	<p>High (Highly Protected) Nearly 80% of the mainstem of the Nisqually River is preserved – its headwaters are in a national park, its mouth is in a national wildlife refuge, and much of the rest is protected as other forms of state, federal, and land trust land.</p>
<p>Legal Power: Access to legal tools useful in advancing adaptation-oriented conservation work</p> <p>High (Robust Legal Tools) Because of the precedent set by the 1974 Boldt Decision, indigenous tribes in Washington State are legally entitled to 50% of the annual catch of the Puget Sound fisheries. This set the stage for the Nisqually Tribe to have considerable influence in ecosystem management, which they use to advance restoration and conservation goals</p> <p>Low (Few Legal Tools) No unique legal tools are available to implement adaptive resource management initiatives</p>	<p>Moderate (Moderately Protected) While 2/3 of the region's land is in federal ownership, it is mixed-use BLM and USFS land. Furthermore, much of the BLM land is in a "checkerboard" ownership pattern, mixed with private land, making management particularly difficult</p>
<p>Institutional Support: The institutionalized support of higher-level governance entities</p> <p>High (Considerable Institutional Support) The Nisqually River Council receives a steady stream of state funding for staffing and projects. Furthermore, because of the Boldt Decision, The Nisqually Tribe has strong support of the Northwest Indian Fisheries Commission, and access to significant funding through state and federal salmon recovery initiatives</p>	<p>Moderate (Moderately Protected) While around 2/3 of the land is federally owned, it is mixed-used BLM and USFS land</p>
<p>Political Power: Connections with political actors that would yield their power to support the aims of governance network actors</p> <p>High (Politically Well-Connected) The NRC was born out of political action at the state level, and several current state and federal legislators were cited as champions of their work</p>	<p>Low (Minimal Institutional Support) Under the Obama administration, interviewees cited the federal agency climate change coordinators as particularly strong allies of SOFRC's work. However, many of these positions no longer exist.</p>
<p>Legal Power: Access to legal tools useful in advancing adaptation-oriented conservation work</p> <p>High (Robust Legal Tools) Because of the precedent set by the 1974 Boldt Decision, indigenous tribes in Washington State are legally entitled to 50% of the annual catch of the Puget Sound fisheries. This set the stage for the Nisqually Tribe to have considerable influence in ecosystem management, which they use to advance restoration and conservation goals</p> <p>Low (Few Legal Tools) No unique legal tools are available to implement adaptive resource management initiatives</p>	<p>Moderate (Moderately Protected) While around 2/3 of the land is federally owned, it is mixed-used BLM and USFS land</p>
<p>Political Power: Connections with political actors that would yield their power to support the aims of governance network actors</p> <p>High (Politically Well-Connected) The NRC was born out of political action at the state level, and several current state and federal legislators were cited as champions of their work</p>	<p>Low (Minimal Institutional Support) Support is not robust, but over many years, some organizations have built strong relationships with federal and state agencies, which has eased permitting processes.</p>
<p>Political Power: Connections with political actors that would yield their power to support the aims of governance network actors</p> <p>High (Politically Well-Connected) The NRC was born out of political action at the state level, and several current state and federal legislators were cited as champions of their work</p>	<p>Low (Politically Isolated) Actors engaged in adaptation-oriented resource management felt very removed from political power; that they had few local, state, or federal political leaders championing their work.</p>



Fig. 1. Study area and study sites in the Pacific Northwestern United States.

efforts.

In both the Rogue Basin and Siskiyou County, no such legal framework exists to drive collaborative management. The only powerful legal tools available to conservation organizations are the Endangered Species Act and Environmental Protection Act, used for challenging management action on federal land. And while anecdotally, the advent of forest collaboratives in Oregon may have reduced litigation battles over forest management, collaboration is entirely voluntary. The unity of a collaborative group can be tenuous: as one interviewee described, whenever major relevant legislation emerges at the state or federal level, some collaborative members have “retreated to their corners” because legislative solutions are more efficient, making the collaborative’s work seem like “such a waste of time and energy.”

Outside of the unique legal context that defines ecosystem management in the Puget Sound, there is far less impetus for collaboration, and less available funding. The Boldt Decision set out a legal framework that empowered the Tribes in advancing adaptation-oriented ecosystem management work, laying the groundwork for both the establishment of crucial streams of funding and productive collaborative relationships among management actors. In the two study areas without such a legal framework, no such groundwork had been laid, and thus governance networks have less access to funding, and less of a structure to cultivate strong relationships among actors.

5.3.3. Institutional support

Nisqually Watershed: High (considerable institutional support).

Rogue Basin: Low (minimal institutional support).

Siskiyou County: Low (minimal institutional support).

In all three study sites, interviewees described the central importance of the support of high-level governing institutions in advancing

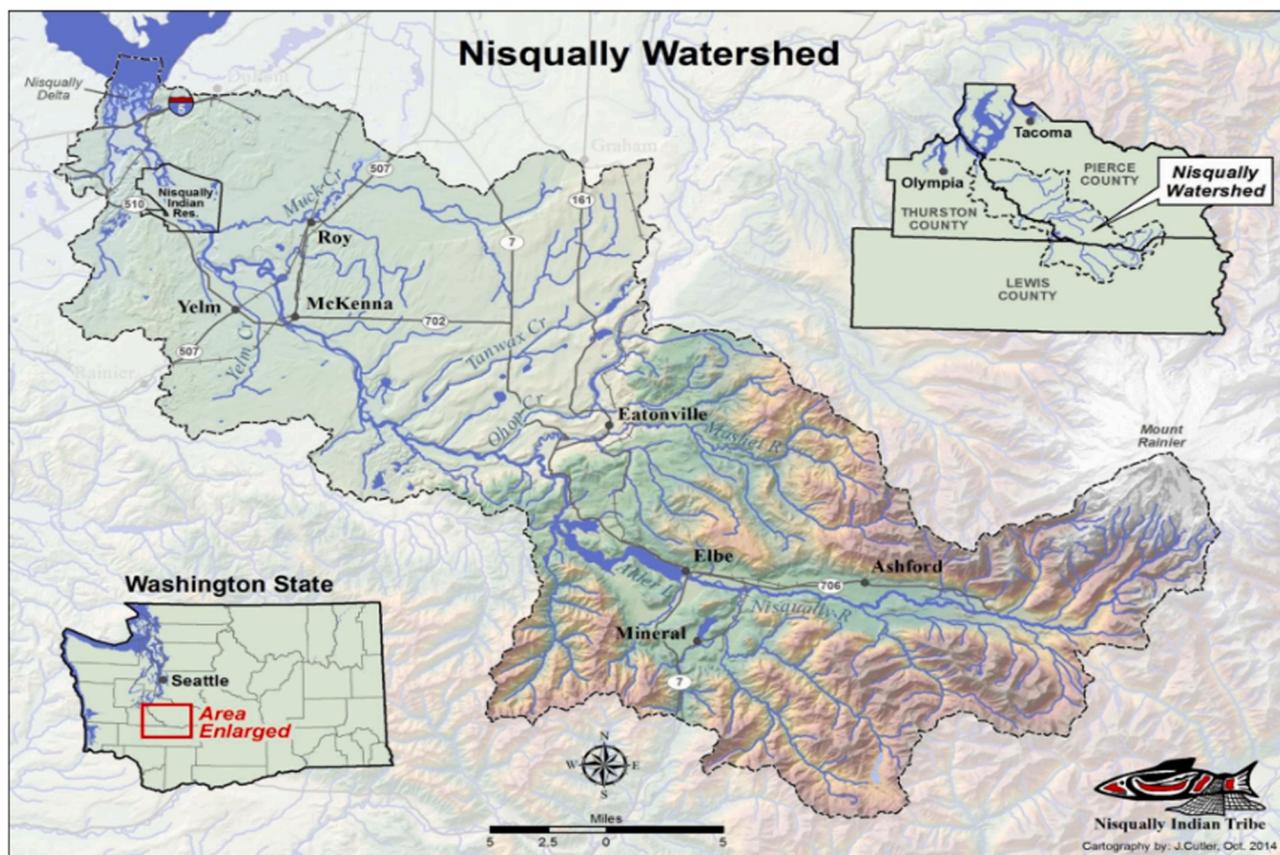


Fig. 2. Map of the Nisqually Watershed from *Forest and Water Climate Adaptation: A Plan for the Nisqually Watershed*, the climate adaptation plan for the Nisqually Watershed, the writing of which was spearheaded by the Nisqually River Council (Figure credit: Nisqually Indian Tribe).

adaptation-oriented ecosystem management work. Such support has been imperative to the success of the NRC since its very formation: while most watershed councils arise organically, the NRC was created through state legislative action. This legislation institutionalized a consistent stream of state funding for the NRC, allowing it to maintain a substantial staff over the past three decades, which several interviewees specifically cited as crucial in sustaining their work. Having staff to handle logistical and administrative work “makes a huge difference” in ensuring their continued successful collaborative management, according to one long-time member. This legislation also created the Nisqually Land Trust, which has proven critical in supporting conservation work. Finally, the Nisqually Tribe, a key actor, is uniquely situated: as both a Tribe and the Nisqually Watershed’s lead entity for salmon recovery, it has access to several streams of state and federal funding for salmon habitat restoration, which has proven essential for the NRC’s conservation and restoration initiatives.

The impact of lack of institutional support was just as clear. Interviewees in the Rogue Basin noted that under Obama, national forests had climate change coordinators that worked closely with SOFRC; when the Trump administration eliminated these positions, collaborative progress on adaptation work slowed considerably. And in much of Siskiyou County, interviewees reported that adaptation-oriented projects faced serious hurdles presented by risk-averse state agencies, which made it difficult to secure permits for nontraditional projects. As described by a representative of one conservation organization, “it’s a huge fight at the state level to get people to understand that giving us one permit at a time...it’s a waste of time.” However, establishing trust and demonstrating the efficacy of such programs can improve institutional support. After years of cultivating relationships with state agencies, this organization was able to secure California’s first adaptive management permit, allowing them to bypass onerous re-permitting

processes.

Institutional support was thus crucial for both accessing adequate resources and building social capital necessary for ecosystem management. In the Nisqually Watershed, consistent institutional support of the state government both ensured a continuous stream of state funding, and created and sustained the NRC, the venue in which crucial collaborative relationships were built. The other governance networks largely lacked such institutional support—as a result, they lacked a strong, stable, venue for collaborative management work, and had reduced access to consistent funding.

5.3.4. Extent of protected land

Nisqually Watershed: High (Highly Protected).

Rogue Basin: Moderate (Moderately Protected).

Siskiyou County: Moderate (Moderately Protected).

Finally, our study provided evidence for the importance of land protection and ownership arrangements in contributing to governance network level adaptive capacity. Protected land in the Nisqually watershed is robust. The river begins at the Nisqually Glacier on Mount Rainier, and flows out through a mostly undeveloped valley into a national wildlife refuge. Nearly 80% of the main stem is protected, a combination of federal and state protected land, 7500 acres owned by the Nisqually Land Trust, and 86,000 acres in a military base. This extraordinary level of protection has buffered development considerably, preserving much of the ecosystem function and the resilience of the watershed. One interviewee pointed out the tremendous importance of the wildlife refuge at the mouth of the river: “because there is no Port of Tacoma here, there is no bigfoot...we don’t have the massive players that are in other watersheds, and that makes a difference.” According to several interviewees, nearby watersheds that are home to major ports are far more prone to conflict among conservation-focused and industry

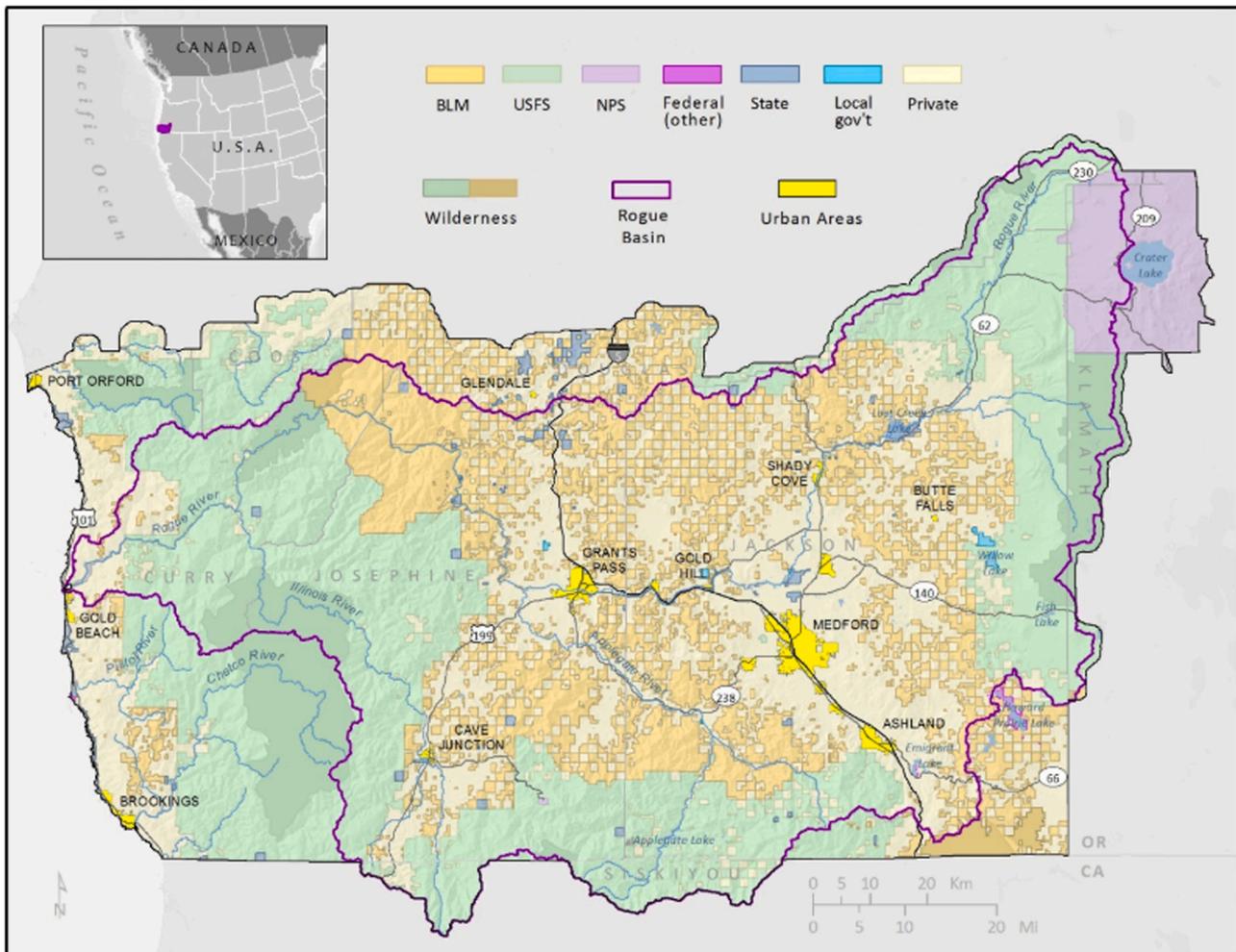


Fig. 3. Map of the Rogue Basin from *The Rogue Basin Action Plan for Resilient Watersheds and Forests in a Changing Climate*, the climate adaptation plan for the Rogue Basin, the writing of which was spearheaded by the Southern Oregon Forest Restoration Collaborative (Figure credit: Southern Oregon Forest Restoration Collaborative).

stakeholders. With such a tremendous proportion of land falling under protected status in the Nisqually watershed, interviewees noted that fewer land management decisions result in disputes; stakeholders representing the wildlife refuge and the national park, for example, are likely to have aligned management goals.

Neither the Rogue Basin nor Siskiyou County contains nearly as much protected land. Though in both regions, over 60% of land is federally controlled, this land is entirely in the hands of either the BLM or the Forest Service, and thus subject to timber harvesting. Though Siskiyou County is home to a land trust, they have far more requests for easements than they have the capacity to handle, and the Rogue Basin lacks a land trust entirely. Further exacerbating this situation in the Rogue Basin is the “checkerboard” land ownership pattern created by the O&C Land Act – a significant portion of the BLM land exists in square mile chunks alternating with private land, making much of it almost entirely accessible for active management. These types of land ownership arrangements provide more fertile ground for conflict among stakeholders. Indeed, both regions are characterized by heated conflicts between extractive industries (i.e. timber and water bottling companies), and conservation organizations in the Rogue Basin have been embroiled in a years-long conflict stemming from divergent views of what constitutes adaptation-oriented forest management and the appropriate level of collaboration with timber companies.

These cases indicate a relationship between the extent of protected land and strong, collaborative relationships in ecosystem management.

With fewer directly competing interests with a stake in management, productive relationships among actors can more easily flourish – when most actors are managing different forms of protected land, priorities are much more likely to be aligned.

6. Discussion

Through qualitative analysis of interviews with key stakeholders, we identified four key socio-political conditions underlying adaptive capacity of these governance networks: political power, legal power, support of higher-level governing institutions, and the extent of land protection. Each of these conditions constituted a distinct part of the context in which adaptive capacity emerged: political and legal power played significant roles in the funding available for adaptation efforts; the support of institutions such as state agencies and legislature aided in permitting processes and assured the longevity of collaborative organizations; and land protection arrangements had a significant influence on regional conflict related to ecosystem management and stakeholders’ ability to plan adaptation-oriented management strategies. In this way, these conditions exact a considerable influence on both the social capital of these networks, and the resources available to them, which, in turn, have a significant impact on the ability of these governance networks to engage in flexible and responsive ecosystem management. Investigating these underlying conditions thus deepened our understanding of the variation in adaptive capacity across the study region.

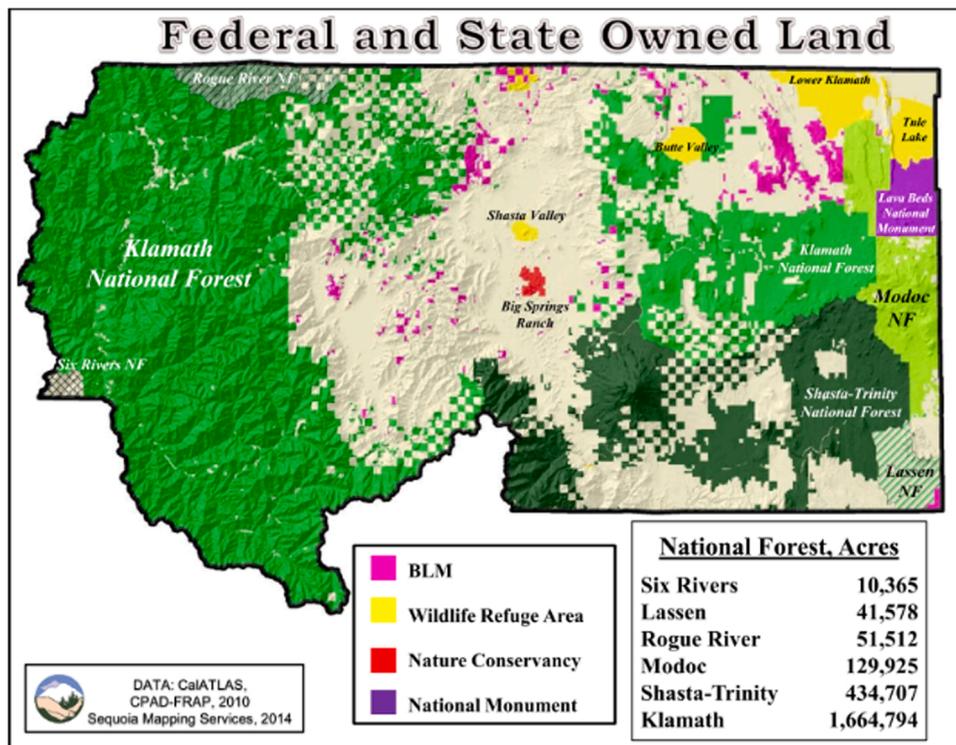


Fig. 4. Map of Siskiyou County from *Renew Siskiyou: Roadmap to Resilience*, the climate adaptation plan for Siskiyou County, the writing of which was led by the Mount Shasta Bioregional Ecology Center. (Figure credit: Mount Shasta Bioregional Ecology Center).

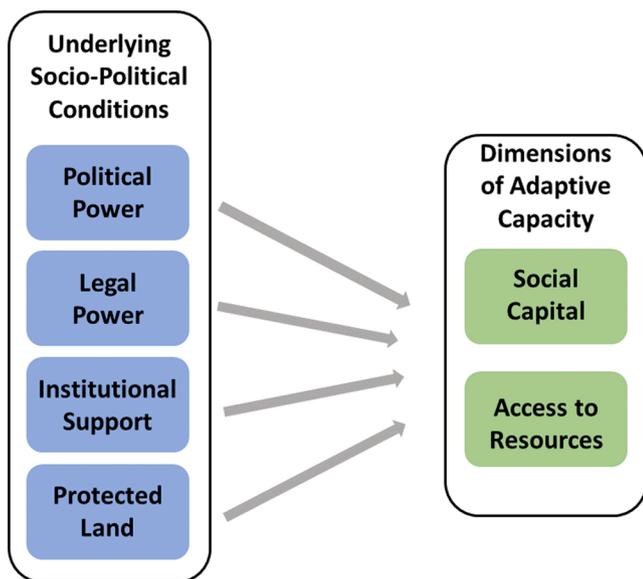


Fig. 5. Diagram of the relationship between the particularly salient dimensions of adaptive capacity in this context, and the underlying socio-political conditions that shape these dimensions of adaptive capacity. While the underlying conditions (in the blue boxes) also interacted with each other, data on these interactions was not robust enough to illustrate them accurately in this diagram.

Furthermore, these conditions cannot be understood in isolation. The creation and sustained support of the Nisqually Land Trust, for example, exemplifies the critical role of access to political power and the institutional support of higher-level governing entities. And in turn, this support from the state government has allowed the land trust to preserve over 7500 acres of land in the watershed. Thus, land protection, political

power and institutional support are intricately linked in contributing to the adaptive capacity of the governance network.

These findings represent an important step in deepening our understanding of the nature of adaptive capacity at the governance network level. Few studies have explicitly examined adaptive capacity in this context, and fewer still have sought to dig below indicators of adaptive capacity to excavate the underlying socio-political conditions. This study pushes beyond the indicator-framework driven approach to assessing adaptive capacity, moving towards a more structural understanding of the variation in dimensions of adaptive capacity across governance networks. While determining that some governance networks have access to more robust financial resources or stronger relationships among stakeholders is useful, investigating *why* this variation exists is crucial to understanding how adaptive capacity might be enhanced.

A small body of literature explicitly examines the socio-political conditions underlying adaptive capacity, the findings of which thematically echo ours. [Vásquez-León et al. \(2003\)](#) elucidate the structural advantages that have made wealthy, white ranchers more resilient to climatic impacts than Hispanic farmers, and [Eakin \(2005\)](#) describes the ways in which neoliberal policies limit the ability of Mexican smallholder farmers to accumulate resources, and thus circumscribe their adaptive capacity. Similarly to our findings, these studies demonstrate the ways in which, broadly speaking, policy, legal history, and institutionalized structures can play a tremendous role in shaping adaptive capacity. A few papers have explored some of the specific conditions that we discussed in this paper. For example, [Kalikoski et al. \(2010\)](#) found that declining support of higher-level governance institutions contributed to increased vulnerability of artisanal fishermen in Brazil’s Patos Lagoon, congruent with our finding that the support of higher-level governing institutions can be instrumental in support a governance network’s adaptive capacity. [Antwi-Agyei et al. \(2015\)](#) and [Panda et al. \(2013\)](#) both assessed the role of land tenure, finding, respectively, that complex land tenure policies and crop insurance played a significant role in shaping the adaptive capacity of smallholder

farmers. This, too, matches our findings about the significance of land ownership arrangements. Though all these studies make rich contributions to the literature on the structural conditions shaping adaptive capacity, they focus mostly on adaptive capacity at the individual level. This study, focusing on examining socio-political conditions at the governance level, presents a unique contribution.

Analysis of the role of legal and political power in shaping adaptive capacity at the governance network level is only just emerging. Morrison et al. (2017) illuminate this lacuna in the literature, arguing that conceptualizations of polycentric governance systems pay too little attention to the influence of power dynamics on climate action. Most existing literature on the subject focuses on the instances in which state actors contribute to a governance network's adaptive capacity by levying taxes and instituting new regulations (Marshall et al., 2013; Fenna, 2012). Our work thus offers distinct insight on the importance of connections to political power, and the significance of legal tools available to governance network actors – in the case of the Nisqually Watershed for example, a legal right to a percentage of the annual salmon harvest, which, in turn, had a massive influence on natural resource policy.

This study had several sampling-related limitations. Although we sought to interview a range of types of stakeholders in each case study region, some were more difficult to secure – namely, representatives of key industries in the region. Thus, our sample did not reflect the full diversity of actors engaged in ecosystem management. Furthermore, limits to time and resources precluded interviewing representatives of each stakeholder group in each region. Nevertheless, we reached saturation through the interviews we conducted; new themes ceased to emerge with additional interviews before we stopped data collection. Researching the governance network in Siskiyou County presented some unique challenges, likely reflecting the fact that the county level may not have been the most productive unit of analysis. While it was chosen because it was the unit at which a climate adaptation plan had been written, the region was likely too large, with too many distinct conflicts in environmental governance, to be evaluated effectively as a coherent governance network. More rigorous preliminary vetting may have resulted in our focusing on just one watershed – for example, the Scott River watershed, home to the Scott River Watershed Council.

Mark Pelling describes a crucial task of scholars of vulnerability and adaptive capacity: to produce research that advances the goal of “tackl[ing] the causes of vulnerability at their roots” (Pelling, 2011: 171). Toward this end, our findings point toward an urgent research agenda: analysis of the historical processes and power dynamics that produce adaptive capacity. In elucidating the influence of underlying socio-political conditions on adaptive capacity, this study takes an important step – however, these conditions are historically produced, and their production warrants robust investigation. This would require pairing key stakeholder interviews with ethnological research methods and a more thorough review of archival materials.

Adaptive capacity is a dynamic and emergent property of a governance network, shaped by the centuries of historical processes that produce these conditions. The Nisqually Watershed represents a useful illustration. Understanding the workings of the NRC today requires tracking the decades-long history of the Nisqually Tribe's resistance to state violations of treaty rights through a campaign of civil disobedience. Only once the Boldt Decision reshaped the legal landscape could the tribes of the Puget Sound situate themselves on more equitable footing and forge a path toward collaborative governance (Brown, 1994). Thus, understanding adaptive capacity in the Nisqually Watershed requires an interrogation of power: the power of the settler state, and the power of indigenous resistance. Future research should face head-on the charge laid by political ecologists, and directly examine the power dynamics that produce current-day adaptive capacity. It is through such critical analysis that the field can advance its most crucial goal: to pave the way toward a more just world in which all communities are equipped to adapt to the impacts of climate change.

7. Conclusion

With this study, we sought to contribute to the understanding of the nature of adaptive capacity in governance network ecosystem management, through an investigation of the socio-political conditions underlying adaptive capacity. Through an inductive, case study analysis, we found evidence that four underlying conditions were particularly influential: political power, legal power, institutional support, and the extent of protected land. In so doing, this study demonstrated the ways in which an understanding of adaptive capacity in this context is enhanced by drilling down below traditional indicators of adaptive capacity to investigate the conditions that contribute to these features: it is not by chance that one governance network may have access to considerably greater financial capital for ecosystem management than others, this variation is historically produced. Future research in adaptive capacity should continue along this trajectory toward in depth, historically situated critical analyses of the ways in which adaptive capacity is produced,

CRedit authorship contribution statement

Matt Sehrsweeney: Conceptualization, Methodology, Investigation, Analysis, Writing – original draft, Funding acquisition. **Dr. Paige Fischer:** Methodology, Supervision, Writing – reviewing and editing, Funding acquisition.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

Funding for this study was provided by the University of Michigan's Graham Institute of Sustainability Catalyst Grant. We would like to thank all of the interviewees, and in particular, the Nisqually River Foundation, The Southern Oregon Forest Restoration Collaborative, and the Mount Shasta Bioregional Ecology Center, whose staff were critical in connecting us with interviewees.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at [doi:10.1016/j.envsci.2022.03.021](https://doi.org/10.1016/j.envsci.2022.03.021).

References

- Abatzoglou, J.T., Rupp, D.E., Mote, P.W., 2014. Seasonal climate variability and change in the Pacific Northwest of the United States. *J. Clim.* 27, 2125–2142. <https://doi.org/10.1175/JCLI-D-13-00218.1>.
- Abrams, J.B., Huber-Stearns, H.R., Bone, C., Grummon, C.A., Moseley, C., 2017. Adaptation to a landscape-scale mountain pine beetle epidemic in the era of networked governance: the enduring importance of bureaucratic institutions. *Ecol. Soc.* 22 <https://doi.org/10.5751/ES-09717-220422>.
- Antwi-Agyei, P., Dougill, A.J., Stringer, L.C., 2015. Impacts of land tenure arrangements on the adaptive capacity of marginalized groups: the case of Ghana's Ejura Sekyedumase and Bongo districts. *Land Use Policy* 49, 203–212. <https://doi.org/10.1016/j.landusepol.2015.08.007>.
- Bodin, O., Garcia, M.M., Robins, G., 2020. Reconciling conflict and cooperation in environmental governance: a social network perspective. *Annu. Rev. Environ. Resour.* 45, 471–495. <https://doi.org/10.1146/annurev-environ-011020-064352>.
- Brown, Jovana J., 1994. Treaty Rights: Twenty Years after the Boldt. *Wicazo Sa Review* 1–16. <https://doi.org/10.2307/1409130>.
- Chaffin, B.C., Garmestani, A.S., Gosnell, H., Craig, R.K., 2016. Institutional networks and adaptive water governance in the Klamath River Basin, USA. *Environ. Sci. Policy* 57, 112–121. <https://doi.org/10.1016/j.envsci.2015.11.008>.
- Clarvis, M.H., Engle, N.L., 2013. Adaptive capacity of water governance arrangements: a comparative study of barriers and opportunities in Swiss and US states. *Reg. Environ. Chang.* 15, 517–527. <https://doi.org/10.1007/s10113-013-0547-y>.

- Cook, A., Thaler, T., Griffith, G., Crossett, T., Perry, J.A., 2014. Renew Siskiyou: A road map to resilience. Model forest policy program in association with the Mount Shasta biogeological ecology center and the Cumberland river compact, Sagle, ID.
- Davis, Emily Jane, White, Eric M., Cerveny, Lee K., Seesholtz, David, Nuss, Meagan L., Ulrich, Donald R., 2017. Comparison of USDA Forest Service and stakeholder motivations and experiences in collaborative federal forest governance in the Western United States. *Environmental Management* 908–921. <https://doi.org/10.1007/s00267-017-0913-5>.
- DellaSala, A.D., Hanson, C.T., 2015. *Nature's Phoenix: The Ecological Importance of Mixed-Severity Fires*. Academic Press, Amsterdam.
- Eakin, H., 2005. Institutional change, climate risk, and rural vulnerability: cases from Central Mexico. *World Dev.* 33, 1923–1938. <https://doi.org/10.1016/j.worlddev.2005.06.005>.
- Engle, N.L., Lemos, M.C., 2010. Unpacking governance: building adaptive capacity to climate change of river basins in Brazil. *Glob. Environ. Chang.* 20, 4–13. <https://doi.org/10.1016/j.gloenvcha.2009.07.001>.
- Fattig, P., 2013, August 24. Frustrated, timber rep exits panel on logging solutions. *The Mail Tribune*. (<https://mailtribune.com/news/environment/frustrated-timber-rep-exits-panel-on-logging-solutions>) (accessed: June 14, 2020).
- Fenna, A., 2012. Centralising dynamics in Australian federalism. *Aust. J. Polit. Hist.* 58, 580–590. <https://doi.org/10.1111/j.1467-8497.2012.01654.x>.
- Fischer, Alexandra Paige, Jasny, Lorian, 2017. Capacity to adapt to environmental change: evidence from a network of organizations concerned with increasing wildfire risk. *Ecology and Society* 22 (1). <https://doi.org/10.5751/ES-08867-220123>.
- Fischer, Alexandra Paige, Vance-Boreland, Ken, Jasny, Lorian, Grimm, Kerry E., Charnley, Susan, 2016. A network approach to assessing social capital for landscape planning: The case of fire-prone forests in Oregon, USA. *Landscape and Urban Planning* 147, 18–27.
- Flitcroft, R.L., Cerveny, L.K., Bormann, B.T., Smith, J.E., Asah, S.T., Fischer, A.P., 2017. The emergence of watershed and forest collaboratives. In: Olson, D.H., Van Horne, B. (Eds.), *People, Forests, and Change*. Island Press, Washington DC, pp. 116–130.
- Folke, C., Hahn, T., Olsson, P., Norberg, J., 2005. Adaptive governance of social-ecological systems. *Annu. Rev. Environ. Resour.* 30, 441–473. <https://doi.org/10.1146/annurev.energy.30.050504.144511>.
- Garmestani, Ahjond S., Allen, Craig R., Gunderson, Lance, 2009. Panarchy: Discontinuities Reveal Similarities in the Dynamic System Structure of Ecological and Social Systems. *Ecology and Society* 14 (1), 15. <http://www.ecologyandsociety.org/vol14/iss1/art15/>.
- Graves, M., 2021. Public and Private Lands in Oregon. *The Oregonian*. <https://projects.oregonlive.com/maps/land-ownership/index.php>.
- Greene, M., Thaler, T.G., Griffith, G., Crossett, T., Perry, J.A., 2014. *Forest and Water Climate Adaptation: A Plan for the Nisqually Watershed*. Model Forest Policy Program in association with the Nisqually River Foundation and the Cumberland River Compact, Sagle, ID.
- Gupta, J., Termeer, C., Klostermann, J., Meijerink, S., van den Brink, M., Jong, P., Nooteboom, S., Bergsma, E., 2010. The adaptive capacity wheel: a method to assess the inherent characteristics of institutions to enable the adaptive capacity of society. *Environ. Sci. Policy* 13, 459–471. <https://doi.org/10.1016/j.envsci.2010.05.006>.
- Habron, G., 2003. Role of adaptive management for watershed councils. *Environ. Manag.* 31, 29–41. <https://doi.org/10.1007/s00267-002-2763-y>.
- Hirschfeld, D., Hill, K.E., Riordan, B., 2020. The regional fingerprint: a new tool to evaluate adaptive capacity. *Environ. Sci. Policy* 112, 36–46. <https://doi.org/10.1016/j.envsci.2020.05.019>.
- Jung, Y., 2018. Here's how much of California is owned by different government agencies and why that matters. *San Francisco Chronicle*. <https://www.sfchronicle.com/bayarea/article/Here-s-how-much-of-California-is-owned-by-16773882.php>.
- Kalikoski, D.C., Quevedo Neto, P., Almudi, T., 2010. Building adaptive capacity to climate variability: the case of artisanal fisheries in the estuary of the Patos Lagoon, Brazil. *Mar. Policy* 34, 742–751. <https://doi.org/10.1016/j.marpol.2010.02.003>.
- Klijn, E.H., Koppenjan, J., 2012. Governance network theory: past, present and future. *Policy Polit.* 40, 587–606. <https://doi.org/10.1332/030557312x655431>.
- Lewis, D.G., 2007. Four deaths: the near destruction of western Oregon tribes and native lifeways, removal to the reservation, and erasure from history. *Or. Hist. Quart.* 67, 14–21.
- Little, J.B., May 28, 2018. Below Mount Shasta, a fight bubbles over bottled water. *High Country News*. (<https://www.hcn.org/issues/50.9/communities-challenge-companies-over-bottling-mount-shastas-water>) (accessed: June 10, 2020).
- Lubell, M., Jasny, L., Hastings, A., 2016. Network governance for invasive species management. *Conserv. Lett* 10, 699–797. (<https://conbio.onlinelibrary.wiley.com/doi/full/10.1111/conl.12311>).
- Marshall, G.R., Connell, D., Taylor, B.M., 2013. Australia's Murray-Darling basin: a century of polycentric experiments in cross-border integration of water resources management. *Int. J. Water Gov.* 1, 197–218. <https://doi.org/10.7564/13-ijwg17>.
- May, C., Luce, C., Casola, J., Chang, M., Cuhaciyan, J., Dalton, M., Lowe, S., Morishima, G., Mote, P., Petersen, A., Roesch-McNally, G., York, E., 2018. Northwest. In: Reidmiller, D.R., Avery, C.W., Easterling, D.R., Kunkel, K.E., Lewis, K.L.M., Maycock, T.K., Stewart, B.C. (Eds.), *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II*. U.S. Global Change Research Program, Washington, DC. <https://doi.org/10.7930/NCA4.2018.CH24>.
- McCarthy, J.J., Canziani, O.F., Leary, N.A., Dokken, D.J., White, K.S., 2001. *Climate Change 2001: Impacts, Adaptation, and Vulnerability: Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, London, UK.
- Metlen, K.L., Borgias, D., Kellogg, B., Schindel, M., Jones, A., McKinley, G., Olson, D., Zanger, C., Bennett, M., Moody, B., Reilly, E., 2017. *Rogue Basin Cohesive Forest Restoration Strategy: A Collaborative Vision for Resilient Landscapes and Fire Adapted Communities*. The Nature Conservancy, Portland.
- Miles, M.B., Huberman, A.M., Saldana, J., 2014. *Qualitative data analysis: A methods sourcebook*. Sage, Los Angeles.
- Model Forest Policy Program, 2020. *Climate Solutions University*. (<http://www.mfpp.org/climate-solutions-university-2/>) (accessed October 20, 2020).
- Myer, G., Thaler, T., Griffith, G., Perry, A., Crossett, T., Rasker, R., 2013. *The Rogue Basin Action Plan for Resilient Watersheds and Forests in a Changing Climate*. Model Forest Policy Program in association with the Southern Oregon Forest Restoration Collaborative, the Cumberland River Compact and Headwaters Economics, Sagle, ID.
- Morrison, Tiffany H., Adger, W. Neil, Brown, Katrina, Lemos, Maria Carmen, Huitema, David, Hughes, Terry P., 2017. Mitigation and adaptation in polycentric systems: sources of power in the pursuit of collective goals. *WIREs Climate Change* 8. <https://doi.org/10.1002/wcc.479>.
- Nelson, R., Kocik, P., Crimp, S., Martin, P., Meinke, H., Howden, S.M., de Voil, P., Nidumolu, U., 2010. The vulnerability of Australian rural communities to climate variability and change: part II-integrating impacts with adaptive capacity. *Environ. Sci. Policy* 13, 18–27. <https://doi.org/10.1016/j.envsci.2009.09.007>.
- Panda, A., Sharma, U., Ninan, K.N., Patt, A., 2013. Adaptive capacity contributing to improved agricultural productivity at the household level: empirical findings highlighting the importance of crop insurance. *Glob. Environ. Chang.* 23, 782–790. <https://doi.org/10.1016/j.gloenvcha.2013.03.002>.
- Pelling, M., 2011. *Adaptation to Climate Change: From Resilience to Transformation*. Routledge, London.
- QSR International Pty Ltd, 2018. NVivo. (<https://www.qsrinternational.com/nvivo-qualitative-data-analysis-software/home>).
- Petersen, Brian, Wellstead, Adam M., 2014. Responding to a forest catastrophe: The emergence of new governance arrangements in Southern California. *ISRN Economics* 20, 1–10. <https://doi.org/10.1155/2014/982481>.
- Scoones, I., 1998. *Sustainable rural livelihoods: a framework for analysis*. IDS Working Paper. Institute of Development Studies, p. 72.
- Seng, Dennis Stanley Chang, 2013. *Tsunami resilience: multi-level institutional arrangements, architectures and system of governance for disaster risk preparedness in Indonesia*. *Environmental Science and Policy* 29, 57–70.
- Siders, A.R., 2019. Adaptive capacity to climate change: a synthesis of concepts, methods, and findings in a fragmented field. *Wiley Interdiscip. Rev. Clim. Chang.* 10, 1–18. <https://doi.org/10.1002/wcc.573>.
- Silas, M.O., Mgeleka, S.S., Polte, P., Sköld, M., Lindborg, R., de la Torre-Castro, M., Gullström, M., 2020. Adaptive capacity and coping strategies of small-scale coastal fisheries to declining fish catches: Insights from Tanzanian communities. *Environ. Sci. Policy* 108, 67–76. <https://doi.org/10.1016/j.envsci.2020.03.012>.
- Taylor, M., 2014. *The Political Ecology of Climate Change Adaptation*. Routledge, NY.
- United States v. Washington, 1974. *Washington Phase I*, 384 F. Supp. 312.
- Vásquez-León, M., West, C.T., Finan, T.J., 2003. A comparative assessment of climate vulnerability: agriculture and ranching on both sides of the US-Mexico border. *Glob. Environ. Change* 13, 159–173. [https://doi.org/10.1016/S0959-3780\(03\)00034-7](https://doi.org/10.1016/S0959-3780(03)00034-7).
- Vincent, C.H., Hanson, L.A., Bermejo, L.F., 2020. *Federal Land Ownership: Overview and Data*. United States Congressional Research Service, Washington DC.
- Washington State Recreation and Conservation Office, 2014. *Washington Public Lands Inventory*. (<https://rco.wa.gov/wp-content/uploads/2019/08/PLIP-2014.pdf>) (accessed October 26, 2020).
- Watts, M., 2015. The origins of political ecology and the birth of adaptation and a form of thought. In: Perrault, T., Bridge, G., McCarthy, J. (Eds.), *The Routledge Handbook of Political Ecology*. Routledge, New York.
- Wilkinson, C., 2006. *Messages from Frank's Landing: A Story of Salmon, Treaties, and the Indian Way*. University of Washington Press, Seattle.