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Title: Ready for Anything: Adaptive Capacity in Western States' Water Plans

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In the western United States, climate change is likely to bring greater uncertainty and extreme events outside the range for which water infrastructure, governance, and allocation mechanisms have been designed. In addition, many water systems already struggle with issues of institutional fragmentation, ineffective governance, and unsustainable management practices. Adaptive capacity, or the ability to cope with stressors and adjust to changing conditions, is a critical factor in reducing system vulnerability and increasing resilience. Two governance approaches, integrated water resources management and polycentricity, have been posited to increase adaptive capacity by reducing fragmentation of governance across sectors and levels of government. This paper examines the water planning and governance systems of 11 states to (1) assess the extent to which they incorporate or promote integrated resources management and polycentricity, and (2) characterize the states' adaptive capacity based on the determinants of (a) comprehensiveness and integration, (b) knowledge and learning, (c) resources, (d) authority and legitimacy, and (e) participation and networks. While governance approaches among states differ based on their historical development, stakeholder preferences, and other contextual factors, states which incorporate more integrated water resources management principles and display

more polycentric tendencies in their water governance were found to have higher levels of all adaptive capacity determinants except for resources. Potential approaches to increase adaptive capacity and promote sustainable, secure water futures in the study area could include better integration of management concerns, greater data sharing and accessibility, dedicated investment in water planning and project implementation, enabling communities or regions to self-organize and tailor local solutions to water issues, and building more inclusive stakeholder engagement and participation processes. The development of inclusiveness and local self-organizing authority could be particularly critical in overcoming institutional rigidity and path dependence, helping to gain the public support needed to reshape entrenched systems.

# Ready for Anything: Adaptive Capacity in Western States' Water Plans

by
Leah R. Cogan

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I understand that my thesis will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my thesis to any reader upon request.

Leah R. Cogan, Author

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TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

Page

TABLE OF CONTENTS (continued)

Page

# LIST OF FIGURES

# LIST OF TABLES

# 1 Introduction

Water has always been a critical resource for human settlements as well as the environment, and the tension between these demands will only increase as climate change creates new challenges for water management. In the western United States (see Figure 1 below), water managers have experience coping with variability in water supply through infrastructure like dams and reservoirs, institutions such as state water planning and management agencies, and exercise of legal and regulatory authority. This region is generally much more arid than the eastern United States, with the 100$^{th}$ meridian serving as an approximate dividing line between eastern states receiving over 40 inches of precipitation annually and the western states averaging under 20 inches (WWPRAC, 1998). These averages mask considerable spatial variability, including formidable rain shadow effects on the eastern slopes of the Sierra Nevada, Cascades, and Rocky Mountains, as well as temporal variability in terms of seasonality of precipitation, delayed streamflow peaks due to snowmelt, and interannual variability influenced by the El Niño–Southern Oscillation (WWPRAC, 1998). The region contains both the Columbia River, with the second largest drainage basin in the nation and the greatest discharge of water into the Pacific Ocean of any river in the Americas, and the Colorado River, where so much water is diverted that it has scarcely reached its outlet in 50 years even before infrastructure has been completed to use all legally allocated water (Dettinger et al., 2016; Wilkinson, 1992). Groundwater has been more reliable than surface water, serving as the primary water source in some areas and a buffer against drought in others, which has led to substantial declines in major aquifers (Dettinger et al., 2016; WWPRAC, 1998).


Figure 1. Map of study area, encompassing the states of Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Wyoming, and Washington.

Water allocation throughout the western United States is dominated by the institution of prior appropriation, which was designed to promote settlement by providing certainty to the earliest 'senior' registered water users that their allotment would be filled during times of shortage before allowing water to be used by 'junior' users with later priority dates (Getches, 2001).

Affirmed in the Colorado Supreme Court's 1882 decision in *Coffin v Left Hand Ditch Company*, the doctrine endorses diversion of water for consumptive uses even if a stream is completely dried up (Wilkinson, 1992). By providing water rights in perpetuity as long as water is continuously put to a beneficial use, the basic principles of the system generally allow little flexibility in responding to changing social values about the uses and sharing of water (Thompson, 1993). The expression of the doctrine is not uniform throughout the West, however, with some states adding layers of voluntary water transaction markets and collaborative processes which serve to increase flexibility and address emerging concerns (Olmstead, 2014; Thompson, 1993). The original system encouraged economic investment in agriculture, mining, and homesteading, and it provided a method for settling disputes during dry years; however, increasing urbanization, condemnation of environmental degradation, and demands for more equitable distribution have strained this "unyielding" institution (Getches, 2001, p. 4; Hill Clarvis et al., 2014). The West is now facing up to its legacy of over-appropriation, dams blocking fish passage, alteration of natural hydrographs, land speculation, overgrazing, and controversial inter-basin water transfers, and while some public policy changes have occurred, such as legal recognition of the value of instream flows for aquatic life, prior appropriation still represents a major constraint on western water governance (Reisner, 1986; Wilkinson, 1992).

Climate change is likely to bring greater uncertainty and extreme events outside the range for which water infrastructure, governance, and allocation mechanisms have been designed (Engle, 2011; Engle & Lemos, 2010; Hill Clarvis et al., 2014). While these systems have typically assumed climate stationarity, this assumption is no longer supported, and new ways of governing water resources are needed to create flexibility within the constraints of western water law's 'first come, first served' prior appropriation doctrine (Gunderson et al., 2017; Hill Clarvis et al.,

2014). Reduced snowpack, more frequent and severe droughts, rising temperatures, and highly variable precipitation are projected to make water supply even more unpredictable in the future (Dettinger et al., 2016; Lall et al., 2018). Climate change is likely to reshape the characteristics of drought such as how much water is depleted from the system and the length of time to recover from shortages, so institutional adaptations to past conditions may be insufficient (Veettil et al., 2018). More than any other impact of climate change, this may be critical because as Pulwarty and Maia (2015, p. 276) point out, "in the arid West, the true test of any water management regime is its ability to withstand drought."

In addition to the novel stressors accompanying climate change, many water systems are already struggling with issues of institutional fragmentation, ineffective governance, and unsustainable management practices, in addition to the inflexibility of the prior appropriation doctrine (Kashyap, 2004; Wilkinson, 1992). Policies enacted in sectors like energy, land use, and agriculture can have unintended consequences and externalities on water systems due to lack of coordination (Weitz et al., 2017). Adaptation strategies common in the past, such as increasing groundwater withdrawals to cope with drought, have not always been undertaken with recognition of the interconnected effects on surface water, ecosystems, or the water rights of nearby users (Brown et al., 2019). Command and control governance paradigms and efforts to optimize resource use for single-purpose projects have left stakeholders out of the decision making process and strained ecosystem functioning (Akamani, 2016; Gunderson et al., 2017). The variability of local impacts and resources to cope with these impacts are likely to put more pressure on governance institutions and lead to uneven outcomes across regions (Huntjens et al., 2012; Olmstead, 2014).

Governance arrangements play a key role in building system capacity to react and accommodate changes in hydrological, climatic, and socio-political conditions. Previous studies have shown that building trust and regional collaboration can act as bridges to adaptation, while partisanship can limit adaptive actions and even decrease the likelihood of state water plans addressing climate change (Hill Clarvis & Engle, 2015; Werner & Svedin, 2017). Both within and beyond existing legal and governance constraints, Dovers and Hezri (2010) suggest potential methods for increasing consideration of climate adaptation in policy processes. Although it is not possible to avoid every negative impact, steps can be taken to increase the ability of social-ecological systems to respond and adjust to changing climatic conditions and governance challenges. The concept of adaptive capacity links the theories of resilience and vulnerability, and it can serve as a starting point for investigating the strengths of different governance approaches in coping with variable and changing conditions (Engle, 2011). While impacts are often localized, water planning and response to water-related crises such as droughts are generally conducted at the state level, and states play a crucial role in mitigating local vulnerability by providing financial resources, technical expertise, and policy coordination (Werner & Svedin, 2017). Since state water plans express the policy preferences and water management strategies prevalent in each state, examining these plans can reveal critical insights into the adaptive capacity of water systems.

While previous research on adaptation has often been conducted at the national level, this study fills a gap in the literature by focusing on a broader spectrum of stressors to water systems rather than solely climate change, conducting an assessment at the state level, and including a comparative analysis of governance arrangements and their influence on adaptive capacity. This paper therefore seeks to add to the growing literature on adaptation in water systems by

answering the question, “How do western states’ water plans and governance arrangements demonstrate and contribute to adaptive capacity?” Both integrated water resources management as well as polycentricity and place-based strategies have been posited to increase adaptive capacity by reducing fragmentation of governance across sectors and levels of government (Carlisle & Gruby, 2019; Cosens et al., 2017; Dyckman, 2016). Thus, my research question can be broken into four sub-questions:

a) To what extent do state water plans and governance arrangements incorporate or promote integrated water resources management?

b) To what extent do state water plans and governance arrangements incorporate or promote polycentricity and place-based strategies?

c) How can the adaptive capacity of each state in the study area be characterized?

d) What patterns emerge among integrated water resources management, polycentricity and place-based strategies, and adaptive capacity?

This paper presents a review of the literature on vulnerability, resilience, the importance of governance arrangements for adaptive capacity, and the potential benefits of integrated water resources management and polycentricity and place-based approaches. Next, a conceptual framework is proposed to characterize elements of integrated water resources management, polycentricity, and determinants of adaptive capacity. An overview of the project’s qualitative methods, including content analysis and semi-structured interviews, is described next. Results of the analysis are then presented state by state, followed by a discussion of trends and patterns. Overall, states which incorporate elements of integrated water resources management and

polycentric governance tend to be associated with higher levels of all indicators of adaptive capacity except for resources, indicating the potential benefits of these approaches as well as highlighting the need for additional investments.

# 2 Literature Review

To provide a background for investigating my research questions and to enable the development of a conceptual framework to analyze my results, the literature review is structured as follows. First, the theories of **vulnerability** and **resilience** are explored to understand the concept of **adaptive capacity**, which is common to both but conceptualized slightly differently in each theory. The relationship of vulnerability and resilience is examined, with adaptive capacity seen as a potential bridge between the theories. Next, the importance of **governance arrangements for adaptive capacity** is described. Strategies for increasing adaptive capacity are portrayed next, including **integrated water resources management**, **polycentricity and place-based planning**, and other promising approaches. Finally, a conceptual framework follows the literature review and provides further details on the **determinants of adaptive capacity** used in the analysis for the project.

## 2.1 Vulnerability and resilience theories

### 2.1.1 *Vulnerability*

Theories of vulnerability and resilience offer insights into addressing the challenges that water systems will face due to climate change and other stressors. The theory of vulnerability historically developed around the concept of individual or collective entitlements to use resources, coupled with the institutional arrangements surrounding and constraining management of those resources (Kelly & Adger, 2000). Often seen as an internal system property, vulnerability is conceptualized as the susceptibility of the system to harm or its inability to cope with stressors (Adger, 2006; Gallopín, 2006; Kelly & Adger, 2000). In this sense, a system's internal characteristics create the context in which it reacts to stress. Vulnerability is also

sometimes viewed as an outcome rather than a system attribute, and it could then be measured in terms of mortality or crop losses, for example, rather than assessed based on system characteristics (Adger, 2006).

Vulnerability can generally be thought of as a function of a system's exposure to hazards and its sensitivity to disturbance modified by its adaptive capacity. The first component, exposure, refers to both environmental and socio-political stressors and perturbations which can be internal or external to the system (Adger, 2006; Gallopín, 2006). Environmental variability can increase exposure to extreme events such as droughts and floods, creating challenges for water management (Adger, 2000). Social and political exposure encompasses stresses such as war, economic fluctuations, and policies affecting access to resources (Kelly & Adger, 2000). Definitions of the second component, sensitivity, vary among authors but generally describe the degree to which a system would be impacted by exposure to a given threat (Adger, 2006; Gallopín, 2006). A system may be more sensitive to particular types of disturbance or hazards while being able to tolerate others (Young, 2010). Frequently referring to social factors rather than environmental attributes, sensitivity is used to explain "how different socio-economic and political characteristics, processes or trends influence levels of vulnerability" (Kelly & Adger, 2000, p. 329). Brooks et al. (2005) point to the importance of characteristics like poverty, literacy, and sanitation for measuring vulnerability at the national level, while governance indicators like representation and government effectiveness may be more important at the state level.

The third component of vulnerability is adaptive capacity. Adger (2006, p. 270) defines this attribute as "the ability of a system to evolve in order to accommodate environmental hazards or

policy change and to expand the range of variability with which it can cope," which can reduce the effects of disturbances to which the system is exposed. Like sensitivity, adaptive capacity typically involves social factors such as governance effectiveness and economic resources (Varis et al., 2019). Some researchers also distinguish between short-term coping capacity, or the ability to deal with the immediate effects of disturbance, versus long-term adaptive capacity, or the power to adapt and significantly restructure the system to not only cope with current stressors but proactively prepare for future stress (Brooks et al., 2005; Gallopín, 2006).

### 2.1.2 *Resilience*

In contrast to the generally social science-driven theory of vulnerability, resilience theory developed historically out of the field of ecology and the work of C. S. Holling in modeling predator-prey interactions (Folke, 2006). With the realization that nature does not invariably trend toward a simple state of equilibrium, researchers began to explore the idea of multiple stable states or domains of attraction driven by different variables and processes (Folke, 2006). After overcoming initial skepticism about the notion of alternate stable states, the concept of resilience became widely promoted beyond ecology in fields such as anthropology, geography, and psychology, resulting in the creation of multiple nuanced and even conflicting definitions of resilience (Folke, 2006; Gallopín, 2006). Drawing on the ecological origins of the concept, resilience generally came to be conceptualized as the capacity to buffer disturbance to a system without changing to an alternate state, or even to reorganize parts of the system in response to change while still maintaining the system's identity, functions, and driving variables (Folke, 2006; Gallopín, 2006; Young, 2010). Other essential features of resilience include the

importance of random events and the interactions of fast and slow ecological processes across multiple scales (Holling, 1973; Sterk et al., 2017).

While some researchers measure resilience in terms of the system's capacity to cope or respond, others measure it more as the size or magnitude of disturbance needed to flip the system into an alternate state (Adger, 2006; Sterk et al., 2017). Holling (1973) initially distinguished between stability, a rapid return to the same equilibrium state following a disturbance, and resilience, or the persistence of a system with the same relationships among populations or state variables even as it undergoes some changes to respond to disturbance. However it is measured, the emphasis is on state change or moving from one domain of attraction to another; some system parameters are expected to fluctuate and change, but as long as the principle identity and driving variables stay the same, the system can be considered resilient (Adger, 2000; Dyckman, 2016; Gallopín, 2006; Pahl-Wostl, 2009). The engineering view of resilience takes a slightly different approach, tending to characterize resilience in terms of the recovery time from a disturbance to the previous stable state or trajectory of the system (Folke, 2006; Gallopín, 2006; Yazdandoost & Moradian, 2016). The caveat to this type of definition is that it assumes the system is naturally stable or trending toward equilibrium and is only disturbed by outside factors, which may not be the case (Holling, 1973; Sterk et al., 2017).

Just as definitions of resilience vary from discipline to discipline, definitions of the role of adaptive capacity within it also vary, ranging from a general component of resilience to a specifically social component that provides capacity to react (as opposed to stressors in the environmental part of the system) to an ability to manage resilience itself within social-ecological systems. Hill Clarvis et al. (2014, p. 99) see it as "the ability to prepare for and

respond to variability, change or surprise," which is similar to Young's (2010) characterization of adaptive capacity as a regime's way of coping with stress. The definition in Engle and Lemos (2010, p. 4) of adaptive capacity as the "ability to recover or adjust to change through learning and flexibility so as to maintain or improve into a desirable state," emphasizes the significance of state changes in resilience theory. Engle later expands on this definition in a collaborative article as the explicit "capacity of actors in the system to manage and influence resilience" which implies that adaptive capacity plays a very active role in what a social-ecological system will actually look like (Engle & Lemos, 2010, p. 650).

### 2.1.3 *Relationship of vulnerability and resilience*

It is clear that many definitions of vulnerability, resilience, and adaptive capacity may be used depending on the field and research tradition. Generally, vulnerability is seen as more of a sensitivity to stress while resilience is seen as the ability to cope with it and maintain or achieve a desirable system state (Engle, 2011; Young, 2010). While Adger (2000) sees the two concepts essentially as opposites—susceptibility to versus avoidance of harm—Gallopin (2006) believes that any definition of resilience must be linked with the concept of multiple stable states and cannot simply be the opposite of vulnerability. In this sense, a system that has low resilience is not only vulnerable to being harmed but to being completely shifted into another state.

Engle (2011) suggests that the concept of adaptive capacity, common to both resilience and vulnerability theories, could be a focus of analysis that bridges these two research traditions and yields valuable insights for designing systems that can cope with variable and changing conditions. Since governance and institutions are critical variables for adaptive capacity in both vulnerability and resilience theories, an emphasis on the social and institutional facets of the

systems being studied could suggest productive avenues of intervention for increasing adaptive capacity, overcoming environmentally-driven vulnerability, and giving the system options in how it responds to change (Engle, 2011; Varis et al., 2019). With sufficient adaptive capacity, stressors that fall inside a system's coping range may be dealt with in a manner that buffers the shock and maintains the system's current form; however, extreme disturbances may require reorganization of the system and its institutions into a different, more resilient form (Gunderson et al., 2017; Gupta et al., 2010).

## 2.2 Governance arrangements

Governance and institutional arrangements are critical components of a social-ecological system's adaptive capacity because their design can either facilitate or hinder adaptive actions (Engle & Lemos, 2010). In general, governance arrangements refer to the system of decision making and set of institutional rules and norms that structure how a resource such as water is managed and the ways in which policies are developed and enforced (Chaffin et al., 2014; Watson et al., 2019). Particularly in sectors like water and environmental management, the concept of governance goes beyond official government entities to encompass a wide network of actors such as non-profits, voluntary organizations, watershed councils, private sector entrepreneurs, and interested individuals (Pahl-Wostl, 2009). While resource management is concerned with implementation and operational decisions, governance denotes the higher level questions of how policy decisions are made, who is allowed to participate, and how rights and responsibilities are determined (Watson et al., 2019). Implementing actions to adapt to any changing conditions, from climate change to resource demand shifts to changing social values,

all require policies to be in place legitimizing the actions taken, so the choice of who is able to participate in shaping these policies is critical (Huntjens et al., 2012).

Various principles of "good governance" have been proposed which may improve adaptive capacity and enhance the functioning of any type of governance arrangements. These include principles such as transparency, inclusiveness, accountability, fairness, cross-scale linkages, and support for iterative learning (Craig et al., 2017; Garmestani & Benson, 2013; Pulwarty & Maia, 2015; Weitz et al., 2017). Rather than solely focusing on what adaptation strategies are chosen, this focus on good governance enables an analysis of how decisions about management and adaptation are made (Huntjens et al., 2012). Emphasizing the general principles of good governance may help stakeholders develop locally effective governance arrangements that give them the adaptive capacity needed to manage toward their socially-chosen desired state instead of seeking one optimal governance system for all situations (Baehler & Biddle, 2018; Cosens et al., 2017; Huntjens et al., 2012). Including requirements and mechanisms for periodic review of governance and policies offers a chance to evaluate institutional fit and effectiveness, giving participants flexibility in updating governance structures before stresses overwhelm the system, which is critical for resilience (Young, 2010).

Governance regimes are a way to characterize particular sets of governance arrangements and institutions, such as a top-down "command and control" model versus an inclusive, participatory "collaborative governance" regime (Pahl-Wostl, 2009). Governance regimes may exhibit a balance of different societal objectives such as inclusiveness and efficiency (Weitz et al., 2017). Berardo and Lubell (2016, p. 739) distinguish between strongly institutionalized governance systems, which provide "stable decision-making forums with clear rules about who can

participate and how decisions are made," contrasted with weakly institutionalized governance systems which have only ephemeral decision-making forums "designed to solve specific issues for a subset of actors." While strict top-down governance approaches typically stifle learning, and purely local level governance does not allow for lessons learned to be shared, Pahl-Wostl (2009) finds that a balance of interlinked top-down and bottom-up governance modes creates the best conditions for social learning and thus may boost adaptive capacity within the system.

Within the western United States, water governance has spanned a wide range of regimes from technocratic government-driven regulation to market-based privatization to decentralized participatory approaches recognizing intertwined social and ecological needs (Dyckman, 2016; Engle & Lemos, 2010; Pahl-Wostl, 2009). In addition, water governance has suffered from fragmentation because water-related policies may be scattered across other governance regimes for food systems, energy production, ecosystem conservation, and other sectors (Weitz et al., 2017). Rather than being coordinated at the national level, water planning and governance is the responsibility of states, leading to additional fragmentation of policies across regions, which can be particularly problematic for transboundary rivers and aquifers (Dyckman, 2016). During the 20th century, Akamani (2016) suggests that the water governance paradigm of rational engineering solutions and top-down control ignored important human dimensions of water systems, reducing learning potential which increased vulnerability and decreased resilience. Similarly, Gunderson et al. (2017) and Craig et al. (2017) observe that optimization of ecosystems and water systems for a single purpose, such as managing rivers for irrigation or hydropower, has likely increased their vulnerability to disturbances, especially those driven by climate change outside the range of previous coping ability.

## 2.3 Strategies for increasing adaptive capacity

Given the anticipated intense challenges to sustainable water management and governance in the western United States, proactive planning and actions will be needed to facilitate adaptation. While some mitigation actions may be able to reduce future exposure to environmental hazards, such as reducing greenhouse gas emissions, vulnerability could also be reduced and resilience increased through deliberate efforts to increase adaptive capacity (Dyckman, 2016; Engle, 2011; Kelly & Adger, 2000). Investment in raising adaptive capacity is especially needed in cases where sensitivity is high or systems are already functioning near a tipping point to another domain of attraction (Varis et al., 2019). It is important to note, however, that not all system state change is to be avoided: what constitutes "desirable conditions" must be socially defined and negotiated in each system, and could include maintaining the status quo or could include deliberately transforming the system to an alternate state driven by different variables and with different institutional and governance arrangements (Engle, 2011; Folke et al., 2005). The deliberative social process of selecting desirable conditions may be facilitated or constrained by the legal systems in place in each system; legislation may build in or restrict measures that allow a social-ecological system to increase its adaptive capacity or experiment with new approaches to adaptation (Cosens et al., 2017; Dyckman, 2016; Hill Clarvis et al., 2014).

While management actions that seek to control variability and smooth out interannual fluctuations can be appealing, Folke (2006, p. 256) cautions that this can make landscapes "spatially homogenized and vulnerable to disturbances that previously could be absorbed." Rather than trying to suppress variability, resilience theory suggests building more flexibility to prepare for and accommodate inevitable changes and surprises, which could be extended to

water systems in terms of drought, floods, or shifts in demand (Craig et al., 2017; Folke, 2006). Holling's (1973, p. 21) suggestions for managing for resilience by focusing on "the need to keep options open, the need to view events in a regional rather than local context, and the need to emphasize heterogeneity" still hold great value nearly 50 years later. Management to support resilience also requires an understanding of what exactly the tipping points or thresholds are beyond which the system would change to a potentially undesirable state, and this requires extensive and possibly novel ways of monitoring changes within the system to know when these thresholds are being approached (Garmestani & Benson, 2013; Sterk et al., 2017; Young, 2010).

## 2.4 Integrated Water Resources Management

One water governance approach which may increase adaptive capacity is integrated water resources management, or IWRM. While initial suggestions for more integrated management began in the early 1900s, the idea of IWRM became more widespread as the century progressed, and it exploded in popularity after the United Nations International Conference on Water and the Environment held in Dublin, Ireland in 1992 (Biswas, 2008; Mitchell et al., 2015; Saravanan et al., 2008; Torregrosa & Sevilla, 2019). Among the most commonly used definitions is one devised by the Global Water Partnership: "IWRM is a process which promotes the co-ordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems" (Global Water Partnership Technical Advisory Committee, 2000, p. 22). This definition describes IWRM as a process rather than an outcome, which highlights the importance of governance design to create a framework for managers to work within (Watson et al., 2019; Yazdandoost & Moradian, 2016). Some researchers have criticized

the concept of IWRM as being too vaguely defined, leading to difficulties with operationalizing it for implementation and leaving it as more of an amorphous buzzword than a specific prescription for management (Biswas, 2008; Medema et al., 2008; Schröder, 2019). Despite differences in exact definitions, commonly accepted key features of IWRM include holistic management of land and water resources, stakeholder engagement in learning and decision making, management based on hydrological boundaries such as a watershed or river basin, flexibility, and seeking a sustainable balance of ecological, economic, and social benefits from water systems (de Loë & Patterson, 2017; Engle, 2013; Medema et al., 2008). In addition to coordinating across sectors, the Global Water Partnership (2000) recommends integrating management of surface water and groundwater, demand and supply, quality and quantity, and consideration of all phases of the water provisioning process from protecting source water supplies to wastewater treatment.

One reason for the increasing popularity of holistic, integrated approaches to water management is the recognition that siloed management has led to unintended consequences on other sectors which decrease effectiveness and cause unacceptable social and environmental externalities, particularly as climate change increases water scarcity and variability (Akamani, 2016; de Loë & Patterson, 2017; Gosnell et al., 2017; Mitchell et al., 2015). Fragmented approaches to managing a crucial but finite resource like water, especially from top-down institutions with a tunnel vision focus on supply only, are increasingly seen as unsustainable (Global Water Partnership Technical Advisory Committee, 2000; Kashyap, 2004; Torregrosa & Sevilla, 2019). IWRM could help overcome these problems by acknowledging links among ecosystems, economic structures, and social systems, particularly when providing opportunities for community

involvement and bridges among sectors with a nexus to water, such as energy, conservation, and agriculture (Mitchell et al., 2015).

Recognizing and dealing with all of these interconnections in water management is not without its challenges. Collaborative processes require greater investment of time and resources to enable participation and build trust among stakeholders, and even at the government level, to overcome interdepartmental political rivalries (Biswas, 2008; Mitchell et al., 2015). To some researchers, IWRM appears impossibly complex and too ambitious to put into practice since there are too many potential interactions to keep track of (Biswas, 2008; de Loë & Patterson, 2017; Medema et al., 2008). Rather than attempting a potentially overwhelming comprehensive approach, Mitchell et al. (2015, p. 719) recommend a form of integration which "embraces the importance of understanding interconnections among variables and relationships, but focuses only on those which are key drivers for change and amenable to being managed." By concentrating on the driving variables in the system, IWRM could thus improve resilience by avoiding shifts to an undesirable domain of attraction while allowing for fluctuation in other variables and characteristics (Adger, 2000; Gallopín, 2006). Another distinction which may help disentangle the multitude of possible interactions to manage is emphasizing coordination of key entities at a governance level instead of trying to coordinate all decisions at the daily management level (Waylen et al., 2019).

In addition to the challenges of coordinating governance horizontally among multiple sectors, even within the traditional water management sector there are vertically fragmented policies and governance arrangements which must be accounted for (Weitz et al., 2017). Relevant to this study area, Cosens et al. (2017) describe how water quantity issues and allocation are typically

state responsibilities, while water quality is jointly managed by state and federal agencies, and land use—ideally a focus of coordination under IWRM—is managed at the local level. The existence of multiple decision-making centers related to water adds a great deal of complexity but could also be seen as creating the necessity to coordinate in order to avoid unintentional negative influences of one decision maker on another (Mancilla García et al., 2019; Schröder, 2019). One of the benefits of IWRM is purported to be increasing institutional fit, or matching the scale of a problem to the scale at which decisions about it are made, and thus the watershed or river basin has been proposed as a way to capture influences that may affect water systems but span multiple political jurisdictions (de Loë & Patterson, 2017; Global Water Partnership Technical Advisory Committee, 2000; Mancilla García et al., 2019; Saravanan et al., 2008). While this idea could certainly help with issues of fragmentation, coordinating water across administrative boundaries comes with its own challenges, and the creation of new basin level organizations can become a confusing additional layer within the existing landscape of water governance (Saravanan et al., 2008; Torregrosa & Sevilla, 2019). Torregrosa and Sevilla (2019) also question the applicability of basin level governance in cases with significant interbasin transfers of water. Mancilla García et al. (2019) observe that municipal level utilities are usually the entities that actually operate water services and infrastructure, so they cannot be entirely replaced with basin level governance but will need to coordinate.

In terms of coordination, IWRM strongly supports the participation of stakeholders in decision making, especially regarding local level resource management, seeking consensus where possible (Akamani, 2016; Global Water Partnership Technical Advisory Committee, 2000). In Waylen et al.'s (2019) study of water governance integration prompted by the European Water Framework Directive, they found that collaboration, stakeholder engagement, and cross-level

coordination were both enablers of integration and also challenges since it was difficult to integrate multiple goals and perspectives simultaneously. Nonetheless, striving to balance the various stakeholder needs, goals, and values is an important part of IWRM because it recognizes the interdependence of all parties and also the connections between ecological and social systems (Medema et al., 2008; Saravanan et al., 2008). While some authors such as Biswas (2004) criticize the promotion of IWRM as a universal solution, particularly in international development contexts, Watson et al. (2019) suggest that IWRM should be adjusted to fit local contexts and observe that there may be many different styles of IWRM reflecting the particular implementing group's balance of policy preferences and social norms of interaction. Schröder (2019) cautions that for a true balance of stakeholders to be represented in IWRM processes, care must be taken to understand existing power structures and proactively support inclusiveness, especially of marginalized or disadvantaged groups who have historically been excluded or whose interests may conflict with a more powerful water-related interest group. By taking care to include all stakeholders and emphasize the integration of multiple forms of knowledge and data sharing, IWRM processes can provide a deeper understanding and way of learning about social-ecological systems (Medema et al., 2008; Pulwarty & Maia, 2015).

Integrating the fragmented governance of water resources could reduce unintended negative interactions and help build adaptive capacity by linking stakeholders who may be able to pool resources and jointly address major threats such as climate change. Recognizing the human dimensions of water governance is likely to build social-ecological system resilience and encourage more sustainable management of water (Akamani, 2016; Cosens et al., 2017). While Engle (2013) observes that IWRM is more likely to be implemented at the local rather than state level, it may increase adaptive capacity locally, and if supported by state policies and resources,

could augment adaptive capacity throughout a broader area. In a case comparing alternative water governance structures in several basins in Brazil, Engle and Lemos (2010) found that not only did those basins with more flexible, integrated, and participatory water management rank higher in their classification of basin-level adaptive capacity than those which were characterized by more centralized management, less integration, and less participation, but the less-integrated group also showed lower success in dealing with drought and floods in practice.

## 2.5 Polycentricity and Place-Based Planning Approaches

Integration across multiple levels can be supported through governance approaches such as polycentricity and place-based planning. Top-down, centralized governance can be inflexible and generally does not match the scale of many resource problems, creating outputs that are too generic to work in every context (Chaffin et al., 2014; Engle, 2013; Pahl-Wostl & Knieper, 2014). On the other hand, decentralized local governance without coordination may lead to duplication of efforts, free riding, and lack of accountability for unintended impacts on resource users outside the local jurisdiction (Chaffin et al., 2014; Milman et al., 2018; Pahl-Wostl & Knieper, 2014). In assessing the institutional fit between a water issue and the scale of governance, it is important to consider both the ecological dimensions of the problem and the social dimensions of whose interests are represented in addressing it (Carlisle & Gruby, 2019).

Polycentric governance refers to a system of multiple local units with the authority for relatively autonomous decision making which are coordinated both horizontally with other decision making units and vertically in a nested system of governance with an overarching rule structure (Baltutis & Moore, 2019; Biddle & Baehler, 2019; Carlisle & Gruby, 2019; Ostrom, 2010; Pahl-Wostl & Knieper, 2014). This stands in contrast to either an authoritative top-down or a

completely decentralized bottom-up planning structure. For the water sector in the study area, this can be envisioned as the devolution of power for water planning to local or regional groups with strong horizontal coordination while nested within the state and federal legal framework. Similarly, place-based planning approaches are locally driven systems for governing water resources that emphasize inclusive, participatory deliberation and actions centered around the place itself, rather than divided by sector or agency (Mucken & Bateman, 2017). Place-based approaches allow for experimentation, development of locally appropriate solutions to resource issues, and collaboration among stakeholders. Although they are nested within a larger governance system including state and federal legal structures and jurisdictions, lower level units and place-based planning groups have a great deal of leeway for self-organization (Dyckman, 2016; Pahl-Wostl & Knieper, 2014).

The flexible nature of defining local units in a polycentric system means that governance can occur at the level of local government, watershed, river basin, or a "problem-shed" that encompasses a water issue at another scale (Muller, 2019). The emphasis on the river basin as the appropriate scale of management in the IWRM policy literature, particularly when promoted in developing countries, has been critiqued as privileging the value of a river's environmental features over resource development and other social priorities (Muller, 2019). In practice, it is not realistic to treat a river or watershed's ecological and social/use characteristics as separate phenomena (Gunderson et al., 2017). It is important to note that the degree of polycentricity may vary based on the unit of focus; for example, a state may be considered polycentric with respect to its groundwater governance but employ more centralized, top-down policies for its surface water management (Schröder, 2018). Fully functional polycentricity can also go beyond the nested governance of federalism to include the potential for overlapping transboundary

governance units operating at whatever scale is relevant to the problem at hand, such as a multi-state or international river basin like the Columbia and Colorado Rivers in the study area (Carlisle & Gruby, 2019).

Given that many management scales are plausible depending on the issue, from an irrigation district to a river basin, the choice of scale makes a difference for deciding whose voices are represented. Power imbalances at the local level can limit representation in decision making processes, and in the extreme case, more powerful interests can capture the process at multiple scales (Carlisle & Gruby, 2019; Schröder, 2019). While local units are viewed as equal peers in theory, the reality may be that some have more political and economic power than others, which could be exercised to influence state decisions about coordination and autonomy (Baltutis & Moore, 2019). Baltutis and Moore (2019) also acknowledge that creating additional locally empowered units without adequately recognizing or distinguishing the rights of indigenous groups is problematic.

In contrast to top-down mandates, locally-led processes tend to generate higher levels of social capital. This can be thought of as a combination of trust, norms of reciprocity, and concern for equity which enables people to work collaboratively (Ostrom, 2010). In turn, high social capital can lower transaction costs and encourage stakeholders to collectively manage resources for the good of the group without the need for top-down intervention and monitoring (Milman et al., 2018; Ostrom, 2010). Continued interactions among stakeholders in place-based systems reduce uncertainty about how others will behave, increasing trust and positive relationships (Berardo & Lubell, 2016; Mucken & Bateman, 2014; Ostrom, 2010). Allowing experimentation with policy responses at the local level along with communication of resulting experiences may give

polycentric systems a better suite of potential adaptation options for challenges like climate change (Carlisle & Gruby, 2019; Pahl-Wostl & Knieper, 2014). While much research points to the prevalence of local level experimentation (Akamani, 2016; Baltutis & Moore, 2019; Pahl-Wostl & Knieper, 2014), Dyckman (2016) observes that since states have the legal authority for water planning and allocation with essentially no federal requirements, guidelines, or funding, they have considerable flexibility to innovate. Formal networks for learning and sharing successful practices and innovations enhance the cohesiveness of polycentric systems and reduce the prospect of ad hoc uncoordinated decisions (Baltutis & Moore, 2019; Carlisle & Gruby, 2019).

To ensure that plans developed by a lower level unit in a polycentric system do not conflict or create externalized problems outside their boundaries, coordinating mechanisms must be present. Horizontal linkages may be coordinated by the state or may be formed through peer-level networks to integrate management across related issues, while vertical coordination across levels of government can ensure that local needs are taken into account in upper level strategic policy decisions and provide the stability of an overarching set of rules, laws, and accountability structures (Baltutis & Moore, 2019; Cosens et al., 2017; Pahl-Wostl & Knieper, 2014). Vertical connections can also provide local units with access to resources beyond what is locally available, which may be very important for large-scale responses to climate change (Biddle & Baehler, 2019; Engle, 2012; Muller, 2019). Although local units have some degree of autonomy, their choices to weigh the actions and needs of other units in their decisions is what makes them function as part of a system rather than as a series of disconnected, decentralized units (Carlisle & Gruby, 2019). Place-based governance can be more scale-specific, providing a better institutional fit by responding to the local environment, water resources, economy, and culture

(Garmestani & Benson, 2013; Huntjens et al., 2012). Local processes can often better incorporate local knowledge, while states may play a role in coordinating the transfer of expertise and resources or stepping in to address local inequities caused by power imbalances (Carlisle & Gruby, 2019; Ostrom, 2010).

Since dispersed and overlapping areas of responsibility could lead to confusion and opportunities to shirk, well-functioning polycentric systems must include clearly defined rules regarding delegation of responsibilities as well as enforcement norms (Biddle & Baehler, 2019; Huitema et al., 2009). The overlapping nature of decision making centers in a polycentric system creates some level of redundancy, which can actually be considered a beneficial feature. Widespread local experimentation mitigates the risk of one poorly-designed central policy damaging the resource as a whole, while the redundancy of a nested system means that if one local area is struggling with resource management, the state can intervene (Carlisle & Gruby, 2019; Milman et al., 2018). Redundancy may reduce vulnerability in the sense that multiple units are available to take over the functions of any unit that is experiencing stresses beyond its capacity to handle (Baltutis & Moore, 2019; Carlisle & Gruby, 2019; Huitema et al., 2009). Overlapping and nested responsibilities can also boost accountability and coordinate management activities with the scale of the resource to be managed, keeping a system resilient within the desired domain of attraction (Carlisle & Gruby, 2019; Langridge & Ansell, 2018). If circumstances have changed to the point that reorganization into a functionally different system is required, cross-scale interactions present in polycentric systems can help with this restructuring (Gunderson et al., 2017).

## 2.6 Adaptive governance

Another approach which was not explored in as much detail for this research project but shows great promise for supporting adaptive capacity development is adaptive governance. Derived from resilience theory, adaptive governance is designed to help social-ecological systems cope with both gradual and sudden changes while maintaining the same basic structure, functions, and ecosystem processes (Arnold et al., 2017; Cisneros, 2019; Engle, 2011; Gosnell et al., 2017). Adaptive governance also includes deliberate transformation and reorganization of the system to an alternate state when this is considered desirable (Arnold et al., 2017; Chaffin et al., 2014; Folke, 2006). Adaptive governance builds on the concept of adaptive management, which is focused on learning through deliberate experimentation and hypothesis testing in order to improve management, typically of ecosystems (Akamani, 2016; Marmorek et al., 2019). Adaptive governance blends this experimentation with deliberative decision making, stakeholder engagement, and cross-scale polycentric linkages (Huitema et al., 2009; Smedstad & Gosnell, 2013). Essentially, Chaffin et al. (2014) describe how adaptive governance relies on adaptive management for the active learning component, while adaptive management requires adaptive governance in order for that learning to be reflected in policy. The new governance structures continue to rely on experimentation, co-production of knowledge, and social learning to develop a greater understanding of the social-ecological system, its resource issues, and potential solutions (Arnold et al., 2017; Chaffin et al., 2014; Engle, 2011; Hill Clarvis et al., 2014). Expanding the focus of learning beyond the ecosystem means that policy interventions, such as regulations or innovative funding structures, can also be the targets of experimentation (Huitema et al., 2009; Young, 2010).

Rather than managing toward a static state, adaptive governance generally recognizes the dynamic nature of interconnections and recommends managing ecosystem functions and processes to boost resilience (Akamani, 2016; Arnold et al., 2017). Adaptive governance promotes collaborative processes with inclusive stakeholder engagement which build trust and coordinate diverse social learning networks across multiple levels (Akamani, 2016; Chaffin et al., 2014; Engle, 2011). Legitimacy of the process is enhanced by the inclusion of a broad and representative array of stakeholders, conflict resolution mechanisms that allow for dissensus and constructive dialogue, and assistance to marginalized or underrepresented groups that may need additional resources to participate in collaborative processes (Akamani, 2016; Cosens et al., 2017; du Bray et al., 2018; Gosnell et al., 2017). Decisions are ideally devolved to the lowest reasonable level, and adaptive governance supports polycentric networking at multiple levels to coordinate these decisions and their effects across scales (Hill Clarvis et al., 2014). Adaptive actions taken in this way, whether focused on social and policy reforms or management interventions in water systems, could thus reduce vulnerability by increasing adaptive capacity and decreasing sensitivity of the systems (Boag et al., 2018).

# 3 Conceptual Framework

The research design for this project consists of (1) an inventory of state water governance, particularly as seen through state water plans and strategies, which seeks to determine whether water governance arrangements include features of IWRM and polycentricity, combined with (2) an analysis of indicators of adaptive capacity for each state. The conceptual framework I used to analyze my data draws on the preceding literature review and includes characteristics of IWRM and polycentricity and determinants of adaptive capacity.

## 3.1 Characteristics of IWRM and Polycentricity

Based on the information presented above, Figure 2 presents the characteristics of IWRM and polycentricity that I looked for in the state plans and interview data for this analysis.

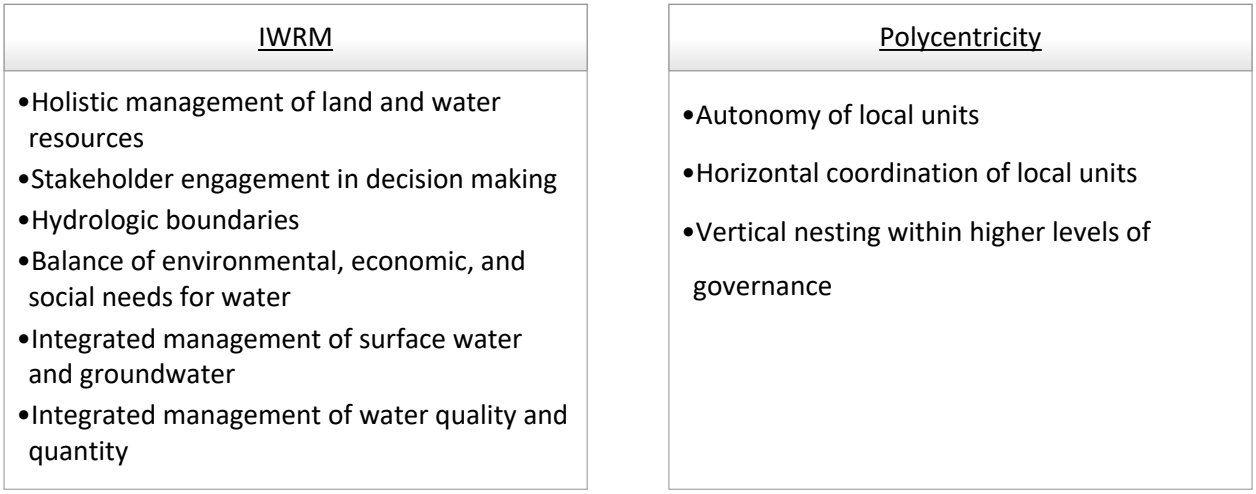


Figure 2. Characteristics of IWRM and polycentricity used in this analysis.

Actual implementation of IWRM and polycentric governance arrangements vary according to different contextual conditions, water issues, priorities, and stakeholder preferences, so they will not look the same everywhere (Watson et al., 2019). The basic characteristics listed in the figure

above may be present to varying degrees in each water governance system. Due to the wide range of variability in scales and characterizations of place-based systems, this analysis focused mainly on polycentricity with observational notes included about place-based planning groups in those states which display some form of this governance structure.

## 3.2 Adaptive Capacity Determinants

Many proposed determinants of adaptive capacity are related to a system's governance and institutional structures, and they have been investigated at the national, local, and intermediate levels (Engle & Lemos, 2010; Kashyap, 2004; Varis et al., 2019). Adaptive capacity is considered a latent property which is difficult to measure directly (Engle, 2013). Some researchers have attempted to overcome this difficulty by assessing the outcomes of past stressful events, such as droughts or floods, along with factors present before and after the event, in order to understand what may have facilitated or limited adaptive responses (Engle, 2011, 2013). Adaptive capacity may also be characterized based on system attributes theorized in the vulnerability and resilience literatures to contribute to it, which can be adjusted to account for the context-specificity of each system and may help to bridge case studies of particular events (Engle, 2011, 2013). Five major categories with subcategories make up the conceptual framework of adaptive capacity used in this project, and they include comprehensiveness and integration; knowledge and learning; resources, including both financial and human; authority and legitimacy; and participation and networks, as shown in Figure 3 and described below.

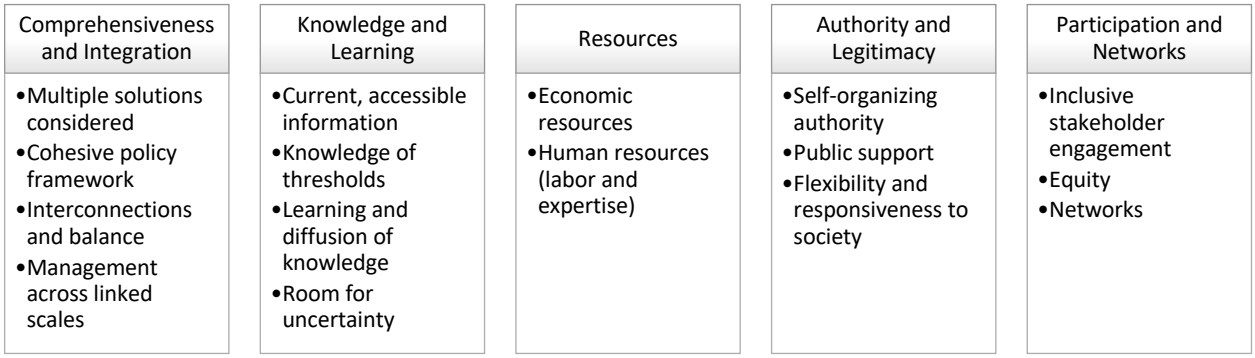


Figure 3. Indicators of adaptive capacity used in this analysis.

### 3.2.1 *Comprehensiveness and Integration*

Previous studies have suggested that comprehensiveness and integration may increase adaptive capacity in water planning by ensuring that all relevant factors are considered and there are no unintended adverse impacts within or outside of the system (Dyckman, 2016; Gupta et al., 2010; Hill Clarvis & Engle, 2015). Comprehensiveness in water planning calls for consideration of multiple problem definitions, multiple possible solutions, and the presence of mechanisms for balancing economic, environmental, social, and other uses of water (Dyckman, 2016; Gupta et al., 2010). Considering a portfolio of management options increases flexibility, especially when multiple solutions can be tested in different local contexts (Hill Clarvis & Engle, 2015; Huntjens et al., 2012). In terms of water systems, options typically include planning mechanisms, such as drought planning or participatory processes; demand management, such as conservation policies, water pricing, and water-saving technologies; and supply management, such as infrastructure development and maintenance, inter-basin transfers, and supply diversification (Engle, 2013; Ivey et al., 2004; Olmstead, 2014). Water banking and markets for trading, leasing, and transferring water rights can also help balance demand and supply (Olmstead, 2014).

Integration of these factors creates a coherent policy framework both internally (public policies are consistent) and externally (policies are consistent with other societal institutions) across linked scales (Bolognesi & Pflieger, 2019; Dyckman, 2016; Hill Clarvis & Engle, 2015). Although integrating policies across sectors could improve adaptive capacity and make systems more robust, it is not an easy task, and Weitz et al. (2017, p. 172) note that "some degree of fragmentation is both more realistic and arguably more inclusive of the multiple perspectives and preferences on how different societal objectives should be balanced than a perfectly coherent policy landscape." Nonetheless, there are many interconnections and feedbacks among water-related sectors, and acknowledging and working with these links can help to balance economic, environmental, social, and other uses of water (Dyckman, 2016; Gunderson et al., 2017). Additional governance strategies that account for linked domains and scales include conjunctive surface water and groundwater management, consideration of upstream and downstream users, and coordination of regional planning and activities through cross-scale networks (Dyckman, 2016; Huntjens et al., 2012; Langridge & Ansell, 2018).

### 3.2.2 *Knowledge and Learning*

Knowledge of the social-hydrological system, including its functioning and thresholds, is critical to current management as well as adaptively planning for the future (Dyckman, 2016; Gupta et al., 2010; Hill Clarvis & Engle, 2015). Combining multiple sources of knowledge, such as local and traditional knowledge coupled with scientific research, can provide more ways to cope with change that are acceptable to all users (Akamani, 2016; Folke et al., 2005). Measurement of system thresholds, such as sustainable yield of aquifers or instream flow needs, helps stakeholders understand how different actions would either maintain the system in its current

state or transform it irreversibly to a less desirable state (Dyckman, 2016; Ivey et al., 2004). Accessible data and deeper understanding can be built through monitoring networks, evaluation, research, and experimentation; social learning networks can diffuse this information to foster collaboration, build social capital, and spark further innovation (Baehler & Biddle, 2018; Gupta et al., 2010; Hill Clarvis & Engle, 2015). Learning from past experiences, and communicating that learning through formal and informal networks, builds proactive, anticipatory adaptive capacity (Baehler & Biddle, 2018; Baltutis & Moore, 2019; Engle, 2011). Naturally, there will always be some level of uncertainty remaining, and adaptive capacity can be increased by incorporating flexibility to plan for numerous future scenarios and try out different policies (Huntjens et al., 2012; Olmstead, 2014; Wyborn et al., 2015).

### 3.2.3 *Resources*

Key resources to support adaptation include financial support, human resources capacity, and technical expertise. Sufficient financial resources are needed to invest in adaptation such as capital improvements and maintenance of infrastructure, supporting stakeholder engagement processes and learning networks, and experimentation and monitoring activities (Baehler & Biddle, 2018; Casado-Pérez et al., 2015; Kashyap, 2004; Langridge & Ansell, 2018). Municipalities and other lower level units of governance may face challenges in this area, since taxation for infrastructure maintenance or collaboration outside their borders may be politically unpopular, and turnover of elected officials may limit the time horizons for which they can easily commit resources (Baehler & Biddle, 2018; Mancilla García et al., 2019). In addition, Schröder (2019) points out that funding incentives from higher levels of government that require local match may not be seen as strong incentives when local resources are already stretched thin. In

addition to monetary resources for adaptive actions, technical expertise, education, and adequate workforce capacity and staffing levels are also needed (Baehler & Biddle, 2018; Engle & Lemos, 2010; Gupta et al., 2010; Ivey et al., 2004).

### 3.2.4 *Authority and Legitimacy*

The level at which authority for decision making rests may be centralized to the state or devolved to local or regional groups. When local groups have the authority to self-organize and manage their own water resources, their adaptive capacity is increased because flexibility and integration of local knowledge may be maximized, and states can play a coordinating role to integrate the actions of many semi-autonomous groups within their borders (Baltutis & Moore, 2019; Gupta et al., 2010; Hill Clarvis & Engle, 2015). Beyond day-to-day management, self-organization at the collective choice level means giving local groups the ability to develop their own rules about the process by which management decisions will be made, which can lower transaction costs and lead to better resource management outcomes suited to the local situation and preferences (Dyckman, 2016; Huntjens et al., 2012; Ostrom, 2009). Providing legal authority for self-organization of local governance arrangements, while remaining connected to higher structures, can promote resilient management by incorporating local knowledge of social-ecological systems, diverse stakeholder participation, and social learning (Dyckman, 2016; Sterk et al., 2017). Huntjens et al. (2012) further suggest that boundaries and responsibilities should be clearly defined among levels of governance, with the possibility of renegotiating as needed.

Institutional legitimacy and public support are important resources for adaptive capacity, and they are built through demonstrations of the governance system's transparency, accountability, and representativeness (Engle & Lemos, 2010; Gupta et al., 2010; Ivey et al., 2004; Langridge &

Ansell, 2018; Saravanan et al., 2008). While interpersonal trust is important at the local level, complex large-scale planning efforts rely on the legitimacy of planning institutions in the eyes of stakeholders (Engle & Lemos, 2010; Huntjens et al., 2012). Greater legitimacy is expressed through public support and willingness to commit resources to planning and resource management (Baehler & Biddle, 2018).

The previous discussion highlights the tension between the competing needs for stability and flexibility in water systems. Stability in governance arrangements enables sustained learning about the water resource system being governed and provides reassurance that long-term investments of resources will be worthwhile (Craig et al., 2017). What is becoming more apparent, however, is that this "stickiness" or path dependence may cause institutions to outlive their usefulness and become too rigid, even when they are no longer serving the social-ecological systems they were designed to support (Baltutis & Moore, 2019; Pahl-Wostl, 2009; Young, 2010). The "delicate balance between innovation and reliability" is a major challenge for any form of governance seeking to increase resilience and reduce vulnerability (Baehler & Biddle, 2018, p. 7; Cosens et al., 2017; Craig et al., 2017; Folke, 2006; Young, 2010). Given the risk of an unchanging governance system eventually becoming overwhelmed and collapsing, allowing some degree of flexibility to change is fundamentally necessary for the system to persist: the only way to be stable is actually to be flexible (Cosens et al., 2017; Craig et al., 2017; Holling, 1973). One way to balance these competing goals is for institutions themselves to incorporate periodic reflection, evaluation, and revision processes within legal and governance structures to allow for responsiveness to changing needs and conditions (Craig et al., 2017; Hill Clarvis et al., 2014; Huntjens et al., 2012; Hurlbert & Gupta, 2019). This responsiveness enables emerging stakeholder concerns to be heard, building legitimacy and trust in the process.

### 3.2.5 *Participation and Networks*

Finally, inclusive and participatory water planning processes can promote equity, transparency, and multi-level networked communication. Inclusive processes build social capital, which can hold together collaborations, support social learning, and foster trust, all of which can increase adaptive capacity and resilience to future water challenges (Baehler & Biddle, 2018; Brugger et al., 2018; Folke et al., 2005). Participation can be supported through either requirements or incentives to all those who may have a stake in the water resource and adaptation processes (Cosens et al., 2017; Huntjens et al., 2012; Langridge & Ansell, 2018). When socially defined goals differ widely or there are significant power imbalances among stakeholder groups, careful attention is needed to structure participatory processes in a way that prevents capture by powerful interests and encourages fairness in deliberation and decision making (Mancilla García et al., 2019; Wise et al., 2014). In particular, processes may need to be designed to actively engage marginalized and vulnerable groups to ensure equitable inclusion in decision making and sharing of costs and benefits of adaptation (Cosens et al., 2017; Huitema et al., 2009; Huntjens et al., 2012). Networks connect stakeholders for negotiation and cooperation and can bridge the gaps between locally autonomous units and higher levels of governance (Hill Clarvis & Engle, 2015). The presence of forums for regional collaboration and networks that can bridge multiple geographic areas as well as multiple governance levels can contribute to the development of regionally appropriate strategies (Engle, 2013).

# 4 Methods

To characterize the adaptive capacity inherent in water governance arrangements in the states in the study area and investigate its relationship with IWRM and polycentric governance, two qualitative research methods were used, content analysis and semi-structured interviews. Content analysis was performed on state level water plans in the study area using the IWRM, polycentricity, and adaptive capacity indicators described in the previous Conceptual Framework section and summarized in Figures 2 and 3 above. Adaptive capacity could either be demonstrated through the plan's description of existing programs and projects which correlate with determinants of adaptive capacity, or the plan could directly contribute to building additional adaptive capacity through setting goals and objectives for new programs and projects that support adaptation. For states which do not produce a statewide water plan, analysis was performed on similar documents such as a non-binding state strategy or vision where available. Washington does not have a statewide document of this type, so analysis relied more on data collected from interviews as well as background research. A list of the primary documents used for content analysis appears in Table 1.

Table 1. Documents used in content analysis.

| State | Document | Year Published |
|---|---|---|
| Arizona | Arizona's Next Century: A Strategic Vision for Water Supply Sustainability | 2014 |
| California | California Water Plan Update 2018: Managing Water Resources for Sustainability | 2019 |
| Colorado | Colorado's Water Plan: Collaborating on Colorado's Water Future | 2015 |
| Idaho | Idaho State Water Plan | 2012 |
| Montana | Montana State Water Plan: A Watershed Approach | 2015 |
| Nevada | Nevada State Water Plan | 1999 |
| New Mexico | New Mexico State Water Plan | 2018 |

| | | |
|---|---|---|
| Oregon | Oregon's Integrated Water Resources Strategy | 2017 |
| Utah | Recommended State Water Strategy | 2017 |
| Wyoming | The Wyoming Framework Water Plan | 2007 |

The second method used was semi-structured interviews with individuals who are involved with state and regional water planning throughout the study area. The initial sample was selected in alignment with the Internal Review Board (IRB) authorization received for this project and was purposive, meaning that rather than a probability-based representative design, the selection relied on researcher judgment to invite participants meeting certain criteria, followed by a snowball sample of additional interviewees recommended by the first group (Robson & McCartan, 2016). Criteria used to select participants include factors such as state or regional plan co-authorship, job titles, and organization charts of state water management agencies. Participants were contacted via email or telephone, and interviews took place via phone or Zoom videoconferencing. Interviews followed a general guide of topics to be covered, but were semi-structured in the sense that the order of questions could be changed based on the flow of the interview, and additional follow-up questions were asked where relevant (Robson & McCartan, 2016). Questions in the data collection instrument were designed to elicit more in-depth information about the development and implementation of state water plans, water governance arrangements including features of IWRM and polycentricity, and indicators of adaptive capacity, as well as informal practices and organizational culture which also play a role in structuring the governance system (Lune & Berg, 2018; Waylen et al., 2019). Using interviews as a secondary method allowed for triangulation of data gathered from the written plans, increasing the validity of the analysis by offering either confirmation or a chance to consider rival explanations (Bowen, 2009). In total, 24 interviews were conducted for this project with a

mix of state and regional water resource managers, including at least one interview for every state in the study area.

Data collected from the documents and interview transcripts were coded using directed content analysis, which includes both categories derived inductively from the raw data as well as pre-established analytic codes developed from the application of relevant theories such as vulnerability and resilience (Hsieh & Shannon, 2005; Lune & Berg, 2018). Coding categories were initially developed based on existing models of adaptive capacity, IWRM, and polycentricity, and then additional emergent patterns and themes which were recognized during coding were used to refine the initial codes and/or add new categories and subcategories relevant to the context of the study area (Bowen, 2009; Elo & Kyngäs, 2008). An explanatory narrative was then developed that recognizes local IWRM variations and manifestations of polycentricity. From this plan and interview based inventory and analysis, a typology of plans was constructed for sorting the states according to relevant variables and concepts, as shown in Figure 4.

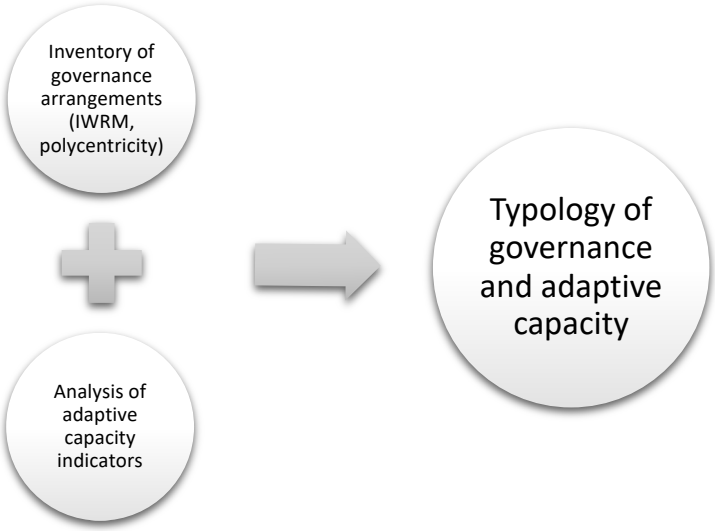


Figure 4. Process of constructing the governance/adaptive capacity typology.

# 5 Results and Analysis

The results of the project are presented state by state below. First, an inventory of water governance arrangements describes the level of IWRM and polycentricity evident in each state's planning document or strategy as well as interviews conducted for the project. This inventory is based on the characteristics of IWRM and polycentricity summarized in Figure 1 above. Next, an analysis of the factors influencing adaptive capacity in each state follows, characterizing this capacity in terms of the five broad categories outlined in the conceptual framework and summarized in Figure 2 above. Most indicators are classified as high, medium, or low, taking into account that several elements contribute to each broad category, so these characterizations represent general trends rather than sharp divisions. Information provided by interviewees is designated by an interview code to maintain confidentiality, e.g., AZ22 represents a participant from Arizona.

## 5.1 Arizona

### 5.1.1 *Governance Arrangements*

IWRM: *high* Arizona implements many of the principles of IWRM, although there are some gaps in integration. Water is considered very holistically as a resource, with demand management strategies such as water conservation considered as part of water supply, and extensive reuse of treated wastewater for purposes such as irrigation and artificial aquifer recharge. The state strategy recognizes the need to balance economic, social, and environmental needs for water. The fragmentation of land ownership among public and private entities complicates integration of land and water management. In general, local entities are responsible for land use planning, although one interviewee described state review of local land use plans

after they are developed (AZ22), and another described the state's Assured Water Supply program which imposes water supply considerations on land use decisions:

> before a subdivision can be built, the developer or the water provider has to prove that there would be a 100 year water supply for that subdivision. So that is not a direct land use planning thing because we still allow, for example, the provider can still decide where that subdivision might be located as long as they can prove that hundred year water supply. So what it is, is rather than being kind of prescriptive about where you can and can't develop, we say, if you can meet these criteria, it's okay for people to develop in a given place (AZ13)

Arizona has designated five Active Management Areas (AMAs) covering Prescott, Phoenix, Pinal, Tucson, and Santa Cruz, which are groundwater basin defined areas surrounding major population centers in which water is managed to reduce aquifer overdraft and try to bring supply and demand into balance. The footprint of agriculture cannot expand within these areas, and the state has also designated additional Irrigation Non-Expansion Areas in recognition of agriculture's high water use which can impact other uses and environmental needs. While surface water and groundwater are governed by separate regulations, integration has occurred at the management level:

> the way our groundwater law was written, it was kind of groundwater focused, but it also allows us to regulate. If a user is using any groundwater, it allows us to regulate their total water use in order to regulate their groundwater use. And most of our users in the Active Management Areas use multiple sources. So, in that way, we kind of integrate the management of those things (AZ13)

In addition, ongoing adjudication processes have recognized the interconnection of surface water and groundwater, although the disconnect in laws around their management has led this to be framed as "some surface water flows underground" (AZ13). Due to the complexities of the transboundary compact governing the Colorado River, this water source is managed separately from both groundwater and other surface water.

Water quality and quantity are also regulated separately, but the state water strategy recognizes that low water quality can limit water availability in many areas, and that groundwater mining can reduce water quality and negatively affect ecosystems. In practice, these connections have led the agencies managing quality and quantity to work together closely (AZ13). The Colorado River Section of the Arizona Water Resources Department does not regulate water quality, other than to cooperate with the other basin states for salinity control prior to delivery to Mexico (AZ24). In terms of the IWRM principle of stakeholder engagement in decision making, there are many opportunities for input from the public, local and regional water user groups, utilities, and entities at all levels of government, although this is often more of an advisory role than direct participation in decisions.

Polycentricity: *low, more top-down* Arizona's water governance arrangements are nested within multiple levels of government, but the state level plays a strong role rather than granting more autonomy to lower units such as the Active Management Areas. The AMA boundaries and their individual water conservation goals are legislatively defined, and the Arizona Department of Water Resources assesses water supply and demand within each area. Stakeholders can influence how the conservation goals are achieved, but they do not have the autonomy to alter the goals, and their management plans are ultimately developed by the state with public input (AZ22). There is little horizontal coordination among the AMAs, but their separation does allow for customization of strategies in the management plans based on local values and needs. In this sense, the AMA plans are place-based, but the participatory process is initiated by the state rather than being locally driven. Based on the advisory rather than semi-autonomous nature of the AMAs and the strong state role not only in coordinating vertically but in developing the plans themselves, this system of governance is more top-down than polycentric.

### 5.1.2 *Adaptive Capacity Analysis*

Comprehensiveness and integration: *high* Arizona considers a diverse range of supply and demand management strategies to meet their water needs. The state strategy emphasizes water conservation as a foundation while exploring supply options ranging from stormwater capture and reuse of treated wastewater to weather modification and desalination of brackish groundwater or an agreement with other Colorado River basin states to fund seawater desalination in exchange for water from Lake Mead. Interviewees for the project recognized regional differences in outcomes while implementing the same strategies and incentives, and they noted that a combination of multiple policy solutions would need to be integrated (AZ13, AZ22). Overall, the policy landscape is complex but not conflicting, except for the separate regulation of surface water and groundwater in most cases despite acknowledgment of their connection unless an entity is using both sources. Multi-level policy interactions are common, particularly with management of the Colorado River:

> the feds had threatened to not provide funding for the Central Arizona Project which delivers Colorado River water to central Arizona, to Phoenix, Tucson, unless we did something to get groundwater overdraft better under control. So the idea of the Groundwater Management Act was to get that groundwater overdraft better under control and also to get that federal funding for the Central Arizona Project (AZ13)

The state strategy is consistent and coordinated with sub-state (Active Management Area) and supra-state (Colorado River) plans and entities. While the links and interactions among water uses are recognized, balancing uses can be challenging since water rights are allocated under prior appropriation, leaving less flexibility to change usage. Within the AMAs, however, water conservation programs take the needs of different sectors into account:

> Rather than trying to frame it as ‘these are competing for the same limited resource,’ we try to frame it as each sector contributing toward progress towards

> the good of the whole. So, we do consider it, of course, a limited resource, but it's something we try to reframe as 'everybody is making the contribution' rather than 'these sectors are competing against each other' (AZ13)

Within the Colorado River basin, water is also allocated by seniority, with additional considerations of infrastructure funding:

> Central Arizona Project water had been allocated to those entities that had the ability to prove water use within their service areas and also those that had the ability to pay for the Central Arizona Project canal itself. So the balancing of the water rights is a combination of whether they could actually prove demand, and whether they had been historically irrigating their land, and also population growth, and their ability to financially be able to pay (AZ24)

While separate state and federal agencies have their own focus areas such as water quality versus quantity, they tend to work together closely and are able to coordinate decision making while maintaining their own areas of expertise.

Knowledge and learning: *medium* Water-related data availability varies throughout the state. Within the AMAs, extensive studies and usage reporting requirements have created high quality data, while estimates and models are used in many rural parts of Arizona with varying degrees of accuracy (AZ13, AZ22). Along the Colorado River, "every drop of the water is monitored and managed" including both supply in terms of stream gages and demand in the form of withdrawals (AZ24). Data is easily accessible to state-level managers for decision making, and efforts are being made to increase accessibility to the public through publication of the Arizona Water Atlas, a statewide water resources data repository, and a variety of data portals and dashboards on the state website (AZ13). Arizona monitors thresholds beyond which water system functioning could be impaired or shifted to a less desirable state, such as safe yield of aquifers, gaps between projected supply and demand, and critical levels in Lake Mead that could trigger curtailment of Colorado River water use (AZ22, AZ24). Social learning is occurring

through the Arizona Drought Preparedness Program and interagency coordinating group, and the Governor's Water Augmentation Innovation and Conservation Council is reflecting on lessons learned from the Active Management Area plans as they contemplate how best to move forward after 2025 when the final round of plans is set to expire (AZ22, AZ13). Uncertainty is dealt with through a combination of storage to buffer against temporal variation, adjudications to increase certainty of water demand, and proactive planning and modeling. As one interviewee described:

> We have always known in this state that water is a scarce thing, that's not new for us. So water has kind of always been a little bit uncertain for us. What we're trying to do a better job of is managing the uncertainty around groundwater, those types of waters that are a little more invisible (AZ13)

Another interviewee talked about the Salt River Project's water management strategy of managing their reservoirs and groundwater use with an assumption of seven years of scarcity:

> They've already had ten years of drought, they're always thinking the next seven years will be dry and managing their water resources as such. So if there is a wet year, it's always great. But they don't count on it (AZ22)

Resources: *medium* All interviewees for the project described how they were doing the best they could with the funding available but could always use more (AZ13, AZ22, AZ24). The state strategy asserts that "only Arizona's community, political, and business leaders are capable of garnering financial resources and mechanisms necessary" to address large-scale water projects through public-private partnerships when state resources are insufficient (p. 69). Colorado River management has a separate funding model of cost sharing among the basin states, federal government, water users, and utility providers, with related projects funded by large nonprofits such as the Walton Family Foundation, Environmental Defense Fund, and the Audubon Society (AZ24). Within the AMAs,

> the conservation requirements for each sector are mandatory and we developed them with an eye toward economic considerations and the cost of implementation,

> but it's not something we provide direct funding to those users to implement. So that's a cost of doing business for them (AZ13)

The state does provide funding for conservation support and research within the AMAs through a portion of the withdrawal fees for groundwater (AZ13). In terms of human resources, two interviewees mentioned a large reduction in workforce around 2008 from which the department is slowly recovering, which has caused delays in developing plans as well as conducting groundwater modeling outside of the AMAs (AZ13, AZ22):

> when the recession hit, the department was cut down from well over 200 people and including an office in each Active Management Area to one central office with, I think at the lowest, they were in the 80s for the number of people. So that's a very big part of the reason why we are behind on the management plans (AZ13)

The Department of Water Resources has been able to develop partnerships for technical expertise with universities and federal agencies.

Authority and legitimacy: *medium* Management and goals of water conservation programs in the AMAs are mandated by statutes rather than developed within the authority of the AMAs themselves. Stakeholders in each area are able to influence how the mandated conservation goals are achieved, and there is recognition of differing needs among the regions, so the plans are not all alike (AZ13, AZ22). Public support for the institutions of water planning is generally strong:

> If you were to ask it as, do you support long term water planning? I think people would generally be supportive of that. I think there would be strong public support for that. I think people from all sectors would support that. What becomes controversial in Arizona, and I think probably in other states, too, is when it comes down to the specific asks of the conservation program (AZ13)

Fostering an inclusive engagement process and showing how the state has responded to and incorporated public comments into plan updates has helped stakeholders gain confidence in the legitimacy of the process as a way to express their needs and opinions. This is also the case in the Colorado River basin:

> It is very difficult to change any way that the Colorado River is managed in Arizona. However, I do have to mention that over the years we have recognized the importance of collaborative decisions and working with each other. And here when we say each other, I'm talking about the other basin states and Mexico and tribes. We have been working very collaboratively with each other over the past decade. Prior to that, it was very litigious (AZ24)

Participation and networks: *high* Interagency communication and networking is strong in Arizona both within state-level entities and among multiple levels of governance on issues such as drought response and Colorado River management. Each AMA has a Groundwater Users Advisory Council (GUAC) which provides local perspectives on water policy. The level of engagement varies, as one interviewee reported, "since the time I've been here, I've seen GUAC meetings with, like, three people in them and I've seen ones that overflowed the room" depending on current issues (AZ13). Stakeholder engagement and feedback has been increasing since the recent negotiation of the Drought Contingency Plan (DCP) for the Colorado River which has raised awareness of water issues around the state (AZ13). Increasing the inclusiveness of the DCP negotiation process was instrumental in its success, as one interviewee described the lack of progress made with a smaller group in the first two years followed by the switch to a more collaborative and transparent approach:

> It was a very hard lesson because it took us three years to get the DCP just adopted in Arizona, which was kind of sad because all of the other basin states except California were ready to go forward, right, and we were really seen as a villain, or the bad guy for three years straight. And we tried and tried and tried and tried and finally realized, let's just go at it together. Problem solve together. And it really worked (AZ24)

Broad stakeholder engagement is planned for the next round of AMA plan updates with the recognition that each region faces unique challenges and local water users should be able to participate in shaping solutions. The state is also exploring ways to address the equity concerns of rural areas which lack the financial capacity to construct or maintain needed water

infrastructure and may be experiencing aquifer depletion but would require a different management structure than the AMA conservation mandated in urban areas (AZ22).

## 5.2 California

### 5.2.1 *Governance Arrangements*

IWRM: *high* California's water governance is deliberately integrative and seeks opportunities for interagency coordination, recognizing interconnections among land and water resources, water use sectors, and scales of management. Land use planning is done at the local level, but the state acknowledges the importance of healthy watersheds, headwaters, and working landscapes for water quality and quantity. The separation of responsibilities between city or county land use planners and water agencies can present challenges to integration, but this can be ameliorated in cases where the local water agency's scope is more comprehensive:

> some water agencies are more about supply, and other water agencies have flood management responsibilities as well as wastewater, and the more that an entity, the more sectors that they have authority over, the easier it has been for them to become more integrated and coordinated amongst those sectors and with their land use planners (CA3)

While surface water and groundwater have traditionally been managed as separate resources, and water quality and quantity are also regulated by separate agencies, the state has made efforts to improve coordination:

> It's kind of a core policy in DWR that all those things are interconnected. Even though some of the legislation has been written as if they're in isolation of each other, the people at DWR understand that they're connected, and at least that helps (CA2)

Long-distance inter-basin water transfers necessitate more coordinated state level management, including transboundary interactions for interstate compacts, and the state plan notes that the "timing, quantity, and location of precipitation in California are largely misaligned with

agricultural and urban water uses" which is managed through storage and intra- and interstate conveyances (CDWR, 2019, p. 1-4).

The state's Integrated Regional Water Management program and Sustainable Groundwater Management Act create localized groups based on hydrologic boundaries (surface water and groundwater basins, respectively) which work to integrate stakeholder concerns for planning within the coordination structure and funding provided by the state. There is a strong focus on balancing the economy, environment, and social equity in these management paradigms, including programs to advance the inclusion of historically marginalized groups such as Native American tribes and disadvantaged communities.

Polycentricity: *medium* California's water governance displays elements of polycentricity, although there may be more vertical connections than horizontal. The state provides policy guidance, technical support, and funding to regional agencies to plan and implement water-related programs and projects:

> That highly decentralized nature is one of the motivations of the integrated regional water management and planning initiative, is through incentive, it's not mandated, encouraging entities at a spatial scale that makes sense to them and the state, to come together while keeping their authorities and organizational identity, agreeing to work on a joint integrated regional water management plan. (CA3)

The local agencies, such as Integrated Regional Water Management groups and Groundwater Sustainability Agencies, have a great deal of autonomy since the state provides assistance but no mandates, and these regional groups are seen as "the building blocks for what future place-based collaboration in California can and should be" (CA3). Although there is some horizontal coordination among adjoining units, there is more vertical policy coordination and information-sharing networks nested among the local, regional, and state levels.

### 5.2.2 *Adaptive Capacity Analysis*

Comprehensiveness and integration: *high* California's water planning structures are deliberately integrative and show a preference for supporting multi-benefit projects such as integrating ecosystem restoration into other water management projects on working landscapes. Diverse solutions are considered to meet California's water needs, including maintaining and rehabilitating aging infrastructure, undertaking managed aquifer recharge, and supporting regional participatory management groups. The state recently released a draft Water Resilience Portfolio which seeks new approaches to improving water systems' capacity to deal with climate change and other water challenges. One interviewee acknowledged the need for policy coherence and described the variety of policy options being tested from the incentive-based Integrated Regional Water Management Program to the more regulatory but still collaborative Sustainable Groundwater Management Act:

> what California needs to work on is coming up with consistent policies that can best leverage incentives and regulation toward a common or consistent policy. And I don't think we're there yet, but I think we're on a trajectory and recognize that it has to be done (CA3)

The state water plan itself has provided some of this consistency, but it functions as more of a strategic vision than a mandate. The plan shows a strong concern for balancing economic, environmental, and social equity needs, and sets an intention of further integrating water management to cope with climate change:

> climate change has exacerbated the extreme events that California is and will experience, and those extreme events, including the fact that our snowpack is diminishing and melting sooner than historically, is requiring fundamental rethinking of how we manage our water resources both surface and ground water, and really will require closer co-management of the different water management sectors than we have done in the past (CA3)

In addition to connecting with local and regional water planning efforts, a State Agency Steering Committee was formed for the water plan's update, and the agencies are now actively seeking opportunities to collaborate and integrate their planning:

> Caltrans, which is our state transportation agency or department, they are on our State Agency Steering Committee and then they've invited us, Department of Water Resources, to be on their committee to put together the state's transportation plan. There's also a similar example with the Department of Fish and Wildlife when they worked on their state Wildlife Action Plan. So there are more and more examples where state agencies are working to cross-pollinate (CA3)

Knowledge and learning: *high* Data management was fragmented and decentralized but is now improving, and the state plan discusses the process of combining subject expertise and stakeholder perspectives in order to make better decisions. New initiatives to make data more accessible include an open water data platform and a Sustainability Outlook web tool to track not only the condition and trends of watersheds around the state but also the impacts of water management actions and investments (CA3). The state places an emphasis on using the best available science, which can be hindered by data gaps such as the lack of a requirement to measure all uses of water (CA2, CA3). Monitoring of water system thresholds focuses on groundwater overdraft, especially in the Central Valley where severe impacts such as land subsidence have become apparent (CA3). Water districts above a certain size must also have drought contingency and water shortage plans in place as part of their required water management plans (CA2).

Learning from experience and incorporating that learning into management decisions has helped the state build resilience (CA2). For example, legislation around water conservation and drought preparedness was passed in 2018 in response to management difficulties experienced during the

drought years preceding it (CA3). Comprehensive scenario planning has been developed in order to cope with remaining uncertainty:

> historically the water plan, when it looked at the future, looked at the future average condition and a future dry condition. And we have now gone well beyond that from the 2009 water plan update to the present where we're looking at dozens of climate scenarios coupled with population growth scenarios (CA3)

Resources: *medium* Current funding for water planning and project implementation is considered inadequate and unpredictable in the state plan. The state is therefore contemplating a range of novel funding mechanisms from infrastructure finance districts to water markets in order to meet demands, and the plan also explores funding scenarios such as emphasizing state general fund versus general obligation bonds. According to one interviewee, only 2% of the state general fund is currently spent on water management, and most of the money spent on water-related issues statewide is spent at the local level for ongoing operations and maintenance (CA3).

The state plan discusses leveraging expertise and project implementation through partnerships at multiple levels of governance, enabling human resources to be stretched further. The Department of Water Resources has ten dedicated staff working on climate change issues, which has been extremely valuable in building capacity within the agency to produce the latest science and then use it in decision making (CA2).

Authority and legitimacy: *high* Local water management groups, such as the collaboratives formed under the Integrated Regional Water Management program and the Groundwater Sustainability Agencies formed under the Sustainable Groundwater Management Act, have a great deal of authority to shape implementation of state goals as well as developing many of their own goals and targets. The state water plan itself provides strategy but sets no mandates and does not have any funding automatically appropriated to implement it, so most actions are taken at the

local level rather than through state enforcement. The need for local solutions was particularly recognized during the drought conditions from 2011-2017, and the state has responded by emphasizing place-based strategies to give stakeholders a voice in the response:

> certainly the latest drought could be thought of as the most consequential drought, even though it wasn't hydrologically the deepest drought or the driest drought, but it was the one that affected most all of the state and the consequences to communities and the environment has been greatest. And during those events, the recognition of the need for more integrated and collaborative place-based approaches are recognized (CA3)

In addition to local level engagement, public outreach is a key part of the state plan update, and public support for the water planning process and institutions is high (CA3). This support has been expressed through funding as well as public comment:

> There was a water bond a few years ago, Prop. 84, and it included a chapter or section funding for implementing the CA Water Plan. What's noteworthy about that one is, that was done through a stakeholder initiative and not through the legislature. So here is a case where stakeholders took it upon themselves to dedicate or allocate some funding in this water bond, not a lot, but to actually help implement the water plan (CA3)

Participation and networks: *high* California's water plan describes water management as "a grand exercise in partnerships," and there is widespread interagency networking among state agencies as well as between levels of government (p. ii, CA2). Increasing collaboration has been in some cases a "heavy lift" in terms of shifting organizational culture and putting in the effort to build and maintain networks, but the multi-benefit outcomes have proven the value of these tactics (CA3). Regional groups have also built place-based networks, and the state water plan provides a forum for robust stakeholder engagement at all levels of government and all sectors of water use. Third party neutral facilitators associated with California State University Sacramento have assisted in this process, allowing stakeholders to "hear each other more constructively" and understand multiple perspectives (CA3). The state also makes proactive efforts to engage with

disadvantaged communities, small water suppliers, and to engage tribes in regional and state water planning activities (CA2, CA3).

## 5.3 Colorado

### 5.3.1 *Governance Arrangements*

IWRM: *high* Colorado's state water plan sets a variety of goals for moving toward more holistic management in order to "embark on a new era of collaboration between state and local government on water and land use issues" as well as increasing coordination among state level agencies (CWCB, 2015, p. xx). Although land and water were historically managed separately, according to an interviewee from the Colorado Water Conservation Board, their interconnections are now being acknowledged, leading to greater integration and coordination with other agencies such as the Department of Local Affairs (CO6). Within the plan, land use is principally discussed in terms of water conservation and demand management as well as the effects of land use change on environmental and water resources and quality. One target set by the plan is that "by 2025, 75 percent of Coloradans will live in communities that have incorporated water-saving actions into land use planning," emphasizing the linkages between water and land (CWCB, 2015, p. 10-5).

At the sub-state level, basin-wide plans following hydrologic boundaries of major river systems were developed with extensive stakeholder engagement in the form of Basin Roundtables. The state further recommends developing diverse partnerships to create localized watershed-level plans with goals for water quality and quantity while promoting watershed health across political boundaries. Although quality and quantity are currently managed separately, the state plan sets a goal of integrating their management by 2050 based on Executive Order D 2013-005 stating that they affect each other and should be managed conjunctively. Where surface water and

groundwater are hydrologically connected, these resources are already managed conjunctively. Under state law, all groundwater is assumed to be hydrologically connected to surface water unless proven otherwise or declared separate through a decree, so the vast majority is managed together with surface water. The state also strives to balance municipal, agricultural, and environmental needs at the basin and statewide scales (CO6).

Polycentricity: *high* Colorado's system of well-connected, semi-autonomous Basin Roundtables coordinated by the state shows strong polycentric tendencies. Basin Implementation Plans were developed regionally, and the Basin Roundtables are able to help direct funding and priorities in their regions while remaining within an overall policy structure developed by the state. The state plays a role in providing information, guidance, and funding incentives, as well as encouraging basin level entities toward state goals such as water conservation, while allowing for local flexibility:

> Ours is much more in the operational space of the carrot. We've got funding ability to make things happen, we have policy, directives and sway…so we have a seat at the table and I would think a leadership role at the table (CO6)

The plan includes clear explanations of the nested levels of policies and responsibilities that apply to water governance in the state. In addition to these vertical connections, the Interbasin Compact Committee (IBCC) connects the Basin Roundtables horizontally:

> IBCC brings together all of those, two members from each Roundtable, essentially to have these statewide conversations, expressly for that purpose, to intentionally build collaborative opportunities…we've also, at the Roundtable level, had a couple of statewide summits to bring together Roundtables (CO6)

Horizontal connections are also strong among state agencies, and transboundary coordination is required for interstate compacts. The recommendation of local watershed planning would create

an additional layer of place-based governance; the basin-level plans were developed with inclusive stakeholder engagement but are much broader in spatial scale.

### 5.3.2 *Adaptive Capacity Analysis*

Comprehensiveness and integration: *high* Colorado considers a wide portfolio of management strategies for both supply and demand in order to close the projected gap between them. The state prioritizes a balance of water conservation and storage, and they employ a mixture of incentives, regulations, new technologies, and funding options to achieve supply goals and avoid potential negative outcomes such as curtailment of allocations of water under interstate compacts (CO6). The state plan provides a thorough explanation of the multi-level nested policy structure surrounding water management in the state, from interactions with the federal Endangered Species Act to the development of prior appropriation in Colorado water law. Although water quality and quantity are regulated separately, their connection is recognized, and the Colorado Water Conservation Board and Colorado Department of Public Health and Environment recently collaborated on a "smart water permitting handbook" to streamline joint water quantity and quality permitting procedures in response to public requests (CO6). The state displays a strong multi-purpose focus for water projects to meet multiple goals:

> the water plan helped set the table, they said everybody has a role here, and if we want the state to grow and prosper, whether that's thriving cities or thriving agriculture or thriving environment, we all need to talk and the goal here is really to keep the most options on the table for our children and their children (CO6)

There is strong concern about maintaining state and local control over water planning decisions in contrast to federal intervention, while still maintaining the requirements of interstate compacts, each of which is explained in detail in the plan with a discussion of how coordination and collaboration are working in each transboundary river basin. Management is linked across

scales from these transboundary compacts to interactions with federal agencies such as the Environmental Protection Agency on water quality issues and then down to regional Basin Implementation Plans which will be rolled up into the next state water plan update (CO6). The state and regional entities are specifically looking for ways to integrate plans from other sectors and levels of government into the Basin Implementation Plans, such as county and municipal water plans, stream management plans, and forest health plans (CO6).

Knowledge and learning: *high* Colorado's Decision Support System (CDSS) is a joint effort of the Colorado Water Conservation Board and Department of Water Resources, and this system contains extensive data and analytic tools from aquifer properties to water right call records to crop consumptive use models. The state supports ongoing research into topics such as irrigation efficiency and water quality, and the state and basin plans rely on monitoring networks of stream gages, snowpack, and water use for technical data in their analysis (CO6). Data gaps exist, particularly for water use by smaller communities and agriculture, but improvements have been made over the past five years (CO6). The state carefully tracks Colorado River reservoir levels to understand when flows may drop below a threshold that would require management actions. In response to flooding in 2013, local watershed coalitions were formed to write stream restoration and management plans, but the state plan notes that "collaboration before a threshold-crossing disturbance takes place sets the stage for faster and more resilient recovery measures," and promotes proactive planning and monitoring of system disturbance thresholds (p. 7-6).

Colorado is actively employing a "Learning by Doing" adaptive management approach for habitat restoration and streamflow enhancement. The state plan includes reflections of lessons learned in a variety of areas from public-private partnership funding structures to alternative

transfer methods for water rights. In planning for the future, the state couples this learning with scenario planning focused on "key uncertainties" with five scenarios considered in the state plan using a range of climate change and population projections, water demand and supply projections, and social value preferences for conservation versus full resource utilization (CO6). Developed in cooperation with the Basin Roundtables and Interbasin Compact Committee, the scenario planning process provides flexibility by identifying tipping points and adaptive pathways among the scenarios. In particular, planning for multiple scenarios allows basin groups to recognize actions that "apply to multiple futures, and Colorado can plan for and prioritize those first, while still monitoring uncertainties that may redirect recent trends" (p. 6-4).

Resources: *high* Describing water as "too important to fail," the state expresses its intention of ensuring that funding is available for water projects while acknowledging that state investment in water resources is low compared to other policy areas (p. xviii). A list of funding needs is provided by basin along with a map visualizing infrastructure needs, and the plan also includes a description of state and other funding sources, noting that multi-level cooperation will be needed in order to meet funding needs especially for large infrastructure projects. The Colorado Water Conservation Board's funding for water planning and other activities is funded through a mixture of self-generated enterprise funds, legislative appropriations, and severance taxes, and is currently adequate but may need more investment in the future (CO6). The budget is also closely linked with staffing levels, and several of the Basin Implementation Plans suggest staffing needs for specific undertakings such as stream adjudications and agricultural water programs. The state is also able to partner with universities for technical expertise and research as well as internship programs that increase labor capacity while building a future skilled workforce (CO6).

Authority and legitimacy: *high* The state water plan emphasizes the importance of local autonomy and control, with the state playing more of a role in guidance and incentives. The Basin Roundtables have great flexibility in addressing concerns for their own areas, and they have the authority to direct state funds to projects they want to support their own water future (CO6). The Basin Roundtables were formally created through the Water for the 21st Century Act of 2004, and the statutory provisions govern many of their collective choice rules, but the groups are able to influence goal setting and implementation.

Describing the water plan as "one of the crowning achievements of the state," an interviewee described how the public engagement process used transparency and inclusiveness to ensure the legitimacy of the final product in addressing stakeholder concerns:

> It was a highly collaborative effort with 3 drafts and 30,000 comments, and of course in the press they, I've heard it both ways, they did all this to inoculate it from criticism, but the other part of that is, you've just built huge collaboration (CO6)

Responsiveness to changing needs while protecting private property rights under prior appropriation is a key theme, and the plan describes the agility of state water law:

> it has accommodated Colorado values as they developed over time: when our mining and agricultural economies grew, when our municipalities on both sides of the Continental Divide grew, when we recognized the connection between groundwater and surface water, when we recognized the need for water for the environment, when we experienced energy booms and busts, and now, when growing demands for water threaten to eclipse diminishing supplies (p. xx)

Participation and networks: *high* The inclusive process for the state plan also made use of the existing communication networks of "key community, civic, and water organizations" to conduct outreach (p. F-2). State level interagency networking is strong, as one interviewee described coordinating with a long list of sister agencies in the water realm as well as some traditionally outside it:

> we even met with the Office of Economic Development the other day just to talk about what we're doing in water planning and how maybe each of us could support each other with grants or just what they might need to know (CO6)

Basin Roundtables increased connectivity at the regional level, and statewide summits have been held to bring the Roundtables together across geographic boundaries to learn from each other and further develop their networks (CO6). The state's grant funding structure for local projects incentivizes stakeholder engagement and networking by seeking multi-benefit projects that might be difficult for one organization to accomplish alone (CO6).

The plan recognizes the unique needs of different parts of the state, asking, "who better than local water users and stakeholders to tackle these challenges?" and acknowledging issues of equity such as mitigating the economic and social impacts to rural communities from transferring water from agricultural to municipal use (p. xx). Noting that "80% of the water is on the western slope, but 80% of the people are on the eastern slope," an interviewee described the delicate balance of interests needed to ensure fairness to source and destination communities for inter-basin transfers, observing the mixed tone of negotiations over time that "discussion has only gotten sharper and more pointed and in some cases more collaborative too" (CO6).

## 5.4 Idaho

### 5.4.1 *Governance Arrangements*

IWRM: *low but increasing* Idaho's state plan specifically encourages "integrated, coordinated, and adaptable water management," and a broad scope of water-related issues are managed within the same agency (IWRB, 2012, p. 6). Land use and development are regulated at the local level, and the plan notes that integrating water and land use planning will require more multi-level coordination than is currently occurring. The plan's discussion of land use particularly focuses

on riparian zones, wetlands, and floodplains with a direct nexus to water, rather than broader landscape decisions.

Watershed health is to be protected as a source of water supply and quality, and an integrated water planning study on the Rathdrum Prairie including quantity and quality was recently completed for the state by the University of Idaho (ID20). Quality and quantity are generally administered separately, and although efforts are being made to integrate the two, an interviewee from the Idaho Department of Water Resources described "not [being] sure if we're getting in other people's lanes" when working with the Department of Environmental Quality on water quality initiatives (ID20). Surface water and groundwater are administered conjunctively where they are known to be hydrologically connected with a goal of maintaining a sustainable water supply.

Polycentricity: *low, more top-down* At the sub-state level, basin and aquifer plans based on hydrologic boundaries have been developed only in areas where conflicts have arisen or are expected to arise based on competing uses. In developing these regional plans and the state plan, there is considerable stakeholder engagement, but this is generally in the form of opportunities for public comment and participation on local and regional advisory committees rather than through direct decision making. Lower units thus have input but not the level of autonomy that would be expected in a polycentric system. There is also less horizontal connection across geographic regions, although they do demonstrate horizontal connection of sectors and across state agencies.

In general, vertical connections are more robust, with the state connecting to governance levels below and above it assertively. Basin and aquifer planning processes have created well-

connected networks within their regions, but these processes are state-initiated and typically begin with the state appointing a committee to represent stakeholder groups in the area and then facilitating the process rather than a more locally-driven, place-based method (ID20). In coordinating with neighboring states and the federal government, the plan asserts sovereignty over water resources and emphasizes state concerns around compacts and hydroelectric agreements.

### 5.4.2 *Adaptive Capacity Analysis*

Comprehensiveness and integration: *medium* A wide variety of solutions are considered in Idaho's water plan, such as aquifer storage and recovery, water conservation, weather modification, and the potential for additional storage capacity in partnership with the federal government and other entities. The Idaho Water Supply Bank helps balance supply and demand among multiple sectors through water transactions. State policy strategies include a variety of regulatory, market-based, and voluntary programs to support both water quality and allocation quantities. Collaborative watershed-level planning is promoted to protect wetlands and riparian areas.

Integrated policy solutions are sought to connect multiple levels of government from community-based programs to working with the federal government on Endangered Species Act compliance. Idaho displays strong concern for protecting state control of water resources:

> The State asserts sovereignty over the development and use of Idaho's water resources for the benefits of its citizens. Any action by the federal government or other states that would impair Idaho's sovereignty over its water resources is against state policy (p. 8)

The state plan also establishes clear policies for all state agencies with water-related responsibilities to follow (ID20).

In considering the many uses of water and potential interactions among them, the state focuses more on balancing needs rather than integrating them, with a slight leaning toward preferences for out-of-stream human and economic uses (ID20). The Idaho State Constitution lists a hierarchy of uses, expressing that during shortages, water should first go to domestic use, then agriculture, and then manufacturing, with the caveat that in organized mining districts, preference would go to mining before agriculture or manufacturing. A special framework has been developed to balance the use of hydropower with other beneficial uses.

Management is linked across scales, with the state plan divided into a statewide Part A followed by sub-state basin and aquifer plans as Part B within the same document. Multi-level coordination is required with other states, the federal government, and tribes for developing interstate agreements around shared aquifers and transboundary river systems. Depending on current projects, an interviewee described interacting with an approximately even balance of local, state, and federal agencies on a regular basis (ID20).

Knowledge and learning: *high* Data collection and modeling are strongly integrated into Idaho's water planning processes at the state and basin level. The state plan encourages quantifying water uses and supplies including research needed for aquifer withdrawals and recharge under different climate condition. Cooperative data exchange policies are endorsed to increase data accessibility and to stretch limited funds for research and monitoring networks. Critical Ground Water Areas can be designated where excessive withdrawals are pushing aquifer systems toward

negative thresholds. In 2016, a Sustainability Policy was added to the state plan to propose strategies for identifying and addressing unsustainable trends toward a system threshold:

> For example, water needs or demands outstripping supply, or declining groundwater levels, or any other way a crisis may rear its head. We tried to create a clearinghouse for what those types of things could be, and benchmarks and strategies for how to address those. And where you'd be if you know you're going in the right direction (ID20)

Adaptive management is discussed at length in the context of the Snake River Basin and Eastern Snake Plain Aquifer, although this term is used more in the sense of monitoring and adjusting management rather than management by deliberate experimentation:

> We develop management alternatives that are designed to do certain things. And if that response is not occurring in a way that all the water users feel is satisfactory, then we start to investigate that a little bit more and see what we're missing, why it's not working, and try to course correct (ID20)

This approach has allowed regional water managers to test out innovative solutions and incorporate emerging insights into management "rather than to try and impose a state solution on a basin and say 'this is how we do it, fit your problem and your solutions into this box,' that hasn't worked as well" as allowing local flexibility (ID20). Flexibility is also recommended as a tool for coping with uncertainty in water supply and demand under conditions of climate change throughout the state, although the state plan discusses climate variability more than direct acknowledgment of climate change (ID20).

Resources: *high* The state plan discusses a wide variety of strategies for funding water projects and programs, from state appropriations and establishing special districts to power franchise fees and taxes and bonds. Recently, the state has made significant investments in aquifer planning, allocating money from the general fund every year for stakeholder engagement and water supply assessments in groundwater basins around the state in addition to substantial funding for

implementation actions in the Eastern Snake Plain region (ID20). While funding for planning activities at the state level has been adequate, an interviewee noted that "without funding, you're kind of just spinning your wheels" in terms of implementing the regional basin and aquifer plans developed with stakeholder engagement, highlighting the need for continued commitment (ID20). Staffing at the Idaho Department of Water Resources has been reduced over the years but is still manageable, and the department is able to provide staff resources to the Idaho Water Resource Board, which is responsible for development of the state water plan but is a voluntary board with no staff (ID20). The state also cooperates with a variety of entities for technical expertise and research, including direct partnerships with water users for data collection and monitoring networks (ID20).

Authority and legitimacy: *low* Idaho supports stakeholder engagement and customization of plans, but regional planning processes are state-initiated rather than basin-led:

> quite often they're requested by water users in those basins, but there's not a way for them to initiate that on their own. They have to approach legislators or approach the Idaho Water Resource Board (ID20)

The state then appoints an advisory committee of stakeholders from all sectors and seeks locally acceptable solutions to increase community buy-in into the final plan (ID20). The state plan has also evolved through multiple iterations over the years in response to changing stakeholder needs and water system conditions, and each revision includes wide-ranging opportunities for public input to ensure that the plan continues to serve the public interest. Public support for the planning process is mixed but generally trending towards supportive:

> we get criticisms from both sides. I wouldn't say both sides, from all sides. I mean we do hear, even engaging in planning is we're doing some sort of UN plot, that's one aspect of it. The other aspect is, you guys aren't doing enough, you need to be more active. But I think the public supports us (ID20)

Public support is also one of the criteria listed in the state plan for consideration of potential new storage projects, and public review is presented as an essential component of planning.

Participation and networks: *medium* Although the formal legal structure of basin planning is state-led, in many cases these activities have built strong relationships, social capital, and stakeholder networks which continue functioning outside of the state process. For example, an interviewee described the planning for the Eastern Snake Plain Aquifer:

> we do have an implementation group that meets periodically. But what we found is so many of our stakeholders have now started meeting on their own and working through problems, and then they provide updates at our regular scheduled check-in meetings. Quite honestly, we're seeing groups continue to work and develop their own networks based out of our planning process (ID20)

Although this networking success has been demonstrated in the Eastern Snake Plain, the same interviewee reported that it is not universal and in some planning areas like the Treasure Valley, "people are all in their own corner" and more effort is needed to build trust, although "getting these groups together really breaks down some of the suspicion" and this process is also trending toward success (ID20). Rather than covering the whole state, regional plans have been developed where specific concerns have arisen, so tensions among stakeholder groups were already evident in these regions. The state has worked to address equity concerns in cases where stakeholder groups would be affected unevenly by water shortages or suggested implementation actions, noting that when political obstacles to implementation are encountered, "usually that means we missed something in how to address this, we didn't incorporate the right people on the committees, or we didn't define the problem the right way" and they seek to increase the inclusivity of the process (ID20).

## 5.5 Montana

### 5.5.1 *Governance Arrangements*

IWRM: *medium, increasing* Montana's state plan specifically references integrated water management in the context of needing a balanced variety of water supply solutions including natural and artificial storage to meet multiple needs, as well as in the context of water data management to make decisions accounting for interacting variables. While multi-level coordination and holistic management of land and water are encouraged, there is still progress to be made according to one interviewee:

> We have county land use planners, or city planners, but none of those local regions have water planners, and so I feel like water is an afterthought in things like growth policies and zoning ordinances and floodplain development. That's a real challenge. And I think that's what we need to be focused on in the future (MT21)

The same interviewee noted that an upcoming Montana Water Summit had been scheduled with a theme of solution-oriented integration of land and water management, and another interviewee added, "I really believe that we're shooting ourselves in the feet if we don't think about the hydrologic implications of what land use planning is doing," and noted the benefits of quarterly meetings with planners at other state agencies (MT7). Both instream and out-of-stream needs are supported in the state plan, and the planning process itself has allowed more integration and consideration of interconnections among sectors even within the context of prior appropriation and individual water rights (MT21). This is particularly evident in the regional plans collaboratively prepared by Basin Advisory Councils convened by the state (MT21).

Surface water and groundwater are generally managed conjunctively, although more studies of their connections are needed according to the state plan. Water quality and quantity are also

acknowledged to be linked, but are managed by separate agencies and the state plan "offers limited guidance regarding water quality issues because DNRC [Montana Department of Natural Resources and Conservation] has no authority to regulate water quality and the state water planning statute does not explicitly address water quality" (p. 4). At the basin level, whether water quality was included seemed to be more economically-driven than hydrological according to a planner working on the Lower Missouri Basin and the Clark Fork Basin:

> I was very interested and in fact encouraged them to take on the water quality issues. Especially associated with oil and gas development. There were calls to our Director of, the state water planning process is, the wheels are coming off the bus because they're talking about, literally I mean that's a quote, because they're talking about water quality and this should be about water quantity…in the Clark Fork, there was a feeling that water quality absolutely had to be part of it. And that water quantity and quality were very closely linked in issues like temperature where we're obviously driven by water quantity and there was a real recognition of the linkage between quality and quantity. And I think that to a certain extent, there was that recognition that the two are linked in the Lower Missouri. But there was a very conscious political effort to prevent those from being from being considered within the same context as you would in IWRM (MT9)

Polycentricity: *high* As shown by the water quality example above, Basin Advisory Councils had considerable control over the development of the regional plans guiding the management of water resources within each of the four planning basins in a generally polycentric system. Within the facilitation structure provided by the state, the groups were able to create their own collective choice rules for decision making, "whether they have some sort of formal structure, voting procedure, or whether they just get together over coffee once a month" (MT21). These standalone basin plans were then vetted by the state for relevance to be rolled up into the statewide recommendations and planning process, with the state plan taking precedence in the event of any conflict with a basin plan. Local watershed plans are also encouraged, with the basin plans occupying an intermediate level between the top-down state planning prevalent in the 1980s and 1990s and the place-based watershed planning that followed in the state.

Montana displays strong vertical and horizontal connections among levels of governance and stakeholder groups. In addition to the nested structure of state-level planner assisting basin planning groups and connecting with federal agencies for water storage projects and interstate compacts, lateral integration is promoted through groups like the Governor's Drought and Water Supply Advisory Committee which connects the heads of multiple state agencies dealing with water as well as statewide water summits which connect stakeholders and regional planning groups across geographic areas for learning. Recognizing the challenges of applying the same strategies across very diverse basins, one interviewee used the analogy of Russian nesting dolls to describe the tiered structure addressing each problem at the level suited to solving it, applying the principle of subsidiarity (MT7).

### 5.5.2 *Adaptive Capacity Analysis*

Comprehensiveness and integration: *high* Montana's water plan explores a variety of solutions such as reservoir storage, natural storage in aquifers and floodplains, water use efficiency and conservation, and drought planning. While water transactions to balance supply and demand are permitted in the state, one interviewee described how "the whole idea of water marketing made them very uncomfortable" in some basins during the public outreach process due to concerns about the impacts on source communities (MT9). The state plan calls for coordination of policy decisions at multiple levels of government and provides a clear explanation of the role of the state in water planning, conducting adjudications through the Montana Water Court, and negotiating settlements with Native American tribes and federal agencies through the Water Rights Compact Commission. The state pays close attention to the nested scales of water management:

> We're trying to build that integration so that you have both this vertical integration as well as lateral at the different levels, whether it's watershed or it's regional or it's basin or it's statewide. So we're trying to connect that, with the State Water Plan being the top level basically of that visionary document that you have to get all the way to the local level to really implement projects where it really makes the difference (MT7)

Regional plans were created by Basin Advisory Councils, and these were used to advise the development of the state plan. All uses of water are considered in the state and basin plans together with interactions between consumptive and non-consumptive uses, and recommendations from the basin plans worked to balance different needs, acknowledging that "water is really a shared resource and so we have to be conscious that within the umbrella of prior appropriation, that we're satisfying various different uses of water" throughout the state (MT21). In addition to thinking about all uses comprehensively, the state seeks integration:

> Whether that's your municipal water supply planning, thinking about having water for your public water supplies, or it's having water for ecosystem services or for river flows or for agriculture or for recreation or wildlife or all the uses…basically water rights in Montana are trumping most of it, and if we stuck by the administrative guidance or the rules…it wouldn't be very integrated. So doing the planning process itself was integrating all the water uses (MT7)

The state is now facilitating the development of local watershed plans for drought and water supply in the Missouri Headwaters Basin through the grant-funded National Drought Resilience Partnership Montana Demonstration Project. The intention is to use the state plan to inform this effort, and then to use the local plans to scale back up to the regions and then the state plan as it is updated in a "seamless method of connecting from the state to the local" (MT7).

Knowledge and learning: *high* Montana State Library's Water Information System contains publicly accessible data on a broad range of water-related topics such as surface water, groundwater, water quality, and climate information. As part of the National Drought Resilience Partnership project, the Upper Missouri Headwaters River Conditions web tool is being

developed to share data from US Fish and Wildlife, state and USGS stream gages, SNOTEL snowpack monitoring sites, reservoir levels, fishing closures, and other information of interest to stakeholders in the basin (MT7). The state plan recommends improving data sharing among multiple levels of government as well as investing in improvements to monitoring and inventories of consumptive and non-consumptive uses. Currently, the lack of requirement to measure water use is challenging for state planners but would likely be politically unpopular to require:

> if there was ever a way to really encourage or even just incentivize better water measurement across different sectors, I think that would be really, really helpful because the number one rule of management is you can't manage what you're not measuring (MT21)

System thresholds are not discussed much in the state plan other than recommending completing adjudications to show if streamflows are already fully allocated in a basin.

In general, Montana places a strong emphasis on learning, with the state plan describing the need to analyze lessons learned from projects ranging from land application of treated municipal wastewater to climate risk assessment pilot studies. The state also hosts a biennial water summit to bring together stakeholders and policymakers for shared learning around complex water topics including the interconnectedness of land use and water planning (MT7). Uncertainty in future supply and demand is dealt with through projections of climate scenarios following a similar methodology to the Bureau of Reclamation's West-Wide Climate Risk Assessments combined with two scenarios for agricultural demand. Although the state encourages basin and watershed level planning for uncertainty, it can be difficult without a focusing event to clearly show the need for planning:

> we encourage local communities to plan for things like reduced snowpack and just variability with water supply. But until something sort of happens within that

> community, whether it's the threat of a certain wildlife species being listed under the Threatened and Endangered Species Act, or whether it's some calamity with the public water system like some failure during a drought, it is hard to encourage that proactive approach in the face of uncertainty. But I think so much of that is just continuing to get out and talk to locals about the challenges that they have and encourage them to plan for the future (MT21)

Resources: *low* State funding for water-related programs has been insufficient, greatly limiting implementation. Two interviewees described writing grants to fund their projects (MT7, MT21). While creation of the state plan was accomplished with limited resources, the plan's recommendations for continued funding of the Basin Advisory Councils and implementation programs have not been met:

> We have requested money from the state for implementation for several years. We have seen none. This year, we did receive funding to update our drought management plan. That's the first direct funding that we received for plan implementation (MT9)

> We didn't get any funding to continue supporting the Basin Advisory Councils, which was sort of tragic right after we had just finished it and launched it and we were really excited. Then we didn't get more any funding for supporting those groups and then our staff levels got cut (MT7)

Staffing levels were reported as a challenge for state planners responsible for vast and diverse geographic areas (MT7, MT9). Partnerships have been instrumental in connecting the state and local levels, as one interviewee described looking at:

> a watershed of resources and figuring out ways to capture those, whether that's technical or human or financial resources from all our partners, basically funnel that through and then spread it out across this landscape to all of these groups where they need it (MT7)

Authority and legitimacy: *high* Basin Advisory Councils were formed by the state, but they have a great deal of latitude in shaping their plans and ongoing implementation actions. The state specifically wanted to empower local planning groups in contrast to previous top-down planning efforts (MT9). While the basin plans do not have the authority of official state policy, many of

their recommendations were included in the state plan. The geographic boundaries of the Basin Advisory Councils were set by the state, but they had the authority to devise their own collective choice level rules, "whether they have some sort of formal structure, voting procedure, or whether they just get together over coffee once a month" (MT21). The state also promotes the formation of smaller sub-basin and watershed-level groups with considerable autonomy, although one interviewee explained that local capacity varies among the groups, so "some watershed groups aren't as functional with turnover of some of their local champions, and others are nationally known like the Blackfoot Challenge" which is often held up as a model for collaborative governance (MT21).

In general, the responsiveness of plans and policies to stakeholder feedback increases as the level of governance becomes more local. The watershed and basin plans are thus very responsive to community input, and the state plan can be modified with more effort as conditions and priorities change, but changing state water policy would be "pushing water uphill" (MT7). All interviewees reported a sense of strong public support for the state water plan and the planning effort that went into it, although stakeholders might be discouraged by the lack of resources for implementation:

> we went through this planning process, we created a good plan, that's a good document, that's a relevant document. And so why is the state not putting more funding into implementing the plan? Yeah, I hear that all the time (MT9)

Participation and networks: *high* Montana generally displays strong networking horizontally and vertically. The Basin Advisory Councils brought together a wide range of stakeholders, and the planning processes built considerable social capital, strong relationships, and understanding of different perspectives:

> When they came as single water user defenders, they left saying, wow this is really hard. This is really hard and we need to pay attention, and we shouldn't be so siloed in our beliefs, and the Trout Unlimited guys were getting along really well with the ag people there, and the municipalities, and with the hydropower and with the miners and all the people that were there. And it was really, I think it was pretty successful (MT7)

The Montana Watershed Coordination Council promotes lateral networking and learning across geographic regions, and the state has an active network of around 70 watershed groups, although the density and connection of watershed groups is higher in western Montana than in the east (MT21). The state plan encourages networking among state agencies and with tribes, other levels of government, watershed groups, and NGOs.

## 5.6 Nevada

### 5.6.1 *Governance Arrangements*

IWRM: *medium* Nevada's most recent state water plan was released in 1999. The legislation mandating its creation and update cycle was repealed in 2005, and the Division of Water Planning responsible for it was restructured to become a section of the Division of Water Resources within the Department of Conservation and Natural Resources. Although the plan is no longer updated, it remains in effect and regional plans need to be consistent with it, although one interviewee from a regional water management agency pointed out that the state plan is very high level so that bar is not high (NV8). Individual applications for new water appropriations are still subject to the authority of the State Engineer's Office, but water planning is now generally done at the regional level (NV8).

The state plan has strong IWRM inclinations including holistic land use and water planning connections, such as protecting groundwater recharge areas with land use controls and

supporting a watershed approach across political boundaries to account for the dispersed effects of land use decisions on water resources. The plan calls for a comprehensive water planning process integrating "water resource development, transport, water treatment, allocation among various competing uses, conservation, waste-water treatment, re-use, and disposal," with water viewed as one resource linked to multiple planning areas (p. 8-13). Regional plans are updated more frequently and are also integrative, applying to all phases of the water supply and treatment cycle and maintaining consistency with local land use plans.

Groundwater and surface water are managed separately, but the state plan recommends integrated resource studies to determine hydrologic connections in order to support conjunctive management. At the regional level, water utility providers themselves contribute considerable input into the planning process, and since they have both surface water and groundwater supplies, both are considered in regional plans in a somewhat de facto integration (NV8). The state plan and regional plans address both water quantity and quality, noting interactions between them particularly in the context of wastewater management. Economic, social, and environmental uses of water are given equal consideration, and the state plan is intended to be growth neutral, neither promoting nor inhibiting population growth anywhere in the state.

Polycentricity: *low, devolved* Rather than being connected in a polycentric system, Nevada's regional planning agencies appear to have a level of autonomy that makes the system more devolved than connected either vertically or horizontally. While the state originally intended to follow up the state plan with guidance for regional planning, the regions have ultimately done this themselves within the boundaries of overarching state laws (NV8). Questioning the value of

a statewide plan given the "almost self-regulating" doctrine of prior appropriation, one interviewee suggested:

> I think the individual needs of the communities, which aren't numerous in Nevada, probably can be dealt with from the State Engineer's perspective and I don't know that a plan really provides him any value because the law's already in place and the precedents for the law have already been set (NV8)

Although appearing somewhat fragmented, this system enables regional agencies to manage water resources as they see fit to best serve their own communities. While the regional agencies work with stakeholder groups and public utilities in their jurisdictions, they have little horizontal connection with the other regional planning agencies (NV8).

### 5.6.2 *Adaptive Capacity Analysis*

Comprehensiveness and integration: *medium* As described previously, Nevada's state water plan was very comprehensive and integrative, but the legislation behind it has been repealed and the department responsible for it restructured. Nonetheless, regional planning agencies continue to work toward integrated water planning, and they consider a broad array of options from reclaimed wastewater effluent to water conservation, with a mix of regulatory and voluntary programs, and as one interviewee said, "There's a solution to every problem" (NV8). The state plan provides an extensive explanation of federal and state interactions on policies such as endangered species conservation, floodplain management, and Wild and Scenic Rivers, accompanied by clear charts of local and state agency authorities for water-related topics as wide-ranging as sewer facilities, irrigation, conservation, water supply, boating safety, and forest practices, together with the relevant citations in statute granting their authority. At the regional level, management is linked across scales vertically, but there is less connection horizontally across regions (NV8). While there has been some complicated "legal wrangling" to work out the

specifics of federal compacts and interactions with tribes, in general the policy landscape is coherent and manageable for regional entities to follow (NV8). The state plan explicitly seeks to balance competing uses of water and recognizes the connections among them. It is growth neutral and observes that:

> economic efficiency may appear to be in direct conflict with environmental protection. However, there is growing recognition that environmental protection is actually an essential component of economic development (p. 1-5)

Although the state follows the prior appropriation doctrine for allocating water rights, balancing uses is still an ongoing need as one interviewee described that "one of our legacy issues is a lot of the local basins around us have been over-appropriated. And that shouldn't have happened" (NV8).

Knowledge and learning: *low* The state plan used the latest available data when it was released in 1999 while also making recommendations for improved data collection and accessibility. With the intention of assessing the accuracy of the perennial yield estimates for aquifers, which were originally estimated by the USGS in the 1950s, a study was initiated at the time of plan in the northern part of the state but was never completed. The study's precipitation cans are still in place so there is now a 20-year record of data that can be used to improve management (NV8). Even though the original project's water balance and basin model were never completed, the perennial yield estimates are now viewed as a starting point for further research. The State Engineer can use this to identify groundwater basins that are approaching the threshold of being depleted and can deny new irrigation appropriation applications, designate preferred uses for the basin, or set limits on groundwater pumping, although more research needs to be done in many areas (NV8).

The state plan promotes the evaluation of lessons learned in previous regional planning efforts as well as major flooding events in 1997 which sparked revisions in floodplain management and construction standards. At the regional level, research studies and monitoring are used iteratively with an interviewee explaining that "we just have to adapt as we go" and remain flexible in the face of uncertainty (NV8). Ensuring adequate storage is another one of the state plan's strategies for responding to uncertainty, and although it does not directly discuss climate change, it acknowledges climate variability and the need to plan for the extremes of droughts and floods. At the regional level, management entities do consider the potential water-related impacts of climate change, particularly promoting the use of reclaimed or treated wastewater as being drought resistant (NV8). The state plan also considers various economic development and population growth scenarios, including observations of how uncertainty in the price of gold could affect employment, population growth, and water use for mining in rural Nevada.

Resources: *medium* The state plan had many recommendations for funding needs as well as a comprehensive table of state and federal funding programs related to a variety of water-related topics from capital improvements for community water systems to flood assistance. The state plan described fluctuations in funding and staffing but is now no longer being updated. The interviewee from a regional planning agency described funding for water projects as ebbing and flowing but overall being sufficient to meet regional needs in their area (NV8). The interviewee did point out that regional programs are funded through local sources such as ratepayer fees, so the level of financial resources varies across the state:

> I think the problem too comes down to, what is each community willing to fund. Because for example we are currently involved in doing a huge push for A+ water, reclaimed water for indirect potable reuse. Well you know that's not cheap, that's expensive, you can't do that if…you don't have enough people to be able to

> support that kind of thing. But we're growing to a point where this is something we need to do (NV8)

Staffing levels vary at regional agencies, with this interviewee currently being one of two staff members at their agency (NV8).

Authority and legitimacy: *high* Nevada's state plan encourages local and watershed level planning for water resources while maintaining state authority over water administration such as the approval of water rights. With the repeal of the state planning statute, local autonomy is high:

> You'd have to kind of understand Nevada a little bit…90% of Nevada is vacant, belongs to the federal government, and so the state planning for the water resources in the entire state is really not a very practical way to do it. It's best with individual counties and areas doing their own planning (NV8)

This sentiment and the repeal of the statute show that state-level planning was not considered as legitimate of a process for addressing stakeholder concerns, so a transition to more regional planning was made. Regional water plans are also used by local governing authorities in land use decisions, such as ensuring that new developments have adequate water availability (NV8). Regional plan updates are conducted periodically primarily to address management changes, since changes in hydrologic conditions between updates are typically minimal (NV8).

Participation and networks: *low* The original planning effort for the state plan represented a broad range of user groups, including all levels of government, tribes, and interests such as Northern Nevada Conservation Forum, Southern Nevada Homebuilders Association, Nevada Farm Bureau, Nevada Cattlemen's Association, and the League of Women Voters. In contrast, the regional planning process tends to have "a fairly barren room" at their meetings, because

> It's not like we're a utility where we're talking to the public about their water supplies, we're talking to the utilities about how they're going to manage their resources, and that tends to be a little bit above the public's frame of reference…

> that discussion gets really complicated for the average person without a water or wastewater or engineering or hydrology background (NV8)

Regional agencies do play a role in coordinating stakeholders within their region, but they focus more on serving the utilities in their planning area rather than serving the public directly (NV8). The regions interact minimally and are more likely to see each other at annual conferences geared toward water professionals than to contact each other for planning or information sharing (NV8). This somewhat fragmented system enables full expression of regional differences and needs in preference to horizontal networking.

## 5.7 New Mexico

### 5.7.1 *Governance Arrangements*

IWRM: *high* New Mexico's water governance arrangements show strong integration, and the statute for the state water plan is specifically focused on protecting both water quality and quantity for surface water and groundwater. Planning spans a wide breadth of water resources from source water protection to wastewater reuse to stormwater capture. The interconnection of surface water and groundwater is recognized with goals of developing better hydrologic models to improve conjunctive management. Due to the low recharge rates of groundwater compared to demand, the state places emphasis on using renewable surface water supplies where possible to take the pressure off of aquifers and leave groundwater supply as a buffer during droughts.

The state plan's 16 water planning regions do not precisely follow either political or hydrologic boundaries but were described by an interviewee as being "loosely composed of areas where people congregate and where water resources are of great interest to that particular locale" with the acknowledgment that future regional water planning might entail realigning boundaries based

on hydrologic basins (NM19). The state plan supports watershed management, riparian restoration, and urban stormwater management to improve water quality, and this recommendation is now being implemented:

> another initiative that was funded during this legislative session was a Forest and Watershed Health Act. And so money was appropriated to be able to go to one of our sister agencies, the New Mexico Energy, Minerals, and Natural Resource Department to be able to put dollars on the ground for forest and watershed health that would directly and positively impact water quality in New Mexico (NM19)

The funding for this program shows the strong state support for water issues as well as interdepartmental integration to reach water quality goals. Water planning is also closely connected with land use planning in the state through laws such as the Subdivision Act:

> it identifies how communities and how local level governments divide land and develop their communities, and that all entails having water availability. And so the land use decisions and water planning go hand in hand (NM19)

New Mexico also emphasizes the importance of balancing economic and environmental uses of water, accommodating industry and other uses equally, and supporting the cultural heritage aspects of water management and use.

Polycentricity: *medium* The state's water governance is characterized by nested plans from the local to regional to state level. Local entities such as municipal water systems or acequias, a type of community-based irrigation district, have considerable autonomy to shape their own planning structures and manage their water supply and demand needs. These local plans and strategies are then used to inform regional plans which are developed within overarching state policies and guidelines. Regional plans are stakeholder-driven with state guidance and have flexibility in expressing how the regions view water management issues such as infrastructure needs and shortage sharing (NM19). The state plan then incorporates regional needs and strategies and is intended to be implemented by the local level rather than from the state down:

> I might know about acequias, doesn't mean that the state is going to dig your ditch for you…So implementation happens at a grassroots level from the bottom up. There are some policy issues and some key issues that happen at a top down level. But for the most part, we see our water plan as having goals and strategies in those water policy topics that anybody at any level within the state can enter into (NM19)

The state is further nested within federal and transboundary level interactions through compliance with interstate compacts, and it conducts government-to-government water planning consultations and adjudications with the nations, tribes, and pueblos located within its boundaries. Vertical coordination appears somewhat stronger than horizontal coordination among regions, although there is horizontal coordination among sectors within regions and between state agencies.

### 5.7.2 *Adaptive Capacity Analysis*

Comprehensiveness and integration: *high* New Mexico's state plan considers a comprehensive range of water solutions such as infrastructure projects, watershed management for water quality and forest health, water conservation, desalination, and state purchases or leases of water rights for threatened and endangered species or to comply with interstate compacts. The plan describes the state's cohesive policy framework and provides charts showing agencies at all levels of government that provide funding or regulate each water-related topic, and one section of the plan is devoted to explaining all the pieces of water law in New Mexico and how they fit together:

> why we do what we do, everything from the 1907 water code to today, how we work with acequias and special districts, how we negotiate and manage interstate stream compacts, how we respond to and plan for severe weather events, how we administer groundwater, how we work to advance these adjudications, and implement environmental laws and regs like ESA [Endangered Species Act] and those kinds of things (NM19)

The state plan was prepared by the Interstate Stream Commission under the Office of the State Engineer in collaboration with the Environment Department, Department of Agriculture, Department of Game and Fish, Indian Affairs Department, Water Trust Board, and Department of Finance and Administration in order to create a "more robust and holistic" plan providing consistent guidance across agencies (NM19). The development of water policy at the state level was prompted by litigation, and the state is particularly concerned with demonstrating management and future plans for all of its compact-allocated water (NM19).

In balancing water for environmental, social, and economic needs, no use is ranked above any other, and one interviewee noted that "at some level, most New Mexicans have a fundamental cultural connection to water" which is also respected in the plan (NM19). The plan also integrates management across multiple scales, with regional plan updates feeding into the state plan and support for continued coordination with local, state, federal, and tribal entities.

Knowledge and learning: *high* Technical data is available for a wide range of water topics, and the plan contains a directory showing which universities and state and federal agencies collect data on streamflow, reservoir levels, soil moisture, aquifer maps, and other issues with hyperlinks to these data sources in the digital version of the plan. The plan also noted data gaps and encouraged increasing data accessibility, which led to the Statewide Water Data Act being passed which appropriates funding to New Mexico Tech to compile data and make it more readily available to the public (NM19). In terms of system thresholds, the plan discusses gaps between supply and demand as well as the tremendous need for alternative water sources in eastern New Mexico where the High Plains aquifer is declining sharply and some communities are reported to have less than five years of groundwater supply remaining.

New Mexico emphasizes learning and used a study of water planning in seven other western states to inform its planning process (NM19). The plan recommends developing adaptive responses to drought, using the best available data combined with predictive models for future climate conditions, and making the planning process flexible to deal with uncertainty. The state is now planning to embark on a new planning effort which will incorporate lessons learned from previous regional and state planning:

> we intend to use everything we've learned from the early '80s in New Mexico water planning to the 2018 plan to today to identify, how do we incorporate issues related to climate change and drought and infrastructure needs and the lack of federal funding, to do good outreach and education and support smart water management to meet not just today's needs, but well into the future (NM19)

Resources: *low* Various funding needs are outlined in the state water plan, particularly for infrastructure projects, wastewater reuse, and groundwater contamination remediation. The plan encourages seeking federal matching funds for state and local investments. In addition to the need for implementation funds, an interviewee described the amount invested in planning as inconsistent and insufficient at the regional and local levels, with regional planning not fully funded between plan updates (NM19). Despite a short timeline for developing the most recent state plan, the state has been able to manage their limited funding and staffing resources as well as leverage partnerships for research with National Laboratories, universities, and other departments at the state level (NM19). The state plan describes the need to provide staff and resources to complete adjudications, inspect dams, and create systems for improving data accessibility, but staffing levels have not yet increased significantly.

Authority and legitimacy: *high* New Mexico strongly supports regional planning and grants considerable autonomy to each region to express its own philosophy of water management and set goals. The state plan includes charts showing which agencies, including local entity types, are

responsible for activities like data collection, drought response, and watershed management. During the regional planning process, an interviewee explained that "each region was able to create a public welfare statement that resonated with them at the local level and cultural level that identified how they viewed water" (NM19). Steering committees were formed to direct the process, and representatives from local government, water utilities, acequias, tribal governments, and other water user groups were identified by the state to serve on the committees (NM19). While the regions did not have complete autonomy at the collective choice level, they operate within a flexible structure developed at the state level:

> We [the state] should be able to gather information on policies, provide technical information, provide what our constraints are legally, and then allow people to be innovative and creative in how they create projects on the ground (NM19)

The responsiveness of the public engagement process for the state and regional plans increased the sense of ownership of the process and public support for the institution of planning, as one interviewee stated, "We can't make all people happy, but for the most part, I think there's buy-in and New Mexicans care deeply and very much about water planning and water administration in the state" (NM19).

Participation and networks: *high* State agencies are well networked and interact "at a worker bee level" consistently as well as coming together to collaborate on formal plans (NM19). The development of the first iteration of the state water plan in 2003 built networks around the state, some of which continued meeting independently and some of which did not feel they had a reason to continue meeting after development of their regional plans (NM19). The stakeholder engagement process for the first round of regional plans and the state plan was very inclusive and transparent, and the state plan describes receiving over 2,600 suggestions for projects and policies from all levels of government at multiple agencies, tribal governments, acequias, and

users from all water sectors. The emphasis on inclusiveness enabled the state to address equity concerns such as tribal water rights as well as regional differences like the need for swift action in the eastern portion of state due to aquifer depletion. For the second iteration of the state plan completed in 2018, the timeline was compressed, and the state was not able to conduct the same level of robust public outreach as they wanted:

> we had one town hall in December of 2017 in Albuquerque, which was centrally located but still people in more rural areas couldn't necessarily afford or get out to that one meeting (NM19)

The state did seek alternative methods for collecting public input for the plan, and they intend to increase the level of outreach and engagement in future planning efforts according to an interviewee (NM19).

## 5.8 Oregon

### 5.8.1 *Governance Arrangements*

IWRM: *high* Oregon's state water strategy is deliberately integrative and holistic with clear IWRM principles and goals. In practice, it has not always been easy to integrate water planning with land use and other policy arenas even when the interconnections are recognized (OR1). Integration is therefore a work in progress both at the state level and at the sub-state level, which is currently undertaking a pilot program of place-based, participatory water planning in four locations around the state. As one interviewee observed:

> The statewide strategy and the place-based plans are both tasked to look at water quantity, quality, and ecosystems or ecology as well as the connections between surface water and groundwater. Tasked to look at the land-water nexus, the energy-water nexus. Kind of inter-sectoral approaches, how do we break down the siloes between different sectors, how do we deal with integration from state to local level and vertical integration (OR4)

Instream and out-of-stream uses of water are balanced, with consideration of the economy, environment, and social needs. The pilot Place-Based Integrated Water Resources Planning program does not necessarily follow exact hydrologic boundaries but is shaped by stakeholders through inclusive processes (OR4). This inclusivity has helped participants understand their own interconnectedness and support integration, such as one participant from the Upper Grand Ronde place-based pilot describing how the county's land use planner was involved and would therefore be able to take the group's water plan into account in land use decisions, while another from the Mid-Coast pilot explained that "forestry practice is a big deal because of how much influence it has over water quality. Water supply is a big deal because of how much influence it has over the economy" (OR14, OR17). Surface water and groundwater are both addressed in the state strategy with linkages recognized, and the place-based planning groups work with both depending on the resources available in their area. Although water quality and quantity are regulated by separate state agencies, the state plan describes goals and strategies for both.

Polycentricity: *high* The place-based planning system shows the seeds of a polycentric structure, although it is currently in the pilot phase. The local units have a high degree of autonomy while staying within the existing legal framework (OR5). The place-based governance documents enable the groups to develop their own collective choice arrangements while remaining nested within the state level, which plays a coordinating role both vertically as well as connecting the local groups horizontally in peer learning networks. Place-based planning is supported at the state level with funding, facilitation, data, and technical assistance, but the plans are ultimately written at the local level. The statewide strategy was developed with extensive stakeholder engagement representing a broad variety of water uses as well as input from ten federal agencies and 18 state agencies with a connection to water, demonstrating the complexity of water

regulation as well as the intentional effort to be inclusive of all aspects of water governance (OR1).

### 5.8.2 *Adaptive Capacity Analysis*

Comprehensiveness and integration: *high* A wide variety of solutions are considered in Oregon including strategies for both supply and demand along with water transfers to balance the two. One interviewee participating in the state's pilot place-based planning program described over a dozen potential options ranging from protecting groundwater recharge areas to irrigation efficiency improvements to better road management to prevent sedimentation into nearby streams (OR14). At the level of implementation, however, it has been challenging to overcome ingrained policy inertia and fully integrate solutions or coordinate the actions in multiple water-related plans within an area (OR5). The state strategy lays out the policy framework in which local and state planning activities operate, and it describes a variety of state and federal water-related policies along with how they fit into the water governance landscape. State agencies have been increasing their horizontal communication, and a collaboration of the Water Resources Department, Department of Environmental Quality, and Department of Fish and Wildlife led to a revised and more efficient integrated water permit review process.

The state strategy acknowledges the connections among various instream and out-of-stream uses, surface water and groundwater, water quality and quantity, and land use and water planning. One interviewee suggested that the idea of integration is "aspirational" and while there has been progress in this direction at both the state and place-based levels, there is still a "long way to go to actually be integrated" but collaborative processes are expected to help with integration especially at the local level (OR4). Interviewees from several place-based programs responded to

questions about integration with optimism, citing progress on balancing agricultural water needs with fish and wildlife needs in the Upper Grand Ronde, efforts to consider the interconnection of surface water and groundwater in Harney County, and the fundamental connection of water quality and quantity at a water supplier level in the Mid-Coast region (OR14, OR16, OR17). The place-based planning process has also increased the cross-scale linkages of water management with the state providing guidance and acting as a partner in local processes (OR16).

Knowledge and learning: *medium* A great deal of data has been collected on water-related issues in the state, but much of it is difficult to find, and the state strategy includes recommendations for improving accessibility and coordination with multiple levels of government. One interviewee described the process of finding data as "extremely difficult unless you are inside an agency or know a lot about how to access databases and GIS layers," (OR1) while another explained:

> a lot of my time over the past couple years has really been understanding how do we take the information, the data that we've been gathering, and apply it to planning. What is an appropriate question to ask it, what are appropriate decisions to base off of it? And understanding a lot of this information and data was not collected for the purpose of planning and decision making, or decision making at this scale (OR4)

The strategy also lists additional data collection needs such as groundwater modeling and water use measurement. The place-based processes have identified additional data gaps, some of which are now being researched such as a groundwater study in Harney County and a study on how water pricing influences conservation behavior in the Mid-Coast region (OR16, OR4). One of the drivers behind the place-based process in Harney County is the acknowledgment of groundwater pumping approaching a critical system sustainability threshold (OR16). The state

also recognizes system thresholds related to surface water and has produced maps showing which areas are closed to new appropriations depending on the season.

Oregon makes active efforts to learn through the planning process and deliberately chose pilot sites for the place-based program from a diversity of geographic regions, economic settings, and planning approaches described in their applications (OR4). The state has also supported a peer learning network among the pilot locations:

> that's a way to bring the leadership of those four planning groups together, develop some skills together, learn from each other, see how each other are doing the work and how they are structuring their meetings, and we think that's been a fruitful exercise for them to learn from each other and they don't feel like they're doing this all alone (OR5)

One group is also working on creating a storyboard model of best practices and lessons learned to be shared with other groups that would like to implement similar collaborative processes (OR17). One of the key lessons has been finding ways to grapple with uncertainty, whether this is done through scenario planning, partnering with research teams to develop downscaled climate models, use of decision support tools, gathering additional data where possible, or as one interviewee suggested, "You accept that you don't know everything and still make a plan" (OR17).

Resources: *low* The state strategy lists a variety of funding needs for planning and implementation, noting that "the state's core responsibilities related to water…are underfunded and have been for years" (p. 165). Resources from the state's general fund are competitive and have been insufficient, federal funding has been decreasing, the strategy suggests that blending multiple funding streams and establishing public-private partnerships will be necessary to accomplish the state's water planning and management goals. Depending on the needs and

resources available in communities, participants in place-based processes described the state's funding support of their planning groups along an array from far less than the need to very adequate, and several participants described the need for local fundraising and grants (OR14, OR16, OR17).

The state budgeting process has hindered some collaborative and integrative efforts, such as joint funding requests being split apart and sent to different committees (OR1). The Water Resources Department and the place-based groups often seek to partner with other agencies and universities for technical expertise and resources when they face capacity issues (OR18). The state strategy notes limitations in field staffing, and interviewees confirmed that vacancies had remained unfilled in offices as well, diminishing their ability to provide assistance around the state (OR4).

Authority and legitimacy: *high* Place-based planning groups are locally initiated and directed with state partnership and support. Each group developed a governance document detailing their decisions at the collective choice level regarding group structure, leadership, decision making and consensus, and goals (OR1, OR18). Local plans and decisions can innovate but must be compliant with existing laws and regulations, a constraint described by interviewees as being "like guardrails or ditches on a road" and observing that "they want us to think outside the box, but not too far" (OR5, OR16). While some participants suggested that changes to the legal structure of planning in the state might be beneficial for more sustainable water management, other interviewees cautioned that changing laws would take considerable time, effort, and negotiation (OR17, OR1).

Local groups have the authority to design their own planning processes provided they include a balance of stakeholder interests including instream and out-of-stream needs. The collaborative, transparent nature of these processes increases their legitimacy for representing stakeholders:

> the people we have at the table for the planning groups do represent the different water interests, and the people we have there are respected leaders in the community, so to some extent they are going to feel like, my interests have been represented. Because that person represents my watershed council, or represents my Soil & Water Conservation District, or whatever it might be. And so they have people at the table without themselves being there (OR5)

The inclusive public engagement process has led to strong support for both the state strategy and the place-based groups in most cases, although some people are still "waiting to see what happens" following the pilots, and vocal support has not always been matched with tangible support such as funding (OR4, OR14, OR17).

Participation and networks: *high* The state encourages interagency networking and cooperation at multiple levels, and the place-based planning groups have developed strong learning networks not only internally but with other planning groups around the state including some groups which applied for but did not receive funding for the pilot program. One interviewee expressed concern that networks of stakeholders built during the state strategy update might be "left to wilt" in the absence of further work on state-level planning, while another suggested that linking the place-based groups statewide could help to "increase the networking opportunities in the water world" (OR1, OR4). Public outreach for the state strategy was deliberately inclusive with active efforts to ensure the participation of under-represented groups, and the strategy also discusses actions to promote social equity and address environmental justice concerns.

The participatory nature of the place-based process has increased social capital, trust, and better relationships among stakeholder groups, as an interviewee from Harney County described there

being “probably no trust before, it’s gone up exponentially,” and another from the Mid-Coast group reflecting that “if we were to end the process now, I would say that it was very successful because of the relationships that we've been able to build” even before implementation of actual projects (OR16, OR18). This exemplifies what is known as the “Oregon Way” of developing policy, which one interviewee described as “bringing folks to the table who have different perspectives but who care about a place or a project or an issue” (OR1) which requires taking the time to develop relationships and trust among groups that may not have worked together before (OR4, OR5). Participants acknowledged that this is not easy, variously describing it as “herding cats” and “not for the faint of heart,” but all described it as worthwhile based on the positive outcomes of collaborative processes for giving a voice to all interests and respecting the diverse needs of different places around the state (OR17, OR18).

## 5.9 Utah

### 5.9.1 *Governance Arrangements*

IWRM: *high* Utah is in the process of updating its state water plan which is anticipated to be released in 2020 but was not available at the time of this writing. The following analysis is based primarily on the 2017 Recommended State Water Strategy. The strategy explicitly promotes IWRM for water governance and implementing adaptation actions. In particular, recommendations are made to integrate land use and water planning in the context of drinking water source protection plans, water use efficiency and water conservation in urban areas, and integration of water management across sectors. While the Utah Board of Water Resources includes representatives from eight major river basins in the state, the boundaries of these planning areas follow political boundaries more closely than the underlying hydrologic

boundaries, and the state has prepared basin-level planning documents for 11 river basins as part of its water planning process. The state is also promoting the formation of more local level watershed planning groups to holistically manage water resources within their own areas. Integrative planning is currently underway around the Great Salt Lake in order to account for multiple interacting variables that cannot be efficiently dealt with separately:

> one of the challenges we have in this state is that the Wasatch Front ends in a terminal basin. And so the Great Salt Lake is a terminal lake that has slowly been dropping in elevation levels, mainly due to the reduction in water supply, as well as the increased consumption throughout the years. So it provides a number of challenges as far as, what do we do about dust, and the migratory birds, and there's mineral extraction industries, and the population that lives along the lake, and there's significant challenges associated with the Great Salt Lake and the declining lake levels as well as an economic impact associated with it. So we have gone through with the Great Salt Lake Advisory Council an effort, there was an RFP put out a while ago to develop an integrated water resource model and so that's looking at the whole watershed, the Great Basin and that feeds into the Great Salt Lake. And we're using that to try to understand the lake and estimate the impacts of changing climate on it and everything (UT15)

In addition to balancing multiple uses of water, the state strategy recommends recognition of the interconnections of surface water and groundwater and managing it conjunctively as one resource. Although the legal system separates the management of water quality and quantity, the strategy discusses both, and an interviewee from the Division of Water Resources described ongoing "cooperative projects with the Division of Water Quality to try to integrate more water quantity and water quality" as well as in interest in continuing to look for new partnerships and ways to integrate management (UT15).

Polycentricity: *medium* Basin plans have been developed by the state Division of Water Resources with extensive public engagement and interagency input at multiple levels, with the most recent basin plan completed in 2016. These basin plans will inform the state plan update as well as being used for management guidance within the basins. Utah is also "trying to get local

groups to develop their own watershed councils that can feed up information to the statewide efforts and policymaking" which is still in progress and could become part of a polycentric system depending on the level of autonomy exercised by the watershed groups (UT15). Currently, local and municipal decisions are made in a more devolved manner, and the state sees watershed councils as an opportunity to improve coordination on goals such as integrating quantity and quality concerns and incentivizing water conservation in agriculture. While water governance in Utah is multi-level, it is not yet as closely coordinated vertically as they would like, and the strategy suggests enhancing this by having the state "set boundaries on the decisions and actions that can be taken locally but enable enough flexibility that unique solutions can be found to fit particular watershed contexts" in a nested system (p. 42). Horizontal connections among state agencies are stronger than between regions, and cooperative interagency decision making is encouraged in the strategy along with transboundary cooperation with other states and levels of government.

### 5.9.2 *Adaptive Capacity Analysis*

Comprehensiveness and integration: *high* Utah's water strategy looks at a wide range of supply and demand solutions, encouraging a cost-benefit lens for analyzing any new water developments and seeking sustainable, holistic management of all water supplies including groundwater, surface water, brackish water, stormwater, and recycled water, which the strategy encourages to be viewed in an integrative way as a "single water system" (p. 91). The state strategy aspires to develop a cohesive, integrated policy system while acknowledging that this will require more interagency coordination among multiple levels of government with jurisdiction over various aspects of the water system. Utah also seeks to enhance coordination of

state and local policies so that water suppliers and municipalities will take into account land use and water connections in their planning (UT15).

The strategy recommends structuring water-related state revenues to "balance social, economic, and environmental values" and provides specific suggestions on supporting the role of agriculture in the economy, protecting the natural environment, and promoting outdoor recreation (p. 5). One way to balance these interests is water banking, which the state has recently allowed to be set up at the local level to provide greater flexibility (UT15). The strategy encourages better coordination with other levels of government especially around issues of climate change, agriculture, and interstate compacts, while recognizing the challenges of harmonizing water policies originally developed in a fragmented manner. Management is linked across the state and regional scales by the Basin Plans which inform the state plan.

Knowledge and learning: *medium* Many entities in Utah collect water-related data and make it publicly available; however, these efforts have not been well coordinated so it can be difficult to know where to find such data. The state strategy recommends improving the quality of data collected as well as increasing its organization and accessibility to the public, and an interviewee described efforts to increase the accuracy of municipal, industrial, and agricultural water use data as well as starting an open data site to increase transparency and access to data (UT15). The state is moving toward a digital format for Basin Plan updates in order to increase their availability and frequency of updates (UT15). Regarding system thresholds, although the Utah Water Code prohibits groundwater pumping above safe yield rates, these rates can be difficult to estimate and have not been established for all basins.

The state strategy recommends supporting learning opportunities for policymakers as well as stakeholders, and an interviewee noted the importance of monitoring and adjusting as new insights are learned (UT15). The state acknowledges uncertainty in water planning due the "impacts of droughts and climate change, constraints on regional population growth, economic cycles, and the politics of water allocation in the West" (p. 64). In the next water plan update, a "range of possible futures" will be considered through scenario planning for climate, population and economic projections, and even housing trends such as the potential for multifamily housing, which typically has a lower water demand (UT15).

Resources: *high* The state strategy sets forth a variety of recommendations for funding, including infrastructure needs, adjudications, research and data management, water rights markets, and watershed health projects. The strategy cautions that federal support for infrastructure has fluctuated and advises searching for "creative funding opportunities" including the potential for seeking financial support from project beneficiaries, noting that a mix of funding sources will be needed for any large projects (p. 61). According to an interviewee, funding for planning activities is currently adequate but may need to be increased if plans and data portals begin to be updated more frequently or additional actions are implemented based on the state and regional plans (UT15). The same interviewee described staffing as adequate for planning and research as well as partnering for technical expertise with universities and consultants (UT15).

Authority and legitimacy: *medium* Local municipalities are responsible for their own water supply and decisions, giving them substantial flexibility to tailor planning approaches to local needs (UT15). While considerable authority is devolved to the local level, decisions are typically made by water providers rather than as part of a participatory place-based process, and the state

is now encouraging the formation of watershed groups to increase public engagement in local decisions (UT15). The state strategy also recommends considering whether to provide additional flexibility to cities by permitting them to sell surplus water, which is currently not allowed under state law.

There is generally support for state and basin level water planning, although an interviewee pointed out that it is easier to generate support for documents like the state strategy that do not mandate specific actions, whereas attempts to set regional water conservation goals have been more controversial (UT15). For the current update process of the state water plan, outreach and engagement are being used to increase the plan's responsiveness to stakeholder needs and opinions, and the plan itself is being adjusted to better fit its audience:

> we're looking at updating more frequently, as well as understanding who our audience is and who we're writing the plan for, which I believe has changed over the years. It used to be more, I would say, beneficial to water suppliers. And I think it's changing, that it will be more bringing the cities and the counties together, as well as legislature, to understand the water issues (UT15)

Participation and networks: *medium* State-level interagency networking has been improving through intentional efforts to work across divisions and departmental silos (UT15). An interviewee described wanting to increase connections between the state and local level, particularly with city and county leadership, noting that they had stronger ties to water suppliers and water conservancy districts than directly with municipalities (UT15). Through the State Water Plan Advisory Committee, state and local agencies have been able to contribute their perspectives, learn from each other, and build networks. Additional public engagement for the state plan sought to reach a wide range of water users and included public comments, meetings, an online survey, and a random-sample poll. The strategy recommends further establishment of regular forums to facilitate ongoing engagement in planning, including seeking ways to better

connect the public with policymakers. To support equitable water planning and development, the strategy advocates for finding ways to:

> Ensure that water users and uses with less financial capacity, such as rural areas, less wealthy communities, and the environment, also receive necessary infrastructure investments to secure their water futures (p. 66)

## 5.10 Washington

### 5.10.1 *Governance Arrangements*

IWRM: *medium* Water governance in Washington displays some elements of IWRM such as conjunctive management of surface water and groundwater as well as integration of land use and water planning issues at the local level. Under the statewide Growth Management Act, one interviewee explained:

> cities and counties have to follow a pre-structured plan for growth, not just in the water area and if the water's physically and legally available, but in the land use area, the zoning, where a county can grow in terms of population, and where they can't in terms of forest protection and wetland protection (WA10)

The same interviewee described how other concerns, such as transportation infrastructure, often take precedence in local-level forward planning, and that water issues may not be considered in depth beyond ensuring that the municipality has sufficient inchoate water rights available to be developed in the future to support population growth (WA10). Some integrated water plans, such as the Yakima Basin Integrated Plan and the Icicle Creek Work Group, have demonstrated success within their planning areas and are seen as models for other areas which may consider similar strategies in the future (WA12). An interviewee from the Office of Columbia River described their holistic approach in trying to create multi-benefit projects balancing the needs of people and ecosystems (WA12).

The transition from managing surface water and groundwater separately to conjunctively has not been easy since water rights had already been granted in perpetuity under the prior appropriation system. Nonetheless, widespread recognition of the interactions of these water sources has led to their joint management, as one interviewee remarked, "Groundwater, surface water, it's all the same water ultimately," while another commented that "it's staggering when you think of those two sources of supply being considered separate buckets from our previous history" (WA11, WA12). Another interviewee described the frustrations experienced by many applicants for new water rights when stringent limits were placed on acceptable impacts to nearby instream flow requirements, but the new streamflow restoration program of 2018 has provided more flexibility to balance instream and out-of-stream needs (WA10). Water quality and quantity continue to be managed separately, and water quality is not a consideration in decision making about new water rights (WA10). Addressing water quality in watershed level plans is optional (Mucken & Bateman, 2014). While the Office of Columbia River decisions are also primarily quantity-focused, they do consider quality issues such as temperature in watershed-based solutions:

> for example, if we were to build a reservoir in the Yakima Basin…that water would be probably too warm to release it back into the river…What we're trying to do now is design a system that would release that water into the canals and conveyance structures as opposed to the river. Irrigation districts get what they need…and we're not putting hot water back in the river (WA12)

Polycentric: *low, devolved* Washington does not have a statewide water plan, but the Office of Columbia River supply and demand forecast covers a large area of the state, and individual watershed plans have been developed in many areas through participatory public processes under the 1997 Watershed Planning Act. These plans allow for the integration of local water and land use connections and concerns. Additional watershed plans are required under the 2018 Streamflow Restoration law in 15 Water Resource Inventory Areas where permit-exempt

groundwater use was cumulatively impacting aquifers and streamflow, and this process is engaging stakeholders with state funding and guidelines to undertake collaborative planning and implementation (WA11). There is a great deal of local flexibility to develop these plans "from the ground up, from the basin up, as opposed to sort of dictate from the state perspective down" (WA12). While there is some nesting of scales of management, especially in the Columbia River basin, there is less horizontal coordination, and in general the system is more devolved than polycentric.

### 5.10.2 *Adaptive Capacity Analysis*

Comprehensiveness and integration: *medium* Multiple solutions are considered such as watershed-level planning, ensuring sufficient inchoate water rights for municipalities, water conservation, aquifer storage and recovery, restoring floodplains, and state purchase of senior water rights to support instream flows (WA10, WA11). An interviewee with the Office of Columbia River described looking for opportunities to integrate multiple benefits into new projects:

> we are often asked to come into areas where just strict regulation has not really solved problems. And when we do come into a basin, we try to look at, how do we leverage opportunities to, if we do this here, can that benefit fish there (WA12)

Several programs exist to conjunctively manage surface water and groundwater, particularly to reduce aquifer depletion, and one interviewee reported that many applications for new groundwater rights are rejected because of their potential impact on minimum instream flows (WA10). In addition to flows needed for fish and environmental conditions, recognition of the connection of surface water and groundwater has raised critical equity concerns:

> That realization is probably the most challenging political issue that I have faced and will continue to face in water resource management in the West. We asked people to come out here, we gave them the opportunity to drill wells and build your dream, but in doing so, we've infringed upon others' property rights, others' water rights. And now we're having to reckon with that. And most importantly, those rights typically are people that were maybe not considered important. And I'm speaking of tribes, speaking of Native Americans who we had made treaties with, and are now having to come to grips that we have taken from them what they have a right to in terms of a certain percentage of that water supply (WA12)

Although responsibilities for water issues such as quantity and quality are divided across programs and the state has no comprehensive water plan, interviewees did not consider management to be fragmented because all of the programs and regional offices report to the same director and are subject to the same laws, agency plans, and budget (WA10). Prior appropriation is considered almost self-regulating as a system, and once rights are granted, it can be complicated to find new ways of balancing competing uses, although recent decisions on instream flow rules have allowed for additional flexibility such as reservations for future population growth (WA10, WA 11). In the Columbia River Basin, water supply decisions are intended to be split one third for instream and fish needs, and two thirds for out-of-stream uses (WA12). Scales of management are somewhat linked, with watershed characterizations and plans intended to bridge the local and state scales, and the Department of Ecology coordinates closely with other state departments, tribes, and the federal government (WA12).

Knowledge and learning: *medium* Washington has a reasonably good stream gage network and many monitoring wells, providing essential data for making water supply decisions, although there are gaps in some areas (WA10, WA11). Water rights information is publicly available in a database, but adjudication is needed to fully understand water use:

> 166,000 of those [rights listed] are claims. We don't know, we have a good sense, a lot of those rights are not being exercised, but some of them are. Clarifying that

> requires adjudication where you evaluate each claim and determine the validity of it and how much it's good for. Most of our state has not been adjudicated (WA11)

Only larger water users are required to report how much water they use, leaving further data gaps in demand (WA11). The state invests considerable effort in identifying and managing for system thresholds, including closing basins to future appropriations if instream flow rules cannot be met, specifying which streams are too ecologically sensitive to permit hydropower development, and conducting well testing to quantify aquifer drawdown (WA10, WA11). Interviewees also described learning efforts such as evaluation of the community-driven Yakima Integrated Plan to find lessons to share with other areas as well as active experimental management of bull trout and salmon (WA11, WA12). Washington seeks to manage the challenges of uncertainty using climate models, population forecasts, proactive drought resilience projects, and ongoing research, while acknowledging the need to move forward with incomplete information:

> there's always uncertainty in water planning, there's always a risk, there's a risk to do nothing, there's a risk to do something. And I think you try to balance those risks in a way that if you are taking an action, that action is actually improving the situation from what the current status is (WA12)

Resources: *low* Water resources management in Washington is primarily funded by a portion of the state sales tax, but it has been inadequate, and one interviewee described that "how that revenue is awarded to us is based on political decisions, not a lack of the money being there" (WA10). Budget cuts within the Department of Ecology have reduced staffing levels over the past 20 years, leading to backlogs of water right applications and other management work (WA10). The streamflow restoration program has separate bond funding, and the Office of Columbia River has substantial financial resources, which has created incentives for municipalities and irrigation districts to seek state support for infrastructure improvements in exchange for helping meet state goals for fish passage and minimum flows (WA10, WA12).

Despite having significant funding available to invest in projects, the Office of Columbia River has a small staff, which limits their capacity to undertake and manage more projects (WA12). The department is able to partner with other state agencies, universities, and consultants for research and technical expertise (WA12). Funding for drought planning and response has been inconsistent (WA11), but a new bill signed into law in March 2020 streamlines funding and interagency coordination and expands response options, according to information posted on the Department of Ecology's website.

Authority and legitimacy: *medium* Watershed management plans developed for specific Water Resource Inventory Areas (WRIAs) have a strong focus on restoring instream flows that have been depleted by over-appropriation of surface water and interconnected groundwater, especially permit-exempt domestic wells which have had a cumulative impact (WA11). WRIA plans are developed at the local level following state guidelines, and the watershed planning groups must structure their preferred strategies within the constraints of prior appropriation and the designated minimum stream flows (WA11). The Office of Columbia River uses WRIA plans when working with stakeholders to develop a strategy and Programmatic Environmental Impact Statement for new projects:

> That gives us a framework that we can work from, establishes the goals and metrics that we will try to achieve, and how we achieve those goals and metrics is really up to the group. We'll decide what we'll invest in. And we'll implement those projects and those investments and then we'll reestablish, sort of reconvene on a regular basis and say are we are we achieving those goals? (WA12)

While the state makes active efforts to include the public's concerns in their planning and decisions, some policies have been set through State Supreme Court decisions rather than developed by the Department of Ecology, limiting the agency's ability to respond to stakeholder input (WA10). Although the minimum streamflow rules in the watershed plans are agreed upon

at the local level, they can still be controversial depending on individual views of conservation versus development (WA10, WA11). Public support for the Office of Columbia River was generally stronger:

> because the alternative is that people don't get water, right…I think there's a fairly strong incentive to provide stability around growth and the environment. And that's what water planning can do. And without that investment, without that continual attention to that, uncertainty, interruption, crises. Those are the alternative (WA12)

Participation and networks: *high* At the state level, interviewees reported high levels of communication with the other programs within the Department of Ecology at their regional offices as well as with numerous other state departments (WA10, WA11). There is also a large state network involved in drought planning and response (WA11). The state does not facilitate connecting stakeholders across basins, and cross-regional connections are generally limited unless local groups reach out about a specific place where they see progress:

> They tend to be not as connected unless they see one basin moving forward in a way that was probably never thought possible. Like in the Yakima where we're doing fish passage on Bureau of Reclamation reservoirs or we're considering new storage. Other basins are saying, gosh, why can't we do that? And so that sort of drives the interconnection between the watersheds. Why can't we have the kind of funding the Yakima is getting? (WA12)

Watershed level planning processes encourage public involvement while leaving the precise methods and strategy up to the participants (Mucken & Bateman, 2014). The Department of Ecology website describes additional stakeholder forums provided at the state level such as the Water Resources Advisory Committee, a group of about 40 individuals representing environmental groups, tribes, water utilities, all levels of government, and other water users which meets regularly for information sharing and discussions on new legislation, statewide water supply conditions, drought planning, water banking, and other water resource topics. Similarly, the Columbia River Policy Advisory Group holds meetings which are open to the

public to gather information about stakeholder priorities and provide legislative and budget updates.

## 5.11 Wyoming

### 5.11.1 *Governance Arrangements*

IWRM: *low, increasing* Wyoming's water governance has not been very integrative in the past, but efforts are underway to improve coordination of management activities. The state plan discusses land ownership more than land planning, and land and water uses are simply descriptive. With Wyoming's low population, competition among uses of water has not been a major issue, but as the population and economy grow, the state recognizes the need for planning to ensure that future needs are balanced (WY23). In addition to quantifying common water uses such as agriculture and municipal demand, the plan also includes calculations of evaporative losses from reservoirs in its water use section to acknowledge the substantial effect these losses have on storage capacity as the state begins to think more holistically about future water supply opportunities at the state and basin levels. Regional plans have been developed based on the hydrologic boundaries of major drainage basins. While stakeholder engagement was conducted for the regional plans, participation was in more of an advisory capacity to a state- and consultant-led process, and future updates of these basin plans are intended to be more locally driven (WY23).

The state plan discusses hydrologic connections between groundwater and surface water but notes that no statewide criteria have been developed to assess their interaction for the purpose of regulation, and they generally continue to be regulated separately. Conjunctive use is mentioned only in the context of jointly regulating specific water users who hold both surface water and

groundwater rights. Water quality is discussed in terms of its effects on both surface water and groundwater, although quality is regulated separately from quantity:

> in our River Basin Plans we do talk a little bit about quality. But that is not under the purview of our office, that's under the purview of our Department of Environmental Quality. So we just talk about it. We don't get into the specifics of it in our water plans (WY23)

Polycentricity: *low* Basin Advisory Groups were formed to develop regional plans, but they played more of an advisory role to the state-led process which engaged consultants to draft the final plans. Since these groups had little authority to develop their own plans and collective choice level rules, it is less of a polycentric system and more a multi-level stakeholder engagement process initiated by the state. The state provided technical assistance and information to the Basin Advisory Groups, and information and recommendations from the groups were incorporated into the state plan after being examined to ensure they were consistent with prior appropriation and interstate compacts, since the state is very attentive to protecting its compact water allocations (WY23). Future plan updates are anticipated to be more collaborative and integrative in order to build local ownership of the process (WY23).

### 5.11.2 *Adaptive Capacity Analysis*

Comprehensiveness and integration: *medium* A wide range of potential solutions are considered in Wyoming's state plan, from the more common infrastructure rehabilitation and conservation incentives to suggestions which have been more controversial, such as increasing runoff from National Forests through increased harvesting. The state is also considering the potential for expanding water banking and water markets, which currently exist but are not very active. Long lists of prospective water projects were identified during the basin planning process, and these were winnowed down to short lists included in the state plan based on criteria such as financial

feasibility, public acceptance, legal concerns, and environmental and recreational benefits. The policy landscape in Wyoming is multi-tiered and complex, and the state plan's explanation of interacting state and federal policies notes that allocations of water for environmental purposes are "at least partially a function of human desires concerning the type of environment in which people want to live" which are expressed through state and federal regulations (p. 6-26). One interviewee observed that leaving water instream could be contentious (WY23). Management is linked across scales ranging from the river basin to the transboundary level:

> since we are a headwaters state, we do have a lot of interstate compacts and decrees. And I believe river basin planning helps us understand what our use has been in the past and what we have to develop in the future. So that's part of our goal here at Water Development is to make sure that we utilize and put to beneficial use the water that we do have in each of our river basins (WY23)

The current set of River Basin Plans was developed via a state-led process employing consultants to conduct public outreach and draft the plans, and the use of different consultants for each area has made statewide comparisons difficult (WY23). In terms of recognizing linkages and balancing multiple uses of water, the state plan is more descriptive of existing uses rather than suggesting ways of balancing them. The plan observes that water availability is related to its proposed uses:

> an industrial use may be able to afford to drill deep wells, sustain large drawdowns, and treat groundwater of undesirable quality, whereas an irrigation use may only be economical where wells are shallow, production is high, and quality is adequate without treatment (p. 12)

Knowledge and learning: *low* The Wyoming Water Resources Data System is housed at the University of Wyoming and provides technical information such as stream gage records and groundwater information to state agencies and the public. Diversion data is limited, and with few reporting requirements for agricultural and industrial usage, estimates and anecdotal information are used to estimate demand in many cases. Data availability varies across the state, with better

records in areas where rivers flowing out of the state are subject to interstate compacts and in areas where known aquifer declines are being monitored (WY23). The North Platte River Basin is considered fully appropriated, and further appropriations of surface water and connected groundwater are restricted in order to prevent the system from crossing a threshold into irreversible decline. Estimates of sustainable yield are available for some other aquifers, but not all basins have been modeled. Overall, a great deal of water data has been collected around the state, but it is not always easily accessible:

> I'm sitting here in my office, looking at these on the shelf, these huge three ring binders full of really, really good information. But you know, I feel like there just wasn't a very good job done of synthesizing the most important elements down to what people want to know (WY23)

The state is now implementing a system of short annual updates to summarize new water data in a more accessible and digestible format (WY23). Drought planning is also set to be incorporated into the next round of River Basin Plans (WY23).

Wyoming has been investing time and effort into a "new way of doing business" and shifting its approach to a more locally-driven and customized planning structure (WY23). In keeping with the state plan's recommendation to "evolve the planning process rather than simply repeating it," the state has been evaluating its own previous efforts and conducted a study of water planning in seven other states to learn from their experiences (p. 2-4). Scenario planning is used to cope with future uncertainties. The state uses three projection scenarios for demand based on population and economic trends as well as three scenarios for surface water supply based on wet, dry, or average climatic conditions, although an interviewee suggested that more robust climate projections are needed to improve this process (WY23).

Resources: *low* The state plan includes a chapter on state and federal sources of water project funding, observing that federal funds have been declining and multiple sources will be needed for infrastructure construction and maintenance. The state provides funding for small water projects such as irrigation improvements through local conservation districts (WY23). Funding for water planning activities at the state level is provided primarily through natural resource severance taxes and has been diminishing despite legislative support:

> We've been really lucky in our agency, because our legislature does really understand the importance of maintaining the water rights that we have and being able to utilize any future water that we have available to us. So they've been very supportive. It's just the economy that hasn't been quite as supportive, so it's not that we have to fight our legislators to understand the work that we're doing, it's just that there's only so much money to go around (WY23)

With only a small water resources staff in the office and field, the state has been increasingly partnering with other state and federal agencies as well as entities like the Western States Water Council to make limited staffing resources stretch further (WY23).

Authority and legitimacy: *low, increasing* As noted previously, River Basin Plans were written by consultants based on a scope of work provided by the state. Basin Advisory Groups convened for this process played an advisory role in directing plan content and issues to be investigated, but they did not have authority to develop the plans independently (WY23). As part of the state's shift toward increasing local-level stakeholder engagement, a new more community-directed process is being initiated for the next round of plan updates, which is anticipated to generate more local buy-in and perception of the River Basin Plans as legitimate expressions of local water issues and priorities (WY23). At the same time, some more standardized indices are being developed to ensure that data collection across regions will be more comparable and be incorporated into the statewide plan (WY23). Plan updates, including the shorter annual

documents, are intended to be dynamically responsive to stakeholder concerns, and the state plan suggests the possibility of changing laws such as the instream flow statute to meet emerging demands for more flexibility of surface water right use.

Participation and networks: *high* Basin Advisory Groups included individuals representing a wide variety of water interests, and in general, the degree of networking in the state could be considered high (WY23). The state plan notes that river basin planning efforts were initially state-led, but that in some areas like the Bear River Basin, members of the original Basin Advisory Group have continued meeting regularly throughout the year to discuss water issues. Further regional planning efforts will include an inclusive balance of all sectors, levels of government, and tribal concerns. State agencies communicate extensively with other entities at all levels of government as well as attending meetings of organizations such as the Association of Conservation Districts and agricultural industry groups to stay informed and network with stakeholders (WY23). The Wyoming Water Forum has increased interagency networking substantially:

> I think that's been really helpful because you sit there across the table from USGS or Department of Environmental Quality and you hear about maybe a watershed TMDL that DEQ is doing, and you're working on a watershed study in that same area. And you're like, oh, I think we need to get together and talk about this…I've more often than not had people look across the table and were like, hey, I need to talk to you after this meeting. I didn't know you guys were doing that (WY23)

By facilitating interagency communication, this forum has helped the state move toward better integration of decision making despite separation of jurisdictional responsibilities.

# 6 Discussion

Based on the analysis above, states were characterized according to the IWRM and polycentricity characteristics evident in their governance arrangements, and a typology was constructed showing groupings of states. These groupings are then compared to trends in each adaptive capacity indicator to explore what this might mean for the futures of the states. Limitations of this study are then described. It is important to note that there is no singular "right" way to do water planning, and differences among states are shaped by their historical development, stakeholder preferences, and other contextual factors. While approaches such as IWRM and polycentricity may increase beneficial outcomes, ultimately each state will choose an approach that works for it.

## 6.1 Typology

Most states in the study area displayed multiple IWRM principles in their water planning, with several states deliberately moving toward integrated styles of management and others describing integration as an aspiration but reporting challenges in implementation. While no state displayed completely polycentric water governance arrangements, many elements of polycentricity were present. Vertical connections among local, state, and federal government levels were more prevalent than horizontal connections among neighboring jurisdictions, although lateral connections among agencies within the same level of government were growing in many states. Table 2 below groups the states in the study area according to their governance arrangements and shows the factors contributing to their adaptive capacity.

Table 2. Typology of governance arrangements and adaptive capacity indicators.

| **More IWRM, More Polycentricity** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **State** | **IWRM** | **Polycentricity** | **Comprehensive-ness & Integration** | **Knowledge & Learning** | **Resources** | **Authority & Legitimacy** | **Participation & Networks** |
| California | high | medium | high | high | medium | high | high |
| Colorado | high | high | high | high | high | high | high |
| Montana | medium | high | high | high | low | high | high |
| New Mexico | high | medium | high | high | low | high | high |
| Oregon | high | high | high | medium | low | high | high |
| Utah | high | medium | high | medium | high | medium | medium |
| **More IWRM, Less Polycentricity** | | | | | | | |
| **State** | **IWRM** | **Polycentricity** | **Comprehensive-ness & Integration** | **Knowledge & Learning** | **Resources** | **Authority & Legitimacy** | **Participation & Networks** |
| Arizona | high | low | high | medium | medium | medium | high |
| Nevada | medium | low | medium | low | medium | high | low |
| Washington | medium | low | medium | medium | low | medium | high |
| **Less IWRM, Less Polycentricity** | | | | | | | |
| **State** | **IWRM** | **Polycentricity** | **Comprehensive-ness & Integration** | **Knowledge & Learning** | **Resources** | **Authority & Legitimacy** | **Participation & Networks** |
| Idaho | low | low | medium | high | high | low | medium |
| Wyoming | low | low | medium | low | low | low | high |

As this table shows, states which incorporate more IWRM principles and display more polycentric tendencies in their water governance tend to have higher levels of all adaptive capacity indicators except for resources. At the same time, states with lower levels of both IWRM and polycentricity do show high levels in some indicator categories, revealing the potential strengths of different approaches.

### 6.1.1 *Trends in Comprehensiveness and Integration*

All states in the study area displayed medium to high levels of comprehensiveness and integration in their water planning, reflecting the increasing recognition of interconnections and the need to shift away from siloed approaches which was mentioned by multiple interviewees.

States that showed lower levels of IWRM, such as Idaho and Wyoming, still exhibited efforts to coordinate among departments even though their management may be less holistic. Part of the challenge of moving toward more integrated solutions is the path dependency of existing legal structures, which can create rigidity in the governance regime and friction when trying to change it (Wise et al., 2014; Young, 2010). Reevaluating water policy is often considered "politically, what they call a third rail" in recognition of the challenge of proposing any changes to "over 100 years of a current framework that people have spent time and money to defend" especially concerning prior appropriation rights (WA12). While interviewees from Washington and Nevada spoke about prior appropriation being more of a self-regulating system for balancing competing uses of water (WA10, NV8), an interviewee from Montana described their collaborative basin-level planning process as a forum for making deliberate choices to integrate concerns which would otherwise have been overshadowed by prior appropriation (MT7).

Integration of water issues can also be a question of scale, such as the policy structures surrounding water quality and quantity. While water quantity allocation and planning are under the purview of states, national policies like the Clean Water Act give more federal authority over water quality (Casado-Pérez et al., 2015). All states except Wyoming have assumed primacy for regulating their public drinking water quality under the Clean Water Act, but quality and quantity are typically managed by separate state agencies or divisions which vary in their level of communication and coordination (WWDC, 2007). This fragmentation into highly specialized governance sub-systems can hinder coordination, thus reducing adaptive capacity (Bolognesi & Pflieger, 2019). Nonetheless, at the local level, water providers must deal with quality and quantity in an integrated manner out of necessity to provide water within their service areas, which may boost adaptive capacity at the local level (OR17).

In states where the Comprehensiveness and Integration indicator is lower, it is possible that decisions in one area will inadvertently impact another, such as the absence of conjunctive management of surface water and groundwater. Decision making does not have to be centralized in one agency in order to ensure integration of concerns; rather, high levels of coordination and open lines of communication among entities with water management responsibilities can help account for externalities while focusing on key drivers in each system (de Loë & Patterson, 2017; Mitchell et al., 2015). New Mexico's state water plan, for example, contains directories of agencies responsible for each topic of water management with links to their websites in the digital version of the plan, so that a reader could easily determine which entities they would need to work with on any program from wetland restoration to water rights adjudications (NMISC, 2018). In Oregon's Mid-Coast place-based planning area, developing cross-scale and cross-sector connections and rapport is increasing the likelihood of making integrative, adaptive decisions, as one interviewee reported that "if it did nothing else but help us know who the other players are and develop those relationships so that we know who to talk to, and who to plan with, it's already been successful" (OR17).

### 6.1.2 *Trends in Knowledge and Learning*

All states exhibiting high levels of IWRM combined with high levels of polycentricity also showed high Knowledge and Learning indicators; however, there was no trend in Knowledge and Learning among states with lower levels of IWRM or polycentricity. Part of the variability stems from this being a mixed indicator encompassing sufficiency of data for water planning, accessibility of data, active efforts to learn and communicate new information about water resources, and consideration of uncertainty in water management.

Two themes that emerged during coding were spatial variability of water data and the lack of tracking and reporting requirements for water use, both of which reduce the ability to fully understand the water resources system and adaptively manage it. Several states reported patchiness of data available, such as Arizona's much greater level of information available inside its Active Management Areas compared to the rest of the state, and Wyoming's widely varying amounts of data collected in river basins depending on whether or not transboundary agreements were in place. In addition, interviewees from over half all states in the study area raised the issue of water use reporting requirements in response to the interview question about sufficiency of data. This means that demand data for water in many places is based on estimates or assumptions about full use of water rights, which may have limited accuracy. Despite recognition of the limitations this lack of data places on water planning, interviewees also noted that imposing new measuring and reporting requirements on any sector from agriculture to domestic well users would be controversial and politically unpopular.

Research on water resources is ongoing in every state in the study area, with interviewees describing a variety of partnerships as well as studies within their own departments. States are increasingly making water-related information available online to expand data accessibility for the public and decision makers. Interviewees from several states including Oregon, Utah, and Wyoming discussed the challenges of organizing massive amounts of available information and making it more useful for the public:

> It's not good for the farmer out there who is not going to want to wade through this information, he might have the knowledge to understand it, but he just doesn't have the time or the inclination to sit down with a three volume report and try to figure out the two pieces of information that he wants to know (WY23)

This type of data overload is now being mitigated by projects such as Wyoming's focused water issue summary documents and Utah's annual "Water for Utah" snapshots.

A prominent feature in resilience theory is the concept of thresholds beyond which a system will shift to another, possibly undesirable, state. Dyckman's (2016) study of state water plans revealed that few states explicitly measure such thresholds, which is mostly consistent with this project's findings, although several states do measure sustainable yield of groundwater and minimum instream flows. In others, persistent data gaps require more resources to overcome, as one interviewee in Nevada described that "if you wanted to develop water resources in the basin, you would know right off the bat that you are going to have to spend some time and money to determine what's available there" and whether new appropriations would deplete the aquifer beyond sustainable limits (NV8). Consideration of system thresholds in water planning could increase adaptive capacity by giving managers a chance to observe trends and take adaptive actions before a threshold is reached.

Social learning is critical to adaptive capacity and resilience because it enables stakeholders within each state to generate and distribute information not only about hydrological and ecological systems but also about their own social and economic needs and preferences (Baltutis & Moore, 2019; Gupta et al., 2010; Pahl-Wostl, 2009). Colorado's "Learning by Doing" approach for stream management and restoration is an example of social learning that adds a layer of experimentation to its collaborative plan development process to provide a framework for making decisions about management (CWCB, 2015). Fora such as Colorado's Interbasin Compact Committee, Montana's water summits, and Washington's Water Resources Advisory

Committee all build adaptive capacity by promoting social learning and networking across levels of governance.

Another theme that emerged during coding was the importance of planning for the uncertainties surrounding climate change. While climate change is anticipated to be a critical stressor for water systems, the politicization of this issue has constrained open discussion in several states:

> the way we have typically approached it and something that we've found to be politically palatable is talking about moving into a brighter future in Arizona and how we need to plan our water resources to anticipate less water supply in the future (AZ13)

Similarly, water planners in Idaho and Wyoming have found it easier to initiate conversations around climate variability rather than directly addressing 'climate change' which can derail the discussions (ID20, WY23). While states with more proactive climate research programs, downscaling to explore potential local impacts, and preemptive consideration of adaptation actions would undoubtedly be more prepared for climate change, discussions of climate variability could also be a starting point for building adaptive capacity, particularly when linked with planning for drought which is widely accepted as prudent by most stakeholders. Indeed, some water planners are already reflecting on their states' drought response actions as a way to increase their preparedness for climate change, with one interviewee in Nevada calling the state's significant past droughts "somewhat of an advantage" because of the experience gained in managing them, and another in Washington likening drought to a way "to test drive climate change, kind of take it out for a spin and see how well we do" (NV8, WA11).

### 6.1.3 *Trends in Resources*

The categorization of high, medium, or low resources in this study is based on the adequacy of funding as described in state plans and interviews, rather than looking at precise dollar amounts spent on water planning and management activities. Due to the differences among states in terms of population, geographic area, governance structure, needs, and methods of reporting water-related expenditures, the exact spending is not easily comparable across states. Instead, focusing on adequacy can help reveal whether each state has sufficient resources in both budget and staffing to meet its goals. In terms of adaptive capacity, having satisfactory resources available should assist states in taking adaptive actions including supporting proactive planning processes as well as implementing projects like infrastructure construction, aquifer storage and recovery, and water conservation outreach programs.

Within the study area, no pattern is evident in relation to the groupings of states with more or less IWRM and polycentricity. In fact, half of those states in the high IWRM/high polycentricity grouping—Montana, New Mexico, and Oregon—reported low levels of resources available compared to their needs. Mitchell et al. (2015) observe that holistic approaches typically necessitate more investment of human resources, time, and money for collaboration compared to planning for a more limited scope of issues, and it may be that some states with higher incorporation of IWRM principles are trying to undertake more integrative processes but lack the resources to fully do so. Interviewees in Oregon and Montana described staff positions going unfilled and the limitations this imposed on their planning efforts, particularly in coordinating between the state and local levels (OR4, MT7). Similarly, interviewees in Washington and

Arizona talked about budget and staffing cuts from which their departments had not recovered, leading to substantial backlogs of work (AZ13, AZ22, WA10).

### 6.1.4 *Trends in Authority and Legitimacy*

As described in the Conceptual Framework, this indicator category specifically seeks to characterize the level of self-organizing authority granted to local or regional groups to manage their own resources collectively as well as public support for planning institutions. Higher levels of local authority are expected to increase the responsiveness of the governance system to changing conditions and social preferences, which can help build legitimacy in the eyes of the stakeholders. The analysis for this project shows a strong trend toward higher levels of Authority and Legitimacy in states displaying more characteristics of IWRM and polycentricity. This is likely to stem from a combination of IWRM's principle of stakeholder engagement in decision making as well as the presence of semi-autonomous local management units in polycentric systems. The overlap in these categories is not precisely congruent due to the additional factors considered in the IWRM and polycentricity analyses, but the evidence does suggest that incorporating these governance approaches into state water planning could be beneficial for institutional fit and subsidiarity, thus increasing overall adaptive capacity.

Arizona, Nevada, and Washington all show medium to high levels of IWRM principles in their planning but less polycentricity, being more top-down in the case of Arizona and more devolved in Nevada and Washington. All three states showed medium to high levels of Authority & Legitimacy, indicating that this facet of adaptive capacity relies less on aspects of polycentricity and that it is possible to build strong public support for the legitimacy of planning in a variety of governance structures. For example, although Arizona's Active Management Areas are governed

by state statute and have their goals pre-set, the system is still able to respond nimbly to stakeholder concerns through forums such as the Groundwater Users Advisory Councils (AZ13). Collaborative work on Arizona's contribution to the Colorado River Lower Basin Drought Contingency Plan increased its responsiveness and legitimacy, eventually creating an agreement that was acceptable to stakeholders where less inclusive approaches had failed (AZ24).

It is also important to note that this assessment represents only a snapshot in time, while in reality, state water governance can be dynamic despite the effects of path dependence. Although Wyoming showed a lower level of Authority and Legitimacy with its system of advisory-only basin planning, an interviewee described how the state-led process has been identified as problematic:

> one of the problems that we identified with these River Basin Plans is it was somewhat of a cookie cutter approach and didn't always fit with all of the different basins and the different issues they were having (WY23)

The state's upcoming revised process is intended to empower local and regional planning groups with considerably more autonomy, increasing their responsiveness to concerns within each planning area, which would change a future analysis of the Authority and Legitimacy indicator to a higher level as well as affecting the polycentricity and IWRM analyses. This shift in governance approach shows the willingness to renegotiate boundaries and responsibilities that Huntjens et al. (2012) describe as particularly important for supporting adaptation.

### 6.1.5 *Trends in Participation and Networks*

States in the high IWRM and high polycentricity grouping are associated with higher levels of Participation and Networks, as might be expected from systems that practice more integrative decision making and coordinated planning activities across multiple scales. Nonetheless, states

displaying high levels of Participation and Networks also occur in both other groupings within the typology, indicating that it is possible to support this component of adaptive capacity within diverse styles of governance. All states described efforts to be inclusive of various stakeholder groups and preferences, demonstrating their commitment to meeting the water needs of their constituents. Actual methods of inclusion varied, from public review of regional plans in sparsely attended meetings in Nevada to California's facilitation of disadvantaged community involvement in the Integrated Regional Water Management program and expanded consultation with Native American tribes to embrace the inclusion of Tribal Ecological Knowledge in water decisions (NV8; CDWR, 2019). Some states take an intermediate approach, as an interviewee from Idaho described the process for developing regional advisory groups, "we'll appoint a committee, and that'll be representative of the stakeholders in the area" (ID20). While this may work in cases where stakeholder interests are already well known, Saravanan et al. (2008, p. 10) caution that selectively engaging "easily identifiable stakeholders…legitimises the existing resource use pattern" and could leave out some interests. In addition, if the existing outreach process is seen as already reflecting all viewpoints, governments could be reluctant to devolve authority to lower levels, potentially homogenizing solutions rather than allowing for expanded local participation (Baltutis & Moore, 2019). Another theme that emerged from the analysis was that stakeholder participation often increased in reaction to conflicts and threats to the system. For example, the urgent need in Arizona to come to an agreement on the Lower Basin Drought Contingency Plan for the Colorado River to address dropping water levels in Lake Mead not only sparked inclusive, collaborative action for that agreement but also led to increased awareness about water issues and amplified stakeholder participation in the Active Management Areas and other long-term planning processes around the state (AZ13).

Collaborative processes can create tremendous social capital and link participants in networks that promote shared learning and integrative decision making, as exemplified by the following three cases from the study area. During the regional water planning process for the Upper Missouri Basin in Montana, one interviewee described the value of social interaction in addition to sharing data on hydrologic conditions and formally expressing preferences and priorities:

> [Some participants] wanted a seat at the table specifically because their fists were clenched, and they were like, 'by God I'm going to protect my constituency as strongly as I possibly can'…I always made them come together in a social setting after we had had meetings, and then before we would have meetings the next day, and try to create this camaraderie. And it was amazing how well it worked. And by the end of all of our meetings, when we were wrapping it all together and finding our recommendations and our discussions, I routinely heard people around the table, particularly the ones that had come with their fists clenched, say, 'I really understand this better now and I can see the issues and how complex and challenging this really is' (MT7)

Similarly, a participant in Oregon's place-based Mid-Coast planning process described the realization that the group's efforts were making progress in bringing together diverse interests in ways that would lead to lasting change:

> In the beginning it was looked at with a lot of speculation and mistrust. We already have plans that are sitting on the shelves doing nothing. Why is this any different? And then, you know, as all these groups dug their heels in, and started their work, that attitude started to shift and they began to realize as we started to engage more and more partners and started to have more and more influence, that there's something amazing happening here (OR17)

A final example from the Yakima Basin in Washington shows the importance of empowering stakeholders to work together and move away from a 'win-lose' mentality:

> We've had people that have worked either on the fish side or the storage side for decades and have not gotten anywhere because each of those interests would stop one another from moving forward…We've developed the strategy where we've agreed to kind of pursue both interests in a way that moves both of those balls down the field for progress, and that's the magic, right? That's that moment when you can actually make some progress. And it's not easy. It takes investment in people (WA12)

Overall, stronger networks and inclusive stakeholder participation are showing positive outcomes in many areas despite the additional effort and resources needed to support these processes. As one participant in Oregon put it, consensus-based inclusive planning "is really the only way you can efficiently manage and plan for water in the state. It's ugly and dirty and slow, but it works" (OR17).

## 6.2 Limitations of the Study and Areas for Future Research

One limitation of this study is that for some states, only one person responded or consented to participate in an interview. In these cases, their perspectives may not be representative of the state as a whole. While reflecting the complete range of all viewpoints in a state may not be achievable, a more comprehensive understanding can be established by conducting interviews until a point of 'saturation' is reached at which additional interviewees are no longer expressing new ideas; if this point is not reached, data analysis may present an oversimplified picture (Elo & Kyngäs, 2008). In states for which more than one interview was conducted, there were not typically sharp differences of opinion on the factors in this analysis; however, there were nuances that were helpful in understanding the complexities of water governance in each state. In particular, interviewing individuals who work in different departments or at different levels of governance (for example, local place-based versus state) provided valuable information to derive a more complete depiction of the policy landscape. Combining the interviews with content analysis of state water plans enabled triangulation of the interview data to increase the validity of the analysis and interpretations (Robson & McCartan, 2016).

Conversely, no state plan was available for Washington, so the analysis relied heavily on data collected from three interviews supplemented by background research. While individual

watershed-level plans were available on the state's website, these were not comparable to the higher level plans analyzed for the other states. A deeper analysis of water governance in Washington using additional interviews and documents could reveal patterns of adaptive capacity beyond the present findings. Further complications arose around the state plan for Nevada, which is still in effect but no longer being updated, so it may contain information that is out of date or no longer part of the general practice of water governance in the state. The states of Utah and Wyoming are in the process of updating their state and basin level plans, and the shift to more inclusive, stakeholder-led processes and evolution of the plans to reflect new concerns could substantially change the analysis for this project. In Arizona, the Governor's Water Augmentation Innovation and Conservation Council includes committees exploring options for future management both inside and outside of the Active Management Areas once the legislation driving the state-directed planning process sunsets in 2025 (AZ13).

In their study of governance arrangements for IWRM, Watson et al. (2019) advise taking a long-term approach to better understand how governance shifts over time, so examining older and newer plans for the same state could be a fruitful future endeavor. While this study focused on state-level plans, a similar analysis could be conducted for watershed or basin plans using the elements of the conceptual framework. Since the scale of local planning may facilitate integration of concerns, such as a water provider needing to consider both quality and quantity, IWRM may be more likely to be implemented at the local level which could increase local adaptive capacity (Engle, 2013). Therefore, analyzing local plans for elements of IWRM combined with the adaptive capacity indicator categories could provide a more in-depth consideration of IWRM's contribution to resilience and reduced vulnerability.

# 7 Summary and Conclusion

This paper investigated the importance of governance arrangements for adaptive capacity, observing the potential for water systems in the western United States to reduce their vulnerability and increase their resilience to both novel stressors such as climate change as well as increasingly evident systemic issues with rigid, antiquated institutions and changing social norms. The paper explored the prospective benefits of integrated water resources management and polycentricity, which can be expressed in different forms but seek to coordinate water resources governance more effectively across sectors and scales. A conceptual framework was proposed for characterizing elements of integrated water resources management and polycentricity, along with five categories of determinants of adaptive capacity. Using content analysis of state water planning documents and semi-structured interviews, eleven western states were examined for trends and patterns among governance arrangements and adaptive capacity indicators.

This research project has shown that including elements of integrated water resources management and polycentricity in state water planning and governance can be linked to higher adaptive capacity in several areas, but the resources needed to translate plans into adaptive actions require additional commitment from legislatures and stakeholders. Improving one component of adaptive capacity, such as self-organizing authority of local groups, could also advance other areas such as inclusive participation, thus providing opportunities to build up adaptive capacity synergistically within a state. Granting more authority to communities or regions to self-organize could help tailor local solutions to problems while retaining connections to higher levels of governance for policy alignment, resources, data sharing, and learning forums,

thereby moving toward polycentric governance. Growing trends toward more inclusiveness of stakeholder perspectives as well as more integration of management concerns are evident in all states in the study area. The development of inclusiveness and local self-organizing authority could be critical in overcoming institutional rigidity and path dependence. Resistance to changing entrenched systems like prior appropriation could be tempered without threatening property rights by gaining stakeholder support of supplementary measures such as voluntary watershed stewardship programs and instream leasing incentives. As demonstrated by the place-based planning process in Oregon and the basin planning in Montana, bringing people together to collaborate builds social capital, enabling greater understanding of other perspectives and cultivating trust in other participants to keep their commitments. Coupled with the authority to self-organize, this could allow flexibility within existing structures and even the creation of new locally-based institutions for issues like shortage sharing.

While data gaps persist, social learning and efforts to increase data accessibility are helping to facilitate participation and integration, but they require resources to sustain, which is not always available even in states with high levels of IWRM and polycentricity. This demonstrates the need for greater investment if states are to meet challenges like climate change, drought, and policy fragmentation. Innovative, coordinated planning will be essential if clean, reliable water supplies are going to be available to humans and ecosystems in the western United States in the future. By supporting approaches such as IWRM and polycentricity, states could boost their adaptive capacity, reduce their vulnerability, and become more resilient, giving them greater flexibility and control over their water futures.

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