Understanding Idaho's Adaptive Capacity to Future Water Resource Change: A Legal and Political Analysis of Climate Informed Drought Planning

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by
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Authorization to Submit Dissertation

This dissertation of Alycia R. Bean, submitted for the degree of Doctorate of Philosophy with a Major in Geography and titled "Understanding Idaho's Adaptive Capacity to Future Water Resource Change: A Legal and Political Analysis of Climate Informed Drought Planning," has been reviewed in final form. Permission, as indicated by the signatures and dates below, is now granted to submit final copies to the College of Graduate Studies for approval.

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Abstract

Geography is a unique discipline of study. From the classic geographical analysis of exploration (completing the mapping of the world), to focusing on the generalities (explaining patterns of human placement and behavior), to regional focus (with less structured explanations than the general), geography has provided diverse ways of knowing. And while 'ways of doing' have changed between idiographic and nomothetic or have focused more on explaining causality or complimenting scientific modeling, the approaches build on the other's strengths. These foundational developments need both the rigor of spatial and statistical analysis as well as the rich and in-depth investigations of exploratory chorography. Geography provides the holistic analytical means to better understand the complexities we face in the 21st century.

There is no more intractable problem of our time than climate change. The impact from increased greenhouse gases has and will continue to pervade every aspect of our lives. Changes to the physical environment affect our economic, political and legal environs as well. In the northwestern state of Idaho some of the most significant impacts of climate change will be seen through water availability. In a snow-rain mixed dominated region increasing temperatures have cascading effects on water resources. Compounding this biophysical issue is the legal issue of water allocation which, in portions of the state, is already over allocated. Meaning, there is already not enough water to satisfy all water rights at certain times of the year in certain locations. Climate change impacts only exacerbate complex water law agreements. The state's document to provide valuable and up-to-date information for Idaho citizens in times of water shortage is now seventeen years old. This outdated state Drought Plan is not for lack of drought in the state. Idaho counties have declared drought eleven out of the past fifteen years (2001 – 2016). Understanding why the slow-onset hazard of drought isn't able to garner the attention of policy makers in the state like other natural hazards, such as fast acting floods or landslides, is imperative to getting drought on the agendas of policy elites.

An examination of geography's role in addressing climate change through geographic thought is woven through the need for this study and the implications of the research (Chapter 1). The dissertation utilizes spatial and statistical analysis to better understand how hydrometeorological and agricultural drought has influenced Idahoans through a climatological drought metric (Palmer Drought Severity Index) and through a political drought metric (county-level drought declarations) (Chapter 2). Drought declarations in Idaho allow for an expedited temporary water transfer process, often providing the much-needed alternative to resolve water shortage issues outside of litigation. One of the most stalwart examples of out of court settlements in the region occurred in southern Idaho in 2015. An adaptive planning framework is applied to the settlement between ground and surface water users to identify areas of flexibility within the stable role of law (Chapter 3). While law has room for adaptability, drought planning must be on the agenda of policy makers in order to advance. Borrowing from the agenda setting literature within political science, this research examines the process of state level drought policy. A window of opportunity opens for policy change when a set of criteria is met. This study demonstrates how the slow onset hazard of drought resists classic policy analysis due to its unique characteristics set within Idaho's unique demographic (Chapter 4). The dissertation concludes with a summary of research findings and recommendations for future work (Chapter 5).

The objective of this research follows the tradition of geographic study of humans and their interaction with the landscape. This paper utilizes an interdisciplinary approach to the complex and integrated water resource issues facing the semi-arid state of Idaho. The central conclusion of the dissertation leans on the studies of climatology, water law and policy analysis to argue that the study of a intractable issue like climate change, seen here through drought specifically, cannot be considered as an autonomous field of inquiry.

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I would like to recognize those individuals who embraced the idea of an interdisciplinary dissertation despite the challenges to combining areas of research and even institutions in this project. I would like to thank the many individuals working on water resources in the state and the region and those who took the time to share their perspective and expertise with me, especially: Alicia Marrs, Amanda Goldberg, Amy Mazur, Andrea Lacy, Brian Chaffin, Bruce Godfrey, David Hoekema, Deb Bathke, Tim Luke, Don Wilhite, Felix Liao, J.D. Wulfhorst, JB Ruhl, Katherine Hegwisch, Lauren Parker, Sarah Pralle, Mark Solomon, Matthew Fontaine, Michael Jennings, Randy Budge, Russ Qualls, Speaker Scott Bedke, Susan Benjamin, Theresa Jedd, Thomas Birkland, and Tony Arnold. I am especially indebted to Dr. Karen Humes who saw the potential in this multifaceted project and advised me on how to work within traditional boundaries to achieve interdisciplinary academic goals. Distinguished Professor, Barb Cosens graciously invited me into her law classes to deepen my exposure to the complexity of conjunctive management within Idaho water law; her attention to detail while balancing the big picture was an invaluable resource in the writing of this paper. I am grateful to the vision and persistence of Dr. Jen Schneider, who even though served on my committee from the greatest distance and from a different institution, Boise State University, felt as if she were right on the University of Idaho Moscow campus. I am equally and sincerely grateful for the mentorship of Dr. John Abatzoglou who worked with me on multiple iterations of how to capture scientific drought research that could be applicable to stakeholders and decision makers.

Lastly, I would like to acknowledge the University of Idaho Geography Department, the Idaho Water Resources Research Institute (IWRRI), the United States Geological Survey (USGS), and the National Science Foundation Experimental Programs to Stimulating Competitive Research in Idaho (EPSCoR) who supported this research.

Dedication

To my son, Brecklen Buchanan – in hopes we may continue to plan for a better future for you. To my parents, Ben and Linda, whose unwavering confidence and unconditional support never went unnoticed. And to Tamara, my sister – here's to you.

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List of Abbreviations

AAG	American Association of Geographers
AF	Acre-feet
AGU	American Geophysical Union
AWC	Available Water Content
BLM	Bureau of Land Management
BOR	Bureau of Reclamation
CFS	Cubic feet per second
CPI	Consumer Price Index (in adjusted cost for drought economic impacts)
CRED	Centre for Research on the Epidemiology of Disasters
DEQ	Department of Environmental Quality
DOI	Department of Interior
ENSO	El Niño Southern-Oscillation
EPA	Environmental Protection Agency
ESPA	Eastern Snake Plain Aquifer
ET	Evapotranspiration
FEMA	Federal Emergency Management Agency
GAO	United States Government Accountability Office
GCM	Global Climate Model
HB	House Bill
IC	Idaho Constitution
ICCG	International Conference of Critical Geography
IDAPA	Idaho Administrative Code
IDWR	Idaho Department of Water Resources
IDWRB	Idaho Water Resource Board
IGWA*	Idaho Ground Water Appropriators
INL	Idaho National Laboratory
IPCC	The Intergovernmental Panel on Climate Change
MACA	Multivariate Adaptive Constructed Analogs
MSA	Multiple Streams Analysis
MSF	Multiple Streams Framework
NASA	National Aeronautics and Space Administration
NCA	National Climate Assessment
NDMC	National Drought Mitigation Center
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
PDO	Pacific Decadal Oscillation
PDSI	Palmer Drought Severity Index
POD	Point of Diversion
POU	Place of Use
PPD	Presidential Policy Directive
RCP	Representative Concentration Pathway

SRBA	Snake River Basin Adjudication
SWC**	Surface Water Coalition
SWE	Snow Water Equivalent
SWSI	Surface Water Supply Index
USGS	United States Geological Survey
WGA	Western Governors' Association

*The acronym "IGWA" is used to refer to the Idaho Ground Water Appropriators, Inc. which is made up of the following parties: Aberdeen-American Falls Ground Water District, Bingham Ground Water District, Bonneville-Jefferson Ground Water District, Carey Valley Ground Water District, Jefferson Clark Ground Water District, Madison Ground Water District, Magic Valley Ground Water District, North Snake Ground Water District, Southwest Irrigation District, and Fremont-Madison Irrigation District, Anheuser-Busch, United Water, Glanbia Cheese, City of Blackfoot, City of American Falls, City of Jerome, City of Rupert, City of Heyburn, City of Paul, City of Chubbuck, and City of Hazelton. The State of Idaho is represented by the Idaho Department of Water Resources tasked with administration and distribution of water rights in Idaho.

**The acronym "SWC" is used to refer to all members of the Surface Water Coalition who are the actual parties to the Settlement Agreement and include the A&B Irrigation District (A&B), American Falls Reservoir District No. 2 (AFRD2), Burley Irrigation District (BID), Milner Irrigation District (Milner), Minidoka Irrigation District (MID), North Side Canal Company (NSCC), and Twin Falls Canal Company (TFC).

Chapter 1 : Geographic Thought and Interdisciplinary Research

Scope and Objectives

The overarching goal of this research is to explore issues at the boundaries between the physical, legal and policy aspects of planning for and responding to changes in climate. In order to define a manageable scope of work for this research, it is focused on evaluating issues at those disciplinary boundaries related to the occurrence of and response to drought in Idaho. The southern portion of the state is particularly impacted by climate change and drought, as it is a major region of irrigated agricultural production in the U.S., existing within a snowmelt-dominated hydrologic system. The state is typical of other western states with regard to major provisions of water law (i.e., “first in time, first in right”) however the state has taken some measures to allow for adaptive management and science-based decision-making with regard to water resource management. Examination of the utility of these approaches is potentially useful to other jurisdictions that may be considering such measures. Additionally, although the state exists within a context of widespread political resistance to creating policies to plan for or mitigate climate change, it has created significant policies and governance structures around the need for water resource planning and management.

Thus, this dissertation will cover three interrelated topics, designed to evaluate issues at the boundaries between physical, legal and policy aspects of drought planning and response:

a) A spatial and temporal examination of county-level drought declarations in Idaho over the last 16 years, including an examination of hydrometeorologic conditions as well as other drivers for drought declaration rooted in policies and laws. (Chapter 2)

b) A critical examination of the successes and failures of Adaptive Planning as seen through the case study of a landmark agreement between surface and ground water users in the Eastern Snake River plain in southern Idaho. (Chapter 3)

c) A conceptual analysis of Agenda Setting and climate informed drought planning at the state level in Idaho through the lens of the Multiple Streams Analysis Framework. (Chapter 4)

The comprehensive examination of physical, legal and policy aspects surrounding drought planning and response fits well within the major themes of the discipline of Geography. The remainder of this chapter is organized to provide: 1) some history of the discipline as it relates to an integrated analysis of the human (social, legal) and environmental (hydrometeorologic) aspects of drought and climate change in general 2) background on each of three major topics defined above and 3) specific research questions to be addressed in each chapter.

Geography's History

This history of diverse methods and means in Geography has traditionally been told chronologically through the concept of paradigm shifts, introduced by T.S. Kuhn, where a paradigm is a shared approach, philosophy or means of conducting research (Kuhn 2012). Each paradigm shift's terminology is used to illuminate the establishment of approved views or to reject the refuted views. During the age of exploration, geographers were called upon to map the world. Once explored, conquered, measured, and divided (and re-divided) there was no longer a need for geography to answer questions about society's relationship to the environment spatially with maps, narratives and increasingly obsolete tools. There was, therefore, an inevitable transition point in the discipline's viability as a necessary science.

The paradigm shifts swung like a pendulum over Geography's rich history from varying degrees of humanism to myriad forms of positivism. For example, before the designation of anthropology, geography served as a much-needed tool for identifying '*who was doing what, when and where'*. Geography was holding fast to its quantitative science, but while answering *where* (i.e. location theory and economic geography), it neglected to ask *why*. In this way Geography was not equipped to analyze social origins of spatial phenomena and was unable to respond to some of the most pressing social and environmental needs of the time (Peet 1979, Cresswell 2012, Johnston and Sidaway 2015).

A multitude of theories emerged that challenged the existing ideological bond of Geography, including theories from: critical geographers, radical geographers, structural Marxist and post-Marxist geographies, humanist arguments, new urban geographies, spatial theories in structuration (and post-structuralism), phenomenology, regulation theories, Fordism, postmodern geographies and feminist geographies. And yet three fundamental elements remained in the development of modern geography: 1) time, process and rates 2) space and scale and 3) one's capacity to interpret and modify their environment (Peet 1998).

Despite the dominance of rationalism and positivism in the Geography discipline, it has been argued that not much changed during the quantitative revolution, during which questions of value and ethics weren't adequately explored (King 1976). These concerns were addressed by humanistic geography (Hasson 1984, Tuan 1976). If the scientific revolution in Geography claimed to be a movement away from specific research to the more general to lead to more scientific analysis, the humanistic approach was to provide geography a mechanism to generate wisdom via theoretical analysis. And while this methodology has been criticized for appearing elitist in its Socratic introspection, the daunting expectations of humanistic geographers has been made tangible through the use of myth and metaphors to explain that which cannot be explained through quantitative science alone (Buttimer 1982).

A 'cultural turn' took place around the 1980s and signified a break in the barriers between the broad discipline's strands of geographies such as social, political and economic (Johnston and Sidaway). This analytical shift in the discipline emphasized social change by way of critical analysis. In response to changes in the structure of national economy and the institutional relationships between it and the political and social forces at work in the 1980s there was an explosion in cultural studies, identity politics, and multiculturalism (Best and Kellner 1997). Geography's long history in the quantitative and qualitative theories made it a viable research arena for this cultural turn. Livingstone (1993) identified geography as the integrating discipline that kept the study of nature and culture under one disciplinary umbrella.

The Call to Action

Geography's history spans the fields of political ecology, sociology and human-environment interactions, situating itself appropriately to address major global issues (Chase-Dunn and Hall 1997) such as climate change. Geographers, as scientists, have been called upon to act on the results of their findings (Harvey 1997). The legacy of the history of geography is seen today through the balance of scientific rigor and the simultaneous qualitative weight placed on the perspective of the 'stakeholder' in geographic study.

For example, when National Aeronautics and Space Administration's (NASA) scientist Dr. James Hansen was confronted with the political and economic realities of inaction in regards to climate change, he felt compelled to write a book with this disquieting title: Storms of My Grandchildren: the Truth about the Coming Climate Catastrophe and Our Last Chance to Save Humanity (Hansen 2010). Dr. Hansen provides detailed information about our changing climate which he purports brings us to the "startling conclusion that continued exploitation of fossil fuels on Earth threatens not only the other millions of species on the planet but also the survival of humanity itself – and the timetable is shorter than we thought" (Hansen 2010).

In 2013, the global concentration of carbon dioxide in the atmosphere reached 400 parts per million (ppm) (NASA 2013). The goal of 350 ppm is needed in order to stabilize climate without future warming (Hansen et al. 2013). According to the National Oceanic and Atmospheric Administration's (NOAA) and NASA data, average surface temperature of the Earth has increased by ~0.8° Celsius or ~1.4° Fahrenheit (NASA 2018). By 2080 this will be in the range of ~3.5 - ~9 °F increase (Melillo, Richmond and Yohe 2014).

We are already seeing the impacts of 1°C of global warming through more extreme weather, rising sea levels, and melting ice caps (Stocker et al. 2013). Climate impacts accompanying global warming of 2°C would be deleterious (Hansen et al. 2013). Extreme temperatures are implicating global warming as the cause for more extreme heat events (Hansen, Sato and Ruedy 2012). The Intergovernmental Panel on Climate Change (IPCC) states there have been significant changes in physical and biological systems that inevitably have posed, and will continue to pose, considerable risks to human and ecosystem health (Allen et al. 2014).

The ability to address the climate change issue necessitates multiple and incremental policy changes, as one bill passed cannot solve the entire problem. Additionally, the issue must be addressed by research in multiple disciplines. The impact of a changing climate permeates through all aspects of our lives and has already affected basic human needs such as world food supply and available potable water, and has threatened many of the most populous cities on earth which are already experiencing sea level rise (Allen et al. 2014)

While the IPCC summarizes what many are already experiencing, NOAA's research solidifies the permanence and continuity of these types of climate changes; even if carbon dioxide emissions are completely eliminated, the changes in surface temperature, rainfall and sea level are largely irreversible for more than a thousand years (Solomon et al. 2009). Roger Pielke Jr. of the Center for Science and Technology Policy Research maintains that even the IPCC projections (Meehl et al. 2007) were considerable underestimates (Pielke Jr, Wigley and Green 2008). Scientific results in a variety of fields point to impacts of climate change as affecting the focus of research (Parmesan and Yohe 2003, Roberts and Emel 1992, Hansen 2010). Camille Parmesan, for example, concluded that while most scientists are in agreement as to the effects of climate change, they are experiencing difficulty in convincing other academic disciplines, policy-makers and the general public of these observed impacts (Parmesan and Yohe 2003).

In 2005 James Hansen wrote a memo to NASA Goddard management saying, "if NASA is to fulfill its mission of providing information that helps the public and policymakers understand and protect our home planet, if it is to uphold its public trust with integrity, it cannot knuckle under to political pressures"(Hansen 2010). Dr. Hansen's plea speaks to the overlap of many different disciplines and value systems imbedded in our society that can be at odds with each other. It is the necessary tension among climate science, public policy, and law that was the catalyst for this dissertation.

Climate Change Impacts and Drought

Global climate change and its impacts are undoubtedly the principal challenge of the 21st century. Many disciplines are being called to work to address these issues, and geography is at the vanguard. Environmental geographers have especially worked to keep the dialog at the forefront of the geographical tradition (Livingstone 1993).

Climate change effects are already being felt throughout the world (Romero-Lankao 2014), including in the northwestern United States (Salathe 2010, Meehl et al. 2005) and within Idaho (Klos et al. 2015). In the inland northwest, a snowmelt and mix rain-snow dominated region (Hamlet et al. 2013, Luce and Holden 2009), the impacts of climate change will be experienced most through the changing regime of water resource availability, quantity and quality (Mote et al., 2003; Hamlet, 2011; Regonda et al., 2005). These changes will have a myriad of impacts in Idaho and will include threats to agriculture (Qualls et al. 2013) increased wildfires (Barbero et al., 2015), and increased hydropower demands (Hamlet et al., 2010).

From irrigation for agriculture to planning for growing municipalities – water resources are becoming less reliable for states like Idaho (Luce, Abatzoglou and Holden 2013, Payne et al. 2004, Stewart, Cayan and Dettinger 2004, Hidalgo et al. 2009). Increasing temperature trends (Abatzoglou, Rupp and Mote 2014, Sohrabi et al. 2013) create moisture related changes that can exacerbate the strain on the available water supply (Wise 2012). Similarly, changes in the amount and timing of streamflow (Luce and Holden 2009, Mote 2003, Rauscher et al. 2008, Elsner et al. 2010, Stewart et al. 2004 2012), and declining mountain snowpack storage (Luce et al., 2013; Lute et al., 2015) are indicators the state could experience more severe drought risk than in the past (Sohrabi et al., 2013; Wilhite and Glantz, 1985; Diffenbaugh et al., 2014; Williams et al., 2015, Trenberth et al., 2013).

While current management reflects economic needs, the changing hydrograph will require changes in management (Dettinger et al., 2015). As climate change impacts and natural variability continue to impact Idaho's potential for increased drought severity, the state's adaptive capacity is low (Pulwarty and Redmond 1997) because it does not have a proactive plan for water shortage (IDWR, 2001; Wilhite, 1997). The projected hydrologic changes will demand tradeoffs between water management for specific uses in the state (i.e. irrigation, hydropower, flood control, and aquatic ecosystems) (Kunkel et al., 2013; Isaak et al., 2012). The multiple indices of drought coupled with natural variability need to be better understood in order to plan for effective water resource management (Gamble et al., 2003). Understanding future drought impacts allows for coordinated efforts to increase capacity to affect Idaho's agriculture and forest industry (Littell et al. 2010, Qualls et al. 2013), and recreation and energy availability (Hamlet et al., 2010) in order to improve water resource management resilience (Callahan et al., 1999).

Previous studies focus on the effects or impacts of climate change on water resources in the region (e.g. the Pacific Northwest (Adam, et al., 2015), the Columbia River Basin (Hamlet and Lettenmaier, 1999; Miles, et al., 2000), as well as statewide impacts (Pan et al., 2011). Several studies have looked at mitigating effects of climate change on water resources in the region (Payne, et al., 2004), assessing the adaptive capacity strictly from the biophysical perspective (Hamlet 2011), or including the social components into increasing adaptive capacity (Lambert, et al., 2010). However, far fewer have studied the combination of climate change impacts and water resource management as necessary for drought planning (Anderson, et al., 2008).

There remains a need for understanding water management in terms of water rights and policy alternatives (Tarlock, 2012, Dalton et al., 2013). Most statewide research topics addressing the nexus of climate change impacts and projections with water availability and drought have been done in water thirsty states like Nevada, Arizona and California (e.g.

Brekke, et al., 2009; Anderson, et al., 2008). Climate change impacts are projected to amplify droughts in the future (Burke 2011, Cook et al. 2014, Dai 2011, Dai 2013).

Resilience through Adaptive Planning

Like the definitional foundations that preceded them, many resilience plans are based on rigid, static and unchanging premises in order to achieve measurable and preferred outcomes (Arnold 2010a). Since adaptation is a response to change (Nelson, Adger and Brown 2007) and adaptive planning is a deliberate step in preparation for a perturbation it is a logical connection to see how Adaptive Governance, Management and Planning address these necessary changes. Similarly, these measures enhance adaptive capacity in preparation for adaptation. The adaptive strategies that can address future climate uncertainties while still planning for adaptability to natural hazards can be seen through the framework of Adaptive Governance (Cosens and Gunderson 2018). Robin Craig (Craig) argues that American environmental law and policy are not keeping up with the need for adaptation, with goals and assumptions based in ecological stationarity. She concludes that, as such, environmental law and policy are unfit for "a world of continual, unpredictable, and nonlinear transformations of complex ecosystems – but that is the world that climate change is creating"(Craig 2010).

Adaptive Management has its roots in Holling's resilience theory (Holling 1978) and is primarily concerned with the management of uncertainty (Lee 2001). Adaptive Management utilizes processed-based learning or "structured experimentation" to best manage uncertainty (Huitema et al. 2009). Lee identified this experimental learning as being moved to the policy arena, calling adaptive management the "implementing of policies as experiments".

Theoretically, utilizing the outcome of experiments seems like an ideal way to continue to assess the successes or failures of a management strategy. This aspect of Adaptive Management is the proactive means of learning by doing (Holling 1978). However, in the real world, resource managers are rarely authorized to experiment, monitor and adjust. The essence of what differentiates Adaptive Management from conventional management is the experimentation phase that implies examination of the system to be managed, monitoring its response, and adjusting interventions based on reiterative feedback (Huitema et al. 2009). Unexpected outcomes in this type of management are not seen as failures but as learning opportunities.

The emphasis on failures as opportunities for learning is seen through the continual ability to improve management policies and practices with each lesson learned from operational activities. This is in contrast to Adaptive Governance, which isn't focused on the day-to-day management or iterative management policies, but the larger and over-arching institutional structures. For example, when addressing their concern for Adaptive Governance in Adaptive Governance and Water Conflicts, the authors recognize their concerns are parallel with those of Adaptive Management in dealing with techniques to deal with scientific uncertainties, yet qualify that they extend that uncertainty to human institutions as well as the natural system (Scholz and Stiftel).

Adaptive Planning measures include management actions, the implementations of plans and experiments as happening simultaneously, the monitoring of management actions, and learning by doing (Kato and Ahern). Adaptive plans need to be flexible, contemplate uncertainty, and include reiterative feedback into planning stages (Arnold). The inherent community engagement of Adaptive Planning has been recognized as a means of reducing vulnerability to future change (Abramovitz et al. 2001, Tompkins and Adger 2004)

Throughout the different adaptive strategies runs a theme of flexibility - whether this is in the ability to have reiterative processes, allowing what constitutes knowledge to change or malleability in experimentation and implementation. It is through this process that policy can be revised with new information (i.e. climate science) and have the necessary capacity to confront variables that have historically been challenged by change (Olsson et al. 2006, Brunner 2005, Webster 2009).

Planning and Perception

When compared with the rest of Americans, Idahoans are less concerned about climate change (King et al. 2015). Idaho ranchers and farmers report experiencing some of the many impacts of climate change – yet they do not attribute these trends to climate change or anthropogenic forcings (Running, Burke and Shipley 2016 2014) This may be explained by the political leanings of most Idahoans, as conservative political ideologies are consistently predictors of skepticism in climate science (McCright and Dunlap). Similarly, farmers specifically tend to distrust sources of information regarding climate change (Arbuckle Jr, Morton and Hobbs 2015 2013). Research has found that individuals trust scientists who are like-minded and share similar cultural belief systems (Kahan et al. 2011).

Agenda setting theories can serve as helpful frameworks to analyze certain issues, explore how they are able to come to the forefront of attention (of the public, policy entrepreneurs, or policymakers), and continue the momentum to find a solution to the issue in the form of a policy enacted (Howlett, Ramesh and Perl 2009). The agenda setting literature provides an avenue to explain the unique patterns that issues often follow prior to achieving necessary notice and governmental consideration.

An agenda has been seen broadly in the policy literature as a set of issues that fall within the range of the polity (Cobb and Elder 1983). Those issues have been identified equally as broadly as whatever subject matter is in contention (Lang 1981). Dearing and Rogers (Dearing and Rogers) noted that it is this contention, or two-sidedness, that is important to understanding how an issue climbs to the top of an agenda. It is the potentially conflicting nature of the issue that helps it gain attention through proponents, opponents and the public battles that the media covers (Cobb and Elder 1983, Dearing and Rogers 1996). The media's amount of news coverage has been shown to affect public opinion, as seen through McCombs and Shaw's groundbreaking look at media content correlating with the public's perception and voting results of the 1968 presidential election (McCOMBS and SHAW 1972, Weaver

2007). Similarly, the media is able to affect salience of an issue through its frequent reporting and repeated messaging (Liu, Lindquist and Vedlitz 2011, McCOMBS and SHAW 1972).

While much of the agenda setting literature since the 1970s has looked at the correlation between news coverage (content and frequency) and the public's perception (through polls and voting results), another important component to agenda setting is not just its influence on the public agenda, but on the political agenda as well (Weaver, McCombs and Shaw 2004). While there have been a plethora of studies focusing on who and what sets the media's agenda (Weaver et al. 2004, Lang 1981, McCombs 2018), Dearing and Rogers (1996) distinguished an additional category of the media agenda as influencing how the media portrays certain subjects. Another interesting component of the agenda setting literature is how this information is portrayed or "framed" within the media (Weaver et al., 1975; Tankard et al., 1991; Gamson, 1992; McCombs, Shaw and Weaver, 1997). For our purposes here, we are concerned with policy agenda and the studies of the media's impact on those agendas.

Iyengar (Iyengar and Simon) identifies two types of news frames that generally cover all types of US media: episodic and thematic. The episodic content is framed through discrete events or individuals, and therefore resonates on a more individual and emotional level. Similarly, the type of episodic framing described by Iyengar can trigger emotional responses that influence public opinion (Aarøe 2011). The thematic framing focuses more on statistics, analytics and less on personal context (Papacharissi and de Fatima Oliveira 2008, Iyengar and Simon 1993).

The idea that the media can set public or policy agendas has made it an important area of research in both the communication fields and political science arenas (Weaver 2007).

> *"On a national and even a state level, the impacts to agriculture and urban areas from the California drought were relatively small, but the drought was newsworthy for years and played a significant role in the passage of new state and new federal laws.*

> *Observations of droughts in the 1980's suggest that turmoil will be greater when the losses are felt more personally and when long term entitlements to water use are threatened." (ACOE 1994)*

While it has been recognized that looking at the influence on policy agendas is more complex due to the role of political actors (Dearing and Rogers, 1986; Weaver, 2007), the agenda setting literature is rich with examination of policy implications (Ostrom 1986, Schneider and Ingram 1993, Protess and McCombs 2016, Baumgartner and Jones 1991 1993). In order for a public issue to be considered in the public policy process, policy elites must be alerted to the issue (Cobb and Elder, 1983; Baumgartner and Jones, 1993; Jones and Baumgartner, 2005). This often happens through the media's coverage of an issue. However, in agenda setting literature policy elites can be made aware of an issue through several avenues such as problem indicators, focusing events, and information feedback (Kingdon 1995, Liu et al. 2011).

These issue attention identifiers have been associated with social significance, policy elite's ideologies, political conflicts and issue attention cycles (Liu et al., 2011). For example, Anthony Downs chose to look at the 'Shaping Of American Attitudes Toward Improving The Quality Of Our Environment' as the case study for his "Issue-Attention Cycle" in 1972. Downs' Issue Attention Cycle walks through a five part process where (1) an issue quickly gains awareness as a problem that needs to be addressed through government action (2) this momentum leads to enthusiasm to address the issue until (3) there is recognition of the actual costs of doing so, so that there is an eventual (4) decline of public interest and (5) the reality of other pressing issues coming to the forefront that then causes the original issue to lose traction. The problem, though still needing to be addressed, fades from public attention until the cycle starts over again when another issue is identified (Downs 1972). Downs identifies a problem as quickly gaining awareness through a crisis or some other dramatic series of events. This sudden attention to a particular issue is a key component of the agenda setting literature and also referred to as a focusing event. Understanding why the slow-onset hazard of drought isn't able to garner the attention of policy makers in the state like other natural hazards, such as fast acting floods or landslides, is imperative to getting drought on the agendas of policy elites.

Policy as seen through Agenda Setting

Planning for water resource management is something Idahoans have been doing for centuries. Since the first water use customary laws of prior appropriation were formed, Idahoans recognized that the western U.S. needed more accommodating regulations (with an average precipitation of 5-15 inches annually) than the riparian laws of the eastern U.S. (with an average of 35-60 inches of precipitation) and adapted to the arid environment accordingly. In order to be productive and have a growing economy, Idaho communities needed to divert water from streams rather than rely on rainfall. The simple act of doing this, diverting water and putting it to a beneficial use, gave them a common law water right. Management of these rights is referred to as "first in time, first in right" giving prior appropriators access to their full allocation in times of scarcity (the amount needed for reasonable use) with junior users only able to divert water if it doesn't affect the senior's allocation.

This 19^{th} century regulation of prior appropriation has served Idahoans well, but adapting to projected water resources changes, while recognizing the significant challenges in the 21^{st} century, is something Idaho has yet to accomplish. It was even on the agenda of legislators in the state to remove all mention of not only climate change from core science curricula, but other references to weather and climate models (Corbin 2017). Even though the Idaho State Water Plan (Board) addresses indicators of climate change, the term "climate change" was not allowed in the writing of the document. Instead, the term "climate variability" was deemed acceptable (Musgrove 2016)

The important difference in the terminology of climate change versus climate variability is that climate change refers to the overwhelming scientific evidence that the globe is warming due to anthropogenic forcings (Allen et al. 2014) and climate variability is categorized by variations in climatic events that happened before the industrial revolution and will continue to occur regardless of human actions, such as El Nino Southern Oscillation (ENSO) events and the Pacific Decadal Oscillation (PDO) (Hamlet and Lettenmaier 1999). It is interesting to note this distinction in Idaho state water planning since both the 2012 State Water Plan and the 2001 State Drought Plan do not mention projected "climate changes", but have the sole purpose of containing plans and procedures to deal with the hydrologic impacts (coupled with climate variability) based on scientific information such as: climatological data, snow surveys, gauging stations and streamflow forecasts (IDWR 2001), all of which have been and will continue to reflect a warming climate (Dalton et al. 2013).

Surprisingly, for lack of reference to "climate change" impacts, the Idaho State Water Plan does address the increased precipitation "in the form of rain and fewer, but more intense, storm events are expected to result in more severe droughts and greater flooding" concluding that water resource managers "must evaluate and plan for these possibilities" (p. 40). Unfortunately, the will to take action stops there. Idaho is not alone in this reluctance; with a few exceptions, government response to the shortages caused by lack of precipitation has been to react rather than adopt an approach that can proactively minimize drought impacts (Walker 1991)

The Idaho State Water Plan suggests that increased monitoring take place and that an "initial vulnerability analysis for watersheds" be conducted, but the list of "milestones" for what has been accomplished to date (as well as the "implementation strategies" of what still remains to be done) do not address any further planning for drought. One bullet point in the implementation strategies does seem to allude to possible future drought planning: "Identify and implement adaptive mechanisms to address the impact of climate variability on water supplies" (p.41).

According to the National Drought Mitigation Center Idaho's drought plan is considered "response based" which is defined as a plan that focuses on the "short-term" threat of drought and has plans for drought monitoring, expected impacts, responding agencies and the triggers that will incite action. However, "actions, programs, or policies intended to increase preparedness before a drought occurs (mitigation) are not discussed within the plan" (NDMC 2016).

These omissions need to be better understood in order to plan for effective drought management in the future (Gamble et al. 2013) and for coordinated efforts to increase capacity (Hamlet et al. 2013). Understanding how and why Idaho's plans do or do not contain certain language and do or do not become state sanctioned documents, policies or procedures can be understood by John Kingdon's "policy primeval soup" (Kingdon and Agendas 2011). Kingdon argues that the issues that surface to the top of the primeval soup bowl all adhere to a certain set of criteria which he examined in his 1985 book, Agendas, Alternatives and Public Policies. The book is still the cornerstone of many agenda setting theories as Kingdon laid the foundation for the key roles people and processes play in creating policy change. In addition to needing to be viable to the public and constituents, the issue also needs to be cost effective in both temporal and fiscal terms. However, even all of these factors combined do not necessarily equate to policy change alone.

Contributing to this soup are the roles of actors (either in or out of government), the forces at work influencing them (lobbyists or private interest groups, stakeholders or the public at large), the way an issue is defined (as an issue or a problem or a solution to an issue or a problem) the finite carrying capacity of policy makers (for only a few important issues at a time, all vying for prioritization) combined with the feasibility of an issue's solution (financial, social and political acceptance) all floating in 'broth'. Some ideas surface to the top while others sink to the bottom. The issues that surface may adhere to a set of criteria that his framework explains. Kingdon clarifies that this continual messy process of suggesting proposals, reconsidering, reformulating, and proposing can take years, even decades (p. 116).

With a long-term issue like climate change, there is will be a need for many surfacing issues in this primeval soup to align actionable items for mitigating and/or adapting to climate change and its impacts. Keeping climate change at the fore for policy makers will be critical because climate change is a long term problem and governments, with short term elected officials, are unlikely to 'solve' the climate crisis with one or even multiple enacted policies (Pralle 2009).

To help understand the process behind how something so seemingly important like climate change adaptation does or does not get "on the agenda" in Idaho, I turn to both John Kingdon's and Anthony Downs' approaches within the agenda setting literature. Unlike some of the other agenda setting models, these two in particular have utilized the example of environmental issues is their modeling, allowing room for analyzing long-term, not easily visible, sustaining issues rather than short-term, highly visible issues.

Kingdon's multiple streams framework shows how policy change can occur when three independent process 'streams' come together to create a 'window of opportunity' for the policy to pass. While it is possible that certain policy change can occur when only one or two process streams come together, it is most likely to occur with the combination of the three: problem stream, policy stream, and political stream.

The problem stream or problem recognition, in the case of planning for drought, is how the issue is brought to the attention of people in and around government. In Idaho this could be the experience of an extended drought that affected a variety of sectors - significant enough to grab the attention of decision makers (a 'focusing event'), or it could be an uproar from citizens about not having enough disaster relief post drought ('feedback from current program or policy'). An example of this can be taken directly from the 2001 Idaho Drought Plan where it clearly attributes action for planning to a focusing event clarifying that "state, federal and local agencies directed considerable effort toward drought planning and assistance as a result of the 1977 drought. Valuable information was collected, many water supply problems were addressed, and drought response procedures were developed"(IDWR 2001).

The policy stream "resembles the process of biological natural selection" in that only the 'best' survive. In the case of best policies proposed, they need to be feasible: technically, socially (fits dominant values) and financially (can work within the current budgetary framework).

The political stream refers to the dominant political mood. Kingdon refers to this in his work as the 'national mood', the amount of turnover in the legislative branches, and the role of special interest groups and pressure campaigns. The same method can easily help outline why some states, like California for example, are able to pass adaptation legislation due to the dovetailing of all three streams, whereas in Idaho, it can be argued that the policy generation and the political stream do not have fitting issues. One crucial component of both streams is 'fitting the mood' of the public. Even if a policy maker wanted to act on climate change impacts as seen through extended drought, would doing so risk his/her political career?

The Yale Program on Climate Change Communication estimates that only 58% of Idahoans think global warming is happening. An even fewer number of citizens in Idaho are worried about global warming (48%) and even fewer yet feel global warming will affect them personally (32%) (Leiserowitz et al. 2010). These statistics have improved since reported in 2014 but they still do not create a welcoming mood for time and energy to pass policy that is proactive against something that most residents do not believe is affecting them. Similarly, the power of interest groups at play in Idaho is likely not a good fit for climate change policy endorsement.

By utilizing Kingdon's model on agenda setting for drought planning in Idaho one can recognize that there is a challenge with the first stream or problem recognition phase in that many actors (in and around government – in a visible cluster of actors or not) do not see drought as a problem that necessarily needs a solution. Since drought is not defined as an impact of climate change, but a process of climate variability, having a fifteen-year-old Idaho State Drought Plan with recommendations for how to best receive federal aid post disaster must be seen as inadequate. This lack of clarity in accurately defining a drought can actually exacerbate the problem.

Anthony Downs chose to look at the 'shaping of American attitudes toward improving the quality of our environment' as the case study for his "issue-attention cycle" in 1972. Like Kingdon, Downs recognized stages that issues had to go through to generate enough political pressure to affect change. He also describes his methodology through the national issue lens, but it is possible to correlate these national environmental issue stages and characteristics to the state level to shed light on why state policymakers in Idaho are not planning more aggressively for drought.

Downs recognized that not all issues go through his five-part cycle, but the example of environmental issues do, which is why I selected it as the second model to look more closely at planning for climate change in Idaho. Before examining the five stages an issue goes through, it is important to note the characteristics of issues that Downs describes as being the best fit for his framework.

The first characteristic is that the issue is not a concern of the majority. The problem is generated by current social arrangements that a majority of people benefit from. Again, this is most certainly the case with drought as an impact of climate change since climate change is caused by an increase in CO2 which is primarily emitted from the burning of fossil fuels. It is this recognition (that climate change is anthropogenic) that is the subject of debate in Idaho (with only 44% of residents who think that global warming is mostly caused by human activities Leiserowitz et al., 2014) more so than the fact that many residents are already experiencing impacts of climate change (Klos et al. 2015).

The second characteristic is “sustained attention and effort, plus fundamental changes in social institutions or behavior” (Downs 1972). Not only does solving the problem require these changes, but in the particular case of drought it is imperative that the impacts of drought are clearly understood in order to accurately monitor and respond to droughts. To manage drought “you have to monitor impacts and understand vulnerabilities of the consequences of those impacts” (National Drought Resilience Partnership 2017).

The third characteristic of a problem that goes through all of Downs’ issue-attention cycle stages is that it has no intrinsically exciting qualities. Outside of the scenario of reporting at the end of a very serious long-term drought, with photos of broken and dried soil near a dried riverbed, there really is nothing “exciting” to report about drought. It has often been said that we do not know we are in a drought until the near end of it (Wilhite 2005). And this is certainly one of the great challenges of defining and depicting drought in relation to other natural hazards. Droughts can last for a long period of time relative to other natural disasters such as floods or earthquakes – but are short relative to climate change. There are multiple types of drought: meteorological, agricultural, hydrological, and socioeconomic and political (Wilhite 2005). The impacts of drought are difficult to quantify as they often have a much longer lag time than other natural disasters. The social impacts of drought are difficult to quantify since so often the water shortages affect agriculture and farming. We can quantify the cost of a house destroyed in a fire, but it is more difficult to quantify the cost of a farm unable to grow, sell and distribute a crop for multiple growing seasons. According to the National Drought Preparedness website, “from 1980-2000, major droughts and heat waves within the U.S. alone resulted in costs exceeding $100 billion. In 2012, approximately two-thirds of the continental U.S. was affected by chronic drought. Severe droughts are projected for the next several decades, impacting the nation’s communities and economy” (National Drought Resilience Partnership 2017).

In summary of the characteristics of issues in Downs' issue-attention cycle, he notes that we should not "underestimate the American public's capacity to become bored – especially with something that does not immediately threaten them, promise huge benefits for a majority, or strongly appeal to their sense of injustice" (Downs 1972).

Unfortunately, planning ahead for action to address the uncertainty of drought threat seems to fit this profile quite well. The stages the issue of water or drought management in Idaho has to go through according to Downs are the pre-problem stage, alarmed discovery and euphoric enthusiasm, realizing the costs stage, gradual decline of intense public interest and finally, the post-problem stage.

In the pre-problem stage most people aren't aware of the issue. This could be synonymous with Kingdon's initial problem stream when the issue is being brought to the attention of people in and around government. It is the 'less visible cluster' of actors who are already aware of the issue in Kingdon's model and in Downs' analysis it is the experts, scientists and actors in public interest groups who are already aware of the severity of the issue. The alarmed discovery and euphoric enthusiasm stage is where the public is now made aware of the severity of the problem and they express alarm as well as the desire to act to solve the problem quickly (via the silver bullet solution or "single action-bias").

Downs' "realizing the costs" stage is especially pertinent to the role of drought and climate change policy planning in Idaho since it is very difficult to quantify, and the impacts are very difficult to single out. Not only does this make it less feasible to fit into a fiscal budget, but a time and commitment budget as well - equating to disillusionment on the part of finding a solution. An example of this can be seen in the initial creation of drought planning in Idaho. The authors of the Idaho State Drought Plan attributed "effort toward drought planning" where "problems were addressed" and "procedures were developed" as a result of the 1977 drought. However, even with all of this momentum, the authors reveal that "an important item not completed in 1977, though, was the production of a "Drought Plan"". That was not accomplished until over a decade later in 1990. The state revised the plan twice since then in 1995 and this most recent draft in 2001. The authors state that the revisions are "reflective on continuing drought conditions and ongoing efforts to find viable responses to problems resulting from drought". (IDWR 2001)

This statement is cause for pause for several reasons: 1) the Idaho State Drought Plan was written in 2001 with much of the state having experienced "severe drought for as many as 7 consecutive years" (Wilhite 2006) so that focusing event was not enough to create change as seen through an updated drought plan, 2) the Idaho State Water plan states that a main goal of that document is to assist "water managers, planners, and users formulate management strategies and policies needed to meet growing changing water use needs (Board 2012) but there was no parallel action with the decade older drought plan even though it is recognized that drought severity would increase, and 3) in the state's webpage on "20 years of Idaho's Disasters" drought isn't even mentioned in the 1976-1996 disaster summary. However, Idaho has certainly experienced the disaster of drought. Since 2000 the state of Idaho has announced 149 drought declarations. The drought declarations are made by county and are typically signed in the summer months. A drought declaration has been signed in Idaho every year since 2002 save, 2006, 2009 and 2011 (Division). In 2005, 99% of the state was in a drought and in 2015 all of Idaho was in a drought according the Idaho State Drought Monitor Report.

These overlaying factors of attention not necessarily given to the impacts of drought could be seen through the lens of Downs' agenda setting theory of issue-attention cycle at the third and fourth stages, or the following stage of waning interest in an issue that just simply can't keep the attention of the public. It also reflects the reality that thus far current water measures such as water banks have been enough for adaptation to the types of drought we have thus far been experiencing.

Finally, the post-problem stage reflects the point at which a different problem has already replaced the issue. Politicians, like the rest of us have a "finite pool of worry" that only has enough carrying capacity for several major issues at a time. When very pressing issues hit "closer" to home then the other issues inevitably fall by the wayside.

Despite the discouraging path the potential policy of adaptive drought management seems to take through both Kingdon's and Downs' models in agenda setting theory, there is still the possibility that the three streams may align to create a window of policy opportunity, that a focusing event may motivate action, or that a policy entrepreneur may spearhead the process.

Research Questions

As described in the first section of this chapter, the overall objective of this research is to examine issues at the boundaries of the physical, legal and policy aspects of drought planning and response, following the tradition of geographic study of humans and their interaction with the landscape.

In Chapter 2, this research aims to identify and separate the various physical and social drivers for drought declarations at the county level. Through comparative analysis of a climatological drought metric, the Palmer Drought Severity Index (PDSI) and county-level drought declarations for the last 17 years, the following research questions are addressed: 1) What are the spatial and temporal patterns of drought declarations in a large, managed irrigated system in the U.S.? 2) How do these patterns correlate with a standard drought index, PDSI? and 3) When patterns of social response, seen through drought declarations, deviate from PDSI drought metrics, what are other possible drivers motivating the drought declaration or lack thereof?

Drought declarations in Idaho allow for an expedited temporary water transfer process, often providing the much-needed alternative to resolve water shortage issues outside of litigation.

To better understand some of the possible drivers of declaring drought, when one may not have been evident through the drought metric, an adaptive planning framework was applied to the legal application of water law in Idaho. The western doctrine of prior appropriation creates a property right to use of water while retaining state ownership. Historically, much of the flexibility in water law has been provided through the private property prong by allowing individuals to transfer (market) water and through the public prong by state and federal development of new water resources. Many state water-planning activities address this later aspect, i.e. the planning needed to meet growing demand.

In Chapter 3, in order to better understand how the integral facets of the Adaptive Governance in a more resilient system, this research looks to the key features of Adaptive Planning and compares them to a case study in southern Idaho. Using the lens of adaptive planning to look at the historic water agreement between ground and surface water users in an already over-allocated semi-arid region, can one illuminate areas of success and room for improvement in adaptive planning?

While law has room for adaptability, drought planning must be on the agenda of policy makers in order to advance. Borrowing from the agenda setting literature within political science, in Chapter 4 this research examines the process of state level drought policy. A window of opportunity opens for policy change when a set of criteria is met. This study demonstrates how the slow onset hazard of drought resists classic policy analysis due to its unique characteristics set within Idaho's unique demographic. The dissertation concludes with a summary of research findings and recommendations for future work (Chapter 5).

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Chapter 2 : Examination of Palmer Drought Severity Index as It Correlates with Drought Declarations for Temporary Water Transfers in Irrigated Agriculture

Abstract

Drought has been declared through the Governor's office in Idaho nearly 200 times in the past two decades, in 11 of the past 16 years. In Idaho, as of 2001, declaring drought allows for an expedited legal water transfer process at the county level and the ability to move water to an area experiencing or anticipated to experience drought in the already dry summer months of June – August (as seen through Natural Resources Conservation Service and the National Drought Monitor projections). Drought declarations are most evident in regions that experience water scarcity and where economies are water dependent (such as the irrigated agricultural regions). Idaho's agricultural industry is third largest in the western United States (Eborn, Patterson and Taylor 2012). County-level drought declarations were compared against the Palmer Drought Severity Index (PDSI). Results showed that about 60% of county level drought declarations occurred concurrent to moderate to extreme agricultural drought, as measured by PDSI values at or below -2.0, the threshold for "moderate drought". By contrast, the remaining drought declarations did not occur during periods of drought as defined by the PDSI threshold. Our research suggests that drought declarations made in the absence of concurrent drought were the result of drought legacy effects tied to reduced water storage and soil moisture deficits in the preceding years. Combined with policies that allow expedited water transfers in counties that have filed drought declarations, the spatial patterns in drought declarations when the PDSI is above the threshold also sheds light on where water shortages occur first in a complex managed system that arises from a combination of a hydrologic, legal and policy constraints on water use.

Introduction

Climate change impacts are being felt globally (Reichstein et al. 2013, Allen et al. 2014) and over the last century, the inland northwest region of the US has been experiencing a trend of average temperature increase that reflects the overall global warming increase of about 0.8°

Celsius (Abatzoglou et al. 2014a, Santos, Rao and Olinda 2015). In the inland portions of the region, which are snowmelt and mix rain-snow dominated (Luce et al. 2013; Hamlet and Lettenmaier, 2007; Hamlet 2013), the impacts of climate change has been and will continue to be experienced most through the changing water resource availability (Mote et al. 2003; Hamlet 2011; Regonda et al., 2005). This is especially important to multi-faceted water dependent economic sectors including irrigated agricultural production (Howden et al. 2007).

Nationally, the average value of agricultural products sold per-farm in 2012 was $187,097, yet the average value for irrigated farms was nearly 2.7 times higher, at $514,412 (Schaible and Aillery 2017). Irrigated agricultural production in the northwestern U.S. consists of about 27,000 square meters (NASS 2012). Idaho sustains about half of all irrigated acreage in the Pacific Northwest at nearly 3 million irrigated acres, most of which lie along the Snake River Plain (Qualls 2013). The Snake River is the Columbia River's largest tributary as well as a vital source of irrigation water for crops in the semi-arid region of southern Idaho. The heterogeneous vegetation and complex topography typical of mountainous watersheds can create variability for both spatial and temporal examination of snowmelt trends (Marks and Winstral 2001). Idaho is a mountainous state with watersheds that are historically a snow dominant and mixed rain-snow region characterized by peak runoff that lags behind peak precipitation. Mountain snowpack is the most vital part of the annual water supply for many northwest watersheds (Graves 2009, Luce 2018, Cayan et al. 2016), and the lag in runoff provides an essential part of water supply relied on in warmer months. In this snow-melt dominated region, irrigators rely on a combination of surface water and groundwater. Of the approximately 830 billion cubic feet per second (cfs), or 19 million acre feet (AF), seventy five percent is surface water primarily from the Snake River (Qualls 2013). The headwaters of the Snake originate in Yellowstone and Teton National Parks. The ~6,000 cfs, or (4.3 million AF), from groundwater is sourced from the eastern Snake Plain Aquifer made up of dense basalt flows and heavily woven sediments (Link and Mink 2002), making it extremely permeable, and one of the largest and most prolific aquifers in the nation.

Agriculture accounts for more than 90% of consumptive water use in the western US (Maupin et al. 2014). Idaho, Texas and California consistently rank in the top three western states for irrigated agriculture water use (Kenny et al. 2009, Maupin et al. 2014). In Idaho, irrigation used for the 3.4 million acres of agriculture accounts for over 90% of water consumed (Kramber 2012). In highly managed irrigated systems like the Snake River Plain of Idaho modifications to the spatial and temporal movement of water occur through water storage, release, and diversions. Water availability significantly affects agricultural vulnerability (Schlenker, Hanemann and Fisher 2007) and while the economic impacts of droughts can be considerable in agricultural economies (Harou et al. 2010) irrigated agricultural systems are somewhat able to adapt to water shortages through increasing the supply or decreasing the demand (Mehta et al. 2013).

This research focuses on the irrigated agricultural system of the Snake River Plain, which depends on the conjunctively managed resources of both ground and surface water (IDAPA 37, Title 03, Chapter 11(37.03.11), Title 67 of IDAPA and I.C. Section 42-603). The state's conjunctive management rules address how one source affects another, though there remain some gaps in understanding the complexity of those relationships over space and time. To mitigate impacts of water shortage from loss of one source in a conjunctively managed system, Idaho allows for expedited transfer of water or temporary changes to places of use for a given water right. Those water rights must be surface water rights as per state code (Section 42-240) and therefore often benefit more "senior" water rights holders, as they were first to put surface water to beneficial use in the hierarchy of prior appropriation. This is made possible through a county-level drought declaration.

Identifying when counties declare drought in order to take advantage of this adaptation measure can demonstrate the physical and/or legal factors that may be addressed in order to manage water resources most effectively. To understand the spatial and temporal patterns of responses to drought conditions in irrigated agricultural systems, this paper looks to the history of drought declarations in the semi arid state of Idaho and the corresponding biophysical drought conditions as measured through the Palmer Drought Severity Index (PDSI). This research is the first to compare county level drought declarations as they correspond with a standard drought index in a state with a major irrigated agricultural system. In doing so we are able to address two main research questions: First, what are the spatial and temporal patterns of drought declarations in managed irrigated systems as seen through one of the most prolific system in the U.S.? Secondly, how do these patterns correlate with a standard drought index, PDSI?

Study Area – Physical and Legal Considerations

1. Physical Characteristics and Sensitivity to Drought

While we are looking at the entire state of Idaho for regulations to legal and political boundaries for water rights, allocations, and transfers, a majority of the research focuses on the semi-arid region of the state in south central Idaho for its prolific agricultural yields. This productivity is due to proximity to the Snake River and the Eastern Snake Plain Aquifer (ESPA).

Figure 2-1: Map at left of Idaho in the Pacific Northwestern U.S. and at right of the Eastern Snake Plain Aquifer (ESPA) in southern Idaho. The three main stretches of the Snake River are above American Falls, American Falls to King Hill and below King Hill.

The ESPA underlies 26,000km^2 of the heavily irrigated portion of southeastern Idaho (Cosgrove, Johnson and Tuthill 2008). The Snake River Basin is made up of three river reaches: above American Falls, American Falls to King Hill, and below King Hill (Figure 2-1).

The reach above American Falls contributes more than 40% of the Snake's natural flow to irrigation. The middle reach from American Falls to King Hill has allocated 30% of the basin flow to irrigation water. And lastly, the lower reach, below King Hill, is not considered as contributing much to irrigated agriculture in the region (Qualls et al. 2013).

The peak runoff of snowmelt in northwest streams is therefore shifting (Rauscher et al. 2008) and occurring about a month earlier than the historical average (Dudley et al. 2017, Jones, Muhlfeld and Marshall 2017). These impacts can result in high stream flows earlier in the year and lower surface water availability when water resource managers need it most (Creighton et al. 2015) to meet the needs for irrigated agriculture (Pathak, Kalra and Ahmad 2017, Malek et al. 2017, McNabb 2017) which is a sector inherently sensitive to climatic changes (Vano et al. 2010).

At the same time, rising temperatures in the region (Abatzoglou et al. 2014b, Sohrabi et al. 2013) lead to increased evapotranspiration (ET) rates during the growing season, (Han, Benner and Flores 2018) which increases demand for irrigation water (Santos et al. 2015). These physical changes in the region are coupled with social stressors such as high annual population growth (0.89% growth rate annually for Idaho; World Population Review, 2015) and increased demand for municipal water uses (Atlas 2018).

These physical changes are all indicators the state will likely experience more severe water shortages than in the past (Sohrabi et al., 2013). In fact, most arid western communities experiencing these impacts may see an increase of drought occurrence (Overpeck 2013, Dai 2013, Abatzoglou and Rupp 2017b) drought severity (Peterson et al. 2013, Luce et al. 2016, Crockett and Westerling 2018) as well as increased sensitivity to future warming (Rieman and Isaak 2010, Qualls 2013). Future drying projections will have a higher level of aridity and drought intensities (Ficklin et al. 2016) than even the most severe megadroughts of the previous millennium (Cook, Ault and Smerdon 2015).

In summary, climate change will exacerbate drought stress in Idaho (Santos et al. 2015) and this additional strain on Idaho's water resources will require strategic water management practices (Creighton et al. 2015, Wilhite, Sivakumar and Pulwarty 2014).

2. Legal considerations due to water right regulations

The history of western water law is uniquely tied to climate in the system of prior appropriation (Kirchhoff and Dilling 2016, Leonard and Libecap 2016). Idaho is among those states that follows "first in time, first in right" doctrine for both ground and surface water (Idaho Constitution Art. XV §3, Idaho Code §42-106).

Although surface water diversion comprises a significant source for irrigation in the study area, groundwater is withdrawn for agricultural, municipal, and industrial uses through extraction wells to access water located in fractures of rock formations and soil pore spaces. Groundwater is considered to be in an aquifer when a unit of rock or unconsolidated deposit can yield a usable quantity of water (IDWR 2017). Since the mid 1990s it has been legally recognized that groundwater in the Eastern Snake River Plain is rapidly recharged from surface sources, including irrigation water and eventually flows to the surface naturally (i.e. through springs and seeps). Surface and groundwater are considered a shared resource that should be managed as such (IDAP 37.03.11, I.C. 42-605).

As Idaho experiences times of drought, junior water users in the state (often those with rights to groundwater) may be curtailed in using their full water allotment as prior appropriation accommodates the temporal hierarchy of those who first put the water to beneficial use. A senior water right holder can request a water delivery call of a more junior water user under this doctrine (Idaho Code, IDAPA 37.03.11). Curtailment orders can be dealt with in a variety of ways for a surface water user seeking a delivery call of a groundwater user through a mitigation plan (CMR 43). The Conjunctive Management Rules (CMRs) provide a device to ensure efforts to improve efficiency by requiring the senior water right holder to show material injury of reasonable use before the call can go forward. Material injury factors include efficiency improvements if feasible. Once a mitigation plan is in place, the Director of the Idaho Department of Water Resources, through the watermaster, can regulate the diversion, transfer and use of water or allow the out-of-priority diversion to continue. Prior appropriation doesn’t prevent water right transfers, but the costs associated with such transfers often can preclude the exchange of water (Smith 2012).

For example, since 2000, ground water users in the Eastern Snake Plain Aquifer (ESPA) area have defended fifteen different delivery calls made by senior right holders. Five of those calls were fully litigated before the Idaho Department of Water Resources, the Snake River Basin Adjudication Court, and the Idaho Supreme Court. In order to avoid curtailment of junior groundwater rights the Idaho Groundwater Appropriators, Inc., (made up of eight groundwater districts and two irrigation districts representing nearly 2,500 water users) secured mitigation plans. These curtailment alternatives involving a wide range of solutions such as water exchanges, groundwater recharge, water delivery and water use reductions. The estimated cost of these mitigation actions is over $65 million (Budge 2015).

In the State of Idaho, as in other western states, most streams and rivers do not provide sustained flow to fully satisfy all water use needs even during good water years; during years of drought, water delivery problems are exacerbated (Tuthill Jr, Rassier and Anderson 2013). In the semi-arid region of southern Idaho do not only occur in years of water shortage. Since water management in the Northwest is based on historical snowmelt and the timing of that snowmelt runoff (Markoff and Cullen 2008, Adam, Hamlet and Lettenmaier 2009, Clifton et al. 2018) the human responses to mitigate the changes in surface water can additionally alter storage allocations (Dalton, Mote and Snover 2013, Qualls 2013). Supplementing the prior appropriation doctrine with well-designed temporary reallocation policies that reduce associated costs could improve economic efficiency during water calls (Elbakidze et al. 2012).

There are several possible responses to drought conditions in irrigated systems, but an important mechanism of mitigation during times of shortage is to transfer water. Under normal circumstances a water right transfer involves an application with IDWR, (including documentation of right, notarized attachments of change of use or diversion, and maps with legal descriptions) a waiting period for public notice and feedback, and an application fee. However, in 2001 the Idaho State Legislature passed a bill by the Resources and Environment Committee, which amended the law to essentially become more adaptable during times of drought.

This adaptability is in the form of a drought declaration made at the county level, allowing all surface water rights holders in that county, and adjacent counties, to have a truncated legal process. The Senate Bill allows for "temporary changes to water rights by transfer or exchange of water during a drought emergency" (Senate Bill no. 1122, 2001).

Idaho has historically experienced severe and long-term drought with the pronounced and chronic droughts during the dust bowl period of the 1920s and 30s. According to the Idaho State Drought Plan, the worst single drought year on record for Idaho was 1977. That drought year was the catalyst for the writing of Idaho's State Drought Plan (IDWR 2001). The climatic conditions in Idaho between 1987 and 1993 in the southwestern part of the state surpassed the Dust Bowl era as the most severe period of drought on record (IDWR 2001) up to that point. Idaho has experienced as many as 7 consecutive years of drought (Wilhite 2006). In 2005, 99% of the state was in a drought and in 2015, 100% of Idaho was in a drought according the United States Drought Monitor Report (NDMC 2016).

Droughts can be defined as meteorological (deficiency in precipitation and/or high evaporative demand), hydrological (deficiency in streamflow and inflow to types of water storage such as reservoirs, lakes or wetlands) and agricultural (deficiency in soil water or plant available water) (Wilhite 2000). In order to quantify drought impacts, we looked to voluntary drought declarations made at the county level in Idaho. These declarations serve as an indicator that water rights holders are being impacted by drought events. Once a county, via the County Commissioners Office, has declared drought, they make a request to IDWR. IDWR then reviews the declarations and sends on to the Governors' office for approval. IDWR drought orders pertain only to the administrative process; they do not apply to disaster support or financial assistance. The only types of water rights that are eligible for those temporary exchanges are surface water rights (section 42-240, Idaho Code). Because of the immediacy of the need, the statute allows for a truncated review by IDWR. According to a memorandum associated with the review process (Saxton 2003) IDWR relies on the recommendation of the local watermaster and the responsibility of the applicant to meet the drought declaration criteria. Whereas, other western states, such as Washington, have a criterion of regular water supply falling below 75% of average before a drought may be declared.

Counties in Idaho have filed 188 drought declarations in our period of study (2001 – 2016). The drought declarations are typically signed in the summer months though declarations following on or more years of drought may declare as early as February. One has been signed in Idaho every year since 2001 save, 2006, 2009 and 2011 (IDWRB 2016).

3. Drought Indices

In order to quantify the hydrometeorologic conditions under which droughts were declared (or not) at the county level during the study period, the Palmer Drought Severity Index (PDSI) was used. The PDSI was created in 1965 to standardize the calculation of relative soil moisture availability, in order to facilitate comparisons across space and time (Palmer 1965). It characterizes the cumulative relative departure of soil moisture to a baseline period using a simplified water balance calculation.

Precipitation, potential evaporation (PET) and soil available water holding capacity (AWC) are the variables used to estimate the soil moisture status. PDSI is the most extensively used drought index since its creation in 1965, having been well tested and verified (Mishra and Singh 2010) and is used commonly throughout the world to quantify observed drought and drought projections (e.g., Dai 2011). While the PDSI has been widely criticized for its lack of including snow into the water balance and other simplicities (Alley 1984, Karl 1985, Werick et al. 1994) it is used here only in the summer months of June, July and August (Pathak et al.), consistent with prior studies (e.g. Cook et al. 2004, Griffin and Anchukaitis 2014). Additionally, it has been shown to have strong correlative relationships with drought impacts including streamflow, wildfire, soil moisture, and drought-related economic losses to agricultural systems (Dai, Trenberth and Qian 2004).

Because water can be managed in irrigated systems, it would not be appropriate to use the PDSI to estimate actual soil moisture conditions in the study area. However, it does provide a good estimate of the hydrometeorological conditions under which water management decisions were being made in irrigated systems, particularly those that rely on surface water supply as it shows significant correlations to interannual streamflow variability in the Pacific Northwest (Abatzoglou et al., 2014). Unlike some drought metrics that only consider precipitation (e.g., standardized precipitation index), PDSI attempts to account for variability in the evaporative demand component, thus incorporating both basic elements of the surface water balance. Similarly, unlike some drought indices that may be better equipped for estimating short-duration drought, PDSI relates best to longer time scales such as between 9 and 12 months (Wang, Rogers and Munroe 2015). In essence, it provides an estimate of the water deficits that had to be made up with irrigation during each of the summer months during the study period.

Methods

1. Datasets

Historical PDSI Values

Gridded values of PDSI for June, July and August for each year of the study period were calculated at 1/24 degree (~4km) spatial resolution. PDSI values were calculated for each grid cell using historical meteorological data from the gridMet data set (Abatzoglou 2013) which incorporates data from the Parameter-elevation Regressions on Independent Slopes Model (PRISM) Group at Oregon State University (http://prism.oregonstate.edu, accessed July 2017) and the Phase 2 of the North American Land Data Assimilation System (NLDAS-2) (Mitchell et al. 2004).

The calculation of PET used in the PDSI water balance estimation can be done using different approaches (Abatzoglou et al. 2014a) including a simple temperature-based approach via the Thornthwaite method (hereafter Thorn-PET; Thornthwaite 1948) and an energy-balance approach via the Penman–Monteith method (hereafter PM-PET; Allen 1998). Thorn-PET is a widely used empirical transformation that only requires monthly-mean temperature and latitude. This contrasts with PM-PET, which is an energy-balance approach requiring temperature, latitude, elevation, wind speed, radiation, albedo, and vapor pressure deficit. Utilization of more complex measurements for PET has not been shown to dramatically influence time series of PDSI over the historical record (Dai 2011, Dai 2010), but may be more relevant for applying climate change scenarios. The method used here for PET was the Penman-Monteith equation for short-grass (Allen 1998).

Soil available water capacity (AWC) in the top 250-cm of the soil was used in the PDSI calculations. Soil AWC data was extracted from the State Soil Geographic Database (STATSGO) at a 1-km resolution and was interpolated to the resolution of the 4km grid cells of the climatic data as in Abatzoglou et al (2017a). Gridded values of PDSI were spatially aggregated to the county level as the average value of the 4km grid cells in each county.

Drought Declarations

Drought declarations made at the county level are submitted to the Idaho Department of Water Resources (IDWR). The county declarations are reviewed and IDWR staff often include supplemental information before the declaration is then sent to the Idaho Governor's office. Once approved, a drought order is issued by the state. The drought declaration and order data are compiled by IDWR and updated on an annual basis.

Water Rights

Water Right information was obtained from the IDWR database for both the rights where water is used, called “place of use” (POU), and where the water comes from, or “points of diversion” (POD). The POU is the legal location where a water right can be used and is described by IDWR in quarter-quarter sections down to a 40-acre tract (IDWR 2017). A quarter-quarter section is part of the Quarter Section delineation of the Public Land Survey System (Interior 2018) and is the equivalent to 1/16 of one square mile (40 acres). Four quarter-quarter sections are within every land parcel. The diversion structure for PODs divert the water from its natural source (i.e. a river, well, canal, etc.) and is necessary to establish a water right. Typical diversions are: head gates, pumps, ditches, dams, or a combination of several diversions. A POD is also described in quarter-quarter sections.

Temporary Water Rights Transfers and Water Delivery Systems

Water Right Transfer Data was obtained from the most recent (revised 2/29/2016) statewide database from IDWR. Information on basin, type of water right changes, applicant, county, source, total cfs diversion rate, expiration date, water right numbers and receipt numbers were available. Total water transfers per year or per county extrapolated. Water delivery systems spatial data were obtained from IDWR via ArcMap and focused on surface water districts and Irrigation organizations. These spatial data were mapped in ArcGIS.

2. Data Analysis

Thresholds of PDSI are typically used to identify severity classes of drought. Usually, PDSI values of -2.0 to -2.99 are classified as moderate drought, -3.0 to -3.99 as severe drought and -4.0 or less as extreme drought. For the purposes of this research, we are concerned with impacts associated with drought occurrences, which are not often experienced during mild drought conditions and therefor have chosen the threshold of <-2.0 PDSI. While the PDSI values were aggregated and calculated monthly, we limited the analysis to average summer (Pathak et al.) PDSI values that correlate well with summer soil moisture (Dai et al. 2004).

Drought declaration data were mapped to give a spatial representation of the distribution of a) cumulative drought declarations by county b) when those declarations occurred when concurrent PDSI <= -2.0, and c) when the declarations occurred when PDSI > -2.0. We additionally considered PDSI conditions one and two years prior to drought declarations. Mean PDSI values were calculated for each county and plotted against drought declaration years to reflect temporal pattern of declarations.

The water right transfers were provided in a format of water right numbers and included approved, amended and denied water rights. Those data were cleaned and prepared for analysis. Application numbers of water rights transfers in the Idaho Department of Water Resources Temporary Transfers database were considered as a transfer (including "partial water rights"). Applications that were withdrawn or denied were removed from the dataset. One application was denied, as water transfers were not allowed in the Eastern Snake River Plain due to limitation of the adjudication process at the time. Years were attributed to each water transfer request and applicant. We calculated the number of transfers per applicant, sorting by year and by county. For those with no date entry in the database for the transfers, we compared the water right application numbers and combined it with the year most closely matching the application number. For transfers listed under multiple counties (i.e. Jefferson, Bonneville and Bingham) we defaulted to the first county, so as to not triple count one water right transfer while still recognizing the drought declarations made in each.

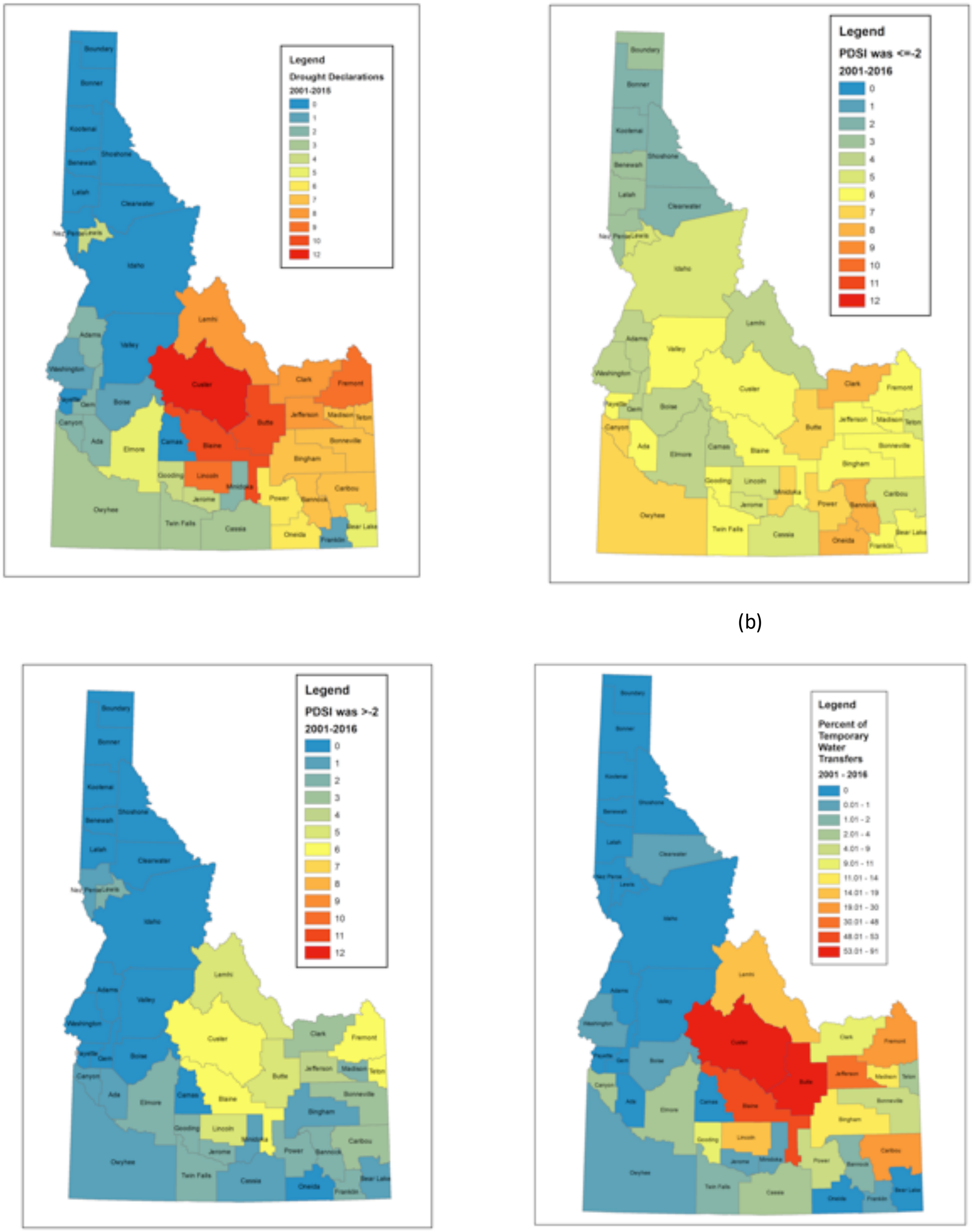
In addition to the drought declaration and order data gathered from the Idaho Department of Water Resources (IDWR) digital datasets and files, water right information was also obtained. At the time of this acquisition, it was the best available compilation of drought related and water rights information. However, the accuracy and completeness of the datasets, including the temporary water transfers set could not be verified. Consistent with prior studies using similar datasets (e.g. Snyder, Risley and Haynes 2012, Bromley 2015, Serbina and Miller 2014) readers should check directly with the Idaho Department of Water Resources to verify any specific dates, rights, orders and transfers.

Results

1. Spatial patterns of drought declarations and drought indices

The number of years in which each county filed a drought declaration with the state over the study period is shown in Figure 2-2a. Custer County in central Idaho declared drought 12 years out of the 16-year record, while the northern counties in the Idaho panhandle rarely, if ever, declared drought.

The PDSI values averaged for the summer months in all counties were evaluated to determine how frequently the PDSI values in those corresponding months would seem to support a drought declaration using this index. Approximately 60% of county level drought declarations occurred with PDSI < -2. To examine the spatial patterns in those figures, the number of years for which both conditions occur (i.e., PDSI is < or = to -2.0 and drought was declared) for each county are shown in Figure 2-2b. For example, the county of Custer declared drought during 12 separate years and the value of PDSI was less than or equal to -2.0 for 6 of those and above that threshold for the other 6 years. The numbers in this map indicate that several counties in the semi-arid region of southern Idaho experienced moderate to extreme drought conditions in at least six of the past fifteen years.



(b)

(c)

(d)

Figure 2-2 a-d: Spatial patterns in drought declarations and PDSI values: (a) The number of years for which each county has declared drought between 2001-2016; (b) the number of years for which each county has declared drought and the summer month values of PDSI have been < or = -2.0; (c)) the number of years for which each county has declared drought and the summer month values of PDSI have been > or = -2.0; (d) the percentage of temporary water right transfers utilized by each county.

To provide a comparison of the number of years for which hydrometeorological conditions would not seem to support the occurrence of drought, shown in Figure 2-2c are the number of years for which the summer-month PDSI value for each county was greater than -2.0 but the county did file a drought declaration. This map shows two spatial clusters of counties with 5-6 years in which droughts were declared in years in which the drought index was not below the typical threshold for moderate drought. Shown in Figure 2-2d are the number of temporary water transfers done over all years for which droughts were declared. A comparison of Figure 2-2c and 2-2d shows that the spatial clusters in 2c are comprised of counties that also had higher incidences of water transfers, suggesting that water shortages occurred even under conditions for which the drought index was above the threshold for moderate drought.

An overview table of all counties, all years and all dates of drought declarations and totals by year and by county is provided in Table 2-1. The declaration data come from the Idaho Department of Water Resources and was compiled through the online drought declaration list. The drought declaration dates online are the dates in which the order was approved by the Governor's office, often approving a handful of counties at a time. To clarify dates of drought requests from the counties, additional information from the individual declarations themselves was compiled. The blue, green, and yellow coding in the sheet clarifies some discrepancies within the datasets (accessed June 2017).

For example, in the blue cells for 2012 and 2015, IDWR lists the counties of Fremont, Owyhee and Lemhi as having a drought order (approval from Governor's office), but there were no corresponding drought declarations or "drought emergency" declarations from those counties in the dataset.

The yellow cell for Clearwater County in 2015 reflects the opposite scenario, where a drought emergency was on record for the county, but no corresponding drought order was on file from the Governor's office. Two occasions in 2014 and 2015 where reconciled as both drought emergency and drought declaration were on file, but neither in the IDWR database. In each instance when the dataset was complete, we erred on the side of a drought declaration being made, as there was record of it on either legal side of the record.

county	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Ada	5/8/01	0	0	0	6/3/05	0	0	0	0	0	0	0	0	0	0	0	2
Adams	6/25/01	0	0	0	0	0	10/26/07	0	0	0	0	0	0	0	0	0	2
Bannock	6/12/01	6/18/02	4/30/03	5/6/04	4/18/05	0	6/25/07	0	0	0	0	8/1/12	8/24/13	0	0	0	8
Bear Lake	6/21/01	9/18/02	6/10/03	8/17/04	0	0	0	0	0	0	0	7/9/12	7/8/13	0	0	0	6
Benewah	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bingham	5/8/01	5/15/02	4/17/03	5/3/04	3/29/05	0	6/15/07	0	0	0	0	0	6/17/13	0	0	0	7
Blaine	4/2/01	4/26/02	5/13/03	4/28/04	4/28/05	0	5/8/07	0	0	4/5/10	0	7/3/12	5/6/13	4/8/14	3/24/15	0	11
Boise	5/29/01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Bonner	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bonneville	4/19/01	4/30/02	8/6/03	5/11/04	3/22/05	0	6/26/07	0	0	0	0	0	6/26/13	0	0	0	7
Boundary	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Butte	4/9/01	4/8/02	2/24/03	4/6/04	2/28/05	0	2/12/07	9/15/08	0	3/8/10	0	0	4/29/13	4/14/14	3/23/15	0	11
Camas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Canyon	4/24/01	0	0	0	3/23/05	0	0	0	0	0	0	0	0	0	0	0	2
Caribou	5/25/01	8/30/02	4/30/03	4/12/04	3/28/05	0	7/2/07	0	0	0	0	0	6/22/13	0	0	0	7
Cassia	6/11/01	0	6/18/03	7/19/04	0	0	0	0	0	0	0	0	0	0	0	0	3
Clark	5/14/01	5/13/02	3/10/03	4/2/04	4/11/05	0	4/25/07	0	0	5/3/10	0	4/13/12	5/13/13	3/24/14	0	0	10
Clearwater	0	0	0	0	0	0	9/25/07	0	0	0	0	0	0	0	7/13/15	0	2
Custer	5/14/01	5/13/02	4/14/03	4/12/04	2/28/05	0	2/16/07	6/25/08	0	2/24/10	0	0	5/14/13	Null	3/9/15	8/31/16	12
Elmore	3/26/01	7/26/02	0	6/28/04	2/14/05	0	0	0	0	0	0	0	0	0	0	0	4
Franklin	0	0	0	7/16/04	0	0	0	0	0	5/11/10	0	0	0	0	0	0	2
Fremont	5/16/01	5/13/02	4/21/03	4/29/04	3/28/05	0	5/17/07	0	0	3/30/10	0	1	5/6/13	0	4/6/15	0	10
Gem	0	0	0	0	0	0	0	0	0	0	0	0	7/1/13	0	0	0	1
Gooding	5/29/01	7/23/02	0	4/26/04	4/25/05	0	0	0	0	0	0	0	0	0	0	0	4
Idaho	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Null	0	1
Jefferson	5/17/01	7/1/02	5/27/03	5/11/04	4/25/05	0	6/11/07	0	0	0	0	0	5/28/13	0	8/24/15	8/8/16	9
Jerome	7/30/01	0	0	7/16/04	5/16/05	0	0	0	0	0	0	0	0	0	0	0	3
Kootenai	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Latah	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lemhi	6/11/01	0	7/14/03	4/26/04	5/9/05	0	4/23/07	0	0	0	0	8/13/12	7/22/13	0	1	8/8/16	9
Lewis	0	0	0	0	0	0	9/24/07	12/1/08	0	0	0	0	8/19/13	0	7/27/15	0	4
Lincoln	4/9/01	5/13/02	4/14/03	4/12/04	4/25/05	0	6/25/07	0	0	4/26/10	0	0	4/8/13	3/24/14	3/26/15	0	10
Madison	5/25/01	5/29/02	5/28/03	4/23/04	4/5/05	0	6/4/07	0	0	0	0	0	7/18/13	0	0	0	7
Minidoka	0	0	0	7/26/04	0	0	7/2/07	0	0	0	0	0	0	0	0	0	2
Nez Perce	0	0	0	0	0	0	0	9/2/08	0	0	0	0	0	0	0	0	1
Oneida	6/1/01	7/15/02	5/12/03	5/12/04	0	0	7/3/07	0	0	0	0	6/28/12	7/8/13	0	0	0	7
Owyhee	6/11/01	0	6/16/03	0	0	0	8/6/07	0	0	0	0	1	0	0	0	0	4
Payette	6/25/01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Power	5/14/01	6/10/02	3/24/03	5/10/04	4/11/05	0	0	0	0	0	0	0	6/24/13	0	0	0	6
Shoshone	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Teton	6/5/01	0	7/28/03	5/24/04	0	0	5/29/07	0	0	3/15/10	0	7/12/12	5/28/13	0	5/26/15	0	8
Twin Falls	4/27/01	0	0	6/28/04	4/18/05	0	0	0	0	0	0	0	0	0	0	0	3
Valley	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Washington	7/2/01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
																	188
Totals	**29**	**17**	**19**	**24**	**20**	**0**	**20**	**4**	**0**	**8**	**0**	**9**	**19**	**5**	**11**	**3**	**188**
	Twin Falls declared drought on July 25, 2001 and Twin Falls Salmon Tract also declared on 4/27/01.						City of Pierce declared drought in Clearwatercounty 8/6/2007. County of Clearwater declared drought on 9/25/2007.			Butte and Custerlisted as one declaration; Freemont and Teton listed as one as well.			Oneida mispelled and therefore not on register				

drought order but no drought emergency (from county)
drought emergency and drought declaration but no data in IDWR database
drought emergency, but no drought order

Table 2-1: Matrix of all counties, the dates in which they made a drought request to the Idaho Department of Water Resources (not the date on which the order was granted) (zeros represent non-declaration years), and the totals by county and year. Some counties had multiple declarations in a given year as a separate declaration went to the Idaho Department of Water Resources from a municipality, or a tract. Highlighted cells explained further in text.

2. Temporal patterns in PDSI and cumulative frequency distribution of PDSI values

Temporal patterns were visualized for each summer month and averaged to give a PDSI value for each county for each year. A spreadsheet reflecting the PDSI change over time can be seen in Table 2-2. The columns correspond to individual counties and the rows correspond to mean summer values for each sequential year. The warmer colors indicate a PDSI at or above the threshold of -2.0 PDSI and the greens indicate wet years. The dataset extends to 1999 PDSI values, although the drought declaration data only became available for the year 2000, in order to examine the relationship between the summer droughts and the years prior. Importantly, this figure suggests a legacy effect, or temporal clumping of drought conditions, as moderate or severe droughts tend to be preceded by mild or moderate droughts as reflected in the PDSI values.

year	Ada	Adams	Bannock	Bear Lake	Benewah	Bingham	Blaine	Boise	Bonner	Bonneville	Boundary	Butte	Camas	Canyon	Caribou	Cassia	Clark	Clearwater	Custer	Elmore	Franklin	Fremont
1999	-0.37	-0.27	3.82	4.52	0.18	3.59	1.95	-0.60	0.75	4.46	1.01	3.75	1.43	-0.92	4.20	3.42	4.09	0.46	1.84	0.23	3.26	4.47
2000	-2.37	-1.72	-3.97	-3.38	0.99	-3.65	-2.95	-2.08	1.58	-2.72	0.88	-3.39	-2.52	-1.94	-3.28	-3.33	-3.00	-0.73	-2.87	-2.26	-3.71	-1.93
2001	**-2.98**	**-3.34**	**-5.46**	**-4.67**	-1.10	**-4.52**	**-3.92**	**-2.56**	-1.00	**-4.31**	-1.12	**-3.99**	-3.81	**-2.11**	**-5.05**	**-3.58**	**-3.84**	-1.16	**-3.21**	**-3.32**	-4.76	**-3.72**
2002	-3.87	-2.51	**-3.22**	**-3.39**	1.88	**-2.84**	**-2.80**	-2.37	1.28	**-2.28**	0.66	**-2.50**	-3.17	-4.30	**-3.30**	-1.71	**-2.59**	1.63	**-2.43**	**-2.99**	-3.10	**-1.88**
2003	-1.58	-0.79	**-4.85**	**-3.77**	-0.68	**-4.32**	**-2.61**	-1.00	-1.15	**-3.11**	-1.09	**-3.57**	-1.79	-2.21	**-3.95**	**-2.76**	**-3.02**	-0.78	**-2.29**	-1.41	-4.23	**-2.49**
2004	-0.41	0.32	**0.56**	**0.64**	2.22	**0.97**	**0.13**	1.23	1.12	**1.54**	0.31	**0.51**	-1.04	0.43	**1.43**	**0.73**	**0.96**	2.91	**-0.09**	**-0.47**	**0.65**	**1.34**
2005	**0.31**	1.78	**1.92**	3.86	0.33	**1.90**	**2.69**	1.82	0.46	**1.69**	0.47	**2.14**	2.59	**1.22**	**2.66**	3.68	**2.22**	0.60	**2.12**	**1.97**	4.85	**1.81**
2006	2.57	-0.70	1.24	-1.19	0.63	3.37	0.27	-0.14	1.07	1.12	0.24	0.13	0.22	4.26	-0.01	3.19	0.18	-0.19	-0.62	1.20	0.90	0.77
2007	-4.00	**-3.95**	**-3.52**	-3.76	-1.82	**-3.66**	**-3.79**	-3.37	-2.12	**-2.52**	-2.05	**-4.35**	-3.83	-3.76	**-4.35**	-2.39	**-4.36**	**-2.13**	**-3.69**	-3.33	-3.76	**-2.69**
2008	-2.83	-1.08	-1.70	0.04	0.75	-1.13	-2.20	-1.25	-0.81	0.26	-1.35	**-2.44**	-1.65	-2.99	-0.40	-1.93	-1.15	1.29	**-1.77**	-1.71	-1.54	0.96
2009	1.71	0.91	3.03	2.50	0.33	4.10	2.70	2.22	-1.00	3.46	-1.96	3.09	2.42	1.48	3.56	2.69	1.41	0.65	2.36	1.87	2.71	2.03
2010	0.86	2.54	-1.90	-1.41	1.83	-0.77	**0.17**	2.48	2.96	0.87	1.26	**-0.48**	1.43	1.24	-0.32	-0.26	**-2.51**	1.80	**1.13**	1.30	**-2.87**	**-0.20**
2011	5.87	3.26	5.47	5.96	4.48	4.67	2.72	3.86	4.93	5.42	3.51	2.34	3.17	6.40	5.85	4.40	1.36	4.56	**2.63**	4.66	6.65	4.14
2012	-1.11	-0.20	**-2.81**	**-2.51**	4.60	-2.61	**-1.54**	-0.21	6.37	-2.42	5.58	-2.59	-0.29	-2.14	-1.86	-2.84	**-3.35**	3.21	-0.60	-0.54	-2.80	**-1.73**
2013	-3.74	-1.73	**-2.92**	**-2.62**	0.52	**-2.18**	**-2.46**	-2.27	3.59	**-1.98**	2.46	**-3.11**	-2.37	-4.03	**-3.82**	-1.80	**-4.00**	-0.83	**-2.33**	-3.00	-3.36	**-2.52**
2014	0.87	-0.40	2.24	2.86	0.30	2.77	**1.88**	1.12	2.51	2.87	2.00	**2.57**	2.05	0.48	2.62	3.22	**1.24**	-0.39	**0.87**	1.68	2.22	2.49
2015	1.70	-2.83	1.63	2.42	-2.57	1.71	**0.24**	-0.69	-2.09	1.95	-2.24	**0.67**	0.81	1.66	2.49	1.24	0.68	**-3.19**	0.20	0.49	1.63	**0.40**
2016	-1.39	-1.69	0.38	1.88	-2.26	-0.17	-0.67	-1.60	-0.82	-0.66	-1.10	-0.99	-1.05	-1.27	1.16	2.44	-1.17	-1.50	**-1.09**	-0.45	0.25	-1.39

year	Gem	Gooding	Idaho	Jefferson	Jerome	Kootenai	Latah	Lemhi	Lewis	Lincoln	Madison	Minidoka	Nez Perce	Oneida	Owyhee	Payette	Power	Shoshone	Teton	Twin Falls	Valley	Washington
1999	-0.46	2.15	-0.06	3.85	3.97	0.68	0.43	1.34	1.02	3.77	4.51	3.35	0.69	3.31	0.05	0.00	3.56	0.97	5.67	1.07	-0.03	0.01
2000	-1.49	-2.71	-2.05	-3.08	-2.62	1.66	0.84	-2.96	-0.73	-3.16	-2.53	-3.30	-0.20	-3.92	-2.87	-1.12	-3.88	0.15	-1.56	-2.74	-2.02	-1.38
2001	-2.21	**-4.25**	-2.01	**-4.49**	**-3.96**	-0.83	-1.75	**-2.72**	-1.26	**-4.34**	**-4.50**	-3.83	-1.77	**-5.08**	-2.82	**-2.58**	**-4.53**	-0.29	**-3.65**	**-3.45**	-3.14	**-2.99**
2002	-2.83	**-2.87**	-0.50	**-2.31**	-1.85	1.77	1.36	-1.52	-0.27	**-2.21**	**-1.78**	-2.13	-0.15	**-2.55**	-2.88	-3.52	**-2.64**	2.43	-0.58	-2.04	-2.53	-2.39
2003	-1.00	-2.77	-1.02	**-4.12**	-2.98	-0.91	-0.63	**-1.61**	-0.55	**-3.14**	**-3.03**	-2.94	-0.44	**-4.60**	**-2.07**	-1.75	**-4.30**	-1.20	**-1.97**	-2.78	-1.41	-0.37
2004	0.43	**-1.74**	1.77	**0.76**	**0.12**	1.95	2.31	**-0.58**	2.05	**-0.32**	**1.22**	**0.52**	1.58	**0.48**	-0.07	0.35	**0.42**	2.69	**1.95**	**0.07**	1.06	-0.19
2005	1.12	**1.66**	-0.14	**1.60**	**2.28**	0.48	-0.09	**0.75**	-2.21	**2.20**	**1.44**	2.96	-3.03	3.99	2.24	0.23	**1.84**	0.87	1.53	**2.95**	1.13	1.55
2006	2.77	3.99	-1.18	2.93	6.16	1.44	0.11	-1.04	-2.02	1.39	2.90	2.46	-1.08	1.43	1.01	5.53	2.41	0.45	1.36	4.25	-0.85	0.31
2007	-3.64	-2.95	-2.86	**-4.28**	-2.68	-1.98	-1.81	**-2.59**	**-3.04**	**0.00**	**-3.64**	**-2.78**	-2.34	**-3.53**	**-3.38**	-3.81	-2.79	-2.24	**-2.13**	-2.51	-3.80	-3.88
2008	-1.78	-1.97	0.08	-1.53	-1.68	0.44	0.73	-0.51	**-1.72**	-1.42	0.85	-2.14	**-0.67**	-1.99	-2.29	-2.39	-2.01	1.34	2.82	-1.85	-1.19	-1.24
2009	1.69	1.78	0.35	3.12	2.55	-0.17	0.75	1.78	0.72	2.70	3.41	3.20	1.11	2.73	1.66	1.52	3.13	0.00	4.62	2.39	1.42	1.48
2010	2.15	-0.55	1.56	-0.95	0.01	3.42	1.85	1.27	1.23	**-0.74**	-1.61	0.08	0.34	-2.33	-0.24	1.79	-1.68	2.66	**0.63**	-0.64	2.12	2.57
2011	5.37	4.70	3.85	3.76	4.11	5.47	4.60	2.88	4.81	4.09	4.72	3.59	5.09	5.51	5.88	6.39	4.33	4.39	5.45	5.08	2.88	4.26
2012	-0.94	-1.10	0.99	-3.37	-1.87	6.19	3.33	**-1.08**	2.44	-1.74	-2.90	-2.25	2.23	**-3.76**	-2.83	-1.93	-3.50	4.35	**-1.87**	-2.06	-0.25	-0.63
2013	**-3.02**	-2.73	-1.57	**-2.77**	-2.55	2.38	-0.80	**-2.58**	**-1.23**	**-2.76**	**-2.44**	-2.23	-1.37	**-3.68**	-3.61	-3.94	**-2.98**	0.16	**-1.83**	-2.56	-1.91	-2.24
2014	0.83	3.03	-0.79	3.41	3.57	2.20	-0.92	0.95	-0.83	**2.92**	2.59	2.75	-1.03	1.69	1.92	0.68	2.10	0.80	2.49	4.23	-0.08	-0.10
2015	0.05	0.63	-3.24	**1.45**	0.71	-2.12	-2.83	-0.90	**-2.29**	**0.23**	0.83	0.29	-2.00	1.43	1.26	0.45	0.93	-2.97	**0.73**	1.06	-2.65	-1.44
2016	-1.18	1.70	-1.78	**-1.61**	2.25	-1.09	-2.25	**-1.48**	-0.36	0.34	-1.06	0.90	-0.95	-0.11	0.45	-1.29	-0.37	-1.48	-0.72	3.29	-2.13	-1.41

LEGEND OF PALMER DROUGHT SEVERITY INDEX VALUES

Cells with boxed outlines indicate a year in which drought was declared

-6.00	-4.00	-3.00	-2.00	0.00	2.00	3.00	4.00	6.00
	Extreme Drought	Severe Drought	Moderate Drought	Abnormally Dry	Mid Range	Moderately Moist	Very Moist	

Table 2-2: PDSI Color Coded Values highlighting multi-year relationships between mean PDSI summer values by county from 1999-2016. See text for further explanation.

For a more quantitative analysis of the relationship between PDSI values during a given year (Y_j) and the prior years (Y_{j-1}), (Y_{j-2}), we separated the PDSI values for the years of the drought declarations for each county from those years in which drought was not declared over the 16 year study period, as well as the PDSI values of (Y_{j-1}), (Y_{j-2}) for the years in which drought was not declared in each county in order to evaluate the cumulative distribution frequency of the PDSI values for those two cases.

Shown in Figure 2-3 is the cumulative distribution function (CDF) of PDSI values each time any of the 44 counties file a drought declaration. Note that the values of PDSI for the summer in which the drought was declared is shown in red. The additional two lines represent the PDSI values for the previous two years.

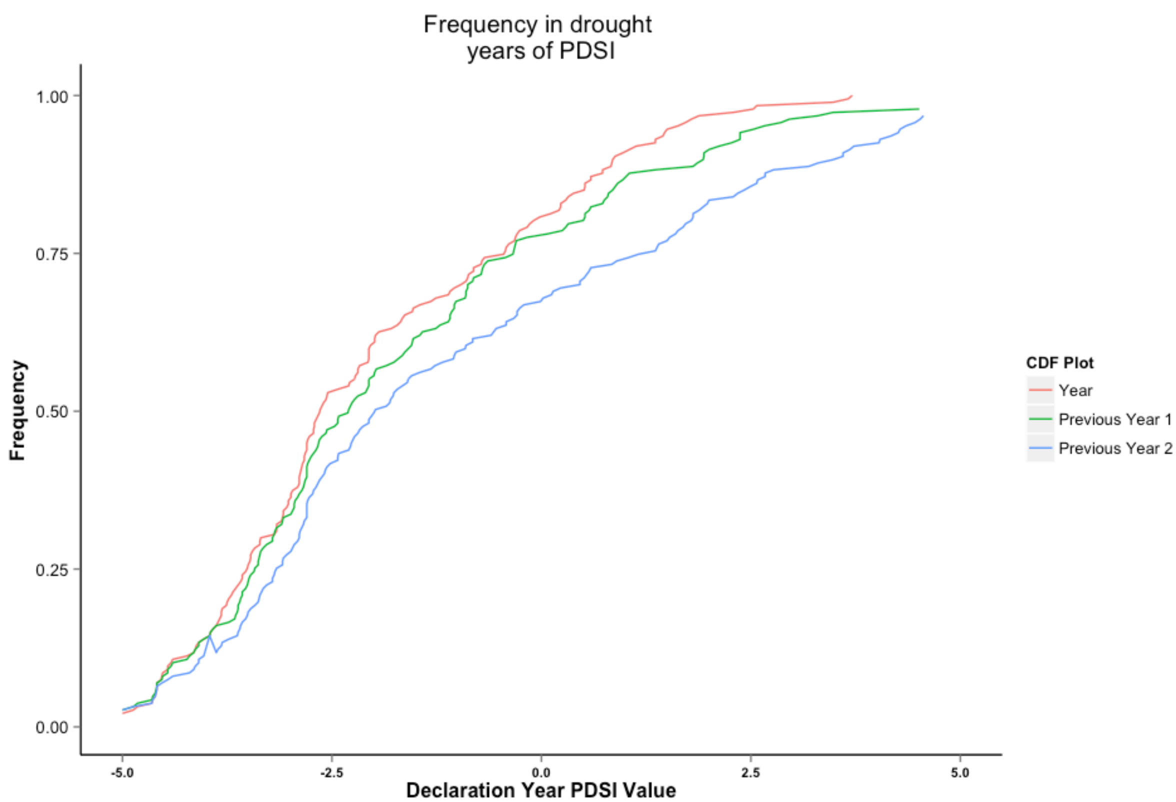


Figure 2-3: The cumulative distribution of PDSI values when drought was declared (in red), the previous year (green) and two years prior (blue).

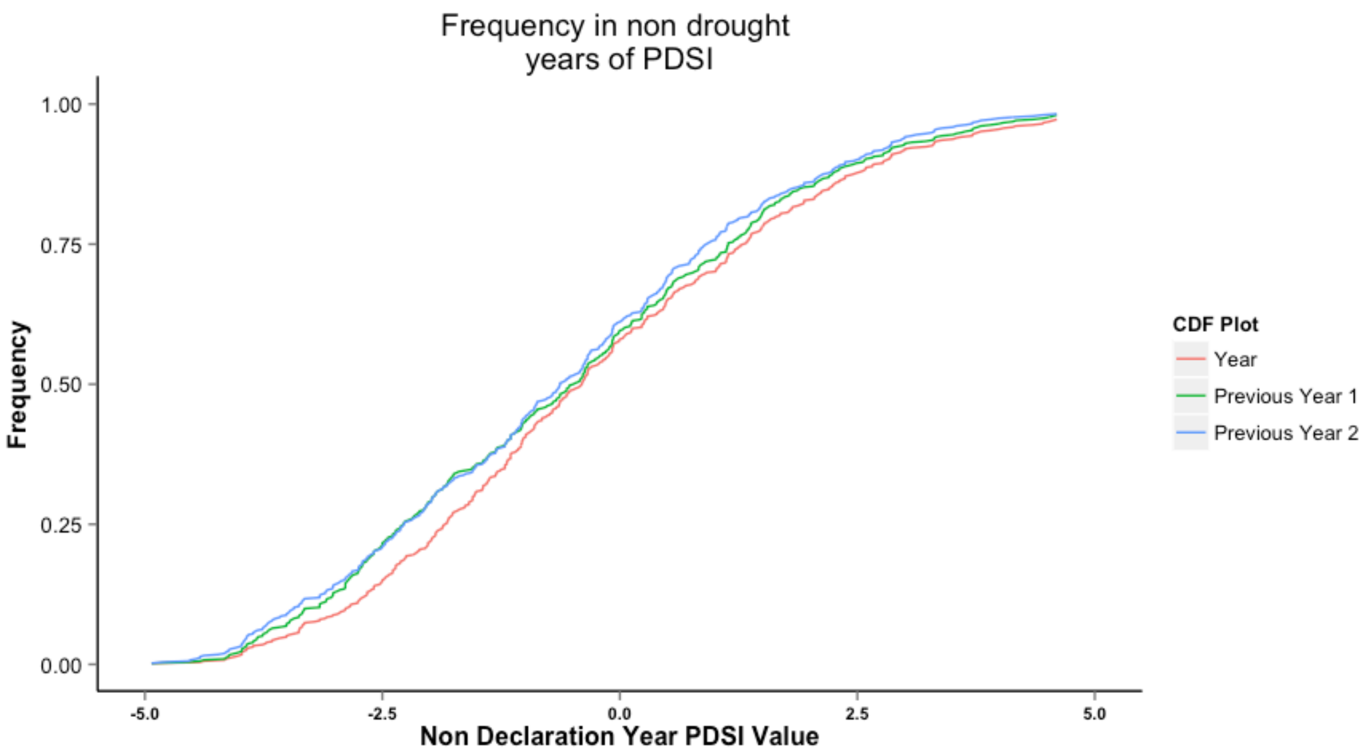


Figure 2-4: The cumulative distribution of PDSI values when drought was not was declared (in red), the previous year (green) and two years prior (blue).

Shown in Figure 2-4 is the CDF for PDSI values in all counties in the years in which drought was not declared, as well as the one and two year preceding PDSI values. We can see that PDSI was less than -2 for more than half of the time (~60%) droughts were declared. Conversely, for years and counties with no drought declared, 30% of the time there was a corresponding drought condition as estimated by the PDSI threshold <-2. An important observation to make for the forecasting of future droughts is that the frequencies indicate a high degree of correspondence between the PDSI value for one and two years prior to the drought declarations, suggesting a "system memory" in generating conditions under which a county would file a drought declaration. This effect is particularly strong for the first year prior to drought declaration.

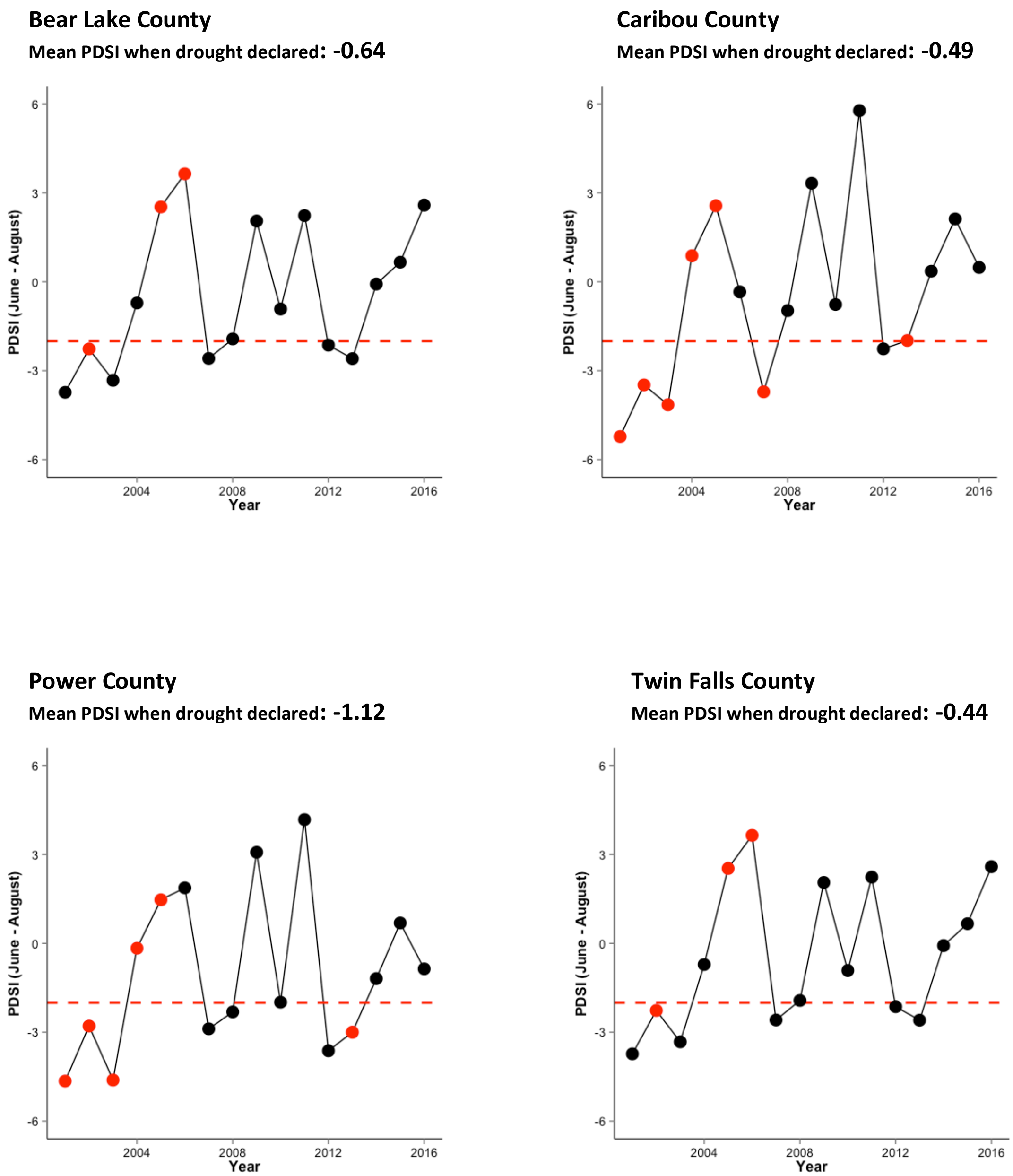


Figure 2-5: Example counties with temporal pattern of declarations (in red) and non-drought years represented by black points. The PDSI threshold is delineated with the dashed red line at -2.0.

Another way we examined the temporal legacy effects was by plotting individual counties' mean summer PDSI values and noting years (and at what PDSI values) a county filed a drought declaration. This also one to temporally examine when drought was declared with a PDSI value of greater than -2.0 (figure 2-5). Four counties, Bear Lake, Caribou, Power and Twin

Falls were selected to illustrate these patterns. The years in which the county filed a drought declaration are shown in red in the period of study (2001- 2016). The red dashed line denotes the PDSI threshold of -2.0. These charts demonstrate (for example, in Power County) that when counties do declare droughts in a year for which the PDSI is above the threshold, those years tended to be preceded by one or more years in which the PDSI values was below the threshold.

3. Spatial and temporal patterns of water rights, surface water use and transfers

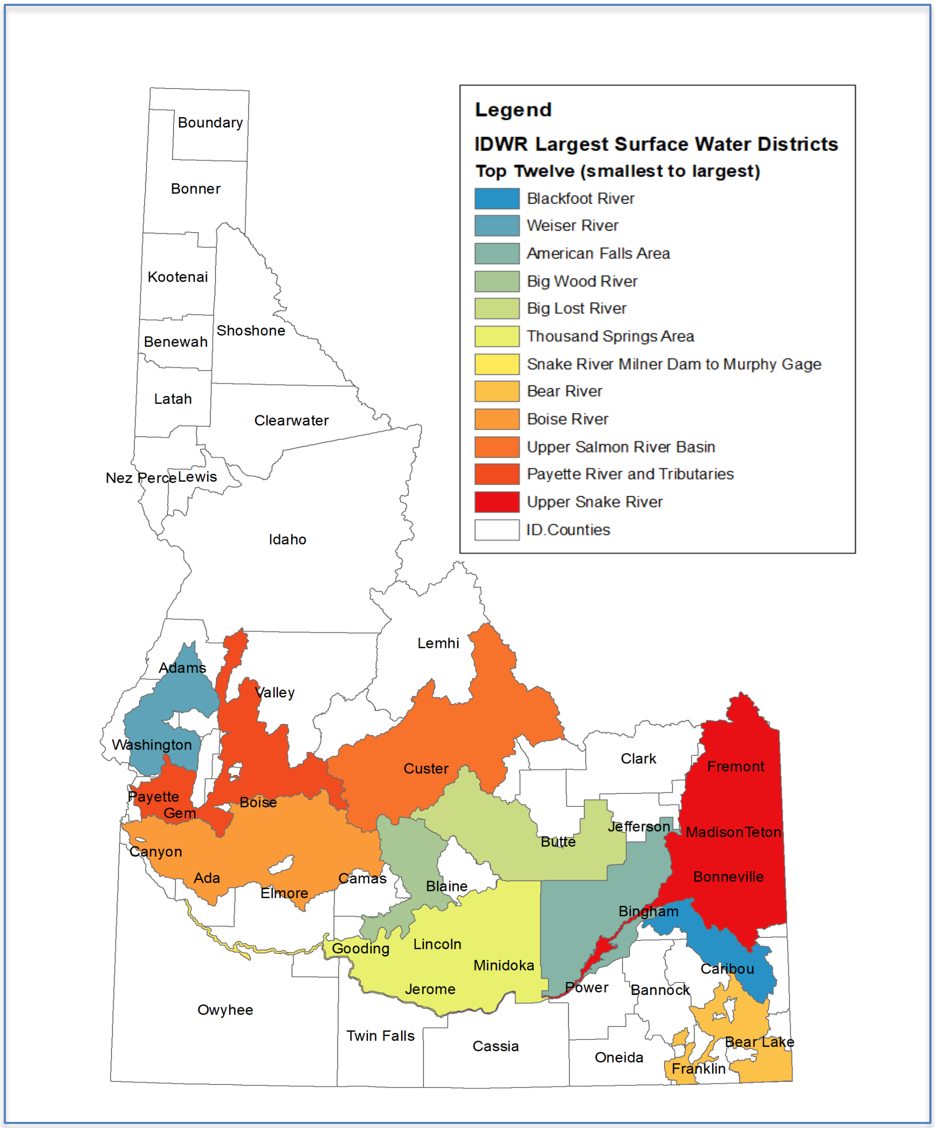


Figure 2-6: The location of the 12 largest surface water districts of the 119 that operate in the state.

Surface Water Districts are identified in Figure 2-6. There are a total of 119 surface water districts, the 12 largest ones being: The Upper Snake River, Payette River and Tributaries, Upper Salmon River Basin, Boise River, Bear River, Snake River from Milner Dam to Murphy Gage, Thousand Springs Area, the Big Lost River, Big Wood River, American Falls Area, Weiser River and Blackfoot River.

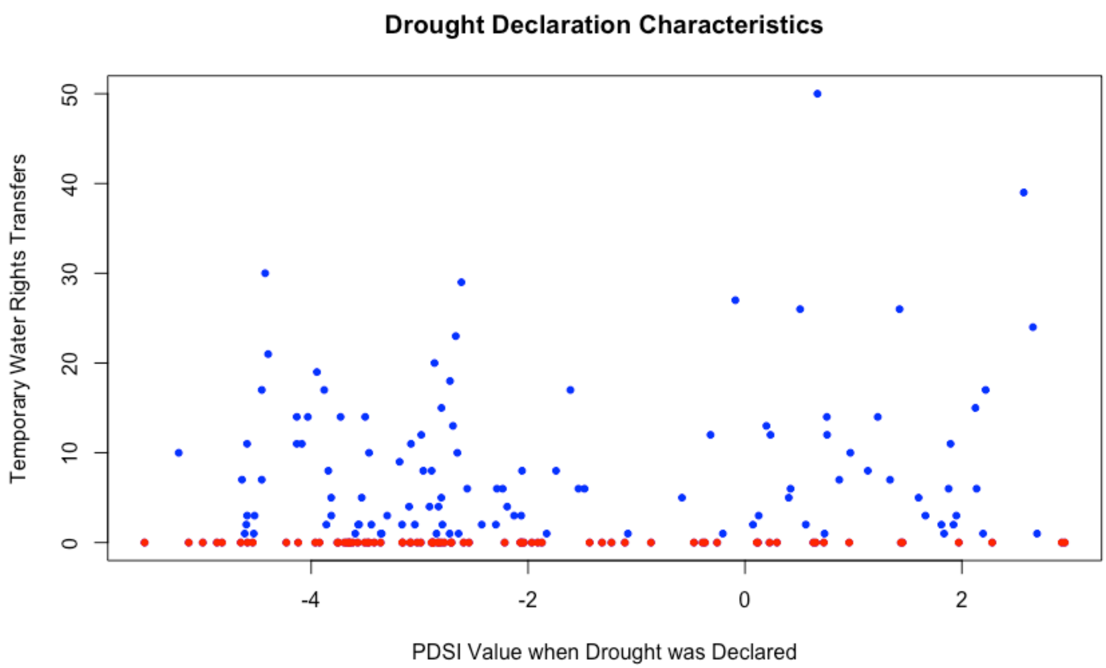


Figure 2-7: The total number of drought declarations in the state of Idaho as a function of PDSI value and the resulting number of temporary water rights transfers.

Idaho Code 42-220 mandates the amount of water for irrigation is not to exceed diversions from the source of more than .02 cubic feet per second (cfs). Many water rights permitted in Idaho assign less than .02 cfs as the right's limit (Fereday and Creamer 2010). Idaho law allows for a transfer of the place of use of a surface irrigation water right from one parcel to another within the same irrigation district of canal company (Idaho Code 42-2501).

To better understand the relationship between water transfers and drought declarations per year, all water transfers were plotted against PDSI values when droughts were declared. In

Figure 2-7 we are able to see that there are many occasions in which a drought is declared, but no transfer occurs. The total numbers of all water transfers recorded in the IDWR database, regardless of PDSI values, are plotted by year in Figure 2.-8. Shortly after the water transfer benefits were made legal for surface water users, many counties that utilized the mitigation measure. The year (2001) was also a very dry year. There has been a declining trend in utilization of these transfers, as represented purely by the number of actual transfers.

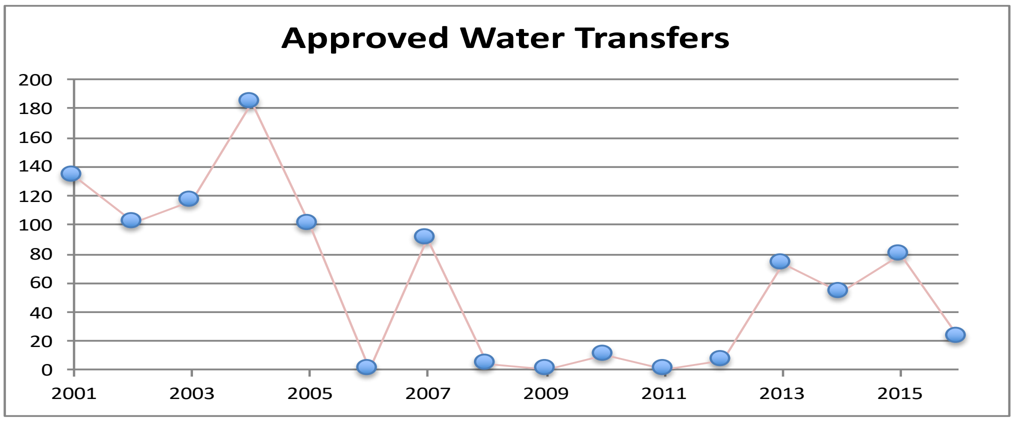


Figure 2-8 :The number of approved temporary water rights transfers by year in Idaho. The cumulative count includes partial water right transfers.

Table 2-3 provides a county-level break down of the number of the total droughts declared and the percentage of the time those drought years corresponded with the PDSI threshold. To get a better understanding of the relationship between drought declarations, the drought index and the resulting water transfers, each are seen in Table 2-4.

County	Droughts Declared when PDSI > = -2.0	Total Droughts Declared	Percentage Droughts Declared when PDSI > = - 2
Ada	1	2	50.0%
Adams	0	2	0.0%
Bannock	2	8	25.0%
Bear Lake	1	6	16.7%
Bingham	1	7	14.3%
Blaine	6	11	54.5%
Boise	0	1	0.0%
Bonneville	3	7	42.9%
Butte	5	11	45.5%
Canyon	1	2	50.0%
Caribou	3	7	42.9%
Cassia	1	3	33.3%
Clark	3	10	30.0%
Clearwater	0	3	0.0%
Custer	6	12	50.0%
Elmore	2	4	50.0%
Franklin	2	2	100.0%
Fremont	6	10	60.0%
Gem	0	1	0.0%
Gooding	2	4	50.0%
Jefferson	4	9	44.4%
Jerome	2	3	66.7%
Lemhi	5	8	62.5%
Lewis	2	4	50.0%
Lincoln	5	10	50.0%
Madison	2	7	28.6%
Minidoka	1	2	50.0%
Nez Perce	1	1	100.0%
Oneida	0	6	0.0%
Owyhee	1	4	25.0%
Payette	0	1	0.0%
Power	2	6	33.3%
Teton	6	8	75.0%
Twin Falls	2	4	50.0%
Washington	0	1	0.0%

Table 2-3: The total number of droughts declarations by county with calculated percentage of how often those counties needed temporary water rights transfers even when the drought index (PDSI) did not reflect a hydrometeorological "moderate drought" between 2001 – 2016.

County	Year Drought Declared	PDSI Value	Water Transfers
Ada	2001	-3.3603	null
Ada	2005	-0.391	null
Adams	2001	-3.507	null
Adams	2007	-4.12	null
Bannock	2001	-5.536	null
Bannock	2002	-3.4194	null
Bannock	2003	-5	null
Bannock	2004	0.5609	2
Bannock	2005	1.9227	2
Bannock	2007	-3.695	null
Bannock	2012	-3.156	null
Bannock	2013	-3.0234	null
Bear Lake	2001	-4.869	null
Bear Lake	2002	-3.571	null
Bear Lake	2003	-3.924	null
Bear Lake	2004	0.1089	null
Bear Lake	2012	-2.833	null
Bear Lake	2013	-2.707	null
Bingham	2001	-4.638	7
Bingham	2002	-2.985	12
Bingham	2003	-4.529	1
Bingham	2004	0.97107	10
Bingham	2005	1.8956	11
Bingham	2007	-3.758	null
Bingham	2013	-2.216	null
Blaine	2001	-4.086	11
Blaine	2002	-2.966	8
Blaine	2003	-2.8	5
Blaine	2004	0.1266	3
Blaine	2005	2.693	1
Blaine	2007	-3.815	5
Blaine	2010	-0.257	null
Blaine	2012	-1.5357	6
Blaine	2013	-2.561	6
Blaine	2014	1.8781	6
Blaine	2015	0.23506	12
Boise	2001	-2.845	1
Bonneville	2001	-4.456	7
Bonneville	2002	-2.427	2
Bonneville	2003	-3.358	1
Bonneville	2004	-1.1073	null
Bonneville	2005	-1.318	null
Bonneville	2007	-3.481	null
Bonneville	2013	-2.063	null
Butte	2001	-4.133	11
Butte	2002	-2.72	18
Butte	2003	-3.86	2
Butte	2014	0.50829	26
Butte	2015	2.136	6
Butte	2007	-4.456	17
Butte	2010	-0.867	null
Butte	2008	-2.875	null
Butte	2013	-3.185	9
Butte	2014	2.5702	39
Butte	2015	0.66836	50
Canyon	2001	-2.288	6
Canyon	2005	0.294	null
Caribou	2001	-5.222	10
Caribou	2002	-3.2994	3
Caribou	2003	-4.133	14
Caribou	2004	1.4253	26
Caribou	2005	2.6553	24
Caribou	2007	-3.5582	2
Caribou	2013	-1.9096	null
Cassia	2001	-3.815	3
Cassia	2003	-3.35	1
Cassia	2004	0.72703	null
Clark	2001	-4.031	14
Clark	2002	-2.909	4
Clark	2003	-3.593	1
Clark	2004	0.96067	null
Clark	2005	2.2189	17
Clark	2007	-4.539	null
Clark	2010	-2.799	null
Clark	2012	-3.618	null
Clark	2013	-4.229	null
Clark	2014	-2.039	null
Clearwater	2007*	-2.641	1
Clearwater	2015	-3.657	null
Custer	2001	-3.466	10
Custer	2002	-2.693	13
Custer	2003	-2.615	29
Custer	2004	-0.089053	27
Custer	2005	2.1242	15
Custer	2007	-3.947	19
Custer	2008	-2.193	4
Custer	2010	1.133	8
Custer	2011	2.6307	
Custer	2013	-2.652	10
Custer	2014	0.86914	7
Custer	2015**	0.19788	13
Custer	2016	-1.0894	
Elmore	2001	-3.566	2
Elmore	2002	-3.044	2
Elmore	2004	-0.47113	null
Elmore	2005	1.971	null
Franklin	2004	0.65201	null
Franklin	2010	-1.4329	null
Fremont	2001	-3.88	17
Fremont	2002	-2.234	6
Fremont	2003	-3.08	11
Fremont	2004	1.3374	7
Fremont	2005	1.811	2
Fremont	2007	-3.445	2
Fremont	2010	-0.20414	1
Fremont	2012	-2.056	null
Fremont	2013	-2.826	4
Fremont	2015	0.40374	5
Gem	2013	-3.08	null
Gooding	2001	-4.522	3
Gooding	2002	-2.89	null
Gooding	2004	-1.742	8
Gooding	2005	1.6639	3
Jefferson	2001	-4.591	11
Jefferson	2002	-2.667	23
Jefferson	2003	-4.397	21
Jefferson	2004	0.75713	12
Jefferson	2005	1.6008	5
Jefferson	2007	-4.424	30
Jefferson	2013	-2.863	20
Jefferson	2015	1.4525	null
Jefferson	2016	-1.6099	17
Jerome	2001	-4.591	3
Jerome	2004	0.11917	null
Jerome	2005	2.2791	null
Lemhi	2001	-3.089	null
Lemhi	2003	-2.056	8
Lemhi	2004	-0.58072	5
Lemhi	2005	0.75468	14
Lemhi	2007	-3.097	4
Lemhi	2012	-1.0796	1
Lemhi	2013	-2.889	8
Lemhi	2016	-1.479	6
Lewis	2007	-3.646	null
Lewis	2008	-2.072	null
Lewis	2013	-1.2305	null
Lewis	2015	-2.545	null
Lincoln	2001	-4.588	null
Lincoln	2002	-2.297	2
Lincoln	2003	-3.534	5
Lincoln	2004	-0.3178	12
Lincoln	2005	2.1952	1
Lincoln	2007	-2.885	null
Lincoln	2010	-0.36898	null
Lincoln	2013	-2.799	15
Lincoln	2014	2.9208	null
Lincoln	2015	0.22653	null
Madison	2001	-4.598	2
Madison	2002	-2.064	3
Madison	2003	-3.502	14
Madison	2004	1.2245	14
Madison	2005	1.4377	null
Madison	2007	-3.842	8
Madison	2013	-2.595	null
Minidoka	2007	-2.821	null
Nez Perce	2008	-0.96	null
Oneida	2001	-5.129	null
Oneida	2002	-2.772	null
Oneida	2003	-4.822	null
Oneida	2007	-3.675	null
Oneida	2012	-3.963	null
Oneida	2013	-3.751	null
Owyhee	2001	-3.16	null
Owyhee	2003	-2.724	1
Owyhee	2007	-3.468	null
Owyhee	2012	-2.872	null
Payette	2001	-2.71	null
Power	2001	-4.649	null
Power	2002	-2.79	2
Power	2003	-4.613	1
Power	2004	0.42054	6
Power	2005	1.8359	1
Power	2013	-2.99	null
Teton	2001	-3.6463	null
Teton	2003	-1.9662	null
Teton	2004	1.9494	3
Teton	2007	-2.1289	3
Teton	2010	0.63044	null
Teton	2012	-1.8724	null
Teton	2013	-1.8285	1
Teton	2015	0.73338	1
Twin Falls	2001*	-3.729	14
Twin Falls	2004	0.073699	2
Twin Falls	2005	2.9486	null
Washington	2001	-3.162	2

*A County declared a drought twice that year (i.e. a municipality or delivery tract made a drought declaration request).
**A water transfer occurred in a year in which a drought declaration was not made.

Table 2-4: Those counties who received approval from the Idaho Department of Water Resources for a temporary water rights transfer and the corresponding PDSI value when drought was declared. * The County declared drought twice in that year (i.e. a City made a declaration or a water delivery tract). **A water transfer occurred in a year in which a drought declaration was made.

Discussion

With drought declarations allowing for an expedited legal water transfer process at the county level in Idaho, declarations are one mechanism by which water users may mitigate water shortages. This ability to move water to an area anticipated to experience drought or water shortage is essential to some counties and not others. Northern Idaho, while not considered a semi-arid region, has seen its share of drought. PDSI values in 2001 and 2007 put several counties in the panhandle in drought conditions.

When county-level drought declarations were compared against objective measures of soil moisture deficits using the Palmer Drought Severity Index (PDSI), results presented here show that 40% of historic drought declarations occurred when there was not a corresponding hydrometeorological drought, as estimated by the concurrent PDSI. There are two important points to draw from the results shown here. One is related to the physical drought phenomenon and one that arises from social constraints (i.e., opportunities for water rights transfers).

First, on the physical modeling of drought conditions, our research suggests that some of the mismatch between drought declarations and PDSI in a given year is due to legacy effects of potentially rebuilding water storage or re-saturating soils that have experienced long spells of drought. Our results indicate, not a direct correlation between PDSI and drought declarations per year, but a legacy effect of previously low PDSI average summer values suggesting that the simple application of a drought index for one year may be insufficient for diagnosing historical water shortages or predicting future water shortages. Rather, drought should be modeled using some combination of PDSI values from the current year and the previous 1-2 summers.

Secondly, it is important to note that in addition to hydrometeorologic conditions, western water law provisions that place social (i.e., legal) constraints on water availability can impact the observed spatial patterns in drought declarations. A qualitative examination was done of the drought declarations that were filed for those years in which the PDSI was above the threshold for moderate drought. This was done to see if it was possible to identify predominant rationales for those filings.

Drought declarations for the years 2001 through 2016, obtained from IDWR, were used for this study. The year 2001 was an exceptional drought year in Idaho, with 75% of the counties declaring drought, and 33 of the 44 counties in Idaho seeking the truncated temporary water transfer process. Historically, in other drought years, there has been an average of 11 counties in Idaho declaring drought, or only 25% seeking drought declaration approval. It was during the intense drought year of 2001 that the Idaho Legislature passed the bill allowing for temporary changes to water rights by transfer or exchange of water during a drought emergency (Senate Bill no. 1122, 2001).

Drought declaration data were cross-referenced with issued drought orders. Over the 16-year study period, the county level declarations designated the drought conditions as drought “emergencies”, drought” disasters” and drought “resolutions”. This may be due to the fact that conditions resulting in drought emergencies, for a given county or contiguous to a drought declaring county, have been eligible for federal loans to producers suffering loss (FSA 2017). USDA Secretarial disaster designations must be requested by the governor’s office and is the most widely used process in the Federal Assistance protocols. Submitting a designation that could serve both the state and federal purposes may have been advantageous since the state does not have official requirements for drought designations.

Additionally, the evaluation of “system memory” (i.e., the impact of dry conditions in previous years) indicates that drought could be better modeled using a combination of PDSI values from the current year and the previous 1-2 summers. This new element of analysis could potentially lead to a new drought index or new ways of applying existing indices.

A qualitative examination was done of the drought declarations that were filed for those years in which the PDSI was above the threshold for moderate drought. This was done to see if it was possible to identify predominant rationales for those filings. In many of the cases where temporary water rights were needed in these scenarios, the accessed water right was from groundwater or from reservoirs.

Because county-wide drought declarations in Idaho allow for temporary surface water right transfers within that county on an expedited schedule, there is strong motivation for county commissioners to file a drought declaration if it will assist constituents in getting an expedited water transfer. That being said, drought declarations are triggered only by the need for an emergency water right transfer and declarations provide an important signal about where water shortages occur and under what conditions.

Temporary water changes are only allowed for the purpose of providing a replacement water supply to lands or other uses that in non-drought years would normally have a full water supply. The Director of the Idaho Department of Water Resources is authorized to approve the temporary changes (Section 42-222A, Idaho Code) providing the request is not for new development or to allow expansion of the current use of water under existing water rights (Section 42-240, Idaho Code). Additionally, special consent must be given through IDWR if the right to use the water is represented by shares of stock in a corporation, or if the diversion works or delivery system is owned or managed by an irrigation district (Paragraph 5 for 2004 Drought Orders, IDWR). The sources of water allowed in temporary exchanges and transfers, as per state code, are limited to surface water.

Thus, in order to understand the spatial and temporal nature of water shortages in the region (and other regions in which water use is subject to similar western water law constraints), it is important to understand when and where drought declarations (or other means of expediting water transfers) are being made in the absence of below-normal hydroclimatic conditions.

The analysis shown here is unique in that we are evaluating hydrometeorological conditions under which county drought declarations were made to the state, in an effort to identify the conditions for which water shortages were impactful to water user.

Conclusion

This study focused on a prolific, water-intensive irrigated agricultural system and examined the relationship between hydrometeorologic drought conditions (as assessed with the PDSI) and declarations of drought by individual counties to the state of Idaho. Moderate to extreme drought conditions, as measured by PDSI values at or below -2.0, occurred concurrently with approximately 60% of drought declarations. However, this research indicates that there are significant legacy effects of rebuilding water storage supplies (in both reservoirs and soils) that last 1-2 years and that future studies to predict drought occurrence in this region should include those system memory variables.

A water transfer can be approved to allow water to be moved from one field, such as alfalfa, to a higher yield crop, such as potatoes. However, that amount of water transferred must be the same as the original source amount. Understanding more about how these transfers are utilized by county could give insight into future water resource planning. With drought declarations occurring in more than 50% of the years in the 16-year study period, our research suggests, given the additional legal considerations that water rights are over allocated in the water reliant portion of southern Idaho (even disregarding environmental instream flows). Should research examining water availability for future water right issuance look to these types of multi-year analyses for determining availability, it may be evident that there is not enough water, even in non-drought years to justify a water right. Looking at the impacts of this research in that way could allow for strategic management practices leading to a new threshold of water right issuance. For example, should a county need to declare drought more than 50% of the time within a given parameter, consideration of programs to retire land from irrigation might be warranted.

An examination of where and when the drought declarations occurred outside of single-year PDSI thresholds for drought provides a better understanding of where and under what conditions water shortages occur in the region. The spatial distribution of water shortages is created in part by the legal framework of water rights that is common to many western states. Thus, future predictions of water shortages must consider both the climate factors as constraints imposed by this social/legal framework.

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Chapter 3 : The Role of Adaptive Governance in Preparing Western Communities for the Impacts of Climate Change

Abstract

Climate change effects are already being felt globally (Reichstein et al. 2013, Allen et al. 2014). In the western U.S., a snowmelt and mix rain-snow dominated region, the impacts of climate change are being experienced through the changing regime of water in terms of timing, quantity and quality. As climate change unfolds, the western U.S. is likely to experience greater extremes in flood and long-term drought. These changes will directly impact a myriad of sectors including economic, agriculture, fisheries and hydropower. Secondary impacts will be felt through increased intensity and duration of wildfire season, and increased electric power demands for heating and cooling (Rose et al. 2014, Auffhammer, Baylis and Hausman 2017). From ranching and industry to planning for growing municipalities – water resources are becoming less reliable for western states. Increasing temperature trends create moisture related changes that can exacerbate conflict already present under current water supplies. Similarly, changes in the timing of snowmelt and declining mountain snowpack are indicators western states could experience more severe drought risk than in the past. This paper examines new forms of governance and applicability to drought preparation for western communities under a future of climate change with specific application to the U.S. state of Idaho. Effective drought management should focus on reducing the subsequent human vulnerability through proactive planning. Uncertainty in how future changes will affect water resources means that the planning should also be adaptive. Idaho is located in the water stressed western United States; it has been well established that climate change will continue to exacerbate strain on water resources in the region. To safeguard this essential resource, Idaho must expand its current ability to respond to uncertainty of water availability by increasing its adaptive capacity. Despite the involvement of the federal agencies at work in climate-responsive adaptive governance, the adaptive capacity of water governance at the state level in Idaho is not as well understood. This paper fills that void and critically examines the successes and failures of adaptive planning as seen through the case study of a landmark agreement between surface and ground water users in the Eastern Snake River plain, which

supports the largest irrigated agricultural region in the northwest. The approach to this assessment is transferrable to understanding the preparedness of other western communities for climate change and long-term drought.

Introduction

Climate change effects are already being felt throughout the world (Adam et al. 2015, Wolf and Moser 2011, Moser 2011, Romero-Lankao 2014), the region (Abatzoglou et al. 2014a, Dalton et al. , Dettinger, Udall and Georgakakos 2015, Grimm 2013, Markoff and Cullen 2007, Miles et al. 2000) and within Idaho (Xu, Lowe and Adams 2014, Klos et al. 2015). From ranching and mining to technology and municipal needs – water resources are becoming less reliable within Idaho's current water allocation system (Klos, Link and Abatzoglou 2014, Lute, Abatzoglou and Hegewisch 2015, Luce, Abatzoglou and Holden 2013, Luce and Holden 2009, Wenger et al. 2011). The most significant impacts of a changing climate felt in western communities will be seen through: threats to agriculture (Dalton et al. , Scott et al. 2010, Qualls 2013), amplified wildfire (Barbero et al. 2015), increased hydropower demands (Hamlet et al. 2010), and endangered anadromous fishes (Isaak et al. 2012, Wenger et al. 2011, Wu et al. 2012) ever critical to tribal fishing and the recreational industry.

With less snowpack, there is less water storage for later times of the year when it is needed most. Even though Idaho can be considered a water rich state (Abramovich 2016) much of the water availability in the ever-productive Snake River plain, is dependent on water storage in the form of mountain snowpack. With the decline in snowpack in the region (Leppi et al. 2012, Rupp, Abatzoglou and Mote 2017) there is increased variability to the timing of spring runoff which has historically been integral to freshwater habitats and hydropower planning (Rauscher et al. 2008) as well as water availability for irrigated agriculture and cold flushing flows to move anadromous smolts out to sea (Wobus et al. 2015).

These uncertain climatic and hydrologic conditions, coupled with increasing air temperatures

(Abatzoglou et al., 2014; Sohrabi et al., 2013), will strain available water resources and increase water demand (Wise 2012). Water in the west has been defined by some significant water conflicts. The history of western water law is uniquely tied to climate in the system of prior appropriation (Kirchhoff and Dilling 2016b, Leonard and Libecap 2016). As a system of usufructuary rights established in the 19th century, the overlay of modern statutes and science-based administration nevertheless retains the priority system in recognition of established rights. Idaho is among those states that follows "first in time, first in right" prior appropriation rule for both ground and surface water (Idaho Constitution Art. XV §3, Idaho Code §42-106). But similar to many states, Idaho maintains that it is the state that owns the actual water, with the right to regulate its use (Idaho Constitution Art. XV §§ 3 and 7). The property right in water that is held by the water user is a mere use right, thus the Idaho Code makes it clear that "the right to the use of any of the public waters . . . shall not be considered as being a property right in itself, but such right shall become the complement of, or one of the appurtenances of, the land or other thing to which, through necessity, said water is being applied" (Idaho Statutes § 42-101).

The projected hydrologic changes in the region will demand tradeoffs in water allocation among uses such as irrigation, hydropower, flood control, and aquatic ecosystems (Mote et al. 2003, Sample, Halofsky and Peterson 2014, Scott et al. 2010, Vano et al. 2010). Changes in western communities' hydrographs will inevitably influence and change the way residents value and govern water resource systems as well as lead to changes in water resource managers' actions (Dettinger et al. 2015). As Idaho experiences times of drought, causing water deficits, "junior" water users in the state may be excluded from water availability entirely as the water law accommodates the temporal hierarchy of those who first put the water to beneficial use. It is necessary to identify and better understand the water resource changes that have been and will continue to affect Idaho's agriculture, forest industry, recreation and energy availability in order to make necessary safeguards in times of drought.

Water shortages have historically equated to conflict in the history of the west as well as collaboration to develop new resources (Wolf et al. 2005). Conflict over something as essential as water has led to cooperation (Ostrom 2015) More than a decade ago, the federal government published a document aimed to prevent crises and conflict in the west. This document recognized that some areas were experiencing inadequate water supplies, even under normal climatic conditions, and would therefore be unable to meet the growing demand (DOI 2005). Water resources in the arid regions of the United States have continued to be affected by climate change (Melillo, Richmond and Yohe 2014) which will continue to affect our reliable water supply (Allen et al. 2014) and intensify stress on water resources (Camacho 2009, Lambert et al. 2010, Wu et al. 2012). While it is true that climate projections show an increase in precipitation in the northwest in the form of rain during spring months (Abatzoglou, Rupp and Mote 2014b), it is also true that the increased air and surface temperatures, coupled with a decrease in mountain snowpack will significantly affect precipitation during the warmer summer months when moisture is needed the most in the region (Luce et al. 2013) leading to drought conditions due to climate change (Dettinger et al. 2015, King et al. 2015).

To safeguard this essential resource, Idaho, and other western communities who seek to thrive in a changing climate, must expand their current ability to respond to uncertainty (Camacho 2009) and increase their adaptive capacity (Moser et al. 2008, Bierbaum et al. 2013b, Vogel et al. 2007, Miller 2014). Uncertainty in how change will unfold provides new challenges for water resource governance (Cosens and Chaffin 2016, Cosens et al. 2014, Kirchhoff and Dilling 2016a). Applying research on the necessary factors to support adaptive water governance (Cosens, Gunderson and Chaffin 2014) to state level approaches to drought preparedness can increase understanding of adaptive capacity under current governance schemes. The research of which, at the state level, is sparse (Kirchhoff and Dilling 2016a, Megdal et al. 2015). This paper is serving to fill the gap of identifying adaptive planning opportunities at the state level based on water law and best available climate science.

According to the Adaptive Water Governance Project, which assessed the resilience of several large water basins, including the Pacific Northwest's Columbia River Basin, a majority of the systems analyzed, while vulnerable to climate change, were still able to adapt to the impacts of these changing climates "if the appropriate resources and legal tools can be applied" (Cosens et al. 2017).

Water Law and Adaptive Capacity

The adaptive strategies that can address future climate uncertainties while still planning for adaptability to natural hazards can be seen through the framework of Adaptive Governance (Cosens 2013, Cosens, Gunderson and Chaffin 2014). It is through this process that policy can be revised with new information (i.e. climate science) and have the necessary capacity to confront variables that have historically been challenged by change (Olsson et al. 2006, Brunner 2005, Webster 2009). These characteristics, structures and processes then can become malleable enough to learn from previous experiences to build future decisions (Chaffin, Gosnell and Cosens 2014). Similarly, adaptive governance prioritizes this learning from past events, allowing for formative collaboration building (McLain and Lee 1996, Rouillard et al. 2013). While many policies and laws must have a base line of stationarity in order to make projections about future management, adaptive planning does not assume stationarity (Craig 2010b, Lins and Cohn 2011, Milly et al. 2008). It does, however, recognize the cultural importance of past experiences, and human agency (Pahl-Wostl 2007). Recognition of human connectivity to the planning process facilitates legitimacy, which is critical to the facilitation of adaptive governance (Tyler 2006, Cosens 2013, Craig and Ruhl 2014).

Literature on adaptive governance relied on for this paper has its roots in resilience theory and the effort to bridge resilience and law. This article uses the term resilience as defined by the ecology literature in which resilience describes a system property – i.e. the degree to which a disturbance affects the ability of a system to maintain structure and function through adaptation and resistance or causes it to transform to a new stable state (Walker et al. 2004, Walker, Salt and Reid 2006, Holling 1978, Holling and Gunderson 2002).

In order for systems to adapt, the laws and rules of engagement for those systems also need to change (Dietz, Ostrom and Stern 2003). Laws for complex environmental systems do not often account for scale and have an intrinsic demand for certainty, as is needed for clarity within the legal process (Craig 2010a). This is particularly evident in the western United States, where a host of complex regulatory frameworks often constrain the ability to manage natural resources with flexible and adaptive measures. Thus, managing for resilience will likely require reform of law to account for the dynamics of social-ecological systems (Cosens 2010, Benson and Garmestani 2011, Bierbaum et al. 2013a). Since natural and human systems are not linear, nor predictable, our management of these systems should reflect that reality. One way natural resource managers, decision makers, and planners are addressing this is through adaptive strategies (Berke, Kartez and Wenger 1993, Burby et al. 1999).

Adaptive governance is an overarching framework containing the tools of adaptive management and adaptive planning. Adaptive planning is literally planning for adaptation in the sense that it includes as a myriad of plans as well as monitoring and trigger points at which the plans should be revisited in order to be adjusted (Arnold 2010a). These steps are much like adaptive management, which is best understood as on the ground experiments (Kato and Ahern 2008), but in a more complicated political process.

It is useful to think about adaptive governance in terms of this dichotomy between the existing (and possibly in need of repair) system and a gradual transition to a new arrangement (Scholz and Stiftel 2010). Adaptive governance looks to keep the aspects of the system that works while also achieving additional features to balance, for example, certainty and flexibility. It is the transition from one system to another that will require time and will need to involve many sectors, agencies, and policies in the process (Chaffin et al. 2016).

Theoretically, utilizing the outcome of experiments seems like an ideal way to continue to assess the successes or failures of a management strategy. This aspect of adaptive management is what Holling referred to in 1978 as the proactive means of learning by doing (Holling 1978). However, natural resource managers are not recognized for their ability to achieve the unexpected, they are rewarded and respected for their ability to manage within given parameters. The essence of what differentiates adaptive management from conventional management is the experimentation phase. Unexpected outcomes, then are not seen as failures in adaptive management, but as opportunities for continued learning (Huitema et al. 2009, Dallmeier, Alonso and Jones 2002).

The lessons learned from these processes are then fed back into the cycle and can lead to management adjustments. However, adaptive management has been criticized for its inability to successfully incorporate the feedback into practice - noting that this is primarily seen in the adaptive planning phase (Arnold 2010a).

Adaptive management is a means of working through what has been planned. Adaptive management is really a style of management that should only be used after parties agree to an agenda using the adaptive approach, which is not the main way it has been utilized (Lee 2001). It is very action-oriented without much planning (Arnold and Gunderson 2013). The ability to alter the actual plan or goal after learning from previous experiences and results is more of a feature of adaptive planning, where there is adequate attention and resources devoted to periodically revising plans. Thus, an adaptive plan is more like a guideline to follow than a rule that can't be broken (Arnold 2005).

For the purpose of this paper adaptive planning is defined as the evolving process of goal oriented natural resource decisions that are based on adaptable, dynamic, and iterative plans. This seems like a *Catch 22* in the ability to not only plan for change, but also have policies and procedures in place to implement these plans. Managers no doubt have a difficult time successfully managing a strategy knowing that it may be subject to change during the next review process. It may make it difficult to take ownership of or feel a stake in these types of initiatives. Similarly, it is difficult to develop budgets around uncertainties. However, this is where adaptive planning takes on the important role of building legitimacy through engagement. Not only are decision makers key to the participation process, but also stakeholders, the public, and related officials. Where other forms of adaptive management decisions are mostly made by resource managers, scientists and experts (Arnold 2010a). The inherent community engagement of adaptive planning has been recognized as a means of reducing vulnerability to future change (Abramovitz et al. 2001, Tompkins and Adger 2004).

The western doctrine of prior appropriation creates a property right to use of water while retaining state ownership. Historically, much of the flexibility in water law has been provided through the property prong by allowing individuals to transfer (market) water and through the public prong by state and federal development of new water resources. Many state water-planning activities address this later aspect, i.e. the planning needed to meet growing demand. As climate change unfolds that planning must not only be broader to encompass response to long-term changes in supply and greater extremes in variability, it must be adaptive. To better understand how the engagement component of adaptive planning, as well as other integral facets of the theory result in a more resilient system, this paper looks to the key features of adaptive planning and compares them to a case study in southern Idaho. Using the lens of adaptive planning to look at the historic water agreement between ground and surface water users in an already over allocated region in this semi-arid region, can illuminate areas of success and room for improvement in adaptive planning.

Long-Term Settlement: Adaptive Planning

The types of water governance that connect knowledge with action are the most resilient (Huitema et al. 2009, Huntjens, Pahl-Wostl and Grin 2010, Nelson, Adger and Brown 2007, Lejano and Ingram 2009). Oftentimes agreements are not successful because there is not a broad range of participants in the creation of the plan. When the conventional methodology of a top-down hierarchical approach is used, an agreement can lack buy-in from participants (Arnold 2010b, Scholz and Stiftel 2010).

Adaptive planning requires participation from all areas of stakeholder interests to stimulate learning and to build trust and capacity, all of which are fundamental to improving water governance over time (Kirchhoff and Dilling 2016a, Gerlak and Heikkila 2011, Cosens et al. 2017). Participation can also increase compliance by presenting a transparent, participatory process (Sabatier et al. 2005). In fact, multi-level interactions between different levels of government and the public in water-related decision making has been shown to be critical to resilient governance (Kirchhoff and Dilling 2016a, Neil Adger, Arnell and Tompkins 2005, Huitema et al. 2009, Huntjens et al. 2011, Olsson et al. 2006, Kok and De Coninck 2007). Additionally, these conventional ways of decision-making have been criticized for their inefficiency, inability to adapt, and stagnancy (Kirchhoff and Dilling 2016a, Huitema et al. 2009, Johnson 1999).

In this paper we build on the body of adaptive governance literature by analyzing the components of a settlement between ground and surface water users in the Magic Valley, Idaho, USA, that facilitates adaptive planning. To look holistically at this shared resource governance, we utilize a conceptual framework that focuses on two main arenas of adaptive planning. First we examine the role of flexibility within the legal system for adaptability to emerge and ultimately provide legitimacy through structure, capacity and process (Cosens et al. 2017). Secondly, we assess the aspects of adaptive planning using a set of criteria for evaluating governance options that focuses on interrelated components of efficacy and fairness, essential to meeting challenges of the water settlement (Kiparsky et al. 2016). This conceptual framework balances the overlapping criteria of adequate resources, human capacity, and authority with the social elements of participation, representation and transparency to reflect the holistic reality of conjunctive management in a semi-arid region.

While there is a wealth of literature on water law and drought, few analyses evaluate how climate change impacts may be affected by water laws and regulatory structures (Kenney et al. 2008, Kiparsky and Gleick 2003) and how local entities may already be self-organizing to adapt (Chaffin, Craig and Gosnell 2014). Regionally, there have been studies examining mitigation or adaptation measures on climate change impacts to water resources (Hamlet 2011, Dalton et al. , Abatzoglou et al. 2014a, Diffenbaugh 2014), and outside of law reviews, several papers tackle climate change impacts and water law (Osofsky 2007, Slaughter and Wiener 2007, Zinn 2007), while focusing on prior appropriation as is necessary for western water law examination. Those that have addressed prior appropriation e.g. (Tarlock 1991, Carter and Morehouse 2001) and long-term drought e.g. (Slaughter and Wiener 2007, Trelease 1977) did not also examine the additional impacts of climate change impacts unique to the western U.S. The studies on climate change and rain-snow dominated watersheds focus primarily on hydrologic changes (e.g. (Hamlet et al. 2005, Mote, Hamlet and Salathé 2008, Gillan, Harper and Moore 2010)) and do not also consider management or legal influences (Qualls et al. 2013). Some have studied the combination of observed and projected climate changes into the future of water resource management, policy and planning (Cosens et al. 2014) and specifically addressing drought planning (Anderson et al. 2008, Cosens 2016). This work contributes to literature in the field addressing the need for understanding future water management not only in regards to the changing climate and its impacts, but in terms of water rights and policy alternatives (Dalton, Mote and Snover 2013, Tarlock 2012).

Climate Change Context

Primarily two types of seasonal phenomena affect climate variability in Idaho: the Pacific Decadal Oscillation (PDO) and the El Niño Southern-Oscillation (ENSO). These phenomena relate to seasonal variability within the Northwest, and in combination with climate change, can mask or enhance its effects. Despite the PDO and ENSO short-term climate patterns, long-term temperature trends within the Northwest are projected to warm more than 3.4°C (6.1°F) by the 2080s under "business as usual" greenhouse gas emission scenarios (RCP 8.5)

Potential evapotranspiration is a measure of transpiration and evaporation that would naturally occur annually if all water needed were available to do so. An average crop to use as a reference point is a well-watered grass surface. There is an increasing trend of variability in cool season precipitation (Hamlet and Lettenmaier 2007, Abatzoglou et al. 2014b, Safeeq et al. 2016) and decreasing precipitation in the summer months in Idaho (Dalton et al. 2013).

These precipitation data minus the potential evapotranspiration values (Figure 3-1) result in water deficit for the area (using localized projections under the 8.5RCP scenarios) of -38.3 inches in the 2025s, -41 inches in the 2055s, and nearly -44" in the 2085s (NW Climate Toolbox, Magic Valley, ID).

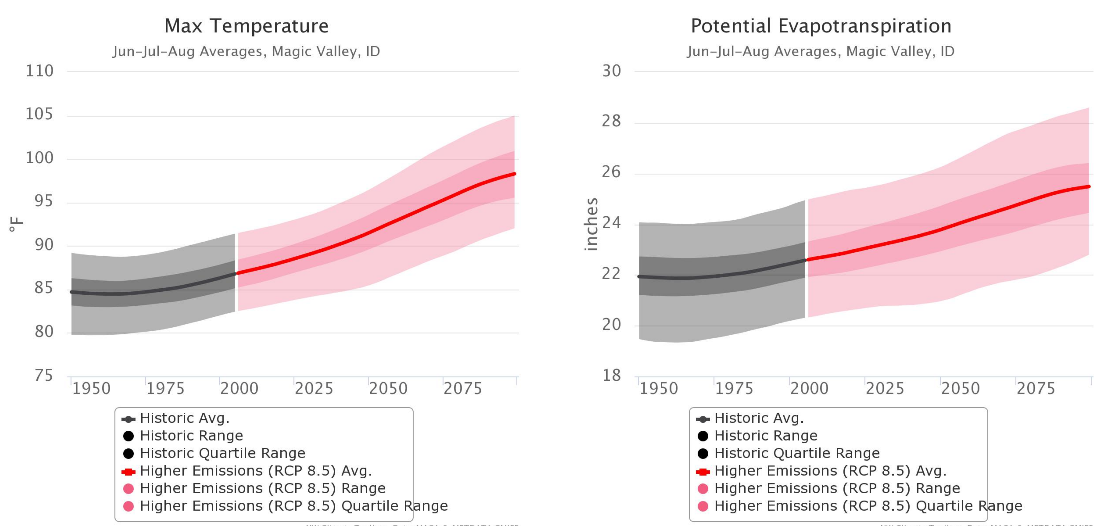

Figure 3-1: For the semi-arid region in southern Idaho, the maximum temperature and the potential evapotranspiration are projected through 2080 showing an increase in both variables despite the emissions scenarios (Image Credit: The Northwest Climate Toolbox).

Idaho is a mountainous state with watersheds that are historically a snow dominant and mixed rain-snow region characterized by peak runoff that lags behind peak precipitation. Mountain snowpack is the most vital part of the annual water supply for many northwest watersheds (Graves 2009, Luce 2018, Cayan et al. 2016), and the lag in runoff provides an essential part of water supply relied on in warmer months. However, Idaho will have less snowpack in the rain-snow dominate watersheds due to climate warming (Hamlet et al. 2013, Rupp et al. 2017, Lute et al. 2015).

Additionally, the peak runoff of snowmelt in northwest streams is shifting (Rauscher et al. 2008) and occurring about a month earlier than the historical average (Dudley et al. 2017, Jones, Muhlfeld and Marshall 2017). Figure 3-2 shows mean results from 10 different climate models' projections and the increase in streamflow cubic feet per second (cfs) as well as the earlier timing of peak stream flow. The timing of snowmelt and peak streamflow is important because of the necessity of adequate water supplies later in the season to be used for irrigated agriculture (Pathak, Kalra and Ahmad 2017, Malek et al. 2017, McNabb 2017). Lower summer stream flows will adversely affect the salmon populations (Mantua, Tohver and Hamlet 2010). For western communities these impacts will result in the increase of drought occurrence (Overpeck 2013, Dai 2013, Abatzoglou and Rupp 2017) and severity (Peterson et al. 2013, Luce et al. 2016, Crockett and Westerling 2018) and increased sensitivity to future warming (Rieman and Isaak 2010, Qualls 2013).

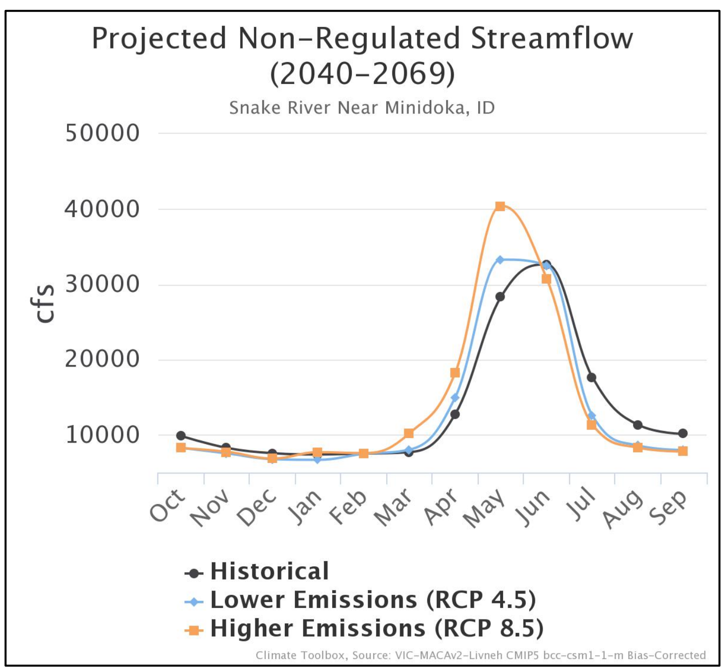

Figure 3-2: Projected streamflow in cubic feet per second (cfs) per month. The different colors correspond to different emissions scenarios; the black line represented observed amounts (Image Credit: The Northwest Climate Toolbox).

With these hydrologic changes to Idaho's water regime come increased susceptibility to wildfires and overall forest health (Barbero et al. 2015, Littell et al. 2009).

The regional economy is significantly affected by changes in temperature and precipitation as they can impact not only irrigated agriculture, but also hydropower and recreation and tourism. In the Columbia River system projected decreases in hydropower production, due to warming temperatures, are about 20% (Hamlet et al. 2013) Idaho's agricultural exports were $607 million in 2017 (Idaho State Department of Agriculture, 2017). The contribution of crop farming to Idaho's labor force is over $517 million (IMPLAN, 2015). Hydroelectric power generation has an industry production value of nearly $100 million. The hydroelectric industry in Idaho is in the top 30% of Idaho's over 500 different industries (IMPLAN, 2015). Sixty percent of the land is Idaho is public land and outdoor recreation, centered around these lands and the state's 107,651 miles of river generated $6.3 billion in consumer spending (Outside 2017).

Since water management in the Northwest is based on historical snowmelt and the timing of that snowmelt runoff (Markoff and Cullen 2008, Adam, Hamlet and Lettenmaier 2009, Clifton et al. 2018) the human responses to mitigate the changes in surface water may alter storage allocations (Dalton et al. 2013, Qualls 2013). In order to juggle the many responsibilities of water management, more difficult decisions will need to be made for reservoir storage. Estimated increase in population growth in the western United States was projected to be nearly 46% between 2000 and 2030, only increasing the amount of water needed by municipalities (Colby and Ortman 2015).

Other states in the region have adopted climate adaptation plans to prepare for and mitigate these changes (e.g. Regional Integrated Sciences Assessments (RISAs) and Community Information Resource Centers (CIRCs). The 2015 drought in Washington has been identified as representative of conditions to come (Marlier et al. 2017). In response, the state of Washington financially supported future drought response efforts, drought contingency plans were updated, safeguards to fish and stream flows were secured, and critical energy supplies maintained (Ecology 2016). Similarly, Idaho could decrease its vulnerability to the impacts of long-term drought by taking appropriate measures to plan for future risk. Many of the water resource problems are more about governance and less about the actual resource (Rogers 2006). Identifying barriers to achieve adequate planning is imperative, (Knüppe and Pahl-Wostl 2011, Rogers and Hall 2003).

The impact of drought on water rights in Idaho need not be limited to drought due to lack of precipitation. The summer of 2014 had record high precipitation levels. The rainfall provided irrigation respite and added unusually high amounts of recharge to reservoirs. This high storage carryover combined with over 100% average snowpack in 2015 on the Upper Snake was cause for the Bureau of Reclamation to spill water from the reservoirs to stay within flood curve rules. What appeared to be a very water rich season was followed by below normal snowfall and four months of drought, inevitably leading to a call for curtailment of junior users to satisfy senior water use in 2015 (Budge, 2015).

Case Study: Magic Valley Conjunctive Management

The Snake River is the Columbia River's largest tributary as well as a vital source of irrigation water for Idaho's crops. Similarly, the aquifer it sits above is one of the largest and most prolific aquifers in the nation and is often referred to as the life-blood of Idaho (Idaho National Laboratory 2005). The U.S. Geologic Survey has estimated the total storage of the Eastern Snake Plain Aquifer (ESPA) (figure 1) to be nearly 250 million-acre feet. The recharge of the aquifer each year comes in primarily two forms. First, the seepage from irrigation in the region is responsible for much of the recharge, and secondly, natural recharge in the form of precipitation and stream loss, adds to aquifer levels (USGS accessed 2017). According to the Bureau of Reclamation (BOR), groundwater levels reached their historic low in the 1960s after a spell of many dry years and increased groundwater pumping.

The landmark water agreement struck between the surface and ground water users in the south-central agricultural hub of Idaho is chosen as a case study for its innovative ability to reduce uncertainty from future water use in the eastern Snake Plain region. The settlement agreement will avoid continued litigation in the region through adaptive planning measures, utilization of best available science, and incorporation of short and long-term goals. These long-term goals include recharging the declining Eastern Snake Plain Aquifer (ESPA) along with curtailment of wells that pump from it The agreement balances certainty with the need for adaptation to change by taking a long-term, yet adaptive approach to allocation and thereby reducing the year-to-year uncertainty that strict application of the doctrine of prior appropriation would impose.

Physical Context:

Conjunctive water management addresses the inherent hydrologic connectivity of the eastern Snake River plain. The connectivity between the aquifer, groundwater and surface water systems is a complex interaction of the lithology, geology and hydrology unique to the area. These hydrologic interactions determine a large portion of the effect of climate variability on the system. The Snake River plain has its headwaters in Wyoming near the national parks of Yellowstone and Teton; the Snake River basin itself continuing west to the Oregon-Idaho border.

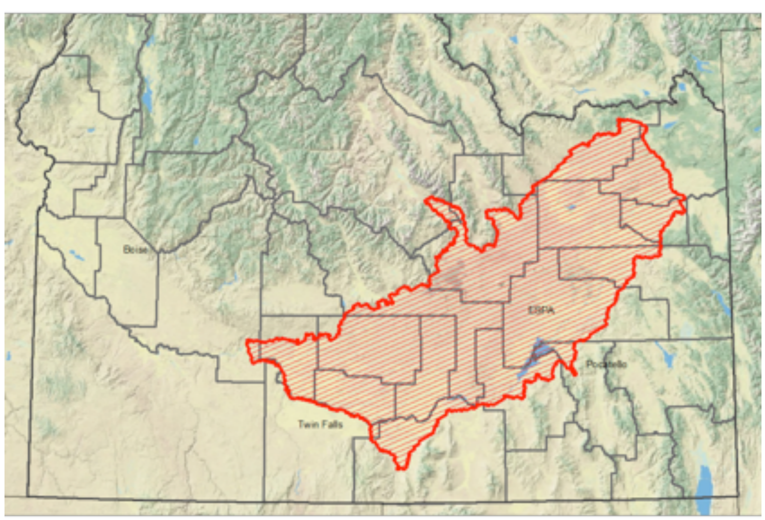

Figure 3-3: The Eastern Snake Plain Aquifer, outlined in red, located in southern Idaho.

The Snake River basin is made up of three reaches: above American Falls, American Falls to King Hill, and below King Hill (Figure 3-3). The reach above American Falls contributes more than 40% of the Snake's natural flow to irrigation. The middle reach from American Falls to King Hill has allocated 30% of the basin flow to irrigation water. And lastly, the lower reach, below King Hill, is not considered as contributing much to irrigated agriculture in the region (Qualls et al. 2013).

The eastern Snake River plain sits atop dense basalt flows and heavily woven sediments (Link and Mink 2002). The aquifer itself is nearly 11,000 square miles. Given that a majority of the irrigated agriculture and trout farming is conducted along or above the Snake River, recharging the aquifer for groundwater pumping to maintain these industries had been of major concern to a variety of stakeholders. Second in the nation for irrigation withdrawals, Idaho draws over 18.5 million acre feet (AF) annually from the aquifer (Qualls et al. 2013).

Over 2 million acres are irrigated on the ESPA region (60% of Idaho's total). The sources of those water are nearly equally split with 871,000 acres from surface water and 889,000 acres from groundwater (the remaining 348,000 acres from mixed sources (2009, ESPA CAMP). Both the ESPA and the river are managed in the same way. Not only does the state recognize this is a hydrologic relationship but, since *Musser v. Higginson* (Idaho 1994), a legally recognized relationship as well.

It is the goal of the state of Idaho to additionally recharge the aquifer at an eventual rate of 250,000 acre-feet per year to restore aquifer levels; though in 2015 this rate was only about 68,000 acre-feet (IDWRB 2016). The U.S. Environmental Protection Agency (EPA) designated the aquifer in 1991 as a sole source aquifer (Idaho Administrative Code 37.03.11.050) (DEQ 2017). This designation recognizes that at least 50% of the drinking water for an area comes from this source. The ESPA provides potable water to over 200,000 people in southeastern and south central Idaho (DEQ 2017).

Historical Context:

Idaho, like much of the western United States receives 5-15 inches annually of average precipitation – compared to most eastern states, which receive annual amounts of 35-60 inches. In the arid west, riparian water law – where one can have rights to access a water source that is on her property – simply was not conducive to the needs of development. In order to be productive and have a growing economy, western communities needed to divert water from streams and rivers and put that water to use. The simple act of doing this, diverting water and putting it to a beneficial use, gave a western denizen a common law water right. With sparse population and large river flows, this common law of many western states of "first in time, first in right" worked much better than manipulation of riparian water law could have.

As development grew in the west through mining and irrigated farming, disputes arose when one water user's rights infringed upon another's. These matters were settled by the law of the state, the authority of which in *California Oregon Power Co. v Beaver Portland Cement (1935*) identified the removal of water from public lands to be available for appropriation according to local customs (*California Oregon Power Co. v. Beaver Portland Cement Co.,* 295 U.S. 142 (1935)). Prior to the 1970s (and the required permitting system) these customs often required users to prove who was the senior water right holder by having diverted and put the water toward beneficial use first. Once this was established, the settlement was based on prior appropriation where the senior water right holder is allotted 100% of her reasonable use and the junior water right holder is allotted her share (or what remains available) after the initial senior use.

Prior appropriation was practiced in the west and seemed generally to serve its citizens well, as in the case of Idaho, "the right to divert and appropriate ... to beneficial uses ... shall never be denied" (I.C. § Article XV Section 1). The weaknesses of this practice were not fully realized prior to the 20th century and would eventually have to be addressed. These weaknesses included a lack of recognition of environmental water "rights" such as necessary instream flows, quantification and regulation of groundwater pumping, and addressing water allocation in drought scenarios.

Settlers of Idaho quickly realized they had a limited water supply in certain areas during the dry summer months (Harrington 2012). As settlements grew further and further from the main sources of water diversion dams and canals were necessary to move water to arid agricultural regions. These types of projects would not have been possible without the help and incentive of the federal government. To assist with the development of the arid west, the U.S. Congress established the Reclamation Service in 1902. Their first project in Idaho was the Minidoka Project along the Snake River in the Magic Valley (Figure 3-4). Since then nearly 100 additional projects have been built on the Snake River and its tributaries in Idaho.

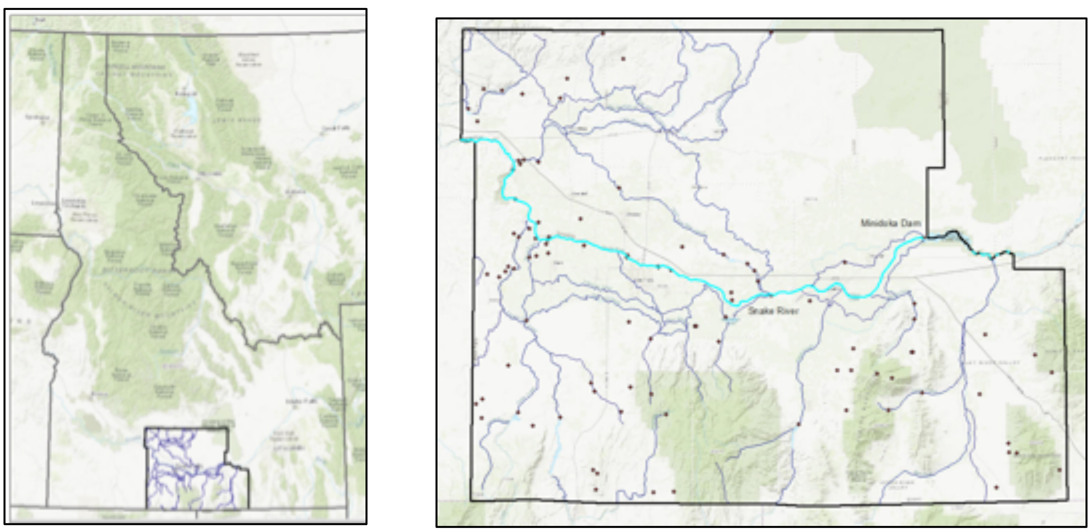

Figure 3-4: The Magic Valley inset in the state of Idaho at left and further detail at right of the first project in Idaho along the Snake River at Minidoka.

In the 1920s an advisory committee, called the Committee of Nine, with representatives from more than 60 canal companies, was created to deal with the water distribution in the arid region; prior appropriation was a useful tool in doing so (Fiege 2009).

One of the most significant results from a prior appropriation dispute in the west came out of this region. The landmark case resulting in the Swan Falls Settlement of 1984, highlighted in the failure to record and define many of the water rights in Idaho prior to development of a mandatory permit system for groundwater in 1965 and surface water in 1973 (I.C. § 42-201). The details of the case actually date back to 1952 when Idaho Power Company subordinated its rights to upstream users on the Snake River in a deal with then Governor of Idaho, Len Jordan to gain his support of the three dams called the Hells Canyon Complex (Jones 2016). Thirty years later ratepayers questioned whether this subordination extended to an earlier dam at Swan Falls; if not upstream users' rights could be curtailed. Since many of these upstream users were producing a robust amount of Idaho's agriculture, a curtailment would have had a significant negative ripple effect through Idaho's economy. This drew the interest of many stakeholders in the region. The court's initial ruling was that the right at Swan Falls was not subordinated (*Idaho Power Co. v. State of Idaho* 1982). However, since Idaho Power had not exercised that full right, there was a risk of a determination that the unused portion was forfeited (Idaho law considers 5 years of non-use of a water right as forfeiture). Thus, both sides of the issue were at risk if further litigation took place. Idaho's governor at the time of the case, John Evans, eventually became involved in seeking a compromise between Idaho Power Company and the state of Idaho. The Swan Falls settlement resulted in an agreement to a smaller water right in the irrigation season in return for an adjudication of all surface and ground water rights in the Snake River Basin to set the stage for administration of the allocation of water.

In 1987 an administrative and legal process known as the Snake River Basin Adjudication (SRBA) began (ID Code 42-1406A). The goal of the process was to identify and catalog all water right claims in the Snake River Basin (IDWR). The adjudication of water rights was an enormous endeavor and the undertaking was not complete until 2014. Understandably, more water law decisions in the state of Idaho were made in the 27 years of the SRBA than in the previous 97 years of Idaho's statehood (Vonde et al. 2016). Overall, the Swan Falls Settlement and the initiation of the SRBA has signified a shift in management of Idaho's water resources. The transition being one that looks to benefit future development of public waters to one that also balances development with protection of uses through integrated water management (Strong and Orr 2016), meaning conjunctive management of ground and surface water.

Groundwater diversions, thanks to Idaho Power's previously cheap and clean electricity, is what allowed for much of the mid-century agricultural development in an otherwise inhospitable landscape unserviceable by canals and surface water diversions (Fiege 2009). The combination of more efficient irrigation (i.e. transition from flood irrigation to sprinkler irrigation systems) and the cumulative groundwater pumping significantly reduced the amount of water stored in the Eastern Snake Plain Aquifer (Ryu et al. 2012). The declining amount of water was compounded by the fact that low ESPA levels meant declining spring flows for surface water users (Johnson et al. 1999).

These factors culminated in 1992 when the Idaho Department of Water Resources placed a moratorium on new water permits from the ESPA (ESA Moratorium Order 19930430, IDWR). The moratorium came after six consecutive years of drought in the late 1980s (Matthews 2016). And in 1995 IDWR was ordered, in Musser v Higginson to treat ground and surface water in the ESP as one source for purposes of administrating a call. Two years later, the state promulgation of the Rules for Conjunctive Management of Surface and Groundwater Resources (IDAPA 37, Title 03, Chapter 11(37.03.11), Title 67 of IDAPA and I.C. Section 42-603).

Governance Context:

Historically, most of the litigation in Idaho regarding water rights and priority dates has been based on cases regarding surface water use. The addition of legal cases regarding groundwater pumping created a new dynamic in terms of how the water supply is being affected by groundwater use since the speed at which groundwater travels is much different than surface water, affecting the timing of injury to senior users. Additionally, groundwater pumping has cumulative impacts over time that may be more difficult to measure whereas the diversion of surface water is only cumulative in the context of water storage and is much more identifiable and easy to measure (Ryu et al. 2012).

The Ground Water Act (I.C. § 42-201), enacted in 1951 states: “while the doctrine of 'first in time is first in right' is recognized, a reasonable exercise of this right shall not block full economic development of underground water resources” (I.C. § 42-226). IDWR has the authority to set reasonable groundwater pumping levels on a case-by-case basis to protect seniors against unreasonable levels of pumping by junior water users.

These issues were decided in the 1970s case where the court held that the pumping of an aquifer at rate which exceeds the annual rate of recharge (i.e. mining) is not allowed and wells would be curtailed in order of priority to achieve the equivalence between pumping and recharge (*Baker v. Ore Ida Foods,* 1973). The Baker case also established precedent for well depth to be protected at reasonable levels regardless of seniority; and the court rejected the argument that senior water rights could be modified (outside mining and reasonable levels of well depth) to achieve full economic development.

In the landmark case *Musser v. Higginson* (Idaho 1994) the question of whether administration in priority extends to impacts of wells on senior surface rights came to the Idaho Supreme Court decision. When a surface water user (Musser) recognized a decrease in water and asked for an administrative call on groundwater pumpers. The Idaho Department of Water Resources represented by the director (Higginson) refused to do so, stating that the department is not able to make a call as such without a hydrologic finding. Ultimately the Idaho Supreme Court stated that the Idaho Department of Water Resources must enforce a call by senior surface water users against junior ground water pumpers. The result of this decision was a need for surface and groundwater to be managed conjunctively if they are hydrologically connected.

Conjunctive Management Rules

The rules for conjunctive management of surface and ground water resources were adopted by IDWR in 1994, followed by approval in the Legislature in 1995 (IDAP 37.03.11, I.C. 42-605). Table 1 summarizes key aspects of the rules. To clarify how these two resources would be managed, IDWR defined conjunctive management as having a “common ground water supply: where the ground water affects the surface water” (010.03). The Conjunctive Management Rules (CMRs) are applicable in situations where water use and diversion by junior users causes material injury to use of water by senior users (020.01).

These rules and their interpretation by the court both clarified the application of existing water law to the complex case of interference between junior groundwater use and senior surface water use and modernized Idaho water law by (among other things) taking an evolving view of reasonable use through the requirement of “material injury” before a call may occur; defining “futile call” in the context of the time lags associated with ground-to-surface water interaction; and by allowing junior users to develop a mitigation plan and thereby avoid curtailment.

In 2005, after the conjunctive management rules were promulgated, the first administrative delivery calls were made ordering junior groundwater users (priority date of 1979 and later) to either curtail use or provide a mitigation plan to rectify use of 133,400-acre feet to senior water users. Both parties challenged the ruling in 2005 in the American Falls Reservoir District Case in regard to the constitutionality of the conjunctive management rules (CMRs). Both parties agreed to all the details as stated to allow the case to go forward on summary judgment motion as a facial challenge to the constitutionality of the administrative rules.

The case answered fundamental questions about Idaho water law in regard to groundwater that had not been decided before including: proof of injury, defining futile calls, full economic development, and use of water models to determine cumulative effects of water pumping. Essentially, the American Falls this case set the stage for junior users to have to answer for actual material injury they cause senior water rights holders and those are subject to several public interest considerations. American Falls upheld the constitutionality of the progressive conjunctive management rules. This is an example of how Idaho water law can support adaptive capacity. Idaho has possibly gone further than any state in allowing the quantity of water under a water right to evolve. Additionally, the director of IDWR is obligated to investigate senior users' injury claims.

Material Injury

A senior water user is only protected from junior water use that results in material injury. In order for the IDWR to determine "material injury" (defined as a "hindrance to or impact upon the exercise of a water right caused by another person as determined in accordance with Idaho Law") and reasonable use there are numerous factors taken into consideration including: the senior water user's effort and expense of diversion, impacts to the quantity, timing, and costs, diversion rate in relation to acreage irrigated, annual volume diverted, efficiency and conveyance of diversions, irrigation methods, and diversion rates in relation to total water rights (CMR 42). This evolving view of material injury allowed for adaptation within the doctrine of prior appropriation in that the senior water users have to found to have been injured before a junior water user can be curtailed. This puts the burden of proof partially the senior water user to show the reasonable use of their water right (not their full paper water right which is a maximum, not a measurement of material injury) is affected by the groundwater pumping. A reduction in water supply, then, due to groundwater pumping resulting in groundwater depletion is not necessarily a finding of injury.

Mitigation Plan

Finally, the conjunctive management rules also identify factors that IDWR will include when considering the validity of a mitigation plan (CMR 43). According to Rule 42.02, the "holder of a senior priority right will be prevented from making a delivery call for curtailment of pumping of any well used by the holder of a junior priority groundwater right if junior right is covered by an approved and effectively operating mitigation plan".

Mitigation Plans can be phased in over a 5-year period and have a wide range of benchmarks taken into consideration for a plan to be acceptable to IDWR. Additionally, the mitigation plans can work within the Idaho prior appropriation law, but still allow junior water rights holders to access water out of priority if needed. The significance of this is to ensure the mitigation plan that takes the place of a curtailment call is more than just a paper document plan, but one that assures senior priority protection. Additionally, while the mitigation plan has to be approved by the director of IDWR, it is encouraged that the junior ground water pumpers and the senior surface water users settle on the formulation of the mitigation plan – though it is not required.

CONJUNCTIVE MANAGEMENT RULES	
CMR RULE NUMBER	**ASPECTS THAT ENHANCE ADAPTIVE CAPACITY**
Rule 20.03 Reasonable Use	This allows for priority rights to be subject to a) conditions of reasonable use (Article XV, Section 5, Idaho Constitution), optimum development of water resources in the public interest (Article XV, Section 7, Idaho Constitution) and full economic development concluding that there is room in the CMR for an appropriatorto be limited in volume of water (surface or ground water) if contrary to the public policy of reasonable use of water.
Rule 10.08 Futile Call	This definition of a futile call becomes more difficult with ground water than with surface water, but the aspect that enhances adaptive capacity is recognition that a call from a senior water user to a junior water user must be able to be satisfied within a reasonable amount of time and that the call would not waste water. Nevertheless, unlike a surface –to-surface water call in which it is deemed futile if the water will not reach the senior user within the same irrigation season, conjunctive management recognizes the long lag times and the cumulative impact of over pumping, thus allowing a remedy for impacts that may be spread over a number of years.
Rule 10.42 Material Injury	IDWR takes into consideration a variety of factors such as efficiency of water use by the senior water right holder, the reasonableness of the diversion amount and means of diversion. The inforamtion gathered comes from both parties and often includes expert reports and analyses, including groundwater models.
Rule 10.43 Mitigation	Can allow for pumping out of priority to accommodate specific situations and can be phased in over the course of 5 years so adjustments can be made gradually. IDWR also takes into consideration whether the plan is consistent with the conservation of water resources, the public interest of injuries and rate of recharge.

Table 3-1: Conjunctive Management Rules (CMRs) with column identifying which aspects enhance adaptive capacity.

Since 2000, ground water users in the ESPA area have defended fifteen different delivery calls made by senior right holders, be it surface, spring or ground water rights (Budge, 2015). Five of those calls were fully litigated before the IDWR, SRBA Court, and the Idaho Supreme Court. In order to avoid curtailment of junior groundwater rights the IGWA (Idaho Groundwater Appropriators, Inc., made up of eight groundwater districts and two irrigation districts representing nearly 2,500 water users) secured mitigation plans involving a wide range of solutions such as water exchanges, groundwater recharge, water delivery and water use reductions. The estimated cost of these mitigation actions is over $65 million (Budge, 2015).

In summary, the key points of the Conjunctive Management Rules (outlined in Table 3-1) can be seen through the evolving definitions of a common groundwater supply where one source is affecting the use of another (CMR 10.01), full economic development as reasonable, not causing injury to others and not exceeding anticipated annual recharge (CMR 10.07), futile call as not being feasible to satisfy a call in a reasonable amount of time or resulting in the wasting of water with the physical differences of groundwater taken into account (CMR 10.08) and reasonable pumping levels for ground water as established by IDWR on a case by case basis (CMR 10.18).

Long Term Planning and Settlement

Over twenty percent of all goods and services in the state of Idaho are produced in the eastern Snake River plain. This water-reliant productivity is estimated to be worth $10 billion a year (Board 2009). In this productive region of the state, avoiding water calls based on prior appropriation, is avoiding an estimated $90 million economic impact (Stapilus 2008). Once the water users understood that senior users would be held to a high standard of avoiding waste and junior users would be held to prior appropriation, both sides as well as the State had incentive to seek long-term solutions.

State Measures

In order to address the long-term management strategies needed to tackle the supply and demand imbalance in the ESPA, a comprehensive management plan was passed into law in 2009. A series of phases allowed for gradual implementation of increasing aquifer storage. The Comprehensive Aquifer Management Plan (CAMP) for the ESPA deliberately sought these incremental changes through adaptive management in order to address the variability of the complex and integrated water system (Board 2009). It is worth noting that despite the State's lack of funding during the economic downturn, many of the objectives researched in the CAMP make it to the settlement agreement.

The stated objectives of the ESPA CAMP were fivefold: increase predictability for water users by managing for reliable supply, create alternatives to administrative water use curtailment, manage overall demand for water within the eastern Snake River plain, increase recharge to the aquifer, and reduce withdrawals from the aquifer (Board 2009). As we will see, these goals are revisited and refined in the historical 2015 agreement between surface and ground water users in the Magic Valley.

In May 2006 the United States Department of Agriculture (USDA) and Commodity Credit Corporation (CCC) came into agreement with the state of Idaho to improve the water quality and quantity in the eastern Snake River plain. The Idaho Conservation Reserve Enhancement Program (Idaho CREP), managed by the Farm Service Agency (FSA) addressed reducing consumptive use through irrigation by establishing more vegetative cover, from current cropland, which could also help with chemical and sediment runoff as well as create wildlife habitat (IDWR 2012).

The major goal of the Idaho CREP was to save up to 200,000 acre-feet of water a year by retiring up to 100,000 acres of irrigated land. The incentive for landowners located within ground water districts is about $30 per acre. However, since the CREP program inception the number of acres enrolled in land conservation has decreased. According to the annual report put out by the Idaho Soil & Water Conservation Commission (SWC) and the Idaho Department of Water Resources, this decrease in enrolled land is due to the significant increase in commodity prices (despite the fact that participants are required to pay a fee to break contracts that are cancelled).

Mitigation

These steps toward reducing pumping of the ESPA were coupled with required mitigation plans by junior groundwater users to senior surface water rights holders. For example, the 2007 purchase of Pristine Springs (in conjunction with a partnership with the North Snake and Magic Valley ground water districts and the city of Twin Falls) provided junior groundwater users with the necessary ten cubic feet per second (cfs) needed to mitigate the water call from Blue Lakes Trout Farm with a senior water right. According to a US State News Article, this purchase helped address a number of conflicts between and ground and spring water users in the Magic Valley (News 2008).

It is important to note that curtailment orders can happen every year. Since the Blue Lakes Trout Farm requires natural flow from the springs and has a senior priority date, this agreement puts a permanent end to an intermittent water call, allowing farmland to continue irrigation of up to 30,000 acres. The deal was a result of collaboration from then Governor Otter, representatives of the Idaho legislature and from the Idaho Water Resource Board. Approval of the acquisition by the Joint Appropriation Finance Committee was unanimously voted in favor in 2008.

In 2011 the Idaho Ground Water Appropriators (IGWA) purchased three aquaculture facilities in Hagerman Valley in southern Idaho. The IGWA raised 3.8 million dollars to purchase this water and pump it uphill to Rangen's fish farm. This purchase allowed for between 150,000 acre-feet to upwards of 200,000 acre-feet reduction in demand, meeting part of the ESPA CAMP objective as well as meeting terms of the Magic Valley settlement. Additionally, the state of Idaho had an obligation to use $5 million to purchase permanent private water rights in the Eastern Snake River Aquifer CREP area.

As these local short- and long-term mitigation plans proceeded, and the State led CAMP failed to receive funding, negotiations proceeded among water users to achieve a long-term solution. The case study of the historic agreement between ten groundwater irrigation entities represented by Idaho Ground Water Appropriators, Inc. (IGWA) and seven large canal companies known collectively as the Surface Water Coalition (SWC) in the Magic Valley in the semi-arid region of southern Idaho was chosen as a case study for adaptive governance because of its unique collaboration to ultimately eliminate future litigation by creating mitigation plans for not only near term needs but long term goals.

The water agreement is a settlement in distribution of water after the initial 2005 delivery call. The settlement agreement was signed on June 30, 2015 with the long-term practices outlined in the agreement commencing in 2016. The main area affected was the Snake River Basin above Milner Dam and in the Thousand Springs near Hagerman. The need for the agreement is summarized in the statement by all parties in the 2015 agreement itself stating: “The SWC, IGWA and State recognize that even with full storage supplies, present (2015) reach gain levels in the near Blackfoot to Milner reach (natural flows) are not sufficient to provide adequate and sustainable water supplies to the SWC.” With there not being enough water in good or “wet” years, as seen by the 2014 - 2015 water availability, addressing current and future water distribution was a top priority of all involved. To better understand the details of the settlement, we integrated two analytical frameworks, one used to understand adaptive capacity (Cosens et al. 2017); and one used to understand sustainable groundwater management. This integrated framework (seen in Figure 3.1) is transferrable to other communities seeking to utilize adaptive planning for increasing resilience to climate change impacts.

Application of the Framework for Adaptive Planning

The ESPA Settlement agreement is not merely a water allocation agreement or finalized mitigation plan. Its settlement does protect groundwater users from future curtailment as long as the components are adhered to, but it is also an adaptive document. It recognizes the impacts of changing water availability due to natural variability and climate change as well as human consumption and management strategies. Because of this recognition, the settlement looks holistically at the water shortages in the Eastern Snake Plain Aquifer region and in doing so identifies the need to be able to address short-term needs and long-term goals. We analyze this agreement by means of three main categories: capacity, process, and structure.

SETTLEMENT AGREEMENT ELEMENTS	
AGREEMENT FOCUS	**ASPECTS THAT ENHANCE ADAPTIVE CAPACITY**
Settle all present and future mitigation obligations ofjunior groundwater users to the SWC	Each participating district can chart its own way to achieve their reduction goals by practical and innovative means
Stabilize the decline in ESPA storage and restore ground water levels in the ESPA to protect and preserve water supplies for surface water users and groundwater users	Collaboration between both parties and the state to distribute burden of aquifer recharge
Provide a "safe harbor" from curtailment and water supply certainty to participating junior groundwater users	Groundwater users will receive certainty by removing the risk of curtailment for the future
Minimize economic impact to state economy and both parties	Once the goals are achieved, groundwater diversion reductions can be reduced or removed

Table 3-2: Elements of the Magic Valley Settlement Agreement and aspects that enhance its adaptive capacity.

As seen in Table 3-2, the main focus of the agreement was to achieve four goals. First, the agreement is a mitigation plan that fulfills the curtailment order from senior surface water users. Secondly, the settlement agreement looks to increase storage in the Eastern Snake Plain Aquifer. Additionally, the settlement sought to provide “safe harbor” from the possibility of curtailment to members of the agreement. Finally, it is a priority of the settlement to minimize the economic impact to the economy.

In seeking to better understand the essential components of the agreement and how they worked in concert with other aspects of adaptive governance, we apply the conceptual framework that combines the flexibility within the legal system for adaptability to emerge (Cosens et al. 2017) and the elements of efficacy and fairness, essential to meeting challenges of the water settlement .

The application of this framework (seen in Figure 3-5) reflects the complicated reality of conjunctive management for a shared water resource and can be applicable to other western communities. In effort to analyze the criteria for adaptive governance we group these main categories into the areas of capacity, process and structure and explain them in relevance to adaptive planning in more detail.

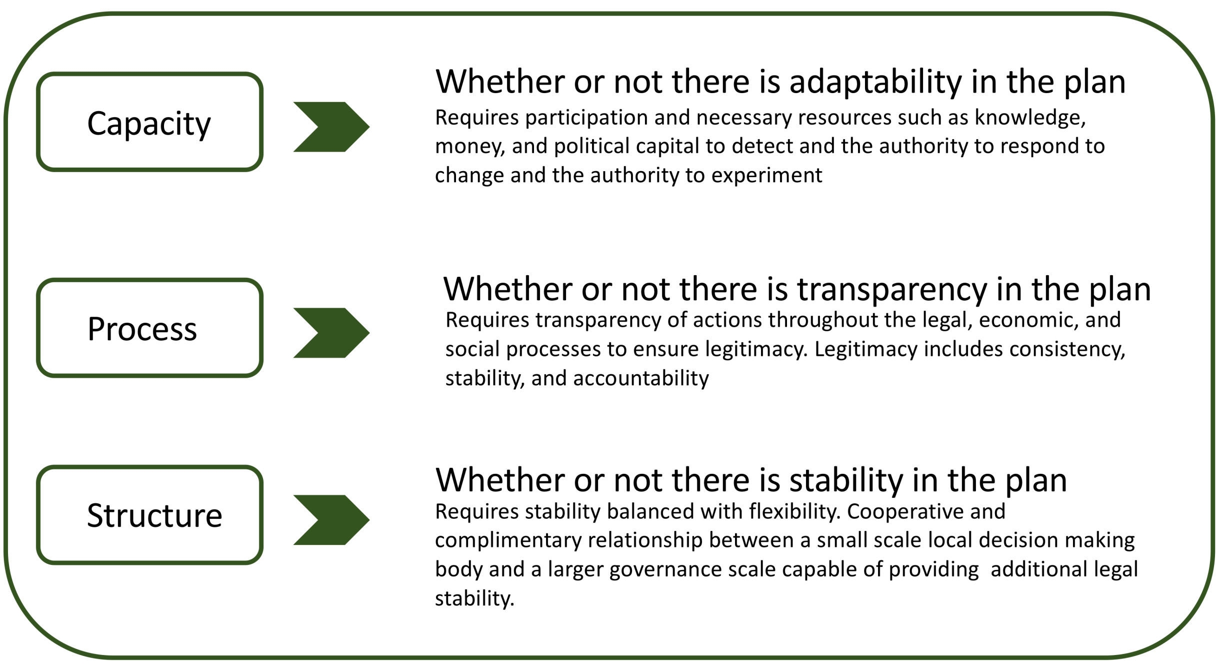

Figure 3-5: Visual representation of the conceptual framework of analysis.

Capacity

Capacity encompasses whether or not there is adaptability in the plan. This adaptability requires necessary resources such as knowledge, money, and political capital to detect and the authority to respond to change as well as the authority to experiment (Pahl-Wostl 2009). Additionally, it incorporates the role of authority and whether the participants affected have a role in decision-making. If there is the capability for participatory capacity in the process, the potential for marginalization is significantly decreased (Cosens et al. 2017). In general the elements that make up capacity include the legal access to decision-making and the adequate resources of knowledge, time, and money to participate in that process (Bingham 2009).

The settlement agreement between the SWC and the IGWA incorporated adaptive tools such as its holistic design for how to approach the problem and its inherent feedback loops, which gave way to opportunities for reflection and learning. One example of this is in the provision of “safe harbor” from curtailment to participating groundwater users. This reassurance of non-curtailment set the stage for some progress to consumptive use reduction through a variety of methods, since there was no fear of automatic curtailment if some methods were not as successful as originally planned.

As in the short-term practices, the IGWA in subsequent years is responsible for storage water through private leases. The IGWA pursuant to the agreement will provide 50,000 acre-feet of storage water to the SWC twenty-one (21) days after the date of allocation. If any water remains of the 50,000 acre-feet from the irrigation needs of the SWC, both they and the IGWA will determine how to use the remaining water. An adaptive management measure of the agreement also restrains the ground water users (GWU) by limiting their dates of irrigation to April 1 thru October 31.

The adaptive groundwater management plan, with the goal of stabilizing levels of the Eastern Snake Plain Aquifer were set to do so by 2020. The steering committee was *tasked* with the development of the plan and given flexibility in determining guiding principles for reaching benchmarks. Part of the flexibility of benchmarks can be seen through the two additional addendums made to the original settlement. The addendums modify components of the agreement, recognizing that if the goals were not achieved, modifications could and should be made to set feasible goals for success.

This flexibility and participatory leadership are essential attributes to adaptive planning. The ability to have the leeway to adjust the unattained benchmarks, while other components of the agreement have been met is an integral part of the process. Allowing for room for review and reassessment to reestablish the Settlement timelines is a way all parties are able to establish successful benchmarks given the various levels of uncertainty surrounding the complex issue.

The fact that the agreement and subsequent addendums have multiple goals, strategies and actions is where this plan is successful in the adaptive planning process. With the incorporation of conserving water use, recharging the aquifer and looking to alternative sources of water storage are all contributing to the overall longevity of the health of the region by creating buffers during times of drought. These long-term goals are able to address the issue in its entirety, rather than just symptoms of the broader problem.

A unique component of adaptive planning that sets it apart from conventional planning is the use of provisional knowledge. The historic settlement between the Idaho Appropriators and the surface water users is an example of a plan that accepts uncertainty. Historically, water managers have struggled to incorporate climate change information into their planning documents (Kirchhoff 2013, Kundzewicz and Stakhiv 2010). Ongoing and updated knowledge about water availability is important, as many irrigators who rely on a groundwater look to adequate forecasting to plan their water use for the season.

An example of illustrating the provision of knowledge to be used in improving management in the settlement agreement can be seen through the Idaho Department of Water Resources utilization of best available science and research to assist with proper management of ground and surface water. IDWR staff measured over 800 wells in the eastern Snake River plain and collaboratively used this information, along with measurements from the U.S. Bureau of Reclamation (BOR) and the U.S. Geological Survey (USGS) Idaho National Laboratory Project Office, to analyze over 1,000 wells' data. The cooperation between these organizations, and the data they collected, has resulted in a partnership to create a groundwater-flow model for southwestern Idaho. The use of hydrologic modeling, according to their 2017 fact sheet, will simulate potential anthropogenic and climate effects on groundwater for water supply planning and measurement (fact sheet 2017MISC), thus enhancing the capacity of the region to adapt.

Another way that this agreement represents a successful adaptive planning process is through the use of best available science, rather than relying on static data. In order to successfully manage ground and surface water in a way that reflects their interconnectedness, Idaho water law looks to hydrologic modeling as a source of knowledge about water availability from groundwater. Since a curtailment call can be made based on findings from these models, groundwater resources can be appropriately managed and planned for. Since curtailment orders are often avoided through mitigation plans, approved by the Director of IDWR, (Idaho Administrative Code n. 120 §37.03.11.043), there is no rigid deadline of a benchmark being made, if the mitigation plan can get senior users their water over a five-year period.

Process

The aspects governed by process really speak to the transparency of actions throughout the legal, economic, and social processes to ensure legitimacy. Legitimacy is necessary for broad support of those affected by the settlement and includes consistency, stability, and accountability (Cosens, 2017). Process also encompasses aspects of good governance and justice as seen through required actions governing transparency and inclusivity (Cosens 2013, Esty 2005). One of the major successes of this settlement is seen through its involvement of so many participants. Representation of this magnitude assists in the establishment of legitimacy from all angles, through engagement in the decision-making process. Additionally, legitimacy in this case looks to those parties that did not decide to sign on to the agreement and recognizes that they are continuously allowed to participate. This rolling invitation to sign on to the agreement ensures there is no deliberate disenfranchisement further creating a sense of legitimacy in the settlement process.

The process is also able to create a sense of culpability by putting measures in place that safeguard its existence. Accountability in this settlement comes from both parties being able to make terms and modify those if end goals are not met. This responsibility and dispute resolution is applicable to both those represented by the settlement and to the state. This is made possible through the steering committee and clear and clarified terms and timelines within the mitigation plans. The settlement agreement process allows all participants to observe, understand and contribute to decision-making and future plans, creating an important form of transparency.

The ability to achieve transparency through participation is also found in the level at which decisions were made. The conjunctive management rules provide room for the agreement to make solutions that work at the local level, with the overarching compliance oversight of the state. By broadening the scale of the problem identified, to include not just the curtailment at one location, but by combining surface and ground water entities, the participants took on more problems to solve. However, in doing so they also were able to bring in more stakeholders and solve the larger problem, not just pieces of it. This nesting of a localized issue in the Magic Valley within the governance of the state (as represented by previous the decisions by the state Supreme Court on both Clear Springs and American Falls) the agreement allows for both flexibility and stability.

The stability in the agreement comes from the state as seen by the decisions of the courts to uphold prior appropriation (as opposed to possibly interpreting full economic development as ground water users not being held to same standard as surface water users). This stability in the law also allowed for innovation and flexibility for localized efforts to come up with mitigation plans that work as necessary, even if those mitigation plans do not also recognize prior appropriation, for example.

Structure

Despite the room for adaptability within the legal system, as seen through the conjunctive management rules (CMRs), the law is purposefully structured to promote predictability (Cosens et al. 2017). The concept of structure encompasses this dual purpose of flexibility and stability through the cooperative and complimentary relationship between a small-scale local decision-making body, able to creatively form viable solutions, and a larger governance scale capable of providing an additional layer of legal stability. This stabilizing structure can foster the multi-scalar decision making, increasing the likelihood that local knowledge will be used to make decisions tailored to the specific problem being addressed (Cosens et al. 2017). Ideally, the scale reflects the shared resource scope. This optimizes the probability of effective coordination of management agencies (Kiparsky et al. 2016).

Structure also incorporates the ability of smaller scale governance to rely on statewide or regional levels for additional oversight, financial support and knowledge. Additionally, should the smaller scale decision making body nested within a higher-level governance structure fail to achieve goals or fail to act, there is there is the possibility of intervention from another governing body. Again, in this structure there is a degree of stability within the governance of the state (through the CMRs) should components of the settlement fail.

The way in which the legal system allocates authority to various levels and sectors of government is also a component of structure. For example, it is necessary for management implementation to keep the decision making process as close to the source of the problem as possible while continuing to function within a larger government structure (Clarvis, Allan and Hannah 2014). These networks created between the multiple forms of governance can build trust while facilitating the flow of information, trust between partners and implementation consistency (Bodin and Crona 2009).

The capability to compel action during the settlement agreement came not only from the Idaho Department of Water Resources requirement for a mitigation plan, but also from the collection of available authorities involved in the process. Rather than creating new enforcement entities that could potentially be too weak to manage the settlement components, the ESPA settlement utilized existing leadership from its parties to form authoritative roles. For example, the steering committee of the agreement was comprised of the chairman of each ground water district: *Aberdeen-American Falls, Bingham, Bonneville-Jefferson, Carey Valley, Jefferson Clark, Madison, Magic Valley, North Snake, Southwest Irrigation, and Fremont-Madison Irrigation District,* and a representative from each member of the Surface Water Coalition: *the A&B Irrigation District, American Falls Reservoir District No. 2, Burley Irrigation District, Milner* Irrigation District, Minidoka Irrigation District, North Side Canal Company, and Twin Falls Canal Company. Keeping leadership and authority at the scale of the settlement itself, rather than a statewide, top-down type of governance structure ensures decision makers are also those affected by decisions made within the jurisdiction of the agreement. Enforcement solely by the state is not necessary then for stakeholders and participants to manage compliance of terms but is used as additional oversight.

Top-down control can present a barrier to adaptability of broad management decisions and could be considered a structural problem. However, within this ability to operate independently, members of the settlement are able to make decisions at the scales necessary to support their sustainability. The agreement could have taken a different approach, such as the CAMPs top-down methodology, but the stakeholders were able were able to learn from the CAMP and tailor it to their particular needs

The steering committee, with oversight of the mitigation plan, meets twice a year to address the settlement components. This is no small task; not only do mitigation plans need to meet the requirements of a curtailment to avoid causing injury, but the Idaho Department of Water Resources (IDWR) Director must also approve the mitigation plans. When reviewed and accepted by the Director the mitigation plan replaces the curtailment and in doing so can provide part or all of the water supply for the senior surface water rights. In this agreement, mitigation plans the steering committee develops are instructed in section b.3.m. of the Surface Water Coalition's and IGWA's Stipulated Mitigation Plan and Request for Order (2016) as being based on technical information supplied by IDWR as well as technical reports from other parties. Since the goal of the agreement is two-fold: to meet the long-term practices set forth in the original agreement and secondly, to meet water level benchmarks over time, the steering committee may make recommendations on additional actions that need to be taken in order to achieve those goals (pursuant to 3.m.iii of the Settlement Agreement).

The authority to innovate and adapt to change is really a process enabled by the nesting of a local authority in a higher and more stabilizing level of government (Cosens et al. 2017). For example, if for some reason the steering committee of the settlement is unable to reach an agreement, then the Director of the IDWR "shall issue an order requiring additional actions to be undertaken by the Districts to achieve the benchmarks or goal not met" (CM-MP-2016 SWC and IGWA Stipulated Mitigation Plan). This nesting feature is significant for the purposes of adaptation in that it increases the likelihood that the knowledge and relationships will already be in place to allow response to any unexpected outcomes. Whereas if policy makers were to try and identify each stage, from the top down, of the plan components – the result would be inadequate and unable to address spontaneous change as necessary (Cosens et al. 2017).

The agreement required groundwater pumpers to reduce consumption by 240,000 acre-feet annually. This reduction, however, is not limited to specific types of reductions. For example, a farmer may choose to fallow a crop one year, fallow only the pivot corners the next year, plant less water thirsty crops or even enroll in the Conservation Reserve Enhancement

Program (CREP). Adaptive planning recognizes the need for flexibility while still fostering predictability. This agreement is a great example of how that balance between predictability and flexibility can be achieved.

A summary of how the Settlement agreement facilitates adaptive management is seen in Table 3-3. Not all components are listed, but examples of components within each of the framework categories were chosen to highlight some of the key capacities for adaptive

ADAPTIVE PLANNING FRAMEWORK AND SETTLEMENT AGREEMENT	
ADAPTIVE PLANNING FRAMEWORK CRITERIA	**EXAMPLES OF ADAPTIVE SETTLEMENT ELEMENTS**
Capacity The Settlement creates an opportunity for adaptive planning through participation in decision making. Resources are made available and there is authority to responde to change.	(1) Safe harbor provision eliminates fear of curtailment if plans fail before being revised. (2) Irrigation season limited to the broad range of April 1 - October 1 eliminates uncertainty of water availability within traditionally changed irrigation dates. (3) Addendums to original agreement allow for certain components to be adjusted if goals are not feasible, while keeping other benchmarks the same.
Process The Settlement eliminate barriers to adaptive process through increased participateion and transparency in decision making processes.	(1) Involvement of so many participants with room for additional parties to join at anytime ensuring no deliberate disenfranchisement. (2) Culpability through parties' authority to make terms and modify if end goals are not met. (3) Mitigation plans able to work outside prior appropriation boundaries on case-by case basis to achieve benchmarks.
Structure The Settlement ensurse legitimacy through stability balanced with flexibility.	(1) Local level decisions and additional stability of state law. (2) Utilization of current leadership in steering committee rather than creation of additional agency oversight.(3) Nesting of local authority (i.e steering committee) with stabilizing government (i.e. Director of Idaho Department of Water Resources) to achieve goals not met in terms of agreement.

Table 3-3: Framework features at left and specific examples from the Settlement agreement at right.

Conclusion

The historic settlement agreement between surface water users and groundwater users dependent upon the Eastern Snake Plain Aquifer and the Snake River Basin states within the first page a startling reality - there is currently (2015) not enough water in certain stretches (of the Snake River) to fulfill all current water rights at all times. This over allocated semi-arid region is also the source of water for more than three quarters of the state's population (Board 2012)

In a highly water-dependent region, supporting over two million (or 60% of Idaho's total) irrigated acres (USDA 2017) understanding future water supply and demand is a pressing issue. Not only are farmers concerned about water availability for irrigation but also so are the myriad industries that combined make up over 20% of Idaho's Gross Domestic Product (DEQ 2005). The aquaculture sector alone produces 70% of all trout production in North America (NASS, 2018); and the booming dairy industry in the region has put Idaho in the top 4th for milk production, and 1st for organic alfalfa hay in the nation (USDA 2017).

While the settlement agreement is not about the impacts of climate change, some of the sustaining features of the agreement come from recognizing the long-term impacts to water resource availability in the 21st century. The impacts of climate change are exacerbated through increased variability in precipitation (Sohrabi et al. 2013). Warming temperatures are already changing the timing of streamflow necessary to irrigate in the dry summer months since the melting of natural water storage from snowpack is occurring earlier in the year (Mote et al. 2018). Additionally of concern for irrigators is the projected increase in evaporative demand (Allen et al. 2005). These impacts will continue to alter Idaho's hydrographs and will inevitably lead to changes in water resource managers' actions (Dettinger et al. 2015).

Understanding future water supply scenarios is not separate from planning for those changes. Transferrable lessons from this case study can provide avenues for adaptation in other semi-arid and heavily water-dependent regions. Adaptability in the Settlement came in the form of participation in not only decision-making, but also legal access to decision making. The ability to have parties join the legal agreement at any time decreased marginalization (Cosens et al. 2017). By utilizing provisional knowledge and keeping decision making at the local levels, the resources and political capital necessary to detect change were not (as big of) a barrier to achieving benchmarks. Similarly, by having individuals involved in the decision-making process, there was a minimized need for external enforcement, as parties were able to evaluate success, and contribute to iterative changes. Because of the incorporation of concepts like safe harbor and broad irrigation timeline for water use, parties were able to be forward thinking in adaptive plans, not having to worry about traditional repercussions based on short term solutions. Long-term solutions of conserving water use, recharging the aquifer, and looking to alternative sources of water storage contributed to the adaptive capacity by creating buffers during times of water shortage.

Some additional considerations that make this agreement adaptive and could provide lessons for other regions are seen through the plan's ability to facilitate legitimacy. For example, there was deliberate opportunity for stakeholder input up front, but also during adjustment periods and when the steering committee met to evaluate success. A nesting of this local governance within the broader state agency (IDWR) and legislative oversight provided additional legal stability. The Settlement's focus on transparent and broad engagement throughout provided a sense of agency in the planning processes. This was necessary in the motivation and deliberation in monitoring goals on multiple spatial and temporal scales. One of the key facets of adaptability was achieved through the authority provided to set and adjust specific goals while keeping other objectives on course. The balance of short term and long-term benchmarks was met through specific goals within a broad timeframe. This provided room for adaptability and learning by doing, despite unforeseen barriers. The settlement then provided opportunities to look at successes and failures from that adaptive management and use those measures as feedback in an Iterative review criterion; if it becomes necessary to make changes, it is feasible to do so.

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Chapter 4 : A Multiple Streams Approach to Understanding Drought Planning in The Semi-Arid State of Idaho, United States

Abstract

This paper applies an Agenda Setting framework to the drought issue in the western United States with the semi-arid state of Idaho as a case study. While water managers continuously interact with drought conditions and engage in planning for drought, long-term planning—particularly at the state policy level—has largely remained off the agenda. Policy scholars have looked at fast acting hazards and their policy responses, though few have examined slow onset hazards, such as drought, because of its inherent resistance to problem definition. Additionally, many Agenda Setting frameworks examine policy formation with the issue having already made it to the policy-maker's agenda. This work helps to fill two gaps in the Agenda Setting literature: examination of how and why an issue stays *off* of agendas and additionally, the analysis of a slow onset hazard through the lens of the Multiple Stream Framework. First, we will discuss the indicators and effects of drought in the west and in Idaho specifically. Then we describe Agenda Setting theory and John Kingdon's Multiple Streams Analysis framework, which provides a structure for analyzing why some items get on the decision-making agenda and some don't. Then we provide an analysis that examines the political, policy making, and problem-solving processes related to drought planning in Idaho to explain why this issue has failed to get much attention since 2001. We conclude with the argument that a reframing of drought may be necessary to keep drought planning a salient issue for policy-makers.

Introduction

In 2017, a House Education Committee in the Idaho legislature nearly decided to remove all reference to rising global temperatures, weather and climate models, and sustaining biodiversity from core science standards (Corbin 2017). This action by the House Education Committee reflects a majority sentiment in Idaho that anthropogenic climate change is not occurring (Howe et al.) and that there is not consensus on global warming, despite scientific evidence otherwise (Hansen, Sato and Ruedy 2012). Not recognizing climate change science eliminates the need to address impacts of climate change, such as warming temperatures, earlier snowmelt, and precipitation falling more often as rain than snow – all of which contribute to drought conditions. Idaho has experienced droughts in 13 of the past 17 years and yet the state has not updated its Drought Plan since 2001, which is meant to be a resource and educational tool to be used when future water shortages occur (IDWR 2001). Scholars who study the intersection of science and policymaking might note that this is yet another example in which social and political ideologies clash with scientific consensus, and preclude effective policymaking (Pielke Jr 2007, Alm, Burkhart and Simon 2010). How drought came to be one of these issues is the focus of this paper. To better understand how combined impacts of climate change, and specifically slow-onset hazards, like increased drought occurrence (Dai 2013), are not getting the necessary attention of policy elites, we look to Agenda Setting theory.

This paper will use John Kingdon's (2001) Multiple Streams Analysis (MSA) to critically examine the lack of state level policymaking around the slow onset hazard of drought in the semi-arid state of Idaho. MSA differs from other theories in the public policy sphere in that it can be applied to an extensive policy arena (Sabatier et al. 2005) and can be used to describe policy making despite uncertainty (Weiner 2011). The applicability of MSA for slow-acting problems such as drought has not been closely examined in the literature. And while the Multiple Streams framework can help to develop strategies for how items can get on agenda (Zahariadis 1995), it has not been utilized extensively to describe how and why items stay off of agendas.

By agendas, we are referring to the set of problems or issues that government officials, or individuals in government circles, are paying attention to at any given time (Kingdon 1995b, Birkland 2006a, Eustis 2000). For this research specifically, we are looking at the state level for drought planning as seen through senate or house bills and legislature-issued agency directives for planning such as the Idaho State Drought Plan. Examining how certain problems garner the attention of policy-makers can illuminate why some issues receive attention and others do not. Drought planning in Idaho is represented at the state level by the Idaho Drought Plan last updated after several years of drought. According to the National Drought Monitoring Center, Idaho's plan is reactive and points to how to deal with drought after it has occurred.

However, drought need not be a crisis that catches us off guard, like other natural hazards. We can anticipate and plan for drought in order to become more proactive, thereby increasing our adaptive capacity to the natural disaster. Doing so could make Idahoans less vulnerable to drought's hydrological, agricultural and socioeconomic impacts. We argue that it may be the combination of drought's characteristics, combined with the political ideologies of policy elites in Idaho, that have kept this issue off the agenda of policy makers at the state level.

First, we will discuss the indicators and effects of drought in the western U.S. and in Idaho specifically. Then we describe John Kingdon's Multiple Streams Analysis framework, which helps us to understand why some items get on the policy making agenda and some don't - as seen through the analysis of three "streams" of processes often needed to combine to create political change. Then we provide an analysis examining those factors: the political, policy, and problem streams, related to drought planning in Idaho. Finally, we will synthesize our analysis, current political factors, and relevant Agenda Setting literature to explain why drought planning fails to not only get the necessary traction from policy elites, but also why it is rarely a priority for policy-makers. This paper is also intended to assist policy-makers in better understanding and managing the policymaking process for slow-onset events.

This paper contributes to Agenda Setting's theoretical knowledge by applying the MSA framework to the slow onset hazard of drought, furthering MSA's usability for long-term, environmental issues. Additionally, it contributes to the utilization of a framework for better understanding how issues fail to garner traction.

Idaho As a Case Study for MSA

This section will introduce the problem of drought in the west, and specifically in Idaho, and projections for future climate change impacts, many of which exacerbate droughts. It also sets the stage for the need for drought planning through policy action.

Climate change is one of the most salient concerns of governments around the globe (Yusuf 2016b). Climate change effects are already being felt throughout the world (Romero-Lankao 2014), the northwestern United States (Salathe 2010, Abatzoglou et al. 2014b), and within Idaho (Klos et al. 2015, Running, Burke and Shipley 2016). In the northwest, climate change is projected to increase the frequency of extreme weather patterns, such as summer drought (Creighton et al. 2015). In the inland northwest, a snowmelt and mix rain/snow-dominated region, the impacts of climate change will be experienced most through the increased variability of water resource quantity and quality (Miles et al. 2010, Markoff and Cullen 2007, Hamlet 2011, Mote et al. 2018).

Idaho, as other states in the northwest, adheres to the global climate paradigm of “dry gets drier, wet gets wetter” (DGDWGW) (Feng and Zhang 2015). This will mean warmer, drier years (often associated with El Nino years) with below normal snowpack will occur more often in the future (Mote et al. 2003). The increased variability in precipitation would be experienced through an increase in precipitation except during the summer months when it is needed most (Isaak et al. 2012).

According to a recent paper out of the National Aeronautics and Space Administration’s (NASA) Goddard Institute, the most important impact of climate change is the appearance of extremely hot summer anomalies (Konar et al. 2016). Over the last century, Idaho has been experiencing an increasing average temperature trend that reflects the overall global warming increase of about 0.8° Celsius, (or about 1.4° Fahrenheit) (Abatzoglou et al. 2014a, Santos, Rao and Olinda 2015). By 2080, this will be in the range of 3.5-9 °F increase (GCRP 2014). Extreme temperatures, which are nearly absent in the climatological history, are occurring over 10% of the earth’s land area in more recent years, implicating global warming as the cause for more extreme heat events (Hansen et al. 2012). Both the National Oceanic and Atmospheric Administration (NOAA) and NASA concur that the five warmest years on record have all taken place since 2010 (NASA News, Jan 18, 2018). These climate change impacts are projected to amplify droughts in the future (Cook et al. 2014, Dai 2013).

Projected heat events in Idaho will impact myriad sectors, including agriculture (Qualls 2013) which accounts for just over 30% of the total employment in Idaho (Idaho Department of Labor, 2014). Ecosystems and the services they provide will be impacted by increased temperatures (Grimm 2013) as well as increased wildfires (Barbero et al. 2015). Of particular impact to the northwest and Idaho, with more than 50% of Idaho’s energy coming from hydropower generation (Idaho Power), will be the increased hydropower demand (Lanini et al.). Historical reservoir operations have seen decreased hydropower generation with higher temperatures and lower precipitation as both contribute to decreased runoff and changes to inflow minimizing turbine capacity (Lanini et al. 2014, Hamlet et al. 2010). Couple these changes with Idaho’s .89% growth rate annually, and the state’s natural resources are put under significant strain (Review 2018).

The greatest impacts of temperature increase will be on the water cycle (Hansen et al. 2012). And while Idaho has been experiencing an increase in precipitation variability under climate change (Abatzoglou, Rupp and Mote 2014c, Mote et al. 2003, Salathe 2010, Wu et al. 2012) more of that precipitation is falling as rain rather than snow (Kunkel et al. 2013, Lute, Abatzoglou and Hegewisch 2015). Much of Idaho's water storage is in the form of snow stored in mountain snowpack. This natural reservoir capacity is measured in snow water equivalent (SWE). Given the increasing rain-on-snow events in Idaho, SWE has been decreasing and will continue to do so (Pierce et al. 2008). Similarly, the timing of this snowmelt is occurring earlier and earlier (Lute et al. 2015, Dettinger, Udall and Georgakakos 2015). These impacts can result in high stream flows earlier in the year and lower surface water availability when Idaho's water resource managers need it most (Creighton et al. 2015).

These long-term trends elevate evapotranspiration rates expected during the growing season and increase demand for irrigation and agriculture (Santos et al. 2015). Higher temperatures may increase evapotranspiration rates by 30%, increasing water needs in southern Idaho by about 150,000 acre feet per year (Han, Benner and Flores 2018). Urban areas and industrial uses are also projecting an increase in water needs (Atlas 2018) making water availability one of the most important pieces of Idaho's future (Ryu 2015). In summary, climate change will exacerbate drought stress in Idaho (Santos et al. 2015) and this additional strain on Idaho's water resources could require improved water management strategies (Creighton et al. 2015). With Idaho being the second fastest growing state in the country (in terms of housing units) at ~2% increase and the city of Meridian, ID in the top ten of fastest growing cities (Bureau 2018) the demand for water is increasing at a dramatic rate.

Half of all total water withdrawals in the country were due to use by just 12 states, one of which is Idaho; and Idaho is one of five states that account for more than half (54%) of the total irrigation withdrawals in the country (USGS 2015). A majority of water use in the western United States, and in Idaho in particular, is used for agriculture. In the United States Geological Survey's 2015 Water Report, Idaho was third in the nation for total water use and water withdrawals per gallons per day. Idaho was second only to California in amount of water used for irrigation. However, Idaho is the lead water user for aquaculture consumption in the United States (USGS 2015). Given the amount of water that Idahoans rely on, water shortages will significantly affect the citizens of Idaho through indirect impacts and costs associated with water-reliant commodities. Additionally, as one of only five US states that relies on ground water for more than 75% of its public-supply withdrawals, declining aquifer levels are of utmost concern to Idahoans (Mortimer and Tuthill Jr 2014). Risks posed by drought to these populations and industries make it a pressing issue for researchers and policy-makers to address.

Literature Review

The Agenda Setting literature provides an avenue to explaining the unique patterns that issues often follow prior to achieving necessary notice and governmental consideration. Agenda setting theories can therefore serve as helpful frameworks to analyze certain issues, explore how they are able to come to the forefront of attention (of the public, policy entrepreneurs, or policy-makers), and continue the momentum to find a solution to the issue in the form of a policy enacted (Howlett, Ramesh and Perl 2009).

An agenda has been seen in the policy literature as a set of issues that fall within the range of the polity (Cobb and Elder 1983). Those issues have been identified equally as broadly as whatever subject matter is in contention (Lang 1981). Dearing and Rogers (1996) noted that it is this contention, or two-sidedness, that is important to understanding how an issue climbs to the top of the agenda. It is the potentially conflictual nature of the issue that helps to gain attention through proponents and opponents (Dearing and Rogers 1996, Cobb and Elder 1983).

Much of the agenda setting literature, since the 1970s, looks to the correlation between media and news coverage (content and frequency) and the resulting public's perception (as seen through polls and voting results). Recognizing that the public agenda influences the political agenda, this paper contributes to the agenda setting body of knowledge by synthesizing the literature that focuses on environmental issues, specifically slow-acting natural hazards such as climate change and drought.

Knowledge

In Anthony Downs' work on American attitudes toward improving the quality of our environment (Downs 1972) he characterizes environmental issues as not being of a concern to the majority, clarifying that "most people will not be continually reminded of the problem by their own suffering from it". Downs then explains a five-part process by which environmental problems usually follow. The first stage is when an issue gains awareness as a problem that needs to be addressed through government action. The momentum of this awareness leads to enthusiasm to address the issue until there is recognition or awareness of the actual cost of doing so, followed by lack of interest in addressing the problem (Downs 1972). The final stage in the process is a reframing of the issue In order to reach a broader audience or focus on a key aspect that may have more salience.

The Agenda Setting literature has a well-established history reporting on the effects of frames of reference that can influence an audience (Scheufele and Tewksbury 2007, Capella and Jamieson 1997). Druckman (2001) identified frames in communication as equivalency framing (using different but equivalent language) and emphasis framing (in which the speaker steers perceptions by focusing on a particular element of an issue) (Druckman 2001). This strategic communication technique used to create salience has been examined for climate change. For example MacDonald's work in the Agenda Setting literature as it relates to public salience followed findings of Mazur (1998) who reported on climate change's peak emergence when coupled with larger, urgent issues such as the Yellowstone wildfire during drought conditions (1988), and the Exxon Valdez oil spill (1989) (Mazur 1998) Problems resurfacing on policy-makers' agendas when linked with another prominent issue can be seen through climate change's relationship with ozone depletion and more recently its relationship with natural disasters and disaster preparation (McDonald 2009).

The body of literature related to slow-onset hazards agrees that disasters have the advantage of being highly visible and intrinsically interesting (Graber 2001) adding to the issue's persistence (Downs). Climate change also resonates more with the public when linked to local stories relating to development, housing, and public (McDonald 2009). We can look to Agenda Setting and climate change as an example of how the literature has addressed slow-acting hazards that are typically difficult to define because they do not always have a central attention-getting focal point, as other environmental issues may.

Circumstance

It is the work of Thomas Birkland that has advanced the Agenda Setting literature's understanding of these high visibility episodes, or focusing events, and natural hazards (Liu, Lindquist and Vedlitz 2011 Birkland and Warnement 2017). Birkland made an important distinction between focusing events and *potential* focusing events (Birkland). Agenda Setting scholars have discussed focusing events in terms of their relevance in hindsight, after a disaster has occurred (Cobb, Ross and Ross 1976 and Ross 1976). Yet, Birkland identified three key elements of natural disasters and the circumstances that would lead to an item getting on the agenda of policy-makers, such as: how many people are affected by the event, the amount of harm done by the disaster, and the rarity of the specific hazard (Birkland

2006a). These are the circumstances that would evolve from a focusing event. However, circumstances where elites or policy-makers have reached a consensus, by a variety of means, can also serve as a type of focusing event in that the public opinion often follows suit, and the issue becomes mainstreamed (McDonald 2009). This is worth noting since members of Congress, for example, can dictate how much and what kind of information is shared with colleagues in order to provide background information for decision-making. For example, in 2006 Senator James Inhofe, of Oklahoma, wanted equal discussion time on the Senate floor for scientists reporting on global warming consensus and those that disagree with climate science, thus falsely polarizing the issue with equal weight (Jensen 2006).

Choice

Building on Agenda Setting research on the rise and fall of agenda items, Pralle focused specifically on strategies for increasing salience of the problem. Salience is equated with a personal connection to an issue. In her examination of the slow onset of climate change impacts she emphasized keeping climate change at the forefront of government decision agendas as critical to addressing the long-term problem that governments are unlikely to ‘solve “with one policy enacted at one point in time” (Pralle 2009). Recognizing that scientific information alone would not increase the salience of an issue, Pralle propelled the concept of inserting moral and ethical perspectives into the debate, since traditional forms of focusing events would not be present to keep the issue at the forefront (Pralle 2009).

Pralle offered strategies for redefining or framing climate change in a way that resonated with the public with the goal of pressuring policy makers to address the issue and hopefully protect against the topic being abandoned altogether. While awareness of an issue does not necessarily correlate to policy change, particularly if there is no sense of urgency, salience can. Salience can imply urgency but with a more purposeful interaction that can resonate with a policy-maker (Pralle 2009). There remains a need to understand how to increase salience of slow-acting environmental issues (Friedl et al. 2004). This is especially true for the slow-onset natural hazard of drought, since by definition, it tends to resist key agenda setting examination processes, as we will see when we walk through the Multiple Streams Framework.

This paper fills the gap in Agenda Setting literature by examining a slow-onset hazard and the corresponding public policy or lack thereof related to planning for it. We seek to build upon Agenda Setting theory by examining the unique facets of slow-acting environmental issues that keep them off the agenda of policy makers.

MSA Framework Applied to Drought Planning in Idaho

John Kingdon's Multiple Streams Analysis (MSA) allows for examination of an issue as impacted by a combination of factors involved in the policymaking process, including recognition and definition of the problem, the formation of the solution to the issue, and the politics at play throughout. Kingdon provides one useful framework to examine why drought planning has not been at the top of policy-makers' agendas. In the MSA, Kingdon's powerful metaphor of several independent "streams" of events and political actors converge to identify how policy is informed and eventually created (or not) from the messy political activity. MSA is one of the most widely recognized approaches (Jones et al. 2016) Other frameworks in the Agenda Setting literature focus more on the policy implementation process or a change of policy-making with the assumption that the issue has already been on the agenda (Yusuf 2016a).

Kingdon's 1984 book, Agendas, Alternatives and Public Policies has been updated twice and is still the cornerstone of many Agenda Setting theories, as Kingdon laid the foundation for examining how people and processes interplay in creating policy change. This section will briefly explain the usefulness of Kingdon's Multiple Streams Analysis (MSA) for looking at the slow onset hazard of drought. We start the discussion with the problem stream and then elaborate on how the issue gets attention from policy-makers through feedback of existing problems, systemic indicators, and focusing events. We identify reasons drought resists these definitions and processes. Secondly, we will look at how drought planning also resists policy proposals that might have a chance to emerge from the "primeval soup" of policy solutions. Lastly, we will look to the political atmosphere during policy formation to see how drought planning at the state level has or has not fit into the agendas of policy-makers.

Problem Stream

The problem stream in Kingdon's MSA looks to how different issues are raised to a level of attention that compels policy-makers to act. Social conditions or issues can be redefined as problems through comparisons and framing. The problem stream looks to the way policy-makers learn about conditions and more importantly, the way those issues are defined. Problem definitions fundamentally influence which policies are possible to push forward, which actors will be invested in the issue and ultimately, which institutions will be involved in its management (Knaggård 2015).

Problem definition has been integral to policy studies (e.g. (Dan Wood and Doan 2003, Crow 2010, Knaggård 2015). Issues or conditions can be redefined if necessary to make new problems and policies or create new coalitions of interests (Jones and Baumgartner 2005). Climate related issues, for example can be framed dichotomously as originating from the natural or human environment and those environmental issues that are impacting the natural or human environment (Tillotson 2015). Drought is often initiated by a lack of precipitation, but when it is defined from this narrow scope, it is strictly a meteorological drought (originating from the natural environment) and depending on the location, if there aren't people affected, can be seen as also impacting the natural environment.

However, to adequately define drought is to broaden the scope to and define drought as existing when supply exceeds demand, regardless of the amount of precipitation (Wilhite, Sivakumar and Pulwarty 2014a, Yahdjian, Sala and Havstad 2015). It is through this lens that drought has been argued to affect more people than any other natural hazard (Wilhite et al. 2014a) and one that can be exacerbated by human activities (Mann and Gleick 2015). For example, there may be significant shortages of hydropower electricity as a result of the lack of streamflow due to hydrologic drought, but also the coupling of the human demand for power generation. With increased population, the demand for resources based on water availability exceeds the supply leading to environmental, social, and economic impacts (Mehran, Mazdiyasni and AghaKouchak 2015). Defining the slow-onset hazard of drought in this way as originating from and affecting both the natural and human environments may generate a sense of salience for policy- makers.

Further complicating problem definition is the fact that impacts of drought often are an accumulation of these various types of droughts: meteorological, hydrological, agricultural and socio-economical (Botterill and Chapman 2002, Wilhite, Sivakumar and Pulwarty 2014b). The Idaho Drought Plan recognizes this multi-faceted way to identify drought and describes meteorological drought as region-specific lack of precipitation, agricultural drought as deficient soil moisture, hydrologic drought and deficiencies in subsurface and surface water supplies, and lastly, socioeconomic drought as negatively impacting people (IDWR 2001).

Drought inherently resists problem definition. Definitions in the Idaho Drought Plan came from a 1985 paper by Donald Wilhite and Michael Glantz. The paper's main objective was to show how the utilization of certain definitions of drought could adversely affect policy makers' decisions on managing for drought since the impact of a drought depends largely on society's vulnerability to it. Not having a clear understanding of drought impacts can often lead to confusion among policy-makers, which in turn can lead to "inaction, indecision, and, in many cases, ad hoc responses with little understanding of the societal and environmental implications of those responses" (Wilhite 1985). Despite the Idaho Drought Plan's holistic definitions of drought, the document still provides action objectives resembling ad hoc response because it is missing the planning component. Idaho's drought plan is considered "response based" plan that focuses on the short-term threat of drought because other actions, programs, and policies intended to increase preparedness before a drought occurs (mitigation) are not discussed within the plan (NDMC 2016).

In addition to the definition of the problem, MSA indicates that drought must also be identified by policy-makers and brought somehow to the forefront of their attention. We discuss three main ways drought is identified: through (1) feedback on current issues (2) systemic indicators of ongoing policies and procedures and (3) focusing events. It is important to note that not all conditions become problems, but those that do have generated enough concern to make it to the decision maker's agenda (Rochefort and Cobb 1994).

Feedback and existing problems

Policy-makers receive information about issues from many sources, including other government officials or experts who review current programs and policies. In their translation of the information, these sources inevitably influence how a decision maker interprets a problem. On the state of Idaho's webpage "20 years of Idaho's Disasters," drought isn't mentioned in the disaster summary (years 1976-1996). This is interesting to note, since it was the 1977 drought that propelled the state to eventually write up its drought plan in 1990, revised in 1995 and in 2001 (IDWR)). According to the Drought Plan itself, conditions in Idaho between 1987 and 1993 displace the Dust Bowl period in the 1930s as the most severe drought period on record (IDWR 2001).

What the drought plan couldn't address in 2001 is that in the years since the last revision the state of Idaho has documented 188 drought declarations. The declarations are made by county and typically are signed in the summer months. One has been signed in Idaho every year since 2002, save 2006, 2009 and 2011 (IDWR). In 2005, 99% of the state was in a drought and in 2015 all of Idaho was in a drought (NDMC 2016). Droughts can be defined as meteorological (deficiency in precipitation and/or high evaporative demand), hydrological (deficiency in streamflow and inflow to types of water storage such as reservoirs, lakes or wetlands) and agricultural (deficiency in soil water of plant available water).

The county level drought declarations represent the need for water transfers and therefore, as discussed in Chapter 2, do not always (60% of the time) correspond to a hydrometeorological drought (in our research, as seen through the Palmer Drought Severity Index).

In using MSA framework, it is evident that even though drought is an existing problem and recognized as such through a variety of ways, policy-makers have not been receiving information about drought impacts in a way that would necessitate drought planning moving to the top of the agenda.

Systemic Indicators

Indicators of existing conditions can be assessed, for example, through research or special studies. The success or failure of an existing program may identify an issue needing attention. Indicators often find their way to the forefront of attention due to routine studies that take account of current statuses, providing the credibility needed for an issue to move to the top of a policy maker's agenda. Reports, while quantitative in nature, still signify a larger indication of a problem and can therefore help move the issue to the top of the agenda. "Policy makers consider a change in an indicator to be a change in the state of a system; this they define as a problem"(Kingdon 1995c).

However, if a report or study is conducted routinely, and there are no significant anomalies, or departures from the normal, then the report can serve as an indicator that things are going along as usual. In the state of Idaho drought is reported or communicated in a variety of ways. We are focusing here only on the Palmer Drought Severity Index (PDSI) and the Surface Water Supply Index (SWSI) as these are the two indicators of drought utilized in the Idaho Drought Plan for Drought Conditions (3.2 Indicators, IDWR 2001).

When a drought is declared in Idaho it is done at the county level and submitted to the Idaho Department of Water Resources for additional recognition of the need for more water, most often through a water transfer, before it is then sent on to the Governor's office for approval. These regular and systemic indicators of drought occur on average, within 15 of Idaho's 44 counties a year, understandably not raising alarm within the traditional annual reporting.

Because Idaho allows for expedited water transfers in times of water shortage regardless of climatological indices like PDSI or SWSI values, policy-makers at the state level are not seeing drought planning rise to the top of their agendas through systemic indicators. However, drought response, in order to be effective, requires long-range planning that has been shown to be a difficult assignment for governments (Wilhite and Glantz 1993). Kingdon distinguishes between "conditions" and "problems." It could be argued that policy-makers for the aforementioned reasons think of drought as a climatological condition that occasionally occurs and can be managed. This is in contrast to perceiving drought as a problem with possible "solutions" through mitigation and adaptation planning. The ability to mitigate drought impacts is less obvious to policy makers because drought impacts are often non-structural (Wilhite et al. 2014b) and in the case of declarations at the county level can be mitigated through expedited water transfers.

Focusing Events

A focusing event, such as a natural hazard or crisis that takes hold, can bring a condition to the fore. Focusing events are usually not the first event to occur, as in a bridge collapse, but may be a second bridge that collapses in the same transportation district, showing that the first was not a fluke accident, but a symptom of a larger problem exacerbated after the first event (Kingdon 1995b). A variation of a focusing event is a powerful symbol that can reinforce the significance of the event

(Kingdon 1995a). These symbols may represent political events or policy proposals and even problems themselves. Symbols serve as reinforcement, however, to something already taking place and not really as a prime mover in Agenda Setting (Kingdon 1993, Cobb and Elder 1983).

While indicators can give the quantitative recognition that an issue is present, or that something out of the ordinary is occurring, it is not always as easy to correlate a specific issue with an indicator. Focusing events like a crisis or a disaster may be able to garner the attention needed to address a problem while simultaneously connecting it to a validating indicator (Birkland and Warnement 2017). Focusing events propel natural hazard issues to policy-makers' desks, demanding action in response to impacts (Birkland 2006b). Because of their slow developing nature, climate change adaptation and drought planning policies may be low priorities for state policy-makers. Taking the back seat to other pressing and sudden-needs issues like jobs or transportation (Tang et al. 2010), drought does not always have a central focusing event to give it the necessary traction it needs, and therefore does not fit the mold of classic Agenda Setting examination for getting on the agenda of policy-makers at the state level through focusing events alone, as some natural hazards can.

We know, however that drought has affected the western United States significantly (NOAA 2017). The greatest recorded drought in the west, since available data in 1980, was in 1988 with 454 deaths and an estimated $41.2 billion dollars in damage. The first draft of the Idaho Drought Plan in 1990 was "reflective of continuing drought conditions and ongoing efforts to find viable responses to problems resulting from drought" (IDWR 2001). There have been severe drought impacts in the west since the first drought plan was drafted in Idaho, since 2002 – totaling over 86.2 billion dollars in damage and over 220 deaths (NOAA 2017). Idaho experienced severe drought for as many as 7 consecutive years since 1999 (Wilhite 2006). Drought impacts society in myriad ways and is especially visible in the agricultural sector. Yet, despite the large number of lives impacted by drought, this long-term water shortage with continued impact on the state's economy in agricultural and irrigation sectors resisted problem definition. Without a singular, rare and sudden focusing event it doesn't necessarily translate to a crisis demanding the attention of policy-makers (Kingdon 1995b). While it may very often be the case that more individuals are adversely impacted by drought than a subway collapse, for example, the focusing event of the latter crisis is much more tangible and able to invoke risk perception and policy change than the slower developing drought crisis. Drought, while usually ascribed to natural forces, is also viewed as a disaster out of our control, an "act of God"(Steinberg 2006). Conversely, the subway example is viewed as a something ascribed to humans and therefore within our ability to address. The projections of impacts from climate change are challenging this dichotomy.

Policy Stream

This stream involves the process by which proposals to solve problems are identified and generated. These usually come from communities or networks affiliated with policy change, such as special interest groups, academics, experts in the field, or non governmental organizations, to name a few. These groups will ultimately be responsible for drafting the language of the rule or policy solution. A single advocate in this solution generation stage is considered a policy entrepreneur – one who is able to take advantage of the policy dynamics and utilize necessary resources to push a solution to the forefront of agendas (Kingdon 1995b).

This policy making process is messy and complicated and has been analogously described as “policy primeval soup” (Kingdon 1995b). Contributing to this soup are the roles of actors (either in or out of government), the forces at work influencing them (lobbyists or private interest groups, stakeholders or the public at large), the way an issue was defined (as an issue or a problem or a solution to an issue or a problem) the finite carrying capacity of policy makers (for only a few important issues at a time, all vying for prioritization) combined with the feasibility of an issue’s solution (financial, social and political acceptance) all floating in “broth.” Some ideas surface to the top while others sink to the bottom. The issues that surface adhere to a set of criteria that the MSA framework explains. This is continual messy process of suggesting proposals, reconsidering, and then reformulating and can take years, even decades.

In this section of the paper, we look to three key components of the policy stream: if the proposal to solve the problem is agreeable, feasible, and acceptable. A main driver to implement policy is the ability to communicate with the aforementioned policy communities and networks in order to illustrate the merits of a solution and eventually broadcast that policy to generate wide support. This stage really highlights the importance of coalition building, persuasion, and the necessary reframing of an issue.

Agreeable

Both coalition building and persuading are based on a foundation of common interest. In the case of preparing for water shortage, the entire nation has reported the shared fear of water shortages. For example, the US government accountability office (GAO-14-343SP) reported in 2014 that according to the literature they reviewed, experts and water managers nationwide believed there would be a continuation of water shortages in the coming decade (GAO-14-430). Of the 50 states' water managers, 40 of them agreed with the literature summary and were expecting to have to plan for water shortages in the next ten years. Every respondent agreed drought conditions would mean a deficit of essential fresh water supply. The GAO noted that drought conditions should be anticipated and cited the National Drought Mitigation Center for "predicting that there will likely be more extreme droughts in the future" (GAO-14-343SP 2014).

In this way, drought planning does fit the dominant mood of the country and as discussed earlier, also fits the dominant mood of regional groups devoted to western issues. However, while the idea that drought needs to be planned for and water shortages anticipated in the future is agreeable, there is not an easy one-size-fits all solution to the problem. The Multiple Streams Framework demonstrates that chances for a problem to rise on the decision agenda are dramatically increased if a solution is attached (Kingdon 1995b). As it stands, Idaho's State Drought Plan relies on short-term relief of federal aid and assistance over long- term adaptive planning measures (Wilhite 1997). According to the National Drought Mitigation Center (NDMC), Idaho's Drought Plan is, therefore, considered merely "response based" and identified as a plan that focuses on the "short-term" threat of drought despite its long-term characteristics and impacts. Similarly, "actions, programs, or policies intended to increase preparedness before a drought occurs (mitigation) are not discussed within the plan" (NDMC 2016). The traditional way of responding to drought, after drought impacts have occurred, limits the attention of policy-makers to drought only when there is a crisis. This process of providing assistance after a drought, feeling apathy when the rain finally comes, expressing fear and concern for the drought and yet again reacting after the fact has been called the "hydro-illogical cycle" because it is ineffective and poorly coordinated (Wilhite 1997). Anticipating and planning for drought can increasing our adaptive capacity to the natural disaster, making Idaho's sectors impacted by water shortage less vulnerable to drought's hydrological, agricultural and socioeconomic impacts.

Feasible

A second factor contributing to drought resisting policy proposal generation is the fact that Idaho has a decentralized water system. Even though the Idaho Department of Water Resources administers water distribution, Idaho does not have an agency devoted to the holistic management of water resources in the state. Agencies in Idaho working on water related issues other than IDWR are the USGS Water Resources of Idaho and Idaho Water Adjudications (ID.gov 2018). The USGS Idaho Water Center's mission is to provide impartial scientific information to local, state, tribal, and federal partners in four basic areas of research: surface water, groundwater, water quality, and water use and availability. The Idaho Water Adjudications office is made up of legal staff devoted to the documentation of permitted water rights in the various basins in Idaho.

Providing information and documenting legal aspects of water resources are both instrumental to the state-wide system. Classifying resources in the state is important for identifying who would be part of the community of individuals devoted to working on water scarcity related issues that would contribute to the proposal for drought planning. Other than the Idaho Department of Water Resources, a non-advocacy-based state agency, there is no official agency or organization devoted to drought management. While there are several non-governmental organizations and institutes within academia and the business sector devoted to water resource management, the overarching visionary agency is not a current part of Idaho's political and institutional make up.

This is in contrast to other western states, such as California or Colorado, that have statewide natural resource agencies devoted to the preservation of water resources. It is this agency, in California, that spearheaded the California Water Action Plan outlining the state's five-year plan toward sustainable water management. The document touts its actions as setting California on a path toward reliability, restoration, and resilience in California water (CNRA 2016). Idaho has a robust program through the Idaho Department of Water Resources, that is collaboration with water users, water managers and the state, for aquifer recharge. In this way, preparing for future water shortage is on the agenda of decision makers in the capacity of storage. A plan that can also address availability, conservation and resilience is necessary, though not under the purview of current agencies in the state. A coordinated and integrated approach that can utilize drought risk projections for planning and mitigating purposes are still needed (USGS Drought Team 2017).

Acceptable

Water shortages also raise social concerns, such as dealing with conflicts between water users and reduced quality of life while simultaneously giving rise to awareness of inequities in the distribution of disaster relief assistance (GAO-14-343SP 2014). Idaho has a centralized operational water system as seen through the vast work of the Idaho Department of Water Resources, however the decentralized water management system does not encourage any one agency or collaborative group to look at these additional concerns and impacts. Because of this lack of overarching oversight, there is also a lack of advocacy among agencies working within water resource management. Advocates are needed to propose solutions to the future drought problems through a drought plan. This is not to say that water management isn't clearly institutionalized as part of Idaho's resource management system. There are dozens of local, state, and federal agencies and organizations engaged in water issues in the state. These groups have largely managed challenges to the system, including calls on water rights, water shortages, and disputes between agencies (Atlas 2018). For this reason, Idahoans for the most part trust that others will do a good job in managing for drought and therefor, does not have a need for a dedicated policy community or network to campaign for drought planning. The conjunctive management rules discussed in Chapter 3 help to illustrate that the irrigation community in Idaho was able to get comprehensive aquifer management planning (CAMP) passed. This community would be an example of an advocacy group drought planning is needed. Each of these stakeholder groups would need to collaborate in some fashion to find and acceptable plan that works for a majority of their needs in order to garner enough support to get a proposal for drought planning to surface to the top of this "primeval soup".

The solutions, or proposed policy changes, from the perspective of advocating for change through campaigns, are often classified through two related traits: the environment from which the hazard originates and the environment affected (Tillotson 2015). Climate science agrees that drought occurrence will very likely increase in the western US due to increased precipitation variability, increased surface and air temperature, enhanced evapotranspiration, and earlier spring snowmelt. Drought in this regard is a natural hazard that is going to occur, though the impacts of climate change are going to exacerbate the severity and duration (Dai, Zhao and Chen 2018).

In terms of the environment affected, Idahoans report experiencing some of the many impacts of climate change – yet they do not attribute these trends to climate change or anthropogenic forces (Running et al. 2016). Compared with the rest of Americans, Idahoans are some of the least concerned about impacts from climate change (Howe et al. 2015).

This balance between needing to plan for longer periods of natural condition drought with recognizing the anthropogenic contributions to enhancing future drought conditions is a sensitive one. Connecting climate change science with drought impacts is unlikely to garner support in a conservative state like Idaho. Idaho was the only state legislature to try and remove all mention of anthropogenic climate change form science standards statewide (Albeck-Ripka 2018), the proposed motion by Republican Scott Syme.

With a policy-making body, reflective of this sentiment, generating a solution to the problem needs to be carefully crafted to address the impacts Idahoans are and will continue to experience. No one bill is going to address climate change mitigation and adaptation. And while recognizing that humans have played a role in increasing global greenhouse gases is instrumental in capturing novel solutions that may arise from adapting to climate change (i.e. decreasing carbon dioxide output or carbon sequestration), incremental steps toward adaptation can be achieved with the goal of keeping salience on the big picture of our contribution to climate change (Pralle 2009).

Political Stream

Kingdon explains the political stream as one of legislative and administrative turnover influencing the passage of policy solutions. A new administration has agenda items that garnered support during campaigns and would already be at the top of many policy-makers' agendas. The turnover of key personnel in government agencies can lead to cascading policy changes, as well as vacuums in which inaction serves as a sort of policy approach in and of itself. In this section we will examine the connection between partisan identity and climate change views, and the agrarian character of Idaho belief systems. We will examine how the transition of an administration led to significant policy change regarding a federal agency as an example of the powerful pull of leadership agendas in the political stream.

Idaho has not experienced legislative turnover from one party to the next in several decades. As a matter of fact, in eight out of the past ten years, Idaho has placed third for “most Republican” state in the country (Gallup Poll, Feb 4, 2015). A follow up poll in 2017 shows Idaho to be one of the few states that ranks significantly higher on the net-conservative list than they do on the net-Republican list (Saad 2018). This is worth exploring in terms of prospects for drought planning as conservative political ideologies are consistently predictors of skepticism in climate science (McCright and Dunlap 2011). Planning for future drought occurrence will require an examination of climatological science in addition to social and economic changes with time.

Of Idaho’s 57 million acres, about 12 million are involved in farm operations. Farmers specifically tend to distrust sources of information regarding climate change (Arbuckle Jr, Morton and Hobbs 2015) and trust sources who are like-minded and share similar cultural belief systems for their scientific information (Kahan et al. 2011). The Yale Program on Climate Change Communication estimates that only 58% of Idahoans think global warming is happening. Less than half (48%) of citizens in Idaho are worried about global warming and even fewer yet feel global warming will affect them personally (32%) (Leiserowitz et al. 2010). If Idahoans do not agree with scientific consensus that climate change is occurring, then there is little perception of risk to the impacts of those changes, nor the desire to understand regional or localized impacts. This poses another barrier to getting drought planning on the agenda of policy makers, as risk perception has been found to affect support for policy initiatives such as adaptation measures regarding climate change (Grothmann and Patt 2005). The need for adaptation to the slow onset hazard of climate change is essential as both a belief system that may need to changing (Smit et al. 2001) and as a process where political action that needs to be taken (Allen et al. 2014).

Federal Policy to reduce risk from natural hazards was recently updated through the Hazard Mitigation Assistance Program (FEMA). Preceding this, President Obama signed the Presidential Policy Directive (PPD-8, 2011) of National Preparedness creating seven capabilities for the National Mitigation Framework including threats and hazard identification, risk and disaster resilience assessment, planning, community resilience, public information and warning, long-term vulnerability reduction, and operational coordination. These types of Federal Emergency Management Agency (FEMA) programs have historically provided the necessary funding for mitigation activities while not incorporating the slow onset hazard of drought. However in 2015 FEMA made some "major adjustments" and integrated climate change and resilience considerations to create more "programmatic flexibility" (statement from the deputy associate administrator for mitigation, 2015). An important addition to the programmatic changes was the creation of a "Miscellaneous/Other" category that allows for "addressing considerations of unique activity types (e.g., drought mitigation projects)"(IBID pg. 21; Part III, E. 1).

> *"FEMA recognizes challenges posed by climate change, including more intense storms, frequent heavy precipitation, heat waves, drought, extreme flooding, and higher sea levels. These phenomena may have impacts on mitigation, preparedness, response, and recovery operations as well as the resiliency of critical infrastructure and various emergency assets. FEMA encourages recipients and subrecipients to consider climate change adaptation and resiliency in their planning and scoping efforts." (p27)*

As Kingdon's MSA framework outlines, the transition of government officials is key to stymying a proposal or seeing it fast tracked to the agenda. When Donald Trump took office in 2018, he gave FEMA a new directive: to remove any reference to climate change from all official documents (Gonzalez 2018), thus halting any momentum in the problem or policy streams of gaining collaboration in the political arena. This 180-degree shift may exemplify the problems that arise when policy is set through administrative action rather than the legislative process. It is important to note as well, the challenges when a legislative approach is taken if, for example, the consensus of Congress does not fit the dominant mood of the president. The polarization in the United States regarding climate change is one of the main reasons it is such a wicked problem. Brock Long, who was directed to run FEMA when the term climate change was omitted from their 4- year strategic plan even noted that the term 'climate change' has become such a political hot button that it keeps us from having real dialogue (Gonzalez 2018).

As a result of some of these key administrative directives regarding federal agency response and disaster preparedness, we aren't seeing lasting federal climate policy, despite scientific consensus on its necessity. And while climate change adaptation may not be broadly on the agenda at the state level in Idaho, local bureaucrats have to respond to the impacts of climate change and often times are already taking actions and inserting policy or ideas that therefore put slow-onset hazards on the agenda that allow for adaptive planning for the future despite state mandates or directives. With policy devolving to the local level, (though in some western states) states to the state level, there planning is very uneven.

Local level bureaucrats are able to influence policy or make necessary change only if they have the necessary autonomy to do so, which varies at each level of local government and is dependent on the other political actors involved in the “primeval soup”. These influential policy elites are able to make policy change with the dovetailing of another stream or multiple streams. For example, the appointment of a leader with publically stated values opposite those of the agency he/she is to represent, is a cornerstone example of an opportunity in the political stream of leadership shifting the tides of the political atmosphere. This can be seen at the Federal level with president Trump’s appointment of Scott Pruitt as Administrator of the Environmental Protection Agency, a position previously held by Gina McCarthy. Under Pruitt’s leadership, the House of Representatives passed the HONEST Act (H.R. 1430) sponsored by Rep. Lamar Smith (R-TX_21) on March 29, 2017. This rapid policy change regarding the sources utilized by policy makers marked a paradigm shift in the way scientific data was viewed and utilized - giving policy makers the ability to use publicly available data, instead of those published in journals and therefore having undergone the peer-reviewed process. Again, for slow onset hazards, like drought, there is scientific consensus that climate change will exacerbate these natural disasters in the future. However Pruitt questioned the established scientific research, even from his own agency. While Pruitt is no longer in the position, under his leadership, he gave directives to EPA employees to use talking points about climate change that went against the robust scientific data. In a letter from the American Geophysical Union, made up of over 60,000 scientists, Pruitt’s actions were called out for failing to acknowledge and inform the public on climate change consensus as not only scientifically misleading, but against the very mission of the EPA. This federal example of change in key leadership positions as having the ability to transform the mission of a national agency is one way to capture the influence of key policy makers in the agenda setting process. Leaders who are able to shift gears in an agency’s productivity from one direction to another further complicate the agency’s ability to efficiently address issues.

This paper recognizes the possibility for drought planning to be addressed through appropriate institutions at the state level, but also the influence of the rapidly changing undercurrents of the politics stream at the federal level. These dynamics need continual study.

Windows of Opportunity

In the Multiple Streams Analysis Framework, a change in policy has the best chance of success when the three streams align and provide an opportunistic "window" through which it may pass. If identification of a problem (in MSA's problem stream) was raised to policy-makers' attention through either 1) feedback of existing problems 2) systemic indicators or 3) focusing events a but was not sufficient to propel action, it potentially could still garner support if coupled with another one of Kingdon's metaphorical streams. If a problem has advocates who work on drafting language for policy solutions to the problem (in MSA's policy stream) but do not have enough buy-in that the solution is agreeable, feasible and acceptable, it too will need to combine with another stream to translate into agenda worthiness. The third stream (in MSA's political stream) reflects the authority by key individuals to influence the passage of policy solutions. But even still, this process often requires the solution generation, in the policy stream, or the problem definition, in the problem stream, in order to be successful.

Fleeting opportunities for a policy to pass through a "policy window" when these three streams converge, creates just the right momentum necessary for change (Kingdon 1995b). Advocates of the proposed problem solutions are much more likely to push their proposals when the problem has been adequately identified and recognized, the solution fits the general mood of the public, and it falls within the realm of the current political atmosphere.

An example of a successful policy passage when all three streams converged in relation to Idaho Drought planning can be seen when the Idaho State Legislature passed a bill by the Resources and Environment Committee, which amended the law to essentially become more adaptable during times of drought. The problem definition was brought to policy-makers' attention through continual statewide economic impacts due to the droughts of the few previous years. The year 2001 was an exceptional drought year in Idaho, with 75% of the counties declaring drought, and 33 of the 44 counties seeking assistance from the governor's office. This is significant because in other drought years, there has been an average of 11 counties in Idaho declaring drought, or only 25% seeking drought declaration approval from the governor's office. While there have been multiple drought years in Idaho, the duration and the severity of those droughts should be taken into consideration.

The Senate Bill allows for "temporary changes to water rights by transfer or exchange of water during a drought emergency" (Senate Bill no. 1122, 2001). Given its focus to water rights, the problem advocates were made up of some combination of staffers at the Idaho Department of Water Resources who deal directly with water rights transfers. The bill goes on to clarify that the director of the Department of Water Resources doesn't need to publish notice or make any findings in regard to these changes, as is normally the case when there is a change of Place Of Use or Point Of Diversion of an existing water right. While this did not correspond to a legislative or administrative turnover, the political stream was in agreement with the statewide need for addressing expedited water exchanges as the bill passed unanimously. The impact of this Bill has resulted in over 150 of drought declarations since 2001, allowing for expedited temporary water rights transfers.

In 2005 the House of Representatives Bill 373 was passed through the Ways and Means Committee. While there was no focusing event, per se, Idaho was still feeling the drought impacts from 2001. Coupled with declining aquifer rates "due to changes in surface water irrigation practices” (House Bill No. 373 Idaho State Legislature, 2005), the legislature found 1) surface and groundwater users were experiencing and may continue to experience water shortages 2) it's essential that the state provides "a reasonable degree of certainty and assistance and water resource management" to maintain local economies relying on water for their viability and 3) the Water Resources Board authorized both constitutional and statutory means to finance water projects to enhance Idaho's water supply. Having state legislative priorities reflect this type of preparedness for Idaho’s water supply reflects that the issue of drought has been on the agendas of policy-makers at the state level, but not at the planning, mitigating adaptive stage. Both bills discussed reflect Idaho’s historical response to drought post disaster, and not proactive planning.

Policy Entrepreneur

Kingdon coined the term policy entrepreneur while describing an individual who advocated for issues of personal interest and took advantage of opportunities to influence policy. They are therefore most active in the policy stream where they work to create solutions to problems and bring them forward in the agenda setting process. Though, policy entrepreneurs need not be in government, nor elected positions to have influence on policy (Kingdon 1995c). They are, however, able to take advantage of the windows of opportunities to promote policy change.

While a policy entrepreneur is not easily identified in drought planning getting to agendas in state level legislation, we have identified administrative bodies that afford the ability to have issue specific conversations that more formal means do not. For example, regional cooperatives that span political boundaries, (i.e. may follow watershed boundaries) can bring vested individuals together with a common interest. These groups can serve as acting grounds for policy entrepreneurs and provide an additional outlet for communicating collaboratively about what problem solutions should look like. For western states, groups such as the Western Governors Association and the Western States Water Council represent these collaboratives. The Western Governors Association Policy Resolution 2015-08, for example, outlines the need for drought preparedness and response. The organization created a drought forum that provides leaders from states, businesses, and nonprofits to identify policy options for drought management. The areas identified as needing additional attention are data, analysis, conservation, forest health, infrastructure, and working within institutional frameworks to proactively manage drought (WGA, 2015).

Conclusion

We extended the Multiple Streams Analysis (MSA) framework to decision making about slow developing hazards that don't instantly grab the attention of policy-makers as earthquakes or floods might. While Kingdon's model was developed as a means to identify significant shifts in the agenda, we utilized the model to describe the need for incremental transformations to existing policy by examining the restrictive components within the problem, policy, and political streams. In doing so, we extend the framework from the Agenda Setting literature into the broader natural hazard and emergency preparedness literature. Doing this allowed us to show the MSA as a flexible model able to identify policy formation through redefinition and reframing of a slow onset problem.

Climate change is creating a future where natural hazards that were once unpredictable and rare are now more of a certainty. Idaho policy isn't considering natural hazards this way. De-polarizing the issue of climate change as related to drought and instead examining the disaster, as one that can be mitigated through planning, may be a more effective route to garner traction for policy implementation in the conservative state of Idaho. The problem definition of drought should address not only the hazard but how many people are affected by the event, the amount of harm done by the disaster, and the rarity of the specific hazard (Birkland 2006a). When viewing slow onset hazards, that resist clear problem definition and lack a significant focusing event, it may be more tangible to discuss planning in terms of emergency preparedness. With this objective, examination in the problem definition stream could look to understanding direct and indirect impacts of the duration and intensity of droughts.

Emergency preparedness has the sole purpose of minimizing damage from inevitable events. The persistent condition of drought impacts can affect all sectors of the economy, as seen through the 2016 western drought (NOAA'S National Centers for Environmental Information Report). Impacts to crop revenues in California alone were estimated at $247 million dollars; the direct costs of the drought, losses in revenue from dairy, livestock and fallowed land as well as net economic impact exceeded $600 million (Medellín-Azuara et al. 2016). Preparing through planning can minimize loss of life and property. For every one dollar spent on preparedness, it could equate to fifteen dollars in terms of mitigated damage (Healy and Malhotra 2009).

There are large efficiency losses associated with underinvestment in disaster preparedness. Should the reframing of drought speak to preparedness and planning, warranting emergency management, the policy that accompanies it could be more useful (Wilhite et al. 2014a). The Idaho State Water Plan for example (2012) addresses indicators of climate change in relation to water resources as "climate variability", not "climate change". The omission in the definition of the problem eliminates the recognition of global warming and its long term impacts, including more severe and frequent droughts (Dai 2013) as a result of cumulative impacts from a changing climate. Hydrologic impacts in Idaho are measured through scientific information such as: climatological data, snow surveys, gauging stations and streamflow forecasts (IDWR 2001), all of which have been and will continue to change due to global warming (Dalton, Mote and Snover 2013, Mote 2018).

The State Water Plan is meant to provide plans and procedures to deal with hydrologic impacts in the future. Not recognizing the climate change projections due to incomplete problem definition is a result of characteristics in the political stream.

In addition, our analysis suggests the processes in the policy stream, where proposals to solve problems are identified and generated, usually come from special interest groups, experts, academics or NGOs. The state agency dealing with drought planning, the Idaho Department of Water Resources simply does not have the adequate resources necessary to devote to those processes and is therefore not a priority for the agency. A coalition of groups could generate a new and adaptive drought plan that reflects best available science and climatological projections. Legal acknowledgement of a long-term emergency provides communities a better chance to protect their precious water resources (Craig and Ruhl 2014) by replacing the common reactive approach to drought planning with an anticipatory approach that reduces risk through appropriate mitigation programs and policies (Wilhite 1997). An updated drought plan generated by stakeholders in the policy stream would need to be prepared and 'waiting in the wings' until a policy window opens and the advocates are then able to push it through.

The "open window" for incremental policy change to drought planning in Idaho consists of the three streams coming together with the additional security of a policy entrepreneur. In the problem stream, drought planning would be inclusive of severity and scale redefining the problem as an opportunity for emergency preparedness. In the policy stream the updated drought plan would reflect this preparedness and use best available science to address future water resource changes. These changes would include the recognition of loss of mountain snowpack, earlier snowmelt run off, increased variability of precipitation (more rain-on-snow events) as they relate to water management strategies. Importantly for the political stream, the polarizing term of "climate change" could be omitted as our analysis shows resource managers and water professionals in the field are already working within scenarios including climate change, despite the lack of legal reference to climate change. This delicate framing in the political stream is necessary to prevent disruption to the status quo and in keeping with the political mood of the state. The political ideologies of the conservative state have deep roots that do not need to be uprooted in the effort to make incremental policy changes for drought preparedness. Finally, a policy entrepreneur would have to be the advocate to see the problem solution through the policy window. The need for the policy entrepreneur is reflective of voters being unwilling to spend on natural disasters before the disasters have occurred (Healy and Malhotra 2009). For politicians, despite best intentions, reelection (which encourages reelection seekers (Mayhew 1974) with short termism (Caney 2016) is the proximate objective. With the additional pressure of voters rewarding politicians for disaster recovery and not disaster preparedness, a politically savvy advocate in either the House or the Senate may be needed, shy of an instrumental focusing event.

Kingdon's MSA has concluded that in order for a policy to make it through these various stages successfully, it may be years, even decades. The unique characteristic of droughts' longevity may serve as the necessary bridge between the usual fast acting focusing events and the generally long-lasting political process. For example, the 5-year drought in California (2011 – 2016) lasted long enough for some policy to be changed. However, the more than a decade long drought in Australia (1997 – 2011) lasted long enough for national drought policy to be transformed (Cosens 2016).

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Chapter 5 : Summary and Recommendations

Summary of Research Findings

Understanding the complex interactions of the physical, legal and policy aspects of drought occurrence and water users' response to drought impacts is essential for comprehensive and adaptive water resource management. To quantify impacts of the slow-onset hazard of drought this research examined the state-wide recognition of drought impacts in Idaho through county-level drought declarations. The research period was 2001-2016, as that was the first year a declaration allowed for an expedited water exchange or transfer. Looking at the spatial and temporal patterns of drought declarations can help paint a picture of which areas in the state experience drought impacts most often. Of Idaho's 44 counties, 9 of them did not need to declare drought even during years in which the Palmer Drought Severity Index (PDSI) reflected drought conditions ("moderate drought" at <= -2.0). There are various reasons why this is the case. Most of the counties that did not declare drought are located in the relatively water rich region of the northern panhandle. Secondly, much of the agriculture that would be affected by drought in the Palouse region of Idaho and eastern Washington is comprised of dry-land farming and some crops are more resilient to drier conditions. A third and socially important variable is the ability to take advantage of a truncated temporary water transfer or exchange process from the Idaho Department of Water Resources (IDWR). While IDWR defers to local water masters within the counties as to validity of need for water transfers, very few applications have been denied in drought years or in the years immediately following drought years. Those that have been denied were done so due to restrictions on water rights in the already over allocated Eastern Snake River Plain, or the request would have enlarged the initial right, which is not allowed (section 42-240, Idaho Code).

When county-level declarations were compared against objective measures of soil moisture deficits, such as the PDSI, results showed that 40% of historic drought declarations occurred when there was not a corresponding hydrometeorological drought, as estimated by the concurrent PDSI threshold of <= -2.0. The state of Idaho and the IDWR use a multitude of indices to evaluate drought, including Surface Water Supply Index (SWSI), the Standardized Precipitation-Evapotranspiration Index (SPEI), and levels of snowpack and reservoir storage. For the purpose of this research, PDSI was selected as a general indicator of soil moisture conditions as it is the most extensively used drought index since its creation in 1965, having been well tested and verified (Mishra and Singh 2010) and is used commonly throughout the world to quantify observed drought and drought projections (e.g., Dai 2011). If a hydrometeorological drought was not occurring in years when a county declared drought, what was the underlying need for a temporary water transfer? The data analysis reflected a lag effect of 1 – 2 years of low PDSI values. In other words, if a drought was declared in 2006, but the Palmer Drought Severity Index was indicating a wet year, it was often the case that the prior years had significantly lower PDSI values. This would suggest that it is an accumulation of warmer growing seasons and variable precipitation that ultimately lead to potential rebuilding of water storage or re-saturating soils that have experienced long spells of drought. The results indicate, not a direct correlation between PDSI and drought declarations per year, but a legacy effect of previously low PDSI average summer values. The application of a drought index for one year is therefore insufficient for diagnosing historical water shortages or predicting future water shortages. Additionally, the evaluation of this type of “system memory” could allow drought to be modeled using a combination of PDSI values from the current year and the previous 1-2 summers; potentially leading to a new drought index or new ways of applying existing indices.

An examination of where and when the drought declarations occurred outside of single-year PDSI thresholds for drought provides a better understanding of where and under what conditions water shortages occur in the region. The spatial distribution of water shortages is created in part by the legal framework of water rights that is common to many western states. A majority of the drought declarations occurred in the semi arid region of southern Idaho where a majority of irrigated agriculture in the state is located (USDA 2017).

Not only is this region in southern Idaho significant for it's prolific agricultural production, but additionally, due to the limitations of water accessibility and the rapid growth Idaho has been experiencing, it is also significant for its progressive conjunctive management of water resources. Increasing temperature trends create moisture related changes that can exacerbate conflict already present under current water supplies. And changes in the timing of snowmelt and declining mountain snowpack in the region are indicators western states could experience more severe drought risk than in the past (Trenberth et al. 2014).

A second portion of this research incorporates western water law into the conversation about new forms of governance and applicability to drought preparation for western communities under a future of climate change. The legal examination highlights successes and failures of adaptive planning as seen through the case study of a landmark agreement between surface and ground water users in the Eastern Snake River plain, which supports the largest irrigated agricultural region in the northwest (Qualls 2013). The legal history in this research walks through some of Idaho's landmark cases and the law's ability to balance economic development and prior appropriation. As a "first in right, first in line" state, adaptability to times of water shortage was limited. The findings suggest that it is through the conjunctive management rules approved in the legislature in 1995 (IDAP 37.03.11, I.C. 42-605) and their evolving definitions that adaptive planning may take place. For example, the changing definition of a common groundwater supply to one where a source can affect the use of another (CMR 10.01) reflected the reality of water use between ground and surface water users. Other important definitions in Idaho's conjunctive management rules, such as full economic development needing to be of "reasonable" use, not causing materially injury to others and not exceeding anticipated annual recharge amounts (CMR 10.07) can allow for iterative planning within a changing and warming climate. Additionally, this analysis identifies the definitions like "futile call" in the context of the time lags associated with ground-to-surface water interaction as progressive in its ability to address times of shortage (CMR 10.08). As we had seen with the examination of PDSI values in county level drought declarations that legacy effects should be taken into consideration.

Idaho water law as many legal processes are, has been identified as rigid and inflexible. Stationarity in legal proceedings is necessary to be able to make consistent decisions and rulings. However, this examination on the groundbreaking ruling allowing for large temporal and spatial mitigation has shown how Idaho's water law and the doctrine of prior appropriation can actually be adaptive through its recognition of uncertainty of annual water resources. The analysis has identified that by ending the cycle of only planning annually for water shortages in the Magic Valley of southern Idaho through this long-term, goal-oriented process, the participants are able to successfully use adaptive planning to prepare for future water shortages. This is unique as the state as a whole has been identified as having a reactive, not proactive approach to drought planning (Wilhite, 2010).

A third portion of this research examines one theoretical framework that could assist in understanding why a state that has been active in water management is still reactive in drought planning. Through the lens of Agenda Setting, this research identified why the slow onset hazard of drought has not been getting the necessary traction it needs from policy elites. By utilizing John Kingdon's Multiple Stream Analysis framework, areas in the "three streams" were identified as being either barriers to policy change or areas where the slow onset hazard of drought was able to garner traction for decision-making.

In the problem stream, the analysis found that due to its inherent inability to be easily defined, drought (which is difficult to identify as beginning or ending, spatially or temporally for example) resists this stage in the framework. As a result, drought must be brought to the attention of policy makers in a different way: through (1) feedback on current issues (2) systemic indicators of ongoing policies and procedures and (3) focusing events. In using the MSA framework, it is evident that even though drought is an existing problem and recognized as such through a variety of indices, policy-makers have not been receiving information about drought impacts in a way that would necessitate drought planning to move to the top of the agenda, save for the drought declarations examined earlier in this research.

It could be argued that policy-makers for the aforementioned reasons think of drought as a climatological condition that can continue to be managed. This is in contrast to perceiving drought as a problem with possible “solutions” through mitigation and adaptation planning. The ability to mitigate drought impacts is less obvious to policy makers because drought impacts are often non-structural (Wilhite, Sivakumar and Pulwarty 2014) and in the case of declarations at the county level can be mitigated through expedited water transfers. Focusing events propel natural hazard issues to policy-makers’ desks, demanding action in response to impacts (Birkland 2006). Because of their slow developing nature, climate change adaptation and drought planning policies may be low priorities for state policy-makers, taking the back seat to other pressing and sudden-needs issues like jobs or transportation (Tang et al. 2010). Drought does not always have a central focusing event to give it the necessary traction it needs, and therefore does not fit the mold of classic Agenda Setting theory.

The conceptual analysis of the policy stream of agenda setting research identifies the need for a proposal to solve a problem through policy if the proposal is (1) agreeable, (2) feasible, and (3) acceptable. Idaho does not have a dedicated policy community or network to campaign for drought planning per se, which is needed in order to propose solutions to the future drought scenarios. This is not to say that water management isn’t clearly institutionalized as part of Idaho’s resource management system. There are dozens of local, state, and federal agencies and organizations engaged in water resource issues in the state. These groups have largely managed challenges to the system, including calls on water rights, water shortages, and disputes between agencies. A closer examination of Idaho as it fits in Kingdon’s political stream identifies that planning for future drought occurrence need not be a polarizing issue based on anthropogenic causes, but on incremental steps able to address water shortage realities.

Recommendations for Future Work

This holistic view of drought in the state of Idaho is valuable in its contribution to understanding the spatial and temporal impacts of drought as seen through multiple indicators. Drought impacts were examined at the county level through drought declarations, at a multi-county level through adaptive planning within prior appropriation, and at the state level as an issue resisting clear definition and political recognition.

To fully examine drought impacts at the state level future work could look at the further impacts on a growing population. Future work could incorporate analysis through the lens of economic impacts as well. For example, a more in-depth look at how transfers would be insightful. In some years drought declarations resulted in just one or two water transfers in the county. Identifying who those water transfer recipients are and how and if they are distributing water to other users in an area that needs further examination. Geolocating these water transfer recipients could identify key locations in the state for future water storage or additional infrastructure projects, identifying how to best use Idaho's limited resources for future water resource planning. Finally, identifying current agencies and water resource professionals that may be already working as "policy entrepreneurs" could set the stage for an adaptive drought plan at the state level to be developed when the window of opportunity opens.

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