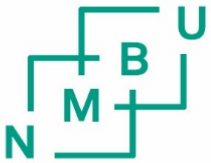

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Water in the West:
Perspectives from an Upper Basin tributary of the Colorado River

Tait James Andersen

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Declaration

I, Tait James Andersen, declare that this thesis is a result of my research investigations and findings. Sources of information other than my own have been acknowledged and a reference list has been appended. This work has not been previously submitted to any other university for award of any type of academic degree.

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First and foremost, I want to appreciate the western land and waterscapes that have inspired and delighted me since my youth. Without inspiration I could not have dreamed of this experience. Without delight, I could not have persevered.

I would like to thank all of those who shared their time and insights with me. This thesis is my take on the workings of a complicated and intense resource, and I could not have developed my own understandings without the open and generous sharing of knowledge I received everywhere. Likewise, the dedication and passion for water in the West that I felt from everyone I interacted with further inspired me along this project.

I would like to thank Bill Derman, my supervisor, whose encouragement and insights helped me to think about water in new and different ways.

Abstract

This thesis explores two institutional frameworks utilized in the governance of water in the Southwest of the United States through how they deliver, or fail to deliver, complex equity. These are (1) the legal framework and (2) cooperative agreements. This is done through a case study in the Roaring Fork River watershed, a major Upper Basin tributary to the Colorado River, by evaluating how stakeholders and different values of water are recognized and included in decision-making arenas. Stakeholders in the watershed can be positioned into three main groups: (1) agriculturalists, (2) municipalities and (3) environmentalists and recreationalists. I argue that neither institutional framework currently delivers complex equity and that achieving such equity will require changes in the legal framework because cooperative agreements do not tackle the core issues of property rights and compensation and thus, cannot effectively operate outside the legal framework.

Water in the West has been a focal point of conflict and controversy since western expansion accelerated after the American Civil War in 1865. Heralded as the key to development, its over-allocation during the last 150 years has led to a situation where more water rights exist than water to fulfill them. The legal framework, developed in Colorado's 1876 State Constitution, allocates water based on four guiding pillars: (1) Public ownership of the water resource, (2) anti-speculation, (3) beneficial use and (4) priority administration. This allocation has resulted in the ownership, by private persons, of valuable historic water rights and gives seniority to historic uses while attempting to protect the water resource from speculation and waste. My research asserts that ownership promotes treating the resource as private property, while allocating based on seniority protects those uses that have existed the longest from physical shortages and from participating in reform that would promote conservation. Likewise, I assert that the legal framework provides only scant protection for water in the natural stream channel, and that both waste and speculation still occur. Cooperative agreements have developed in an attempt to satisfy diverse human needs while attempting to coordinate diversions to promote river health. These agreements are partnerships based on trust between water users and although they have the potential to make more water available for diverse uses and the river, they do not tackle key issues. These issues are that water rights are sellable and thus seen by owners as private property to protect by diverting and the issue of whether historic uses should be compensated for providing water to the river or whether the river is entitled to water because it was the original natural state. Without participation from senior rights holders these agreements have no sway within a watershed, however, getting buy-in from senior holders requires "treading lightly" around the subjects of property rights and compensation. Without tackling these issues, cooperative agreements do not necessarily promote complex equity. They may provide a viable intermediary option, while legal reform is needed. Municipalities face challenges in providing security in their water supply. The City of Aspen has been faced with this challenge and in response, it attempted to perfect its right to build two dams for which the City holds conditional water rights in Castle and Maroon Creeks. The City's strategy followed supply oriented solutions, and the City accepted science that promoted the construction of the reservoirs, while the City did not utilize dramatic demand-management strategies such as soft path solutions. Supply oriented solutions, this thesis argues, inevitably necessitate additional supply in order to keep up with demand, and supply infrastructure carries high environmental and cultural costs, especially as the prime locations for such infrastructure have already been developed.

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List of Abbreviations

EGS	Environmental Governance Systems Framework
CWCB	Colorado Water Conservation Board
MAF	Million acre-feet of water
CAP	Central Arizona Project
ATM	Alternative Transfer Mechanism
RICD	Recreational in-channel diversion
CFS	Cubic feet per second

Chapter 1

INTRODUCTION

When traveling through the Southwest of the United States, green fields of hay and clean-cut turf lawns stand in shimmering heat-wave contrast to the semi-desert landscape that dominates. It's been likened to a perpetual mirage where historical pro-development narratives have constructed an image of the Southwest as a water rich region to entice settlement (Webb, 1957). Classic sayings from the time such as "rain will follow the plow" were developed much like the idea of manifest destiny, not only promising that the region was destined by divine right for settlement, but that the very act of settling would increase precipitation and that developing and "greening" the region was good economically and ordained by God (Reisner, 1993).

This belief has been challenged both academically and through experiences like the Dust Bowl of the 1930s. Climate data in the Southwest now reaches back 1000 years, showing that the natural variability of rainfall has been dramatic, and that the area has experienced much lower precipitation levels than recorded in modern history (Meko, Stockton, & Boggess, 1995). Indeed, as Reisner (1993) quoted Webb (1957), the Southwest is a semi-desert, with a desert heart, and a soul too dark to be truly converted for agriculture (pg. 5). Similar sentiments have been echoed throughout the ages, reaching back to John Wesley Powell, who, in his 1879 Report on the Lands of the Arid Regions of the United States argued that the land west of the 120th parallel was unfit for wide-spread agriculture and proposed that the land boundaries in the area should follow watersheds to minimize conflict (Reisner, 1993). Despite these forewarnings there has been widespread agricultural development in the Southwest, and today it also boasts one of the fastest growing populations of any region in the United States.

The Colorado River is often likened to the bloodline of the Southwest, as it is the main surface water source for the region and currently supports 40 million people in seven states and Mexico (Famiglietti, 2014). It's one of the most developed rivers in the world, with 15 dams on its main stem and hundreds more on tributaries. In recent dry years these dams have shown massive "bathtub rings" of sediment as water levels drop to historic lows. In supporting 40 million people, this vast array of water infrastructure has been developed based on a long and complicated history of water allocation policies between western states and Mexico. Currently it is argued to be one of the most over-allocated rivers in the world (Castle et al., 2014).

Water use in the Southwest has been dominated by the agricultural sector, and today, 80-90% of consumptive water use in the West is due to agriculture (Booker & Young, 1994; Schaible & Aillery, 2017). As increasing urban areas exert growing pressure on water resources, water allocations for agriculture are coming under pressure with some water managers agreeing that farmers are over-watering, and using water inefficiently through historic flood irrigation practices (Ransford, Interview 14; Tasker & MacDonald, Interview 13; Derwingson, n.d.). Irrigators contend that flood irrigation boosts return flows, effectively storing water for later in the year, and that replacing infrastructure is too expensive to be economical (Blakeslee, Interview 9). Additionally, irrigators highlight the pressure to maximize water use under the current "use it or lose it" narrative, which they contend strips water rights from those who cannot

document that they have put their full allotments to "beneficial use" (Brundige, Interview 7; Ransford, Interview 14).

Water is a value and power laden resource, and as Riesner (1993) highlights, in the Southwest, it is viewed very much as the key to development, where "wasting" water is allowing it to pass by without putting it to economic use.

If the region is going to achieve sustainable water practices, it may not be enough to simply change who has access to water, but instead there may need to be a reevaluation of the core assumptions surrounding water and development in the Southwest. Although the region is diverse in culture, economy and landscape, all populations are connected via a shared reliance on the water resources in the region, specifically, the Colorado River. Thus, this thesis strives to understand the governing institutions and related values surrounding water use, lending insights into how institutional regimes reinforce the current over-allocation.

Research in the region has revealed that measures that prioritize further infrastructure development are favored by the public to solve future water problems (Krannich et al., 1995). However, infrastructure development is not socially or politically neutral, as development of dams and canals involves landscape change, changes in who gets access to water, and changes in the physical qualities of that water.

1.1 Motivation

The development of this study was based on a primary interest in how humans value and interact with their environments. Water was chosen as a lens through which to investigate this connection because no human anywhere can go without it for more than a few days, thus making it essential to the human experience. Likewise, water is an absolute necessity to humans, increasing the motivation to look at issues of power and control of the resource in that light, as those who control water have vast influence on society.

The study area was chosen by acknowledging that there are environmental and social issues that warrant investigation in my own culture. So often environmental and social research is projected onto foreign and exotic places and people, while issues at home are not confronted. This choice was made easier by the deep love and sense of home that I feel in the Roaring Fork River watershed. Additionally, as a member of this community, I feel a responsibility to use my study and my time to shed light on issues that may benefit this place. To this end I have attempted to ask research questions that delve into both the process of governing water and the corresponding outcomes, with the goal of pointing towards strengths, weaknesses and barriers towards achieving equity that the current institutional arrangements provide.

1.2 Research Questions

1. Are the current institutions capable of handling environmental problems such as the drying-up of Colorado's river systems?

2. Do the current institutions incorporate complex equity in distributing access to water and granting recognition and participation to associated decision-making arenas?

3. How has the City of Aspen approached its water situation?
    - What strategies has the City used to balance supply and demand of municipal water?
    - Do these strategies provide complex equity for the diverse uses and values of water that community members hold, while providing for the environment?

1.3 Objectives

This study will examine a diverse community of stakeholders in the Roaring Fork River watershed, a large Upper Basin tributary of the Colorado River, as a case study to explore different institutions governing water use in the region. These institutions will be examined in context with the values and uses they support and/or ignore in recognition of Arnold's (2017) idea of complex equity, which he distinguishes as a form of justice that honors the diversity of values surrounding a complex good such as water (pg. 67). If some values and uses are given more credence than others, this imbalance will be explored.

1.4 Structure of the Thesis

The next chapter (**Chapter** 2) is the Conceptual Framework, which outlines the principles of political ecology that serve as a foundation for this thesis. It then delves into relevant literature on resource scarcity, the moral economy and soft path solutions before outlining institutional theory using the Environmental Governance Systems Framework. Finally, it describes the two institutional frameworks that are being used to govern water in the study area: Colorado water law and social capital. **Chapter 3** outlines the methods used in this investigation. **Chapter 4** highlights the contextual background, starting with the history of water development in the Western U.S., followed by the ecological changes that human development has influenced, finishing with a look at how water supplies are heavily dependent on the condition of the winter snowpack. **Chapter 5** outlines the pertinent local history and water development that has shaped the study area within the broader western context, resulting in the current situation. **Chapter 6** details the findings of this research, focusing on responses from interviewees in understanding water in relation to agriculture, municipalities and environmental interests. **Chapter 7** discusses these findings in context with the broader western situation, also focusing on the applicability of these findings in light of the theoretical foundation described in Chapter 2, focusing on answering the research questions from section 1.2. **Chapter 8** concludes by highlighting the significant findings from this research, focusing on how different valuations of water affect the resource.

Chapter 2

CONCEPTUAL FRAMEWORK

This thesis examines the effectiveness of the institutions governing water, incorporating the values and uses that these institutions support in the Roaring Fork River watershed. This inquiry is based on a foundation of political ecology, where decisions regarding access and control of environmental resources are seen as value-laden, with winners and losers (Robbins, 2011). This thinking requires a shift from the dominant "apolitical ecology", which presents itself as objective and science-based, while policy recommendations developed with such thinking often have negative consequences for some, and positive consequences for others. Hence, the non-neutrality of apolitical ecology (ibid). Where apolitical ecology presents itself as neutral and objective, political ecology recognizes the consequences of changing access or control of environmental resources and thus, starts from a foundation that acknowledges that any change will have consequences for users.

This recognition then leads to the goal of political ecological studies as Watts (2000) describes, "…to understand the complex relations between nature and society through a careful analysis of what one might call the forms of access and control over resources and their implications for environmental health and sustainable livelihoods" (p. 257). This understanding is based on a recognition that society's relation to nature is based on cultural norms and knowledge, the creation and propagation of which allows some uses of environmental resources to be culturally accepted, while others are not. As Robbins (2011) put it, "…not only [are] ecological systems political, but […] our very ideas about them are further delimited and directed through political and economic processes" (pg. 20). Political ecology strives to explore power over knowledge and narrative. It strives to uncover and make evident who has the power to form the dominant narrative and who wins from this perspective, and who loses (Robbins, 2011, pg. 20).

This exploration of "Who holds the looking glass? …whose theories and reality counts?" (Blaikie, 2001, pg. 136) is meant not only to expose the often hidden power within environmental resource governance, but also attempts to come up with alternatives that are based in fairer power dynamics. These solutions are rooted in a recognition that there often times are marginalized voices that need to be incorporated and that environmental policy needs to focus on social ends in an accountable way, based on locally grounded truths (Blaikie, 2001).

This chapter will begin by outlining relevant literature on resource scarcity (**2.1**) and the social implications of such labeling following the political ecology model that labeling a resource as scarce is not neutral. This will include an acknowledgement of the notion of moral economy, based on the idea that environmental resources can be used in a variety of ways, each with corresponding value systems. Using political ecology, these must all be taken into account for decisions to be made equitably. This will lead to the idea of the Soft Path (**2.2**), conceptualized to allow for a different decision-making process concerning how environmental resources are valued and used. This will be followed by an outline of the Environmental Governance Systems Framework (EGS) (**2.3**) to understand how a variety of institutions facilitate the governance of environmental resources. The chapter will then describe the key governing institutions of

Colorado water law (**2.4**), followed by the idea of social capital (**2.5**), which, as opposed to the legal framework, bases relationships around trust and reciprocity to achieve governance.

2.1 Social Implications of Resource Scarcity and The Moral Economy of Water

The labeling of western water resources as scarce is common, spanning back to John Wesley Powell, who argued that there being more land suitable for irrigation than water to irrigate it would lead to the "total utilization" of water and still, he warned, there wouldn't be enough (De Buys, 2001). But enough for what? Scarcity is not simply a natural fact, but involves a human element of demand, and beyond demand, a cultural determination of water supplies as insufficient. These societal aspects of resource scarcity are not neutral, and, as Kaika (2003) shows in her example from Athens, constructing societal perceptions of resource scarcity can be harnessed to forward political and economic goals that may otherwise have been seen as unfavorable. Kaika (2003) shows how constructing water scarcity as a solely natural phenomenon allowed the introduction of exorbitant price hikes that benefitted large water users (higher social strata), as the idea that water was naturally scarce induced the logic "scarce = valuable = expensive" (pg. 948).

Aquilera-Klink, Pérez-Moriana and Sánchez-García (2000) bring a case study from the Canary Islands, arguing that water scarcity there is neither physical or natural, but instead is the result of historically contextual social processes concerning the distribution and valuation of water. They show how perceived scarcity, born from over extraction of limited aquifers in a race to capture as much water as each individual could, has supported a societal view of water as a commodity to be bought and sold privately, instead of as a communal good to be shared equitably.

Such aligning of certain values of water with governing institutions is a chief focus of the moral economy of water as proposed by Arnold (2017). Arnold proposed that many different uses of water correspond with an equally diverse set of values associated with the resource while governing institutions may only promote a certain type of use and corresponding values. As he pointed out in the American West, "The regulation of scarce western water on the basis of only one inherent principle of distribution, to the exclusion of the others, leads… to the domination of every other sphere of value and meaning…" (pg. 67). This is highlighted in the West because water has historically been associated with competing values, as Arnold (2001) stipulated "[Water] is valued not only as a source of sustenance but also as an instrument of agriculture, object of beauty, industrial commodity, means of transportation, community good, fuel for urban development, clean and pure resource, and place for recreation and wildlife habitat" (pg. 93).

The complication in the West with having such diverse uses and values of water lies in the region's aridity, where all uses and corresponding values cannot be achieved equally (Arnold, 2001). This goes so far as "realization of any one value may well preclude that of one or more others" (Arnold, 2001, pg. 93). The reality that one value set may preclude another through management decisions and the adoption of certain governing institutions such as priority administration shows water as political in nature, with no management decisions being neutral. As Arnold (2001) put it:

> Because of these deeply valued and clustered senses of community and self, water issues turn on far more than questions of how to allocate efficiently an increasing scarce yet increasingly valuable resource. Also involved is the more difficult but important question of which water-related value should prevail and why in given situations (pg. 93).

Determining how different value-laden uses should be prioritized, Arnold (2017) argued, is a matter of complex equity, which is "…a function of decision-making principles that formally recognize and meaningfully sustain water's many different values, community in particular" (pg. 66). As well as due process, which he explains:

> Decisions are just if they are made fairly. Decisions are fair if made publicly and on the basis of deliberation. Public decision-making forums grant all affected interests a voice in the process and guarantee that all of water's many values and uses are meaningfully taken into account. Equally important, the principle of due process assures participants that the inherently collective act of allocating water in the arid American West remains the responsibility of the affected interests and communities (pg. 68).

The current governing institutions that comprise the legal system, as well as those that comprise cooperative agreements, will be discussed in this light, looking at whether these institutions allow the expression of water's many values, and whether decisions regarding its allocation include elements of both complex equity, and due process.

The City of Aspen's potential dam projects highlight aspects of water scarcity and its social construction within the study area, and thus will be discussed in light of these theoretical underpinnings. The situation does not exactly mirror Athens, however, scarcity seen as an inherent natural risk which would, under 1 in 100 chance models, result in an inability to meet a projected demand, was used as an argument to promote the development of additional, and culturally contentious, water infrastructure (Headwaters Corp., 2017; Gardner-Smith, Presentation 5). The City's rationale and process will be discussed acknowledging that decisions regarding water are not neutral, nor is the definition of inherent risk of a water shortage.

In addition, the notion of water, viewed as a valuable resource to be bought and sold for private gains, as articulated in Aquilera-Klink et al. (2000), will be investigated. They stipulate that societal valuations must be taken in their historical context, and the background chapter, (Chapter 4) will cover the historical development of water in the study area. In addition, authorities ranging from Powell to former Chief Justice Hobbs have argued that water is the most valuable resource in the West, but ideas about how it should be treated differ, as do perceptions of how it is treated presently (De Buys, 2001; Hobbs, Presentation 1) These diverse uses will be examined in relation to decision making power and equity of allocation. Finally, the perceived demand for water from both the Front Range of Colorado and the Lower Basin States of the Colorado River Basin will be explored in relation to the development of social perceptions of the water resource in the study area.

2.2 Soft Path Solutions

Often, when the complex legal structures of Colorado water law come under attack, defenders reply that if not this system, then what? Without thinking unconventionally, the question can be a difficult one. How is a growing region of the United States, already faced with water shortages, supposed to accommodate more people and more uses of water? Soft path thinking offers a possible solution. Originally developed by Amory B. Lovins during the energy boom of the 1970's, it was a concept that looked at curbing demand for energy instead of relying solely on propping up the supply curve with the introduction of new large scale energy plants (Holtz and Brooks, 2003). Lovins looked at energy as a conduit for the services it provided and then asked what other ways we could go about achieving those services without using more energy (Brooks and Holtz, 2009). This is the core of the soft path: To look beyond water as the end goal, and instead see it for the services it provides, then ask in what other ways those services can be achieved that take less, or no water (Brandes & Brooks, 2005).

When water supply is seen to be low, or almost incapable of meeting demand, three main strategies can be taken to solve the problem. Managers can attempt to increase supply to meet an anticipated future demand by exploiting new sources of water. This can take place through the construction of dams, pipelines, canals, wells, desalination systems and trans-basin diversions (Brandes and Brooks, 2005). Although these may alleviate shortages temporarily, new sources of water will always have to be found and exploited, and new infrastructure will always have to be built to keep up with demand.

Water managers can also attempt to reduce the demand so it does not outpace the available supply. This can be done through the implementation of efficiency programs that encourage the installation of low-flow fixtures and toilets. It can also involve changing pricing mechanisms to encourage consumers to conserve through an economic rationality (Brandes and Brooks, 2005). Where demand management centers on how to deliver the same service with less water, soft path thinking focuses on why water needs to be used to deliver the service at all (ibid). As the authors put it: "By focusing on "why" the soft path greatly increases the number of possible solutions. The approach is broadly applicable, not just to houses and gardens, but also large buildings, factories, and farms—indeed across sectors and to entire cities" (pg. 9).

An example could be waste removal. Everyone uses toilets; a water based system for removing waste. However, it isn't the water in the system that is key, it's the removal of waste. Using the soft path, as Brooks and Holtz (2009) explain: "Why, for example, do we use water to dilute and transport urban and industrial wastes? Demand management would urge low-flow toilets and leak reduction in pipes; a soft path argues for moving toward waterless or composting systems for homes, and on-site methods of waste treatment and reuse for larger buildings" (pg. 161).

2.2.1 Cultural Implications of the Soft Path

The soft path is certainly the most dramatic water-saving strategy, but it is not without its challenges. As Tyler (2007) points out, the strength of soft path solutions is in possible structural shifts within a culture that could significantly reduce water use. At the same time, these structural shifts are not neutral because realigning what behavior is socially acceptable will restrict some activities and underlying values and promote others. Imagine attempting to garner

public support for the implementation of a xeriscape policy that uses no water in the "almost fanatic" lawn culture of Columbus, Ohio described by Robbins, Polderman and Birkenholtz' (2001). All of those who value their lawns as a symbol of prosperity and order would have that symbol taken away, while the established routine of lawn care would also change. Brooks (2009), however, argues that in areas where water is still available, but supplies are dwindling, soft path solutions might be more acceptable.

Because soft path solutions require cultural shifts, they necessitate garnering public support. Wutich et al. (2014) interviewed participants from four areas around the world trying to understand the social acceptability of soft path solutions across both cultural and developmental boundaries. As such, they chose Bolivia, Fiji, New Zealand and Phoenix, Arizona as their study areas. They found that people living in developed countries were more likely to suggest soft path solutions, and that those living in water-scarce areas were less likely to suggest soft path solutions, and more likely to see no path at all. They also ascertained that those living in water-rich sites were more likely to see potential soft path solutions than those living in water scare areas (ibid). The researchers proposed that the lack of support for soft path solutions by residents of water scarce sites may be due to having already implemented socially acceptable soft path solutions, meaning that those solutions that are left to be implemented are more contentious.

Phoenix, Arizona is outside this study area, however, it is relevant to the scope of this thesis because the city lies at the bottom of the Colorado River basin and is tied to the headwaters, where this study area is located, through legal structures such as the Colorado River Compact of 1922, as detailed in section 2.4.5. Thus, Phoenix resident's perceptions of soft path solutions as detailed in Wutich et al (2014) will be described here as contextual cultural insights.

Wutich et al's (2014) research focused on Laveen, a historic farming town outside of Phoenix which is being incorporated into the metropolis as Phoenix grows. As such, its historic water use was centered around agriculture. However, that water is more and more being used for municipal needs in Phoenix. Respondents to surveys conducted by the research team found that soft path solutions suggested by participants focused on restricting and regulating both water use, and population growth. Regulating water centered around limiting human use, not watering golf courses and limiting the number of swimming pools that could be built. Population control solutions centered around limiting development and the number of people who could move to the area.

These suggestions are socially contentious and show that soft path thinking can lead to suggestions that are certainly not neutral. As such, soft path thinking in itself cannot be taken to be solely positive, and the consequences of implementing such solutions must be weighed carefully. Brooks and Holtz (2009) stress along political ecological lines that public participation in soft path thinking is key as it gives minorities and those who may be more dramatically affected a space to voice their concerns and be included.

2.3 EGS Framework

This study aims to understand the social and environmental implications of the resource regimes associated with water use, focusing on a shift that is occurring in some areas away from a legal

authority governing the resource towards a common-pool governance system. This will be done using three main theoretical understandings. The first is institutions, the second is resource regimes, and the final is the Environmental Governance Framework (EGS) put forward by Vatn (2015). Each builds off the previous, and thus institutions will be described first.

2.3.1 Institutions

Institutions, as Vatn (2015) defined them, are "the conventions, norms and formally sanctioned rules of a society. They provide expectations, stability and meaning essential to human existence and coordination. Institutions support certain values, and produce and protect specific interests" (p. 113).

The three types of institutions outlined above can be further described: Conventions help a society with coordination problems, operating where there are low levels of conflict, and allowing more straightforward coordination. Norms are different in that a certain situation is combined with a required act or solution that supports an underlying value (ibid). Hence, they impose certain acceptable ways of behaving and treating others.

Finally, formally sanctioned rules differ from the above institutions in that they "combine a certain situation with an act that is either required, or forbidden, and is governed by a third party" (Vatn, 2015, p.117). Their use is highest where interests are conflicting. In this study, the most applicable legal relationship can be described as right vs. duty, in that a certain actor Alpha has a right to use a certain good – water from a certain stream – and Beta is not allowed to use that water, nor is Beta able to use the stream for other purposes if the water is no longer in the stream, or if Beta's use will affect Alpha. In short, Beta is bound by a duty to let Alpha decide what to do with the resource (Vatn, 2015, p. 118). This plays out in that agricultural users have the most senior water rights, and thus other water users, or potential users, have a duty to allow agriculturalists the water they are entitled to, which is, by some estimates, nearly 90% of the appropriated water.

Institutions are also important for forming power relations and, in addition, are sources of power. They influence power relations in three ways: (1) epistemic and normative power, which is the power to influence knowledge and perceptions, and shape values; (2) positional power, determining who has access to what resources, and decision-making powers; (3) coordination power, the capacity to coordinate human action towards common goals (Vatn, 2015, p. 129-130). This shows that institutions are not neutral, and can be used to protect certain values and interests. Normative power is important to this study, as commonly held values such as "greening is good" will be studied in this light.

2.3.2 Resource Regimes

Resource regimes are defined by Vatn (2015) as the institutions governing use and protection of environmental resources and processes (p. 181). Vatn (2015) emphasizes two main types of institutions that are crucial in establishing resource regimes: the first is the rules concerning access to environmental resources, and the second is rules concerning interactions within and between actors having access to such resources, as well as being influenced by decisions regarding them (p. 181).

In regards to the first set of institutions, this 'access' can come in many forms, from the right to enter to the right to exploit, to the right to exclude. It also extends to different classifications of property type: private, state, common and open access. In all, except perhaps open access, there is the existence of a third party who guarantees that those holding the rights to property or a resource have rights to benefits from that resource. This third party can be a state, or it can come from customary law (ibid). In this case, third party authority for water right holders has come from the legal structure developed by the state of Colorado, while also emanating from the federal government and interstate compacts as detailed in section 2.4. Although authority over granting access comes primarily from this long-substantiated legal structure, interaction rules have been practiced on a more *de facto* basis, with agriculturists largely coordinating amongst themselves (Blakeslee, Interview 9). With increasing diversity of water uses and values, this mode of interaction is increasingly under legal scrutiny, and some water users have begun to create more formal agreements based on community-generated rules, with the goal of both increasing interaction between diverse water users, and protecting historic *de facto* water sharing practices between agriculturalists (Brundige, Interview 7).

It's important to understand that the type of property or use rights that exist around a resource have a direct affect for the strategies and abilities of that resource to be governed, and these are not neutral, as different designations may affect actors differently. The reluctance of some water users towards interacting with this new emerging system will be discussed in light of this point: that using a different system may be seen as a threat to their control over the water resource.

There are four types of rule-based interaction institutions involved in resource regimes: trade, command, community rules and no rules. Trading involves exchanging goods and services against a payment. In principle, it's a voluntary transaction, based solely on price and quality of the goods or services exchanged (ibid). Command, as Vatn (2015) explains, is based on hierarchical power. Although it can be used in a myriad of ways, our focus is on command 'between' actors, which is third party authority. Community-based rules are norms of reciprocity, where strengthening relationships is key.

No rules mean that there are no commonly defined ways to interact. People can do whatever they want. When settlers first started harnessing Colorado's water resources in the mid 1800s there was no need to establish laws to govern the resource because it was ubiquitous. However, as the resource dwindled due to increasing demand, conflict began to arise, as Vatn (2015) would describe it, over the question of who had the right to use the resource: Those who were there first? Those who owned property adjacent to water courses? Those who used it for certain purposes? Or did the natural environment have a right to the water? These questions were all decided through a long set of court cases, establishing the four pillars of Colorado water law, which govern the resource today and will be described in the next section (2.4).

2.3.3 Environmental Governance Systems Framework (EGS)

The Environmental Governance Systems framework (EGS) requires including the actors involved, which Vatn (2015) divides into three groups: economic, political, and civil society.

Vatn (2015) looks at economic actors as those who have 'access' to a given environmental resource. He adds that these actors may be private, state, or community based, but that they can

be divided into two roles: producers and consumers. Producer's main goal is to maximize profit, while consumers attempt to attain the products they want at the cheapest price, for the best quality (ibid). In this case, producers include agriculturalists, municipalities, and the recreation industry. It is slightly more complex than simply maximizing profit however, as each type of water user may also attempt to maximize water use in the effort to solidify their future access to the resource, regardless of the effect on their current profit. Consumers are those who purchase agricultural products such as hay, alfalfa and beef products, as well as municipal water users and recreationalists who pay to be guided on the river, either for rafting, fly fishing or nature watching. Another group of consumers are those land owners whose property values are influenced by their proximity to streams and rivers.

Political actors are those who have the power to define the property or use rights and interaction rules. They decide who has 'access' and what that access looks like (Vatn 2015). In this case, the main political actor within the state is the Colorado water court system and the Colorado Supreme Court, as they not only create and maintain the resource regime, but they also act as a third party in conflict. On a larger scale, the U.S. Supreme Court acts as a third party in interstate conflicts over water, and this "threat" of external authority will be discussed as a motivator for local collaboration.

Finally, civil society actor's role is to ensure that there is democratic legitimacy in the political process (Vatn 2015). NGOs are a common civil society actor, who may attempt to express the interests of the society to political officials at all levels. Within the study area, NGO's such as The Roaring Fork Conservancy, American Rivers and Trout Unlimited are the main civil society actors, and represent environmental and science-based interests in water through advocacy, collaboration and litigation.

It's also important to note that the outcomes, which are the specific states of the resources, influence the choices of all actors, because if outcomes are seen to be unsatisfactory, civil society may attempt to intervene in the political process. Vatn (2015) stresses that it's the perception of the state of the resource that counts, not the actual state. This is a key point concerning this study, as water levels are perceived by many in civil society to be too low for both environmental and municipal needs, and that perception is a driving concern for economic actors such as agriculturalists, who fear a change in legislation will strip them of their water resources. Below is the EGS framework as developed by Vatn (2015).

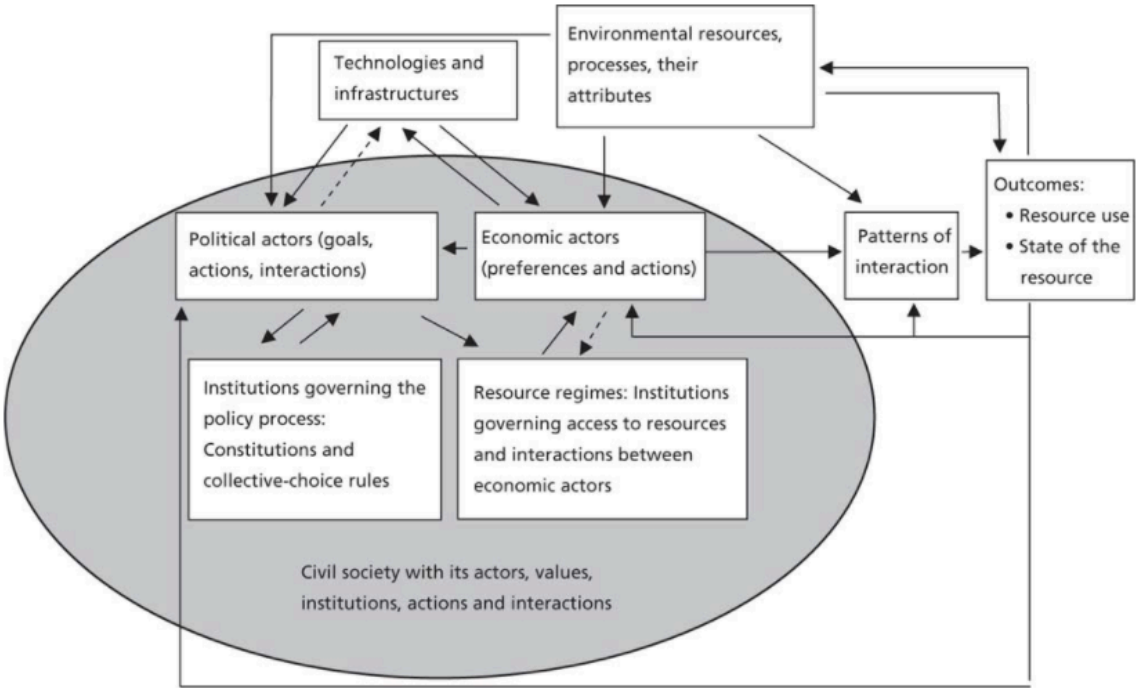


Figure 1: The Environmental Governance System Framework, from Vatn (2015).

2.4 Colorado Water Law

When settlers began arriving in earnest on Colorado's eastern slope in the 1850's, they came for gold. As former chief justice of the Colorado Supreme Court Gregory Hobbs described: "It was rumored that the miners liked to eat. Right on the heels of the miners were the farmers who wanted to feed their families and the miners" (Hobbs, Presentation 1). Thus, on the edge of the Great American Desert, a system of irrigated agriculture began to develop haphazardly. Water from creeks and rivers was diverted by whomever decided to divert it, bringing water to land that could suddenly produce a crop, where before it had been impossible (DElgin, 2016).

After the end of the Civil War in 1865, people flocked west in droves, rolling away in wagons from a land they had known, a land that was endowed with plenty of water. They crossed the great expanses of the treeless plains, fortified against the endless dryness by commonly held beliefs of the time that water would follow the plow and that by planting trees the hydrology of the area would change to provide more water (Reisner, 1993).

However, such notions proved to be of little comfort when rivers in Eastern Colorado, whose water had once flowed into the Missouri and down to the Gulf of Mexico, were quickly turned into dry gravel beds, their waters' utilized and fought over by rapidly growing settlements. These conflicts sometimes bordered on physical confrontation, as when the Union Colony awoke one morning in 1874 to find that their ditches were dry due to the younger Fort Collins Colony having taken all of the water. Hobbs explains: "What do you think the people at the Union Colony thought? They thought we better get on our horses and get up there as fast as possible. 'put the river back, can't you see we are relying on it? Put it back!'" (Hobbs, Presentation 1).

Fifteen years later, John Wesley Powell, the first man to lead an expedition through the inner canyons of the Colorado River, would warn the young Montana Constitutional Convention "…that litigation is a prolific source of expense and evil, and you should endeavor to provide for a proper system at the very beginning of your State for adjusting rights by your fellow citizens among yourselves" (De Buys, 2001, pg. 242). Indeed, in Colorado, litigation had already become the most powerful tool in deciding water disputes.

With the settlement of each new dispute, precedents were set, forming the basis of today's four pillars of Colorado water law: Public ownership of the water resource, anti-speculation, beneficial use, and priority administration. Colorado water law is often perceived as being very complex, and key interviews revealed that there are many interpretations of key points. This section will only outline the four pillars of the law, leaving for the findings and discussion sections a more in-depth look at the various interpretations and resulting effects.

2.4.1 Public Ownership of the Water Resource

In the American West, water was put under public ownership, as Mertz and Raley (1986) describe, through the Mining Act of 1866 and the water provisions of the Colorado Constitution. This ownership is defined as all of the water of the natural streams being the property of the public and dedicated to public use (ibid). The role of the government is one of trusteeship, where government officials have the responsibility for water administration. This responsibility means that, according to Hobbs (2013), the government must administer water in a way that conserves the resource and avoids waste, promotes beneficial use by helping those who want to put it to use to do so efficiently and effectively, maintains the use regime of the resource, and promotes stewardship of the resource as would be expected from a trustee.

In Colorado, the first Adjudication Act of 1879 charged the courts with water administration through a system of hearing claims of water rights and sorting them out through priority date. This system of prior appropriation is described in section 2.4.4. This same act created the role of water commissioners – those representatives of the state who go into the field and administer rights as decreed by the courts. Two years later, in 1881, the Office of State Engineer was created as an umbrella for the water districts, in which the water commissioners operate.

2.4.2 Anti-Speculation

Speculation, at the time, was based on a fear of growing monopolies. John Wesley Powell was fearful that wealthy interests would be able to buy the right to water resources with the sole intention of selling them or renting them later for a sizable profit.

> The pioneer is fully engaged in the present with its hopes of immediate remuneration for labor. The present development of the country fully occupies him. For this reason, every effort put forth to increase the area of the agricultural land by irrigation is welcomed. Every man who turns his attention to this department of industry is considered a public benefactor. But if in the eagerness for present development a land and water system shall grow up in which the practical control of agriculture shall fall into the hands of water companies, evils will result there-from that generations may not be able to correct, and the very men who are now lauded as benefactors to the country will, in the ungovernable

> reaction which is sure to come, be denounced as oppressors of the people (De Buys, 2001, pg. 204).

Riparianism is an idea prevalent in the Eastern U.S. determining that only those landowners who were adjacent to natural waterways could have access to the use of that water. This was seen as an inroad for speculation, for buying riparian land was an easy way to secure the resource. Instead, because water in the West was almost always taken out of the riparian area to be used, and because of the threat of speculation, support grew for priority administration. However, the threat of speculation still arises, and thus there is a portion of the law called Abandonment of Water Rights which stipulates that if a right is not put to beneficial use for 10 years, it can be subject to abandonment, meaning the user loses the right to that water (Ferril, 2004). This has led to the popular and somewhat over-hyped slogan "Use it or lose it", which will be discussed in later chapters. In addition, water speculation may still exist, existing in the increased value of land that has water rights associated with it. This will be detailed in the findings (Chapter 6) and discussion (Chapter 7) sections of this thesis.

2.4.3 Beneficial Use

Beneficial use is a doctrine that has been broadening in its application since its inception in the Colorado Constitution. Ferril (2004) describes it as "a lawful appropriation that employs reasonably efficient practices to put that water to use without waste" (pg. 7). He also lists the broadening range of uses that are allowed under the doctrine, where there was initially only agricultural, mining and municipal. These uses have expanded to include Colorado Water Conservation Board instream flows, commercial, domestic, dust suppression, fire protection, fish and wildlife culture, flood control, industrial, irrigation, mined land reclamation, municipal, nature centers, power generation, recreation, recreational in-channel diversions, release from storage for boating and fishing, snowmaking and stock watering.

The appropriation of water for recreational, in-stream and aesthetic purposes has been a recent development, and a controversial one. Proponents argue that such appropriations are the only tools environmentalists and recreationalists have to protect the resource (Poschman, Interview 5), while others view aesthetic and recreational uses as not vital like agricultural uses (Blakeslee, Interview 9). A recent supreme court case sided that aesthetic uses are not beneficial, and although some rights to aesthetic uses exist, no new ones will be appropriated (Blakeslee, Interview 9). In-stream flow rights, which can only be held by the Colorado Water Conservation Board (CWCB), were once seen as the solution to keeping a healthy amount of water in the rivers, but the likelihood that any more will be approved is very low, and the kayak park constructed in 2016 in Basalt, Colorado may be the last one approved in the state (Poschman, Interview 5). The discussion chapter (Chapter 7) will look at these shifts in detail.

2.4.4 Priority Administration

Priority administration, often called "first in time, first in right," may be the most important aspect of Colorado water law concerning its administration. As Ferril (2004) describes it: "Water users with earlier water rights decrees (senior rights) have better rights in times of short supply, and can fill their needs before others (junior rights) can begin to use water" (pg. 6).

This doctrine is perhaps the most incendiary, as it distributes risk of shortage unevenly between users, and decreases the potential for more equitable water sharing (Burness & Quirk, 1980). Still, authorities such as Hobbs argue that the doctrine is necessary and works because it accommodates the hydrology of the area and allows administration by protecting those who were there first. He also argues that this doctrine came out of practical experience from the first settlers of the area, and thus is endowed with local knowledge (Hobbs, Presentation 1). Still, it's hard not to wonder if the writers of Colorado's constitution could have anticipated that thousands, perhaps hundreds of thousands of water rights would be developed, leading to a system that, under scarce conditions where every right holder calls for their water, it takes incredible resources to administer. To illustrate, the table below, adapted from Ferril (2004), is an example of how the priority system works in practice on a very small scale. In reality, there would be thousands of rights' holders, both above and below any call that came in.

Table 1: Workings of a water call, from (Ferril, 2004).

1) Irrigator Jane contacts her local designated ditch official, and says she needs to call for her water. She can only call for the amount of water provided in her water right decree, and only for the amount that she can actually put to beneficial use (e.g., irrigation of a crop).
2) The ditch official contacts the local water commissioner at the Colorado Division of Water Resources and places the initial call. Depending on the river system, a verbal call may be made, but in many cases a formal written call for water is required.
3) When the call comes on, the water commissioner verifies its legitimacy, then starts looking upstream to shut down all undecreed uses. Still not enough water!
4) The water commissioner then limits all decreed upstream users to decreed amounts of diversion. Still not enough water to fulfill irrigator Jane's 1940 water right!
5) Now, the water commissioner will use the priority system to look upstream from Jane's headgate diversion, for decreed users with priority dates more recent than 1940.
These users are considered "junior" and their diversions will be reduced or shut down.
6) Each decreed junior water user, based on their order of priority, junior to senior, is shut down until Jane gets enough water to fulfill her 1940 water right.
7) However, stream levels are still dropping, and now, downstream municipal user Blue City does not have enough water to fulfill its 1927 water right. Blue City places a call.
8) The water commissioner will go through the same process, reducing or shutting down all rights more recent than 1927 until Blue City's rights are met. This may mean that irrigator Jane will have to let water flow past her headgate to fulfill Blue City's senior downstream right.
9) If you don't comply, the water commissioner will lock down your headgate!

Within this system the Colorado Constitution stipulates that when there is not enough water to meet these needs, domestic water has preference over all other types, and agricultural use has

preference over industrial (Ferril, 2004). However, in a case before the Colorado Supreme Court in the early 20th century, a junior municipal user attempted to override a senior agricultural user, and it was decided that this stipulation was not intended to over-ride the appropriation system. However, regulated under a statute, municipalities have the ability to condemn water rights previously held for other purposes if those other users are paid just compensation. This tension between municipal and agricultural users is still strong, and in following chapters will be explored in-depth.

2.4.5 The Colorado River Compact of 1922

The Colorado River Compact of 1922 has been the chief interstate governing institution for allocating Colorado River water. In 1922, seven western states: Colorado, Utah, Wyoming, Nevada, New Mexico, Arizona and California came together with the direction of the Secretary of Commerce Herbert Hoover to create a mechanism to equitably distribute the water of the Colorado River (Danver, 2013). Before the Compact, each state was allowed to create their own governing institutions for water use within their borders, however, interstate water use operated without any formalized governing institutions (ibid). When negotiations first began, headwater states such as Colorado, Wyoming, Utah and New Mexico were motivated to create an agreement because they worried that the more developed states such as California would secure senior rights to the water, effectively limiting headwater state development (Kuhn, Presentation 4). States who were affected by the Colorado River below the Grand Canyon were driven to the table because they needed political support in Congress to pass the Boulder Canyon Project which created Hoover Dam, providing flood control and easier access to water (ibid). Stakeholders that were affected by the compact but were left out of the discussion include Mexico, where the river historically flowed into the Gulf of California, Native American tribes and environmental organizations (Adler, 2008).

The confluence of these motivations did not present an easy setting in which to divide the river's waters, and initial attempts to divide the river between states failed (Danver, 2013). This failure was met with a proposal from Hoover to create two basins, split at Lee's Ferry, Arizona. The Upper Basin is composed of Colorado, Utah, Wyoming and New Mexico, while the Lower Basin is composed of California, Nevada and Arizona (MacDonnell, Getches, & Hugenberg, 1995). It was proposed that there were 15 million acre-feet (maf) available for allocation each year from the river, so each basin was given 7.5 maf. The presumption that the river could supply 15 maf annually has not only been debunked recently (Meko, Stockton, & Boggess, 1995; Sabo et al., 2010), but was potentially understood as a farce at the time of the Compact's creation (Poschman, Interview 5). However, under compact rules, the Upper Basin, where the water originates, has a responsibility to deliver 75 maf to Lee's Ferry over a ten-year period.

This allocation scheme was meant to protect the future of Upper Basin development, as Lower Basin states regularly used their allotted 7.5 maf, while Upper Basin states still only use around 4.5 maf (Kuhn, Presentation 4). However, because the river rarely provides 15 maf annually, Upper Basin states cannot use 7.5 maf and still meet their delivery to the Lower Basin (Blakeslee, Interview 9). If Upper Basin states do not fulfill the delivery, all Upper Basin water rights issued after the signing of the Compact in 1922 can be curtailed until the delivery is met. However, as Bill Blakeslee explained "I think it would trigger somewhere between 10-15 years of litigation in court. I don't think that the changes would be dramatic until all the litigation had

taken place". Still, with continuing water shortages, the threat of the "Compact Call" as such a curtailment would be called, is present and makes all pre-1922 water rights in the Upper Basin extremely valuable, as they would not be curtailed. In Colorado, 99% of these pre-compact water rights are held by agriculturalists, while Front Range cities who depend on trans-basin diversions from the Colorado River would be curtailed under the Compact Call (Kuhn, Presentation 4).

Later compacts further complicated the system, as Mexico was given 1.5 maf, increasing total Upper Basin deliveries at Lee's Ferry to 8.23 maf, regardless of actual streamflow conditions in the Upper Basin (MacDonnell, Getches, & Hugenberg, 1995). In 1948 Upper Basin states came together to form a compact dictating use between themselves, based on percentages of available water as opposed to fixed amounts (ibid). Colorado was awarded 51.75%, Utah 23%, Wyoming 14% and New Mexico 11.25% (ibid). This dividing of the Upper Basin's share cleared the way for federal projects that increased the Upper Basin's storage capacity, recognizing that the Upper Basin faced the brunt of risk of curtailment if river levels dropped below 15 maf (ibid). These projects include The Aspinall Unit on the Gunnison River in Colorado, Navajo Dam on the San Juan River in New Mexico, Flaming Gorge Dam on the Green River in Utah and Glen Canyon Dam on the Colorado River in Northern Arizona (ibid). Hence, the use of 15 maf as the dividing amount for the Colorado River lead to the necessity of these huge storage projects, which carried enormous cultural and environmental costs (ibid).

2.4.6 Change of Use Case

Water rights owners who wish to change the place or type of use of their water right while maintaining their priority date may do so, however, they must fulfill three obligations (Ferril, 2004). First, it must be approved by a court decree, second, the amount of water that they can transfer to a new use or new area is dictated by the "…historic beneficial consumptive use in time and quantity" (pg. 15). This historic consumptive use is measured through an engineering formula that takes into account the type of crop grown, the acreage, the soil type, and the diversion records (ibid). It is this last component that can motivate irrigators to show high diversions, lest they wish to change the type of use from agricultural to municipal, they may have more water to sell (Ransford, Interview 14). Thirdly, it must be shown that changing the place or type of use does not increase the water right, or harm other rights holders who may be dependent on return flows or ditch push water that would be impacted (Ferril, 2004).

Hence, when land that has a water right attached to it is sold, the water right remains with the land with its priority date (Ferril, 2004). However, should the new owner wish to use the water for a different purpose, or in a different location, they will need to go through the change of use proceedings. If land is purchased without a water right, the owner may apply for one, but they have to demonstrate that there is unappropriated water available, and the size of the right will be based on the crop they wish to grow, the soil type, and the historic diversion amounts in similar settings, or it will be based off of the number of houses they wish to provide for (ibid). The priority date will be set as the date the water right is approved by water court. In over-appropriated watersheds it is still possible to secure water rights, however, the water may only be available for a short time of the year, or only in high water years (ibid). To increase the security of such water rights developers may create an augmentation plan, where they purchase water from a reservoir to supplement their withdrawals. In the study area, Ruedi Reservoir provides the chief source of augmentation water, allowing a developer to pump tributary groundwater for

their development out of priority, using the augmentation flow from Ruedi to satisfy senior users (ibid).

2.5 Social Capital

2.5.1 Social Capital Definitions

Social capital is often heralded as a concept that is too broad. As Narayan and Pritchett (1997) put it, "[Social capital is] a notion that means many things to many people" (pg. 119). As such, it requires a careful delineation in how it will be applied in this study. In their review of the concept, Adler and Kwon (2002) put forth a coherent definition which will serve to clarify the concept:

> The core intuition guiding social capital research is that the goodwill that others have toward us is a valuable resource. By "goodwill" we refer to the sympathy, trust, and forgiveness offered us by friends and acquaintances… If goodwill is the substance of social capital, its effects flow from the information, influence and solidarity such goodwill makes available… these benefits are accompanied by costs and risks (pg. 18).

Of course, this definition requires unpacking. Goodwill is not universally available, and, as Adler and Kwon (2002) explain, its availability to groups and individuals lies in "… the structure and content of the actor's social relations" (pg. 23). Social relations can be understood as different dimensions within social structure, falling into three categories of relations. The first is market relations, which are relations where products and services are exchanged using an institution such as money, or through the act of bartering. The second is hierarchical relations, which are based on authority and obedience, which are used to provide material and spiritual security. The third is social relations, where favors and gifts are exchanged using trust. As Adler and Kwon (2002) explain, "It is this third type of relationship that constitutes the dimension of social structure underlying social capital" (pg. 18).

Although these categories are useful in a theoretical sense, Adler and Kwon (2002) acknowledge that relationships often involve some mix of all three types. Where market and hierarchical relations exist, there is repeated interaction among actors, which, as they point out, creates social capital, albeit indirectly.

2.5.2 Sources of Social Capital

There is much debate as to the sources of social capital, split primarily into two branches. The first, as Adler and Kwon (2002) explain "locates the source of social capital in the formal structure of the ties that make up the social network" (pg. 23), focusing on features of structure such as closure and structural holes. This branch focuses on social capital's creation in relationships where information and other social capital resources are needed when other options for attaining them are less efficient or absent (e.g., holes). They go on describe the second branch, "…which focuses on the content of those ties" (pg. 23), emphasizing tie content such as commonly held beliefs, shared norms and shared opposition, as well as abilities in creating social

capital. In this branch, these commonalities are the well-spring of social capital.

The importance of social ties will be investigated due to the rallying effect on diverse Western Slope interests that can come together with a common enemy in the Front Range cities such as Denver, Colorado Springs and Pueblo, and the Lower Colorado River Basin.

2.5.3 Benefits and Risks of Social Capital

Although heralded by some as only positive, the risks of social capital are more and more being included in the discussion of the concept, with studies confirming that social capital is not the panacea once thought. Here, both the benefits and the risks will be explored.

2.5.3.1 Benefits

The most direct of social capital's benefits is access to information with lower costs of attaining it (Adler and Kwon, 2002). An example used by Coleman (1988) looks at a social scientist who is exposed to new information in their field everyday through informal interaction with their peers. The studies confirming the access to easy information gathering provided by social capital are ubiquitous, and are showing that information flows using social capital have the potential to help whole sectors (Uzzi 1997).

A second benefit from social capital is the ability to use influence, control and power that has been established through social capital. Coleman (1988) found that some U.S. senators were more influential than others because they had built up favors from others, which they could use to control votes. Although power may be seen as posing a risk by becoming coercive, Alder and Kwon (2002) argue that: "Power helps get things done" (pg. 29).

Solidarity is the third benefit of social capital, as strong norms and customs that are stringently followed reduce the need for formal rules, and thus increase efficiency. An example comes from Nelson (1989), where he shows that groups who interact frequently were able to deal with conflict faster and had less buildup of tension from unresolved disputes.

2.5.3.2 Risks

The first risk in social capital comes from the idea, that as with any investment, it takes resources to build social capital. In some cases, Adler and Kwon (2002) argue that the benefits of the relationships established may be outweighed by the cost of creating them.

Secondly, they argue that an actor operating in a network with many ties to other actors who, in turn, have many ties to other actors, will have less power than if they were operating in a network with fewer ties. This is because the actor will have less influence on those around them because they are all so highly connected.

Third, solidarity can be a strong influence on groups, dissuading them from integrating new, and potentially better information from other groups. This exclusion can extend from information to

persons, and groups can become extremely hard to enter as an outsider (Portes & Landolt 1996).

In this study both the benefits and risks of social capital will be explored, in light of disparate communities in the study area and their ability or inability to coordinate outside the legal framework. Also, the role of "outsiders," such as the Front Range and the Lower Basin states in the Colorado River Basin will be explored as motivators for local formation of social capital and the associated benefits and risks to that development. Institutions such as solidarity will also be explored as an instrument used to move away from reliance on legal rules to control the water resource, as those agriculturalists who have strong ties will be shown to rely more on informal relations based on social capital.

This chapter has outlined the five main concepts that will be used to frame and discuss the findings of this study. The next chapter will outline the methodology used to realize this research.

Chapter 3

METHODOLOGY

3.1 Research Approach

This study uses a qualitative research approach to investigate a diverse community at the headwaters of a major tributary of the Colorado River. The qualitative approach has been taken because it yields descriptive data expressed through words, focusing on the interpretation of the specific situation, with the goal of exploring the complexities in the context in which they exist. (Bryman, 2012). This, in contrast to quantitative studies, which focus on testing the probabilities, distributions and frequencies of specific phenomena in isolation (ibid).

As such, the qualitative research approach involves coming up with research questions focused on exploring who, when, where, why, and how, whereas quantitative research strives to answer questions such as how much, how many and how often. The qualitative process allows for an in-depth investigation of many variables, where the research process is flexible and integrated, allowing the adoption of new knowledge throughout the process. Thus, it relies on inductive reasoning – that theory builds throughout the study, guided by findings that are collected throughout the process. Had a quantitative approach been applied, the process would have been more linear, with the generation of hypothesis based on prior theory leading to data collection that either confirmed or rebuked the hypotheses. This would have been an exercise in deductive reasoning (Bryman, 2012).

3.2 Research Design

This study aims to understand the variations in perceptions, valuations and interactions with water by different stakeholder groups in the study area, and thus it incorporates aspects of cross-section design, as described by Bryman (2012). "Researchers employing a cross-sectional design are interested in variation… Variation can be established only when more than one case is being examined" (pg. 59). This study focuses on three different cases: (1) ranchers and agricultural valuations of water; (2) The City of Aspen and municipal valuations of water; (3) recreationalists and in-stream valuations of water. Bryman also stipulates that cross-sectional data collection takes place at a single point in time. For this study, data was collected over six months, but the goal was to understand the situation during this specific time period, contrasted by longitudinal studies, which aim to understand how things change in relation to time (ibid).

Additionally, most cross-sectional studies look for patterns of association, meaning they attempt to relate variables to each other. In this study, this could mean looking at the similarities and differences of how the three groups value water. Bryman (2012) warns that cross-sectional studies lack the ability to order variables by time, meaning that it becomes much more difficult, or impossible, to establish causality. This point is made mostly in reference to quantitative studies using a cross-sectional design, whereas in this study, the goal is less to point towards causality than it is to discuss the variation that exists among stakeholders and the corresponding effects on water resources.

The investigation into municipal, agricultural and recreational water values and uses can be described as case studies, which Bryman (2012) explains: "The most common use of the term 'case' associates the case study with a location, such as a community or organization. The emphasis tends to be upon an intensive examination of the setting" (67). This intensive investigation, Bryman continues, "…often favour qualitative methods, such as participant observation and unstructured interviewing, because these methods are viewed as particularly helpful in the generation of an intensive, detailed examination of a case" (68).

The case studies in this thesis were selected through starting with a broad examination of the entire study area, which revealed that it was too large and complex to be studied in its entirety, but that three main stakeholder groups existed within the area: (1) municipal water managers and users; (2) ranchers and other agricultural users; (3) recreation and environmental users. Persons and organizations of interest were then identified within each of these groups through purposive and snowball sampling. Semi-structured interviews with these persons formed the backbone of this study through exploring their insights into perspectives of the stakeholder groups.

3.2.1 Data Collection

This study uses semi-structured interviews, in context with participant observation, to gather detailed information about the narratives different stakeholder groups use to value and explain water in the study area. Textual analysis has formed the background and contextual information that informed these findings. This type of data collection is the essence of a qualitative study, which Berg and Lune (2011) describe: "Qualitative procedures seek patterns among cases, but do not reduce these cases to their averages ... As a result, qualitative techniques allow researchers to share in the understandings and perceptions of others and to explore how people structure and give meaning to their daily lives. Researchers using qualitative techniques examine how people learn about and make sense of themselves and others" (8).

To achieve this, the first interviews were conducted with sources who I was familiar with and who had broad knowledge. I would start by describing to the interviewee my project to give them context. Then I used very broad and open questions, resulting in a fairly informal conversation that ranged wherever the interviewee chose, as long as it had something to do with water in the area. When a point of interest came up, I would ask follow up questions that became more specific, eventually leading to suggestions for people to interview who would further inform me. The last question I asked during every interview was "is there anything that we haven't touched on that you want to add?" This sometimes sparked insights that I had not anticipated, and led to deeper understandings. As I became more informed, I reached out to people with more specific knowledge and to those who I knew held information that was sensitive to current issues, and with whom my questions would have to be more delicate. Likewise, my line of questioning became more specific, focusing on what influenced conflict and what shaped stakeholder perceptions. This progression worked well because, by the time I interviewed key stakeholders, I had achieved a sufficient vocabulary and understanding of the water management system and local situation that they spent very little time explaining fundamental concepts, and instead focused on more in-depth and nuanced insights.

This method can be characterized as an example of purposive sampling, which Bryman (2012) explains is not random, but is a method where the researcher uses samples that are relevant and

diverse to build a broad and full picture of the situation. Qualitative studies do not rely on random, or probability, sampling as their results are not meant to be extrapolated to larger populations, and are instead meant to focus on exploring the unique or interesting aspects of the population being studied (ibid). Thus, purposive sampling worked well in that it allowed those stakeholders who were most relevant and diverse to be selected.

In addition to a purposive approach, snowball sampling was used, which Bryman (2012) describes as: "…the researcher makes initial contact with a small group of people who are relevant to the research topic and then uses these to establish contact with others" (pg. 202). The benefit to using snowball sampling was that it put me in contact with people in a manner where I was already legitimized through my introduction from someone they knew and often respected. This may have allowed them to feel at ease sooner in the interview process, allowing for a more productive interview. In addition, it allowed me to reference points made by the person who had made the introduction, asking how the current interviewee felt about that perspective. In this way, I was able to triangulate information and gain further insights on critical points.

Interviews were conducted where and when it was convenient for interviewees, sometimes in coffee shops, offices, or at the local library. Twice, they were over the phone. Once, the interview was conducted onsite on an interviewee's ranch. This onsite interview, although difficult to record, lent insights that the others did not. During the interview I was led around the ranch and shown the workings of the flood irrigation system. The tour lasted around two hours and involved a discussion of the benefits of flood irrigation in producing springs that the family had used for two generations as drinking water, as well as a general discussion on coordination among ranchers. I also helped with pregnancy checking cows and giving immunizations to calves at a different ranch within the study area, and although these two days were perhaps too short to label as real ethnographic research, which Bryman (2012) stipulates requires living immersed in a culture for months, they did give me insights into the ranching culture that allowed me to have a more informed discussion about that culture during subsequent interviews.

In addition, I attended a community meeting focused on water through the lens of business. I also attended a public tour of the City of Aspen Municipal Waste Water Plant. Finally, I toured the public ditches in Carbondale with the utility manager and participated in a community meeting hosted by the City of Aspen to collect information about public support for various water-based initiatives. These meetings further allowed me to collect ethnographic data through observation and interaction with fellow attendees and informal conversations with both Aspen's Waste Water Manager and Carbondale's Utility Director., These were excellent settings for me to introduce myself and my project to potential interviewees. Appendix A details the interviews and meetings that were conducted and attended in order to inform this study. This diversification of data collection techniques is critical to triangulation, as detailed in the following section.

3.2.2 Triangulation

Triangulation, as Bryman (2012) points out "entails using more than one method or source of data in the study of social phenomena" (pg. 392). Although originally conceived by Webb et al. (1966) to promote using more than one method to develop a measure, and thereby increase confidence in quantitative studies, Bryman argues that triangulation is very much applicable to qualitative studies, referencing ethnographers checking their observations using interview

questions to make sure they had not misinterpreted what they had seen. This danger of misinterpretation is far more likely to occur when only one form of data is used, such as strictly relying on interviews. As Berg and Lune (2011) point out, using only one form of data requires acceptance of the assumption that reality is completely observable through that technique. Applied to this study, data collected through interviews was cross-checked by asking interviewees to weigh in on points made during pervious interviews and on-site tours, through using participant observation in meetings and while spending time on ranches, and through using textual sources to confirm what had been detailed and observed in interviews and observations.

3.3 Analysis and Coding

Almost all interviews were recorded using a digital voice recorder, which I later transcribed, including relevant hand written notes on the behavior and emotions of the interviewee. An exception was the interview conducted in the field. In that case, notes were taken by hand. Directly after leaving the field, I wrote everything I remembered from the experience. This was also the method used during meetings and tours of both the waste water plant and the ditch system. Interviews were coded by highlighting themes that emerged through reading and reviewing the transcribed interviews. These themes informed the organization of both the findings and discussion sections of this study.

3.4 Reflexivity, Ethical Considerations and Limitations

The concept of reflexivity can be seen as too nebulous (Lynch, 2000; Finlay, 2002), thus I wish to use the concept more narrowly to discuss my personal connection to the study area and the topic of study as part of practicing honesty in research – a core component of research ethics. As Lynch (2000) puts it, reflexivity can be seen by some as methodological self-consciousness "… to be conscious of their own assumptions and prejudices, and to focus upon uncertainties, possible sources of bias, and problems of access and reactivity" (pg. 29).

With this in mind, the Roaring Fork River watershed, which is the study area (detailed in Chapter 5), is my home. I use home in the sense that it is my place of origin, but more important, it is where I feel I belong. My childhood and adolescence were spent roaming its wilder valleys and ridges with mentors, family and friends. All of the relationships I value as critical to my development have taken place through a dual exploration of the watershed's natural environment and an internal exploration of humanness. Throughout my college years my range extended, spanning continents. But always, my dreams have been in this watershed, and a deep longing to be here pervades my being when I am away.

When I accepted how intense this thesis project would be, I realized that there was no place I would rather explore and understand in a new way. My focus on water stems from the aridity of the area and water's absolute necessity for life. Clear mountain rivers flow through each valley, fed by countless veins of equally clear and cold streams. However, outside the riparian corridors, the topography is much drier. This contrast was beautiful to me as I wandered the area in my youth, finding desert and riparian systems within feet of each other. How this contrast plays out in the human sphere is interesting as a conflict of values.

Before I began my research I was aware that I could develop strong biases favoring certain water uses and opposing others. However, as I "dived in", I discovered how little I knew about water and the local situation, and it allowed me to see that bias develops through ego. My sheer lack of understanding stripped me of any ego I had going into the project. This allowed me to hear any viewpoint without cringing inside, without disagreeing. I developed the mindset that each person I talked to helped to educate me, not bolster a viewpoint that I either favored or disagreed with.

Likewise, I was afraid that as a "local" I might take cultural nuances for granted. Instead, I have discovered that I am not a local in any of the water cultures that have been investigated in this study and, to my delight, I have had the opportunity to see this place and its people in a completely new light. I have observed two benefits to conducting research in this area, the first being that my family name is recognized and thus when introducing myself to potential interviewees, it was easier to break the ice, as they inevitably knew my family, or at least knew of them. Secondly, my deep love for this area showed in my interest, and I believe interviewees picked up on that, sharing stories and insights that I doubt they would have shared with an outside researcher. In relation to this, the knowledge that I live here, and that I plan to stay, changed the relationship from one where interviewees were giving data to someone who was going to disappear at the completion of the project, to sharing insights with a fellow inhabitant, thereby spreading local cultural knowledge.

Each interview began with me describing my project and the interviewees potential role in it, allowing them to decide whether or not they wanted to participate. One interviewee, a Pitkin County Commissioner, stipulated that before he is quoted in the published document, he would like to see the pertinent section to make sure that he agrees with it. At the end of each interview I asked if I could continue communication to clear up any further questions I had, and every interviewee agreed. This allowed me to double check that I was using the information they gave me in a way that they agreed with.

Some of the issues described in this study, namely the debate around the potential construction of two proposed new dams outside the City of Aspen, were politically contentious and ongoing during the research period. However, I was pleasantly surprised to have open communication with stakeholders on both sides of the issue, with the only limitation being slight reluctance to speak in specifics, as dictated by their attorneys. Still, I felt sufficiently informed to understand the issue.

A second limitation was a reluctance by some potential agricultural stakeholders to talk with me about their water. This reluctance will be discussed in subsequent chapters, but even with an introduction from a notable City of Aspen employee, an agricultural stakeholder who has recently decided to join cooperative discussions was still unreachable. However, a sufficient number of agriculturalists and water experts operating in the sector were forthcoming enough to allow for theoretical saturation, which is when data has been collected to the extent that there is enough data to build a coherent theory of the situation in question (Bryman, 2012).

This section detailed the methods used to conduct this research, stressing the qualities of a qualitative study that made it the most applicable methodology, arguing that this study's focus on exploring a specific situation within the context that it exists, drawing conclusions from

inductive reasoning, where observations form the core from which broader theories can develop, warrant using qualitative techniques such as in-depth, semi-structured interviews and participant observation. The next section will focus on describing the contextual picture that frames this study.

Chapter 4

BACKGROUND

This thesis is based on a qualitative research approach as detailed in the previous chapter. The findings of qualitative research must be grounded in the context within which they appear (Bryman, 2012). This is the idea that nothing happens in isolation and to truly understand a situation a thorough understanding of the historical context must first be established. Thus, this section begins by outlining the historical context of water in the Western United States, focusing first on John Wesley Powell, then moving forward to water development in the 20th century. It will also highlight the human influenced ecological changes on western water, culminating in the current and possible future effects of climate change on the water resource. These insights will situate the findings of this study in context with the broader issues and driving forces of change in the region.

4.1 John Wesley Powell

No study of water in the Western United States would be complete without including a section on John Wesley Powell. Powell is a figure of legend in the West, most notably for leading the first expedition down the Green and Colorado River in 1869. He is often quoted and misquoted to substantiate arguments for why water law is working, or not working in the West today (Hobbs, Presentation 1) Although his entire life story is interesting, the focus here will be on outlining his main arguments surrounding the development of water in the budding Western States.

Powell understood the West's aridity in a time when western expansion was seen as unquestionably good, and any potential limitations were swept under the rug. One such limitation, in Powell's view, was water. Settlement was egged on by the Homestead Act, which allowed anyone to claim 160 acres as theirs if they staked the property corners and "improved" the land for five years. In the Eastern U.S., 160 acres may have been enough to make a decent living, where soils were fertile and crops and livestock could be sustained from rain. But in the West, 160 acres, according to Powell, amounted to a cruel joke (De Buys, 2001). Powell saw the riparian corridors, and the land adjacent, where water could be taken from the natural channel and used for irrigation as the only exceptions to this joke. Here, he argued 160 acres was too much, an unfairly large amount of land, especially due to the extremely limited amount that existed in the West. Everywhere else, he argued, 160 acres was not enough to range cattle, nor was it possible to grow crops without irrigation (ibid).

Unfortunately, like so many of Powell's warnings and cautions, he went unheeded. Advertisements in the East encouraged western expansion, claiming that where water was scarce now, settlement would bring moisture (Reisner, 1993; Sabo et al., 2010). Popular climatologists of the time explained that plowing the soil released moisture and brought rain, that planting trees and shrubs brought more moisture, and finally, that the sheer added vibrations in the atmosphere from human activity increased cloud formation, and thereby rain. This final point led to the popular act of dynamiting the air in the 1870s. Also, and conveniently, they stipulated that these changes would be permanent (Reisner, 1993). Essays by Powell that attempted to dispel this popular notion fell on deaf ears, partly due to a high moisture cycle that characterized the late

1860s and was seen as validation of the human power to change climate (De Buys, 2001; Reisner, 1993).

The winter of 1886, however, was harder for settlers who had staked their arid 160 acres to ignore. The winter brought blizzards the likes of which settlers had never seen, covering the entire northern plains with feet of snow. Those ranchers who did not have access to irrigated land and therefore solely relied on ranging their cattle year round, instead of stocking them with hay for the winter, saw their herds decimated. Its estimated that cattle died by the hundreds of thousands (De Buys, 2001; Reisner, 1993). Subsequent years were characterized by drought, ruining those farmers who relied on rain. Farmers cursed the weather, but Powell saw that it was not the weather that was to fault, but the human institutions that had put so many people at risk. As De Buys (2001) put it:

> For [Powell], the lands and waters of the Arid Region were no mere stage on which society's actors might freely play out their roles. He saw the physical environment as a force, unforgiving and powerful, that would shape society whether society wanted the shaping or not. His advice […] was that society should adapt itself to the imperatives of that force to preserve the benefits of the land and then share those benefits equitably among its people (pg. 249-50).

In this push to shape the burgeoning western culture to the land, instead of forcing the land to fit human ideals, Powell found himself alone. To the Montana Constitutional Convention in 1889, Powell stressed that county boundaries should follow watersheds, arguing that this would create units of government whose collective interest would be a significant check against abusing water resources, which he saw as the most important resource in the West (De Buys, 2001). De Buys (2001) explains politicians' lack of interest in that Powell's watershed counties would have reshaped the political boundaries that elected them in the first place.

Powell, as the director of the U.S. Geologic Survey, brought his watershed political boundary ideas to Congress where they were likewise received poorly by western politicians who, like those in Montana, didn't like the idea of seeing the political landscape that had brought them to power changed. This, coupled with his unpopular ideals of adapting western culture to the realities of the land, soured his support in Washington, leading to his resignation in 1894 and subsequent removal from the political limelight.

4.2 Water Development 1900-present

Powell's resignation paved the way for a new era of water development in the West, one that centered more and more on large federally funded projects that tamed the major waterways with incredible dams and infrastructure projects, bringing irrigation to land that had before been unusable for agriculture, and electricity to rapidly growing desert cities, fueled on an increasing availability of water (Reisner, 1993; Sabo et al., 2010).

By the late 1890s the easily irrigable land had already been claimed and further expansion, it was decided, rested on the ability to bring water to land that was further from the natural water course and situated in water basins whose unruly spring runoff's had repeatedly destroyed any attempted irrigation projects. Thus, in 1902, western politicians pushed the Reclamation Act

through congress, arguing that federal funding was necessary to construct water development projects of a magnitude great enough to bring order and affluence to a region whose natural state had been characterized as unruly and hostile (Reisner, 1993).

The early years of the Reclamation Service were rickety, with mixed public support for federal projects funded by tax payers. However, in 1928, the old Reclamation Service, renamed the Bureau of Reclamation, was given the nod from congress to commence construction of the Boulder Canyon Project which would create Hoover Dam, allowing the stabilization of flows coming from the upper Colorado River, which previously had turned into large floods in the spring during the snowmelt runoff from the headwaters. In addition to flood control, water from Hoover Dam was used for irrigation in California, municipal water in Las Vegas, which previously had seen Colorado River water as impossible to utilize, and hydroelectric generation for the entire region (Kuhn, Presentation 4).

Hoover Dam was precedent setting, fueling the acceptability of other large scale projects and, coupled with a desperate workforce during The Depression, and later, a push for economic growth after WWII, water infrastructure projects became ubiquitous status symbols for western politicians garnering constituent support (Reisner, 1993; Sabo et al., 2010). This, despite the lack of clarity on the economic rationale behind such large scale projects.

A dramatic example is the Central Arizona Project (CAP) which pumps water more than 2,000 feet uphill from its intake in the Colorado River at Lake Havasu, transporting it 335 miles to its terminus in Tucson (Hanemann, 2002). Conceived by Arizona politicians as early as 1947 as a project to secure Arizona's right to Colorado River water, it was only after 40 years of severe lobbying, and a Supreme Court case between Arizona and California that the project was approved by congress and completed (ibid). Although the water made available by CAP was intended to be used to support Arizona's agricultural economy, economists as early as Young and Martin (1967) argued that the project would not be cost effective if agriculturalists were charged the actual price of the CAP water. Although unheeded, later work by Holland and Moore (2003) has shown that CAP indeed was too expensive to be cost effective, and thus agriculturalists were not charged the actual price, in effect subsidizing their use of CAP water at a loss of $2.4 billion for the project. They go on to argue that economically, CAP was built 87 years too early. The economic dubiousness of CAP is stereotypical of water projects in the West, as other authors have argued water law, political power and citizen impressions trump economics and logic, if only temporarily (Reisner, 1993; Sabo et al. 2010; De Buys, 2001; Kelso, Martin & Mack, 1973). The result is that today, there are between 75,000 – 100,000 dams in the Western United States, 2,000 of them categorized as very large, and their necessity: often questionable (Reisner, 1993, Sabo et al., 2010).

4.3 Human Influenced Ecological Changes

Western expansion has always been tied to river courses. Early settlers relied on water for agriculture and mining activities, while the placement of today's super highways took advantage of the path of least resistance watercourses cut through the landscape (Wolh, 2001). Although today western rivers hold a form that is appealing to the mass culture, defined by factors such as lush bankside vegetation, clear water and limited erosion, many of the underlying functions of western rivers, such as their ability to move sediment and water to the sea, as well as support

intact ecosystems, have been significantly altered through human action (ibid). As Wolh (2001) articulates: "A river ultimately absorbs everything that happens in its drainage basin, and the basin is the fundamental organizational unit for the physical, chemical, and ecological flow of materials and energy. Rivers thus reflect the cumulative historical effects of our activities" (Wohl, 2001, pg. 7). Understanding this cumulative effect, and its influence on today's predicaments, is a critical component of a qualitative study. Thus the following section outlines the most dramatic changes that have occurred to the rivers of the West, including those in the study area.

4.3.1 Castor Canadensis

The first Europeans to push into the great western wilderness were inspired not by visions of gold, but by the absolute plethora of beaver. European fashion in the mid 1800s included beaver fur hats, and their pelts, easily obtained through trapping, were worth a substantial amount of money. Beaver existed in almost all riparian habitats across North America, from the artic to northern Mexico. As eastern populations were decimated, trappers moved west (Wohl, 2001). Its estimated that prior to European arrival, there were 60 to 400 million beaver in the streams and rivers of North America (Naiman, Johnston & Kelley, 1988; Wohl, 2001). Their ecological importance stemmed from their proclivity to build dams. Wohl (2001) describes the areas waterways as "…a series of stepped ponds delineated by beaver dams, rather than the steep and rapidly flowing ribbon of water that characterizes today's rivers" (pg. 46). Today, beaver populations are between 6 and 12 million, less than one tenth of their historic numbers (Naiman, Johnston & Kelley, 1988).

Beaver ponds in East Sopris Creek, with the Elk Range beyond. Note the stepped nature of the stream channel, and its broadness.

The ecological significance of this change is hard to overstate. First, beaver dams reduced a stream's velocity when it entered a dam, reducing the stream's ability to carry sediment, thereby regulating sediment transport and reducing both bank and channel bed erosion at the dam site, as well as upstream (Olsen & Hubert, 1994). This slowing of water also increased the availability of subsurface water, promoting streamside vegetation, which, in turn, promoted the improvement of

water quality (Butler, 1995). Likewise, beaver dams reduced the severity of floods, releasing the water gradually, smoothing out the hydrograph (ibid). Furthermore, beaver dams diversified a stream's reach by creating slow pond sections between swift moving sections. This allowed a higher diversity of aquatic and riparian habitats, as well as the creation of habitat for both bird and animal species (Wolh, 2001). When a beaver dam filled with sediment it was generally abandoned, leaving a nutrient rich area where meadow grass as well as alder and cottonwood trees could take root (ibid).

Many of today's water predicaments stem from high sediment loads, dramatic hydrographs and decreasing aquatic diversity and endemism (Reisner, 1993; Sabo et al., 2010; Richter et al., 1997; Wohl, 2001; Baron, 2002). As such, it would be difficult to argue that there is a water issue today that is immune to the change caused by the beaver's eradication.

4.3.2 Timber

In addition to water, Colorado's chief industry of mining required a large amount of lumber (Andersen, 2014). This lumber had many purposes, from forming the internal structure and support of a mine to building miner's cabins, to supplying heat throughout the long winter, to being turned into charcoal in order to refine the raw ore for easier shipment through the rugged mountains, to supplying the railroad ties for the budding railroads (Andersen, 2014; Wohl, 2001). A chief strategy to transport lumber was down the river. These waterways had to be severely manipulated to allow lumber to float down easily, including the straightening of the watercourse, the removal of any woody debris, and the removal of bankside vegetation (Wohl, 2001). Studies have shown that rivers that were historically used to transport lumber are between 1 and 3.6 times wider, with reduced streamside vegetation, degraded aquatic and riparian habitat that is much more uniform than it is in those waterways that were not used for lumber transport (Wohl, 2001; Richmond & Fauseh, 1995).

The deforestation that supplied the lumber likewise resulted in significant ecological change. Vegetation acts to reduce sediment run-off, both stabilizing forested slopes, and reducing the size and amount of sediment that is transported in rivers and streams (Wohl, 2001). A study conducted in Washington State showed that basins that have been severely logged have rivers that are more uniform, possessing fewer and smaller pools, as well as supporting less aquatic and riparian species diversity (Ralph et al., 1994).

When, in 1878, the U.S. Congress created the Free Timber Act, prohibiting cutting live trees on public land, settlers began burning forests, thereby creating the charcoal that they required, and sidestepping the law (Wohl, 2001). Before European arrival, natural fire cycles in Colorado averaged 12 years (ibid). These fires were characterized as small ground fires, burning the accumulated woody debris on the ground, while leaving the forest canopy intact. Deforestation, and subsequent fire suppression, have changed the character of fire, reducing its frequency, but severely increasing its severity. When forests burn today, nothing escapes, resulting in deforestation, the negative effects of which have already been detailed.

4.3.3 Mining

If beaver trapping drew the first Europeans to Colorado, it was mining that made them stay (Baron, 2002). Tens of thousands of settlers poured deeper into the mountains after each discovery, urged on by a "get rich quick" mentality, which lent to a complete disregard for

effects their activities were having on the environment (ibid). Ore was soaked in a solution of poisonous liquids such as cyanide, mercury or an acid solution to separate the valuable metals. The waste was then dumped on the ground, or in the nearest waterway (ibid). Smelters refined the ore further, releasing sulfur gas mixed with heavy metals, which later, through acid rain, permeated the local lakes and rivers (Baron et al. 1986, Norton et al. 1985). The mining of streambeds destroyed all ecological functions there, and further taxed the area because dams and diversions were required for the process (Baron, 2002). As Baron, (2002) puts it: "Mining is destructive by definition" (pg. 87).

The exploitation of Colorado was so dramatic that today there are 7,000 abandoned mines, which is more than any other state or province (Ferderer, 1996). Baron (2002) estimates that in the state alone 1,616 miles of streams are influenced by historic mining activities.

4.3.4 Cattle

With the influx of miners came a whole host of entrepreneurs who understood that miners couldn't dig on an empty belly. The mountain valleys surrounding mining camps became chiefly grazing land for cattle, whose introduction resulted in soil compaction, limiting moisture infiltration, accelerating erosion (Wohl, 2001). Cattle needed water, and their trampling of bankside habitat resulted in destabilized banks, further increasing erosion and limiting aquatic habitat (ibid). Stuber (1985) compared streams that had and had not been grazed, and found that those that had not been grazed had two times the trout population of those that had been grazed.

Johnson, Gary and Ponce (1978) found that cattle excretions in the riparian zone added significant amounts of nitrogen, with detrimental effects to the aquatic ecosystem including fish die offs and eutrophication of the river.

4.3.5 Dams

As already detailed, there are 75,000-100,00 dams in the western U.S. (Reisner, 1993, Sabo et al., 2010), thus, it's important to include their ecological effect. Dams effect rivers in three major ways: (1) they change the temperature cycle of the water, usually from one where temperature is higher in the summer and colder in the winter, to a condition where the temperature of the river leaving the dam is always the same. (2) They strip rivers of their sediment loads, leaving them clear; (3) they change the hydrograph, reducing the size of spring floods and increasing the flow in late fall (Wohl, 2001).

Changing the temperature of a river may eliminate temperature cues that are vital to aquatic insects and invertebrates, reducing their chance to survive, likewise impacting those fish that feed on them (Wohl, 2001). Changing the sediment load of a river may change the bankside features, expose native fish who use the sediment as camouflage, and, when the dam is dredged and sediment is flushed down river, it may kill algae and invertebrates (ibid). Lastly, changing the hydrograph of a river may impact streamside vegetation that relies on floods to restore nutrients and deposit seeds (ibid). It may also impact channel bottom ecology through allowing the growth of algae that would normally be swept away each spring (ibid).

4.3.6 Urbanization

It's important to add that increased urbanization results in added sediment disposition in rivers through bankside construction (Wohl, 2001). Once construction is complete, it generally leads to more cement in the waterways, quickening run-off, decreasing sediment loads and leading to increased erosion (Riley, 1998). Likewise, storm water systems add contaminants such as gasoline, oil, and lead, as well as pesticides and herbicides from residential lawns (Riley, 1998; Wohl, 2001). In addition, unpaved roads can add sediment loads through erosion, while paved roads add contaminants and sediment through the application of magnesium chloride and sand for winter traction (Wohl, 2001).

4.4 Snow and Water

Colorado is in a unique position at the headwaters of the Colorado River in that it is a major supplier of water to downstream users. Seventy-five percent of that water arrives as snow, and is stored in the high mountains until spring run-off, which, historically, has coincided with temperatures that are conducive to beginning agriculture, and thereby diversions, in the lower valleys (Doesken, 2013). However, climate change models increasingly show a trend toward more frost free days, resulting in a larger percentage of that 75% of Colorado River water falling as rain instead of snow, although there is not consensus as to whether precipitation amounts will be affected significantly (Christensen & Lettenmaier, 2006; Wi et al. 2012; Ficklin, Stewart & Maurer, 2013; Baron, 2002). Models show that this shift from snow to rain will result in increasing challenges for the water management system in the region (Christensen et al. 2004; Wi et al. 2012; Ficklin, Stewart & Maurer, 2013). Effects of climate change are still forthcoming, but it is certain to have a sizable impact on the region.

This chapter has provided the context that will be used to place the findings of this study in the broader situation. It has included a description of the historical development of water in the region, as well as a description of the most pivotal changes to the land and waterscapes that have occurred since European arrival in the region in the 1850s. Finally, it has included a glimpse of the possible effects of climate change. The next chapter will hone in on the study area, describing the area historically, naturally, and culturally to further provide context.

Chapter 5

STUDY AREA

Looking Southeast along the Elk Range from the summit of Capitol Peak (14,131') in June 2011

5.1 Physical and natural descriptions

The Roaring Fork River watershed is located on the Western Slope of Colorado. It is surrounded by the Sawatch, Collegiate and Elk mountain ranges, including seven 14,000 foot peaks (Spackman et al., 1999). It has an area of 1,451 square miles, and supports three main rivers: The Roaring Fork, The Fryingpan and The Crystal (ibid). The Fryingpan and Crystal Rivers, along with many tributary creeks, feed the Roaring Fork River, which flows into the Colorado River in Glenwood Springs.

The watershed is diverse in landscape, characterized by mountain valleys with eco zones ranging from western desert scrub in the valley floors to alpine tundra on the mountain tops (O'Keefe & Hoffmann, 2007). A biological inventory conducted by the Colorado Natural Heritage Program between 1997-1999 found over 78 rare and imperiled plant and animal species in the watershed, 21 of which have global significance (Spackman et al., 1999).

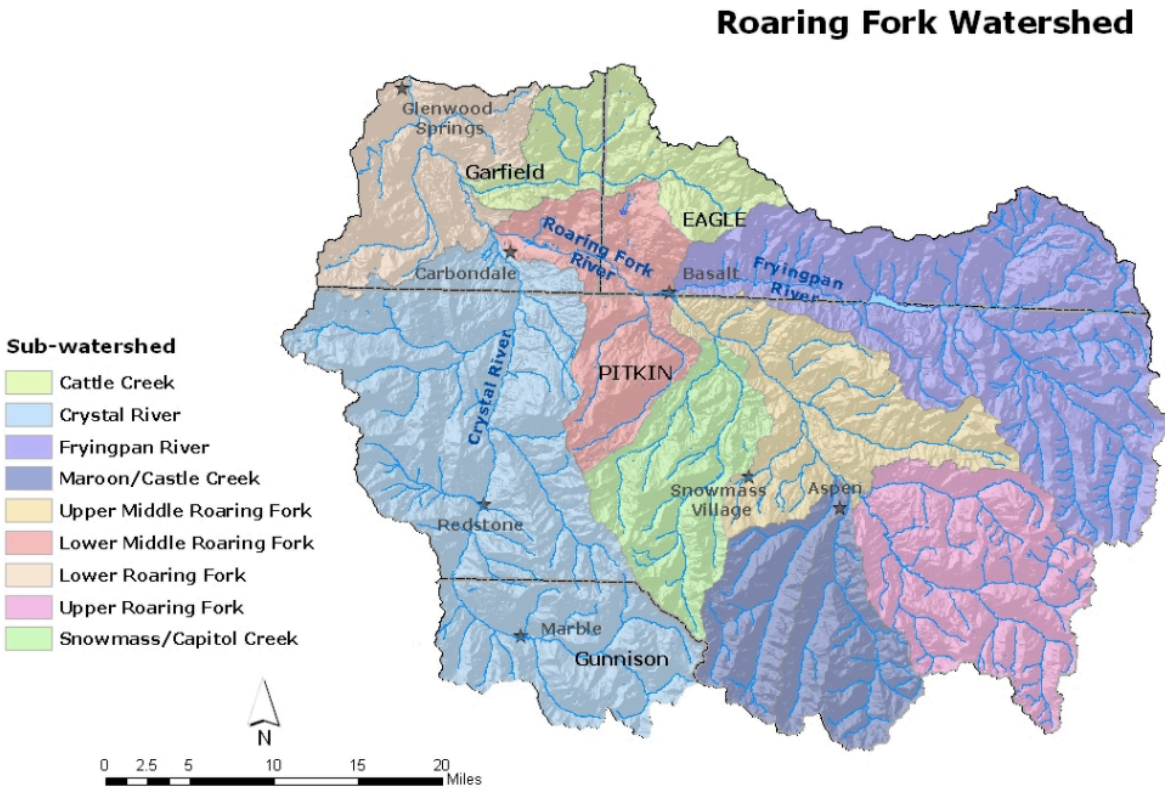


Figure 1: Map including towns, counties and topography of the Roaring Fork Watershed, from SK. Mason Environmental LLC, (2013).

The climate, as Spackman et al. (1999) describe it: "…is generally characterized by long, cold, and moist winters, and short, cool, dry summers" (pg. 6). This results in a majority of the precipitation that falls in the watershed coming as snow. O'Keefe and Hoffmann (2007) calculated that as much as 80% of the precipitation in the study area falls as snow. Snowmelt in the spring causes high runoff periods where the rivers swell with water while fall is characterized by low water levels once all of the snow in the high-country has melted. Precipitation amounts vary within the watershed, with higher elevations receiving higher amounts. Table 2 shows the precipitation averages within the study area.

Table 2: Average Annual Precipitation by month in inches.

Monthly Precipitation (inches)			
Region	**Aspen**	**Basalt**	**Glenwood**
Period of Record	**1900-1979**	**Interpolated***	**1900-1997**
Elevation (feet)	**7,910**	**6,620**	**5,910**
January	1.81	1.57	1.43
February	1.63	1.39	1.25
March	1.80	1.53	1.38
April	1.68	1.59	1.54
May	1.48	1.42	1.38
June	1.16	1.09	1.05
July	1.44	1.31	1.24
August	1.72	1.54	1.44
September	1.58	1.48	1.43
October	1.48	1.44	1.42
November	1.48	1.22	1.08
December	1.69	1.41	1.26
Annual	**18.93**	**17.17**	**16.19**

The watershed boasts six native fish species: Colorado River cutthroat trout, mottled sculpin, bluehead sucker, flannelmouth sucker, speckled dace and mountain sucker. Of these, the Colorado River cutthroat trout is on the Colorado special concern list. There are also four non-native species: mountain whitefish, rainbow trout, brook trout and brown trout (O'Keefe & Hoffmann, 2007). There are two stretches of river within the study area designated as gold medal trout fishing: The Roaring Fork River from the confluence of the Crystal to the Colorado River, and the Fyringpan River below Ruedi Reservoir to the confluence with the Roaring Fork. In total, these equate to 26 miles of gold medal water (ibid).

5.2 Human History

In the 1990s, scientists discovered human remains within the study area which they dated back 8,000 years (O'Keefe & Hoffmann, 2007). This skeleton was the ancestor of the local Ute Indians, which called the area home until 1880 when they were forcibly removed (Andersen, 2007). The Utes lived a semi-nomadic life, hunting elk and deer in the mountains during the summer, before moving to lower sites near present day Montrose for the winter (O'Keefe & Hoffmann, 2007). Signs of their passing can still be found within the study area, and the author has found their arrow heads on mountain ridges as high as 12,000 feet.

Arrowheads found in the study area by the author and his family.

Because of the rugged terrain in which the Utes lived, they were relatively undisturbed by encroaching settlers until the mid 1800s, when treaty after treaty shrunk their area (Andersen, 2007). The Brunot Treaty of 1868 removed the Ute's legal rights to the upper Roaring Fork, while still giving them control of the lower valley (ibid). This opening of Ute lands, coupled with the first geologic survey of the area, conducted by Ferdinand Hayden and his team of surveyors in 1873-74, paved the way for prospectors who were eager to push west into new country.

Early incursions by prospectors coming over the high peaks from Leadville to the East were rewarded with rich mineral finds, sparking the growth of new boom towns: Ashcroft and Aspen. Although the mountains were rich with silver, and to a lesser extent gold, they also harbored the last remaining Utes who, after being cheated and lied to repeatedly, were sometimes hostile. The Governor of Colorado, Fredrick Pitkin, was sympathetic to the prospectors, and began a movement under the banner "The Utes Must Go!" Governor Pitkin believed that a forced relocation was an acceptable solution, but he also proposed extermination, justifying that the price it would cost to kill them all would be easily repaid by the exploitation of the land it would make available (Andersen, 2007). In 1879, the Governor had his chance to act upon the Utes after the Meeker Massacre, in which Utes in the White River Ute Indian reservation revolted against their Indian agent; Nathan Meeker, who had plowed under their horse racing track in an attempt to break them of their more nomadic ways, in favor of agriculture (ibid). It was the excuse Governor Pitkin needed, and the remaining Utes were forcibly marched to two separate reservations, neither of which includes any of their historic territory, nor are they in the study area (Andersen, 2007; O'Keefe & Hoffmann, 2007).

Figure 2: A banner from Governor Fredrick Pitkin's movement to relocate the Utes (Andersen 2007).

With the Utes out of the picture, prospectors, in ever increasing numbers, were free to roam the mountainsides, staking claims wherever the rock looked like it held promise. The promise it held was in huge silver deposits, and by the late 1880s, Aspen was a full boom town, with two competing railroads serving hundreds of local silver mines and, in 1892, a population of 12,000, marking Aspen as the third largest city in Colorado, after Leadville and Denver (Andersen, 2007). However, the boom was not to last. In 1893 the U.S. was hit by an economic depression, and the Sherman Silver Purchase Act of 1890, which forced the U.S. Treasury to back their notes with either silver or gold, was partly blamed. As a result, it was repealed in 1893, plunging the price of silver overnight, and effectively ending the mining era in Aspen (Andersen, 2007; O'Keefe & Hoffmann, 2007).

With Aspen's chief industry abandoned overnight, the boom town collapsed, thrusting Aspen into what is known locally as "the quiet years" (Andersen, 2007). Between 1893 and the beginning of the ski industry in 1936, Aspen, and the rest of the Roaring Fork Valley, became primarily an agricultural community. Chief crops were alfalfa, timothy and brome grass for hay, used to feed both dairy and meat animals, as well as potatoes, barley and oats (Andersen, 2007). The trains that had once hauled silver ore soon had agricultural products as their load, taking them down to New Castle and on to market (ibid).

In 1936, two young friends who had skied the European mountains serendipitously met T.J. Flynn, who was a Coloradoan and attempted to interest the men in buying silver claims in Ashcroft, despite the lackluster feasibility of such a venture. When he showed them pictures of the claims, the two men became interested, however, not for the silver, but for the mountains that formed the backdrop. They were equivalent to the mountains the men had skied in Europe, and they decided to investigate. Although one of the men, William M.L. Fiske III, would go on to be the first American to die as a pilot in WWII, the dreams of a ski area in the Roaring Fork Valley persisted. Starting as a $.50 ride up the backside of Aspen Mountain on a horse drawn sleigh,

development has, over the subsequent 75 years, created a world-class ski destination, boasting four distinct mountains and thousands of acres of terrain (Andersen, 2007).

Today, around 40,000 people call the watershed home, spread through eight towns: Aspen, Basalt, Carbondale, Glenwood Springs. Redstone Mable, Meredith and Thomasville. In addition, the watershed is part of four counties: Pitkin, Eagle, Garfield and Gunnison. The economies in the watershed are linked primarily to tourism, ranging from skiing, hiking, rafting, fly fishing and biking. In addition, the ranching culture persists, with traditional cow-calf operations and, a more recent subculture of organic farms that cater to local farmer's markets and locavore movements by providing vegetables, fruits, meat, dairy and eggs.

5.3 Water Development

When the first settlers began developing Aspen, their water came from three creeks and the headwaters of the Roaring Fork River. This water was initially so clear and clean that drinking water was sourced directly from the streams, or from ditches that ran past home sites (Andersen, 2004). However, it didn't take long before the combination of pack animals and mining activity dirtied the water, and in the 1880s, down valley ranchers sued mining companies for polluting the Roaring Fork River to the point where it was unusable for their agricultural purposes (ibid).

It wasn't only the ranchers who were upset about the water situation, as the headline: "We Must Have Water" from the Aspen Times pointed out a lack of municipal water in 1882. Indeed, the pressure on the water resource from mining had, in a few short years, utilized all of the pristine water from the creeks, and returned it to the river downstream extremely polluted (Andersen, 2004). The City government began the process of creating a central water system, but as early as 1883 they were embroiled in a legal dispute against the town planner, who held enough water rights to effectively create a monopoly (ibid). Although drinking water was in limited supply and bad quality, the real threat came from fire. Aspen was built from wood, and without pressurized water, a fire in 1884 burned half a commercial block before the local firemen, who pulled the makeshift fire "truck" in harnesses, were able to put it out (ibid).

The Aspen Fire Department in the early 1880s. Photo Credit: Aspen Historical Society

Finally, in 1885, the legal disputes settled, the city secured the rights to Castle, Maroon and Hunter Creeks. By the end of the year they had pressurized fire hydrants installed throughout the town (Andersen, 2004). To fully utilize these rights for municipal water, the city hired two notable Aspenites – H.P. Cowenhoven and David R.C. Brown- to build a reservoir up Castle Creek and a system of wooden flumes to deliver the water to town. The city paid $3,000 for the system, which, although the components have been upgraded, still serves as the municipal water system today (ibid).

With the delivery of pressurized water came the possibility of hydroelectric energy, which Aspen desperately needed. Because the Roaring Fork River watershed is surrounded by extremely rugged terrain, developing railroads into the area was very arduous, and in 1885 Aspen still relied solely on pack animals coming over the high passes for all imports (Andersen, 2004). This made developing carbon based electricity impossible, so instead the City turned to hydro.

Wealthy silver mining interests were the chief customers of electricity, and their investments in the system allowed Aspen to create a hydroelectric plant that powered all of the city's lights and silver mines. It was cutting edge for the early 1890s, and Aspen was lauded in the Journal of Electricity in 1919 as the first city in America to light both its streets and mines from hydropower (Andersen, 2004). When the price of silver crashed in 1893, power needs dropped sharply, so the Aspen Electric Company began selling power down valley, supplying the first light to Basalt and surrounding communities. When, in 1947, the first chair lift opened on Aspen Mountain, it was powered completely by hydro (ibid).

In 1956 the City of Aspen took over the utility company which still supplied 100% of the electricity for the city from hydro, and in 1958 they were faced with a decision: Replace aging wooden flumes and lines to keep the hydroelectric plant running, or, for a slightly lower price, scrap the entire system and join the grid as customers of Holy Cross Energy. The City chose the latter, scrapping the entire hydro system in favor of joining the national grid (Andersen, 2004). However, through Holy Cross Energy, today, the City still boasts 100% renewable energy sources, 33% coming from the hydro plant at Ruedi Reservoir, 5% from a micro hydro project on Maroon Creek, and the rest from a reservoir on the Gunnison and Colorado Rivers (Andersen, 2004).

The old hydroelectric plant next to Castle Creek. Photo Credit: Aspen Historical Society.

Despite the silver crash, utilization of the watershed's rivers and streams has been on-going, simply supplying water for other uses; chiefly, agriculture. In the 1890s, farmers on Colorado's drier eastern slope began looking west in search of more water. They realized that if they could find cheap water to irrigate inexpensive desert land, they could inflate the value of that land, and make good money from growing sugar beets (Wohl, 2001; Andersen, 2014). The search was headed by the Twin Lakes Reservoir and Canal Company, who came over Independence Pass, into the Roaring Fork River watershed, where they discovered ample water supplies, and no one to protest their taking of them (Andersen, 2014).

In 1930, construction began on the first trans basin diversion, including 12 miles of ditches and pipelines that would collect water in Grizzly Reservoir from five tributary creeks before sending it through a five-mile-long tunnel to the Eastern Slope. In 1935, the system was completed and water began to flow under the Continental Divide, taking 38% of the natural flow from the headwaters of the Roaring Fork River (O'Keefe & Hoffmann, 2007). The success of this project prompted the young Bureau of Reclamation to investigate the possibility of developing greater trans basin diversions, and their eye turned towards the headwaters of the Fryingpan River.

This next project, known as the Fryingpan-Arkansas project, created a system of 26.7 miles of ditches and tunnels to collect the water from many tributaries of both the Roaring Fork and the Fryingpan Rivers, before sending it through the Boustead Tunnel and into the Arkansas River (Andersen, 2014; O'Keefe & Hoffmann, 2007). This diversion was approved by the U.S. Congress in 1953 and developed between 1963-1980 (Clarke et al., 2008). In addition to ditches and diversion tunnels, the project also includes Ruedi Reservoir, completed in 1968 in the upper Fryingpan River valley to mitigate the impact of reduced flows from the trans basin diversions on the Western Slope (Clarke et al., 2008). The reservoir holds a maximum capacity of 102,373

acre feet of water, with 56,000 acre feet allowed to be sold to water users in the Western Slope for any purpose, usually involving augmentation flows (Clarke et al., 2008).

The diversions created from the Fryingpan-Arkansas project take 41% of the headwaters of the Fryingpan drainage, or 69,200 acre-feet annually to the Front Range. Curt Carpenter, a local book designer and cartographer, argues that these diversions essentially move the Continental Divide west, shrinking the watershed.

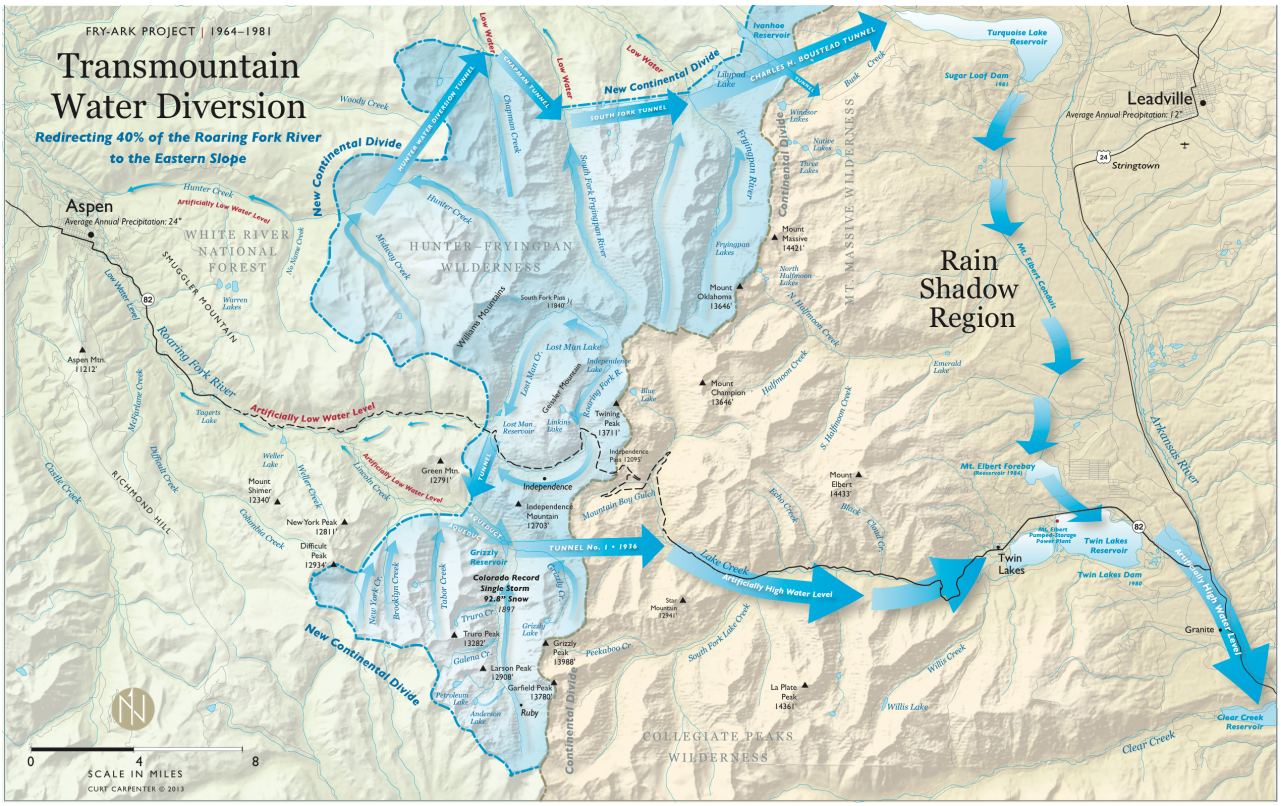


Figure 3: Trans mountain diversions realigning the Continental Divide. Credit: Curt Carpenter in (Andersen, 2014).

The water that remains serves three main purposes: Irrigation for agriculture, municipal water, and environmental and recreational flows. Of these three, irrigation constitutes the largest consumptive use - that is, water use that makes that water unavailable for other uses (Clarke et al., 2008). This is depicted in Figure 4.

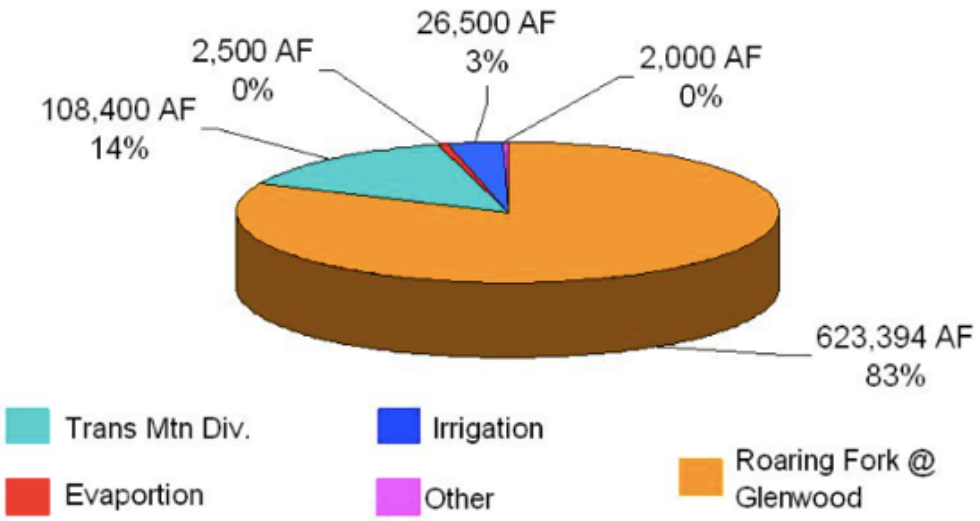


Figure 4: Consumptive water uses in the Roaring Fork River watershed per year in acre-feet (Martellaro, 2005).

As Figure 4 shows, an average of 623,394 acre-feet join the Colorado River in Glenwood Springs, supplying 8-12% of the water in the Colorado River (Clarke et al., 2008). Of this amount, the Crystal River supplies 32% and the Fryingpan River supplies 14%, with the Roaring Fork suppling 54% (O'Keefe & Hoffmann, 2007).

In subsequent chapters the main water uses in the watershed: Agriculture, municipal and environmental will be explored in detail, using interviews conducted with stakeholders in the watershed as the chief mode of investigation. This chapter has shown light on the historical context within which this research is grounded, focusing specifically on the local situation. The goal has been to paint, in broad strokes, the historical context, while the next chapters will dig into specifics.

Chapter 6

FINDINGS

Looking over the snow covered Elk Range in April, 2018, with irrigated fields of hay in the lower portions of Capitol and East Sopris Creeks.

The next chapter describes how the three main stakeholder groups in the study area value and use water, including struggles and conflicts both within groups, and amongst them. These groups are (1) agriculturalists; (2) municipalities; and (3) environmentalists/recreationalists. These groups are explored through their access to water, the purpose to which they put it towards, and their ability to work with the legal system. They are explored in descending order of water use, and seniority in the study area. It begins with agriculturalists, whose use a`ccounts for the majority of the consumptive use of water in the study area, followed by municipal use, and environmentalists advocating for in-stream flows. A breakdown of water uses in the study area is shown in Table 2.

Table 3: Water Use Within the Study Area in 1990 and 1995 (O'Keefe & Hoffmann, 2007).

	1990		1995	
Water Use	**Total Withdrawal** (Mgal/day)	**Total Consumptive Use** (Mgal/day)	**Total Withdrawal** (Mgal/day)	**Total Consumptive Use** (Mgal/day)
Public Supply	8.53	N/A	10.4	N/A
Commercial	0.49	0.45	0.49	0.51
Domestic	0.39	1.32	0.33	1.33
Industrial	0.10	0.03	0.01	0.04
Thermoelectric Power	0.00	0.00	0.00	0.00
Mining	0.55	0.18	0.26	0.07
Livestock	3.78	0.12	0.12	0.12
Irrigation	184.94	43.91	167.52	32.36
Hydroelectric Power	0.00	0.00	0.00	0.00

6.1 Agriculture and Water

Agriculturalists have the longest history using water in the study area. Although miners used it first, agriculture followed close behind, and has persisted when the mining industry collapsed. Today, their presence and culture goes back generations, with families whose history and water rights stem from the 1880s (Childs, Interview 6; Brundige, Interview 7). Their role can be seen from two main perspectives: water stewards, or water wasters. This section explores that dichotomy.

Agricultural stewardship can be seen as emanating from their long - sometimes over 100-year-history working with water through flood irrigation practices. This long-standing history has shaped the agricultural culture as Seth Mason (Interview 10) explained:

> … the agricultural community at large perceive themselves, and they have been for a long time, as stewards of that resource. They really bristle when someone says you aren't being a steward of this resource. They would whole heartedly disagree. They care about the river. They live on it, their kids fish on it, it's a part of their lives in ways that we will never understand as folks who aren't ranchers.

Flood irrigation is the most common irrigation practice used in the study area, and is a technique where water is diverted out of rivers and streams through mostly unlined ditches, then spread over furrowed fields, with the excess being captured in a ditch at the bottom which is then applied to lower fields, or returned to the watercourse (Childs, Interview 6). This practice is the most contentious aspect of agricultural operations because it can be argued to be wasteful (Ransford, Interview 14). Irrigation in the watershed is a necessity in order to grow enough hay to feed cattle through the winter and to sustain any other crop as well. As Steve Childs (Interview 6) pointed out, it is impossible to ranch in the study area without providing winter hay and only relying on browsing, because the winters are too harsh, with too much snow, and last too long. Flood irrigation is the historic method of irrigating in the watershed, requiring no mechanized technology to operate, it instead relies on constant vigilance and physical labor to change the gates that take water from field to field as they become saturated (Childs, Interview 6).

An unlined ditch near Carbondale. Note the willows, characteristic of riparian environments.

Proponents of flood irrigation list many benefits which go far beyond simply delivering water to crops. First, because it requires very little technology and only basic infrastructure, the costs of maintaining the system are fairly low, and because most systems were built over 100 years ago, the infrastructure is in place and little additions are needed (Childs, Interview 6). This, opposed to sprinklers, which require pressurized pipes to bring the water to high-tech sprinkler systems, which require regular maintenance. As Steve Childs (Interview 6) explained, the more advanced the irrigation system, the more expensive it is. He proposed that those ranches using pumps to create pressure for their sprinkler systems are likely "dude ranches", meaning they are not using irrigation technology that makes economic sense, if the ranch is reliant on the profit from their fields.

Secondly, transporting water through unlined ditches and spreading it over fields saturates the soil, increasing the water table (Carbondale Ditch Tour). This process, in some areas in the watershed such as Missouri Heights, arguably fills domestic wells, where they would otherwise run dry (ibid). This is due to return flows, an often complicating aspect of irrigation practices. Return flows can be described as the water that percolates below the root zone, adding to the shallow groundwater profile (Ferril, 2004). Because Colorado water law stipulates that all the water of the natural streams, including tributary groundwater, is to be administered for public use, historic return flows have become part of the legal system, protected under the priority system for those downstream users who rely on them (Ferril, 2004; Hobbs, Presentation 1; Blakeslee, Interview 9). This complicates a water user's ability to change the type of irrigation they use, because if they do not irrigate in the same manner, return flows are certain to be impacted, possibly hurting downstream users, which conflicts with Colorado water law (Hobbs, Presentation 1). In addition to hurting other water users, changing irrigation practices can also impact wildlife, drying up creeks and meadows that wildlife has come to depend upon (Poschman, Interview 5).

In the case of ranchers, return flows can create springs, which are often used for livestock and domestic water purposes (Childs, Interview 6). As already detailed, the water that falls in the study area comes primarily in the form of snow, and the subsequent melting flushes more water than could possibly be used past ranches in the spring, while in the fall, when fields still need to be irrigated, the rivers are too low to supply all water needs. The effect of return flows percolating into the ground delays the movement of the water downstream, effectively storing the spring flood and releasing it slowly in the summer and fall when it is needed most (Blakeslee, Interview 9). Bill Blakeslee expands:

> The catch 22 comes about when people decide that sprinkler irrigation is more efficient than flood irrigation. What the change there is: yes, sprinkler irrigation can be more efficient because you're only putting onto the land what the plants can consume. Your leaving the rest of it in the river. Ok. That goes to California. The other part is then and the difference is, with flood irrigation, you apply that to the land, and instead of that going back instantly to the stream, there's a portion that is held with the land, and is gradually given back to the stream. So in August and September, that water comes back to the stream and supports the health of the stream. If you've changed over to sprinkler

> irrigation, you put out enough water to feed the plants, you've already sent your excess water down to California. So your actually in a sense, harming the system, or the river, later in the season.

Still, with all of the benefits that return flows and flood irrigation provide, they are the most contentious aspect of agriculture, and the arguments supporting their necessity can be seen as the first line of defense agriculturalists take in deflecting any discussion of water reform (Ransford, Interview 14). Furthermore, Ransford asserts that return flows justify wasteful irrigation practices, exemplified by the ranchers in the Roaring Fork Valley, whose fields see an annual average of 43 acre-feet of water per acre of hay, while in the Western U.S. hay only requires 2 acre-feet annually (Blaney & Criddle 1962; Ransford, Interview 14).

This discrepancy between applying enough water to satisfy a crop and putting substantially more than the plant needs on a field is at the base of the perspective of agriculturalists as water wasters. However, applying water is more complicated than simply looking at the needs of a crop. First, to arrive at a field there needs to be a certain amount of water in a ditch or else no water will reach the field where it is supposed to go (Childs, Interview 6; Carbondale Ditch Tour). This is called the push water. In sprinkler systems, this is an extra 50% of water and in unlined ditches it's an extra 100% (Ransford, Interview 14). In addition, ditches soak up about 5% of the water they are carrying, necessitating adding that much more (Carbondale Ditch Tour). Still, simple arithmetic shows that even with these factors accounted for, 43 acre-feet per acre is still an exorbitant amount.

Table 4: Water required and applied for 1 acre of hay in the American West, per year.

Water required for 1 acre of hay in the American West	2 acre-feet per year
Push water	100% = 2 acre-feet
Ditch seepage	5% = .02 acre-feet
Total	4.02 acre feet of water per acre of hay per year
Water applied to an average acre of hay in the Roaring Fork Valley	43 acre-feet per year
Water applied to an average acre of hay in the Crystal Valley	23 acre- feet per year

The existence of the discrepancy between what crops and irrigation systems require, and the amounts applied, is a deeply divided topic in the study area, and in the state as a whole. Some agricultural proponents argue that overwatering is not really happening at all, as Hobbs (Presentation 1) asserted: "There are those who say that western water law promotes waste. It's in fact the counter… I don't think farmers waste water generally." His argument goes on to support the ability of Colorado water law in protecting against waste, citing current law created by the territorial legislature of Colorado in 1876: "…during the summer season, it shall not be

lawful for any person or persons to run through their irrigating ditch, any quantity of water than is absolutely necessary for irrigating his or their said land, and for domestic and stock purposes. It being the intent and meaning of this section, to prevent the waste and useless wasting and running away of water" (Ibid). Although the law exists, some argue that the administration of the law is what is missing, and some water commissioners have expressed that this is due to the incredible resources it would take to check every headgate during the irrigation season (Tasker, Interview 13; Light, Presentation 6).

A second argument used to support the current practice of flood irrigation is return flows, which have already been described. As Ken Ransford (interview 14) put it:

> One of the advantages of that is, return flows stop any meaningful discussion of water reform today. The minute you start saying 'isn't there a way to leave more water in the river?' Immediately someone raises their hand and says yeah but you're going to impact the return flows, so all those people who relied on them won't get them anymore so you are damaging people's water rights. You feel like this nuclear explosion just went off.

A third argument involves the price of changing from flood irrigation to a more efficient irrigation system, such as sprinklers. Such upgrades require complete system changes and as Mark O'Meara, the Carbondale Utility Manager pointed out, these upgrades can be extremely expensive. Any reform that forced ranchers to pay the cost of converting to sprinklers would likely bankrupt many in the area (Blakeslee, Interview 9; Childs, Interview 6).

A fourth argument involves the fear of losing one's water right by diverting less. Chelsea Congdon Brundige (Interview 7) explains:

> People are worried. There is some confusion on the part of irrigators about what really constitutes their water right. They have a right to the beneficial use of water for the purpose they are putting it to, which is irrigating hay. On top of that they have permission to divert more than that amount of water so that they can push the water that they are entitled to. But the amount of water you legally have title to is the amount of water that your hay field consumes through evapotranspiration to make hay grow. The rest of it is delivery water, and you don't have a right to that water. You can use it to make sure you get your water to your farm, but that delivery water, that extra push water is not yours, and I think some farmers think that it is. And so when you talk about reducing your diversions, they say 'oh my god, that might reduce my water right'. But it won't reduce your water right, because it's not your water to begin with.

This fear of losing water rights due to limiting diversions appears to be ubiquitous and debilitating for any sort of water conservation work. As Lisa Tasker (Interview 13) put it:

> There is this 3 in 10-year agreement that allows an irrigator to not take their water for three out of ten years. So a lot of people do not want to sign up for that because in order to do that, they are really going to have how they use their water come under scrutiny. That's a real bummer, because to me it proves that they are wasting water and they are scared to be called out. People are going to say actually, the water that you own, you're wasting a lot of it, your

> "wasting," you're not able to put it to beneficial use, just taking it out at your headgate, its leaving the river for two miles, and you're just doing that so that when the water commissioner comes by and looks at your headgate, your diverting what your right is.

Although the Office of State Engineer, which is charged under Colorado law with the duty to administer water, has held many conferences around the state attempting to inform irrigators about what really does constitute their water right, the fear of negative consequences from reducing diversions is still prevalent (Ransford, Interview 14). This may be partly due to water lawyers around the state urging their clients to continue diverting the maximum they can in order to protect their water right, which Ken Ransford explains:

> …the last thing you want is zeros for diversions in a year. This is everybody's mindset, including the water bar. There's a pretty open minded water lawyer named Andy Jones, from Denver… he said when push comes to shove, the more you show you divert, the bigger your water right. He's one of the most progressive, open minded water lawyers that there is. He's telling his clients at the end of the day to take as much as they can. The typical hard ball water lawyer has been telling his clients that forever.

This legal advice is supported by recent legal battles with Aurora, a large Eastern Slope municipal user, who bought agricultural water rights from the Western Slope, did not irrigate with them, and later attempted to convert them into municipal rights. Western Slope interests, including Pitkin County, argued that due to their diversion records, those rights should be reduced, and the Colorado Supreme Court agreed.

A final argument used in support of flood irrigation and high diversions stems from the threat of an outsider taking any water that local users let pass by. Whether this is cities on the Front Range of Colorado or cities in California, Nevada and Arizona, irrigators argue that local control of water helps keep the water here. As Bill Fales, a local rancher attempting to enroll in a water conservation program was quoted in a local radio interview: "If we don't come up with something ourselves, the state will tell us what to do, or the Front Range will come knocking" (Presentation 5).

This threat, although many experts today consider it almost mythical because it is so remote (Brundige, Interview 7; Gardener-Smith, Presentation 5), has an historical basis in the study area stemming from the trans-mountain diversions and related infrastructure, including Ruedi Reservoir, built in the area in the 1930s and 1960s. As Mark Fuller (Interview 4) pointed out: "When Ruedi was built, when the whole Fryingpan-Arkansas Project was built, there were objections, but like I said, there were very few people here, so it was easy to sort of nod and say 'yeah, go away.' There was no power."

Although the local voice in the study area was not respected during that era, subsequent to those projects' completion, Colorado Supreme Court cases have asserted the power of counties in approving future trans-basin diversions, and a bond measure in the 1980s and 90s that asked voters to approve a $200 million project to expand the Fryingpan-Arkansas Project failed, in effect ending any new trans-basin diversion projects in the area, for now. Although currently the threat of new trans-basin diversions is low, Mark Fuller (Interview 4) stipulated "It's not really

over yet, it's kind of bubbling under the surface, like Voldemort, it never totally went away." The response from irrigators is one of greater protectionism and skepticism, both about the risk of trans-basin diversions taking water out of the basin, but also extending to threats from other water uses within the basin, such as municipal and environmental.

No matter what perspective one develops towards agricultural use of water, what is essential is understanding that it is by-far the chief consumptive use in the watershed, and holds the most senior water rights. Any other stakeholders in water thereby have to interact with them on their terms. This translates to the state level as well, as Ken Ransford (Interview 14) explains: "I think they have a lot more power than the general public thinks. The reason is because they control the water. They are very powerful down at the state legislature. If you look at the water bills that get passed, and I've been following them now for about 12 years, they are almost all pro-farmer, pro-irrigator." In the study area, environmental and science-based organizations whose goal is to promote river health "tread lightly" by avoiding advocating environmental flows and instead using science based studies to talk about river health (Tasker & Macdonald, Interview 13; Lewin, Interview 15). As Lisa Tasker (Interview 13) said:

> I would say that we never ever intended to say hey everybody, we are coming out and we want to do environmental flows. Because that would scare everyone out of the room who has the water right. That would be the end of the conversation.

It's important to remember why irrigators are scared at the possibility of having their water rights reduced. In the American West, water is the finite resource that dictates the development of any industry, city and most recreational activities (Blakeslee, Interview 9). Being the most ubiquitous, and the most senior water right holders, agriculturalists, in a diversifying economy and culture, can feel that all eyes are on their rights. Bill Blakeslee (Interview 9) explains:

> As our valley has grown, and our population has increased, the desires to do other things beyond agriculture has grown way above and beyond what the agriculture was importing at the time. We would like to believe ourselves to be an agricultural community, but we really aren't anymore. It's about recreation. And the recreation is about personal pleasure. It's not really about being a steward of the land, being a steward of the water. It's very selfish, in my term.

Those diversified uses and an expanding population have impacted the agricultural community through greatly increased land prices, especially land with water rights. Ken Ransford (Interview 14) argues that land with water rights sells for three times as much as dry land in Colorado, and ten times as much in the Lower Colorado River Basin. This phenomenon has created a huge demand for agricultural land, tempting farmers and ranchers to sell to development, either allowing them to retire, or their children to receive inheritance, while the land is turned into subdivisions. Bill Blakeslee (Interivew 9) commented:

> And that is what is destroying our agriculture in this valley. We have seen a fair measure of it here. And what happens is the income derived from being a steward of the land, and trying to make your living there, is not enough to sustain the families and the value of the water ultimately causes the agriculture to go away, and the subdivisions to come in.

This has also been seen by some as an opportunity to make money, and these speculators are buying up agricultural land and irrigating it, only to wait until the price of the land increases so they can sell it for a profit (Wohl, 2001; Brundige, Interview 7). These speculators have had no interest and have been hostile toward any talk of reducing their diversions in an effort to conserve water. Instead, they follow the maxim of divert as much as possible, thereby increasing their future profits (Ransford, Interview 14). This speculation exists despite the foundational pillar of Colorado water law described in section 2.4.2 attempting to limit speculation.

The next section explores this demand for municipal water through the context of the City of Aspen and their conditional rights to build water storage in Castle and Maroon Creeks.

6.2 The City of Aspen and Water Storage

Regardless of the occupation of Roaring Fork Valley residents, they have always required water for their domestic purposes. This section will focus on the City of Aspen, exploring issues related to municipal water in the study area through an investigation of the City's municipal demands and supply in light of its proposal to build new dams in Castle and Maroon Creeks to create storage capacity for its municipal water.

Although perhaps counter intuitive, this investigation begins at the bottom of the municipal water line: at the waste water treatment plant. The plant is located down valley from Aspen, on the bank of the Roaring Fork River. Its run by Nathan Nelson, who leads tours for school groups and interested parties. The plant runs waste water through a multi-step process, where waste water entering the plant is first filtered for inorganic waste, then aerated with bacteria, then allowed to settle before it's filtered for micro particulates and released back into the river. The left-over "sludge" which has settled out is dewatered and taken to the landfill, where it is used in compost (Aspen Waste Water Plant Tour).

The investigation into Aspen's municipal water starts here because all water used indoors comes through here, and thus, Nathan has a solid understanding of how much water is used indoors every day. As he explained, the plant was built to handle 3 million gallons per day, but only receives an average 1.2 million. He went on to describe that because Aspen is a tourist destination, high seasons, such as the Fourth of July and Christmas, can see the plant's load double. When asked what the trend in municipal water use has been, he responded that the adoption of low flow fixtures has actually reduced the amount of water that the plant is processing, but that the water that flows into the plant has higher concentrations of waste, prompting him to adapt the process to deal with higher concentrations.

Another important aspect of the waste water treatment plant is that all of the 1.2 million gallons of water that enters the plant leaves the plant and returns to the Roaring Fork River, to be used by all downstream water users. This is an example of a non-consumptive use of water, meaning that the water is available for other uses after being utilized for municipal purposes (Clarke et al., 2008).

Non-consumptive uses of water still impact the watershed, as the 1.2 million gallons of water that comes through the waste water plant has been taken from Castle and Maroon Creeks, dewatering the creeks and by-passing the Roaring Fork River until it re-enters the river at the treatment plant, while the quality of the water can also be affected (Upper Roaring Fork River Management Plan Meeting).

These findings at the waste water treatment plant showed that indoor use of water has not increased in recent years although Aspen is still a growing city. To understand the full picture, the investigation turned to outdoor use. The average price of a home in Aspen is $2,404,245, and it is regularly listed as one of the most expensive places to live in Colorado (Clarke et al., 2008). This extravagance plays out not only inside the home, but in the associated landscaping as well. As Margaret Medellin (Interview 8), the City's Utility Director described it:

> Outdoor water use up here is incredible. You think, why do you need it? Some of it I get. Some of it is fire mitigation around your home. Some of it is so extreme, it's like how can you live in the Arid West and think you need Kentucky blue grass?

Ryland French (Interview 11), a staff member with the City's Sustainability Department expanded: "Residential is our largest source of water use because there's a lot more irrigation space there than in commercial. Most of them definitely in the City of Aspen and even in the peripherals, are on our treated potable water." This outdoor water use accounts for the bulk of Aspen's water demand, with single-family residences, as Ryland French pointed out, accounting for the majority of that demand. This is shown in Figure 5.

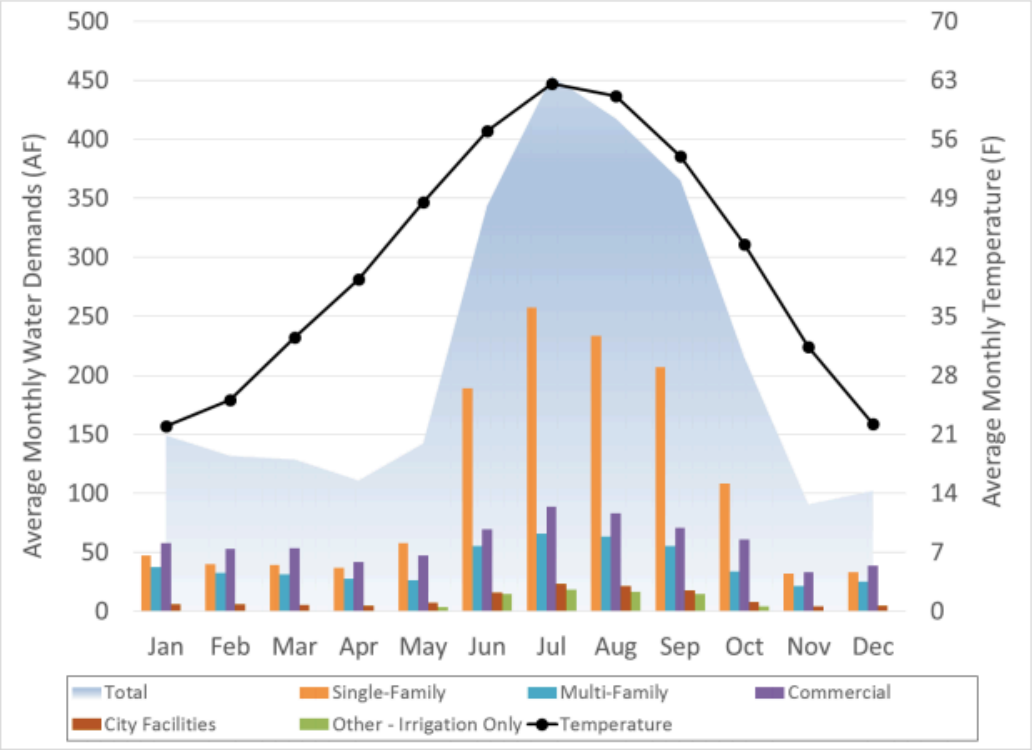


Figure 5: City of Aspen Average Monthly Metered Treated Demands by Sector, from 2009-2013 (Element Consulting and WaterDM 2015).

In an effort to curb outdoor use, the City began a dryland landscape pilot program in the summer of 2017, encouraging the largest private users to cut back through contacting them with the offer to install hi-tech rain sensors into their watering systems for free. Ryland French (Interview 11) described their process:

> They will go to a home, turn on a control system in some of them, some are smart and Wi-Fi and able to consider weather forecasts, evapotranspiration demands, you can attach rain censors so if it's raining or just rained you're not going to water that day. But a lot of the systems are still just these old control systems, and what we've found is that a lot of homes are watering a lot more than they need to, both in terms of frequency and duration.

This overwatering, Ryland French explained, comes from a tendency to err on the side of caution, with residents and property managers alike watering their lawns and landscaping seven days a week for 40 minutes at a time, while the City has found that to have green vibrant grass it only requires watering two or three days a week for 10-20 minutes. When these landowners were contacted, Ryland French was encouraged by the response.

> We had a homeowner with a really big property who had us do the free assessment, and he said I want to do all of it. He hired the contractor to come do all of it. I think at least 10 of the homeowners that we reached back out to in September and said we want to come install rain sensors for free, are you in? They said 'heck yeah, let's do it.'

Other examples of a positive response were homeowners who, during the free assessment, were told that their systems were set to over-water, but that the assessor could change the scheduled watering immediately. Ryland French said that many agreed on the spot. When asked why he believed there was such a positive response, he explained:

> I think water is more tangible to people, water is water... I think a lot of people know that the water we are using here is coming straight out of the mountains, we only have so much of it, we have times when we are running the creeks lower than we want to, and with the water storage and the castle creek energy center there's been a lot of discussion about it and I think people identify more with water in a community sense, in that it's a shared resource. I'm not sure about this but it could also be, I don't think there's much disagreement about the importance of water and having enough of it.

Indeed, at a community meeting held by the City of Aspen to discuss the Upper Roaring Fork River, participants ranked water uses in order of importance, and municipal uses were second only to ecological. These rankings, and associated comments are shown in Table 5.

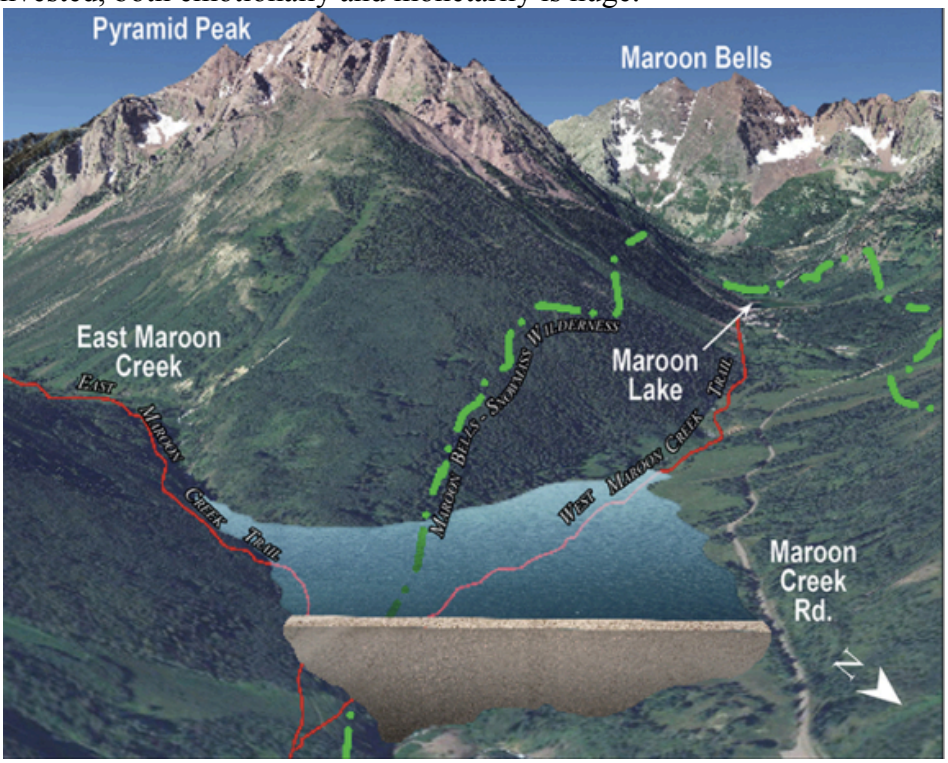
Table 5: Aspen community rankings of water uses by importance

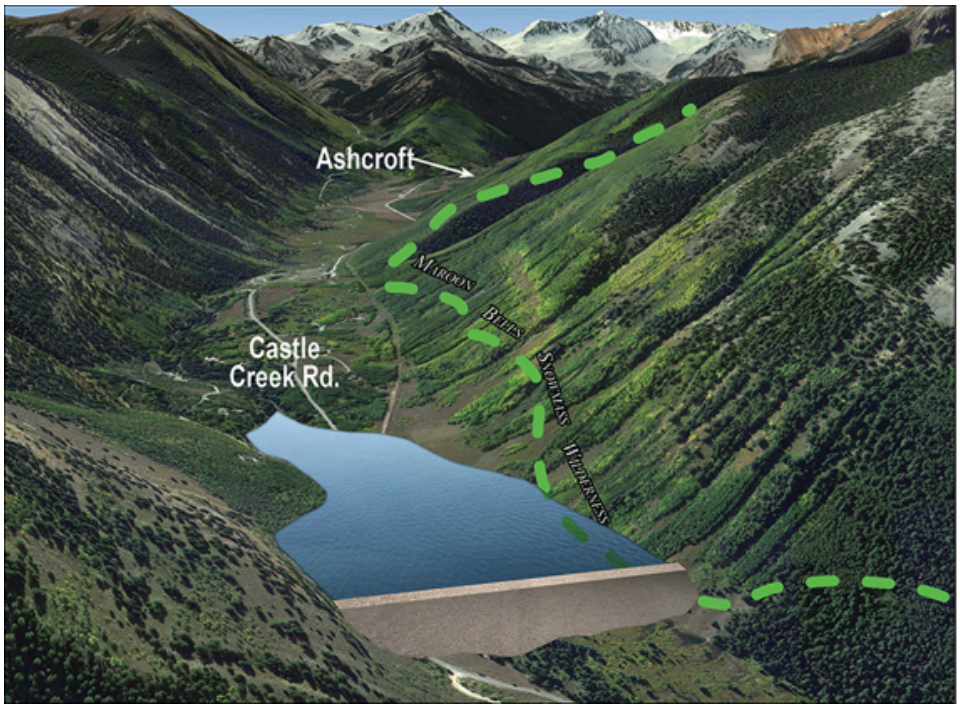
Category	Ecological Integrity	Municipal Drinking Water Supply	Local Food Production	Fishing/Boating	Snow Making	Parks and Fountains
# of votes	36	33	22	17	6	4
	• Underlies the whole • Quality of Life • Identity (both personal and city) • Most important • Fulfilling this makes everything else fall into place • Would change this place without it • Moral responsibility • Will never be whole because we have consumption	• Necessary • Are we at risk? • Pragmatic • Can't live without it • Can cut back in dry years • Can explore more conservation	• what food do we actually produce? • Scenic vistas • Ranch culture • Small use in this area of watershed • Fosters future of how we will live • Could truck in hay instead of growing it here • Water as return flow • Eating locally could decrease fossil fuel consumption	• Can fish elsewhere • Not a deep foundation here • Supports economy • Separate issue • If river is healthy than recreation is taken care of • Why I live • Gets its needs met in ecological health	• Could use less in drought conditions • We are a ski town • Ok with changing seasons • Adds to runoff • Economy • Sustain community	• Can have unwatered parks • We have other parks • 1 year without water couldn't end parks • if we had drought green parks would be sanctuary • important to avoid sprawl

Although community members gave municipal use of water a high ranking, the community's support for two new dams that would bolster the City's water storage capacity to 8,500 acre-feet has been low. In 1965, the City Council voted to apply for a conditional water right to build two dams, one in Castle Creek, and one in Maroon Creek. In Colorado, there are two parts to establishing a water right. The first involves declaring an intention to develop a right, and the second is developing it and putting it to use (Ferril, 2004). In this case, the City declared its intention to build dams in both valleys, securing that date in the priority system (Gardener-Smith, 2016). However, instead of developing the dams, it simply had to show a water court every five years that it was still pursuing the project, but never made any firm moves towards actually developing the dams. (Gardener-Smith, Presentation 5). This process of showing due diligence, as Brent Gardener-Smith explains, is very easy: "it's a super low bar. It's like you don't have to really clean up your room, you just have to kick the clothes on the floor under the bed. Very low bar. Except when 10 opposing parties come in and tell the court we don't think they have cleaned up their room, we don't think they have been diligent. Then the stakes get higher."

Although the City had been, somewhat covertly, showing due diligence every five years since 1965, this time around, it was met with opposition, casting the situation into the political spotlight. When Mark Fuller (Interview 4) described the development of water infrastructure in the Roaring Fork River watershed, he described a plan that the Bureau of Reclamation developed to build a dam east of Aspen in the early 1960s, in what is today the North Star Nature Preserve. He described the social backlash towards the proposal from the community in Aspen, including a former undersecretary of the Air Force who purportedly pulled strings in Washington D.C. to make sure the dam was never built. Mark Fuller's conclusion was "Castle and Maroon are iconic

in terms of their public knowledge and investment…where you put something relative to where people are invested, both emotionally and monetarily is huge."





The proposed locations for dams in Maroon Creek (top) and Castle Creek (Bottom). From (Reservoirs, 2016).

The amount of opposition raised in response to these dams is confirmation of Mark Fuller's point, as the City is being sued by the Forest Service, Pitkin County, four environmental groups and four property owners. Will Roush (Interview 12), the Director of Conservation at the Wilderness Workshop, one of the environmental groups opposing the City, explained their position:

> The impetuous for our engagement with the City was the diligence application that was due at the end of 2016, and so we filed a statement of opposition to those rights largely based on the ecological and cultural impacts building the dams would have. Those valleys are so important. Both dams would flood at least a portion of wilderness. From an ecological prospective, the biggest impact would be putting concrete dams across the streams. We just want to make sure that never happened. And while we understood that the city had no plans to build those dams in the near future, it was unclear whether the city council actually wanted to reserve that right to build them down the road or if they just wanted to maintain a water right without using it which they felt was valuable.

Likewise, Pitkin County argued in their letter of opposition "…this water right is unnecessary to meet current and future demand within a reasonable planning period using normal population growth assumptions."

Margaret Medellin (Interview 8) explained the motive of the City Council, and the Utility Department, in continuing its due diligence, citing The Headwater Study, which was contracted by the City. That study overlaid the municipal water intake with possible future demands, including the most dramatic possible climate change scenarios, and plotted the probabilities in the supply and demand curves. As Margaret Medellin put it, "…you never want those lines to cross. Especially if you don't have storage. And we in our simulations, the lines crossed. So really we are looking at providing enough storage that those lines never cross."

Although the Headwater Study showed a need for storage, Brent Gardener-Smith (Presentation 5) argued that the science is not quite so neat. Prior to the Headwater Study, the City hired Wilson Water, a water consulting firm headed by Aaron Wilson, who Brent Gardener-Smith asserts is one of the most respected water consultants in Colorado. That study compiled water demand and supply data, and used models to simulate future demands, concluding that if the City continued its water conservation program and added a few wells to supplement surface water supplies, it would not need to add storage capacity. Why the discrepancy between studies? According to Brent Gardener-Smith, "The key to the Headwater Study is how do you define a water shortage? How you define a water shortage has everything to do with how big it is" (Presentation 5)

This interpretation of a water shortage is key to the issue, with the City defining it one way, and the opposing parties defining it differently. Margaret Medellin (Interview 8) explained the utility department's view.

> …the city of Aspen has 12 hours of storage; it is kind of crazy. And I think, it's also just not quite fair, because so much water from the Roaring Fork Basin goes over to Twin

> Lakes and on to Colorado Springs and Pueblo. Even though we live in a pretty water rich area, we don't have really a lot of that water because it leaves the basin.

Although trans-basin diversions do de-water the headwaters of the Roaring Fork River and Hunter Creek, the majority of the City's water sources lie in Castle and Maroon Creeks, neither of which are affected by trans-basin diversions. Still, operating a water utility without significant storage capacity is seen as a challenge and a threat to the security of the supply, as Margaret Medellin (Interview 8) explained: "Even if we were really aggressive with our water use, because we live off the direct stream flow, we would really suffer a lot if we didn't have water. Because we are kind of alone up here, we cannot do an emergency tie-in with another community." Brent Gardener-Smith (Presentation 5) defended the benefits of storage as well, saying:

> It's hard to argue that stored water doesn't have value, especially in times of drought. If you're a municipal water provider, you wake up every day saying we have to a have a secure source of water. So there is certainly value in stored water. If you're a water provider it's a great luxury to have stored water. It can be very helpful. You can't necessarily attack the motives of trying to have a reliable water supply.

However, with decreasing indoor water use and the implementation of outdoor water conservation programs, Margaret Medellin lamented the difficulty in raising public support for the dams, saying "I'm not a public communication expert by any means, and I don't think any of us at the utility are, and so I think that's where we get in trouble sometimes, if we don't know how to get our message across." This difficulty in presenting a message of water scarcity is only made harder, she continued, because unlike on the Front Range, where the public can easily see the levels of the reservoirs dropping, there is no indicator for the public to see that there is a water shortage.

Currently, the City is attempting to move the water right to a former gravel pit down valley of Aspen, which is more publicly acceptable (Medellin, Interview 8). Thus far the opposing parties seem to be agreeable to this move and a settlement moving the right out of Castle and Maroon Creeks in return for the opposing parties giving up the right to oppose the City's new location is in the works (Roush, Interview 12).

Although this section has been solely focused on the City of Aspen, it has attempted to show that municipalities in general are not free from the constraints of the Arid West. Margaret Medellin (Interview 8) put it this way: "There's not enough water in Colorado. So it's really not like there's a community that I can think of that has too much water." Thus, the City of Aspen's struggle to secure water storage is an example of the struggle of municipal providers whose chief concern is having a secure supply of water, no matter the environmental circumstances (Medellin, Interview 8).

On the Front Range, this search for security has led to municipalities buying senior agricultural rights, then leasing the water back to the farmers with the stipulation that in times of drought the water will be taken from the land and used for municipal purposes (Ransford, Interview 14). Such alliances between farmers and cities have yet to form extensively on the Western Slope, but

Margaret Medellin mentioned emerging strategies such as Alternative Transfer Mechanisms (ATMs), which are voluntary agreements that allow cities to lease water from farmers during times of drought, without having to buy the right and fallow the fields as has happened on the Front Range (Castle et al., 2017). Whether such agreements can supply enough water to convince the City of Aspen that there is no longer a need for a dam is yet to be seen, as are the impacts of such agreements on the agricultural community. However, as detailed in section 6.1, any discussion about changing agricultural practices to make more water available to other users is a delicate topic within the agricultural community and can take years to formalize any agreement (Brundige, Interview 7; Lewin, Interview 15).

Although the City of Aspen has had trouble building support for an expansion of their water storage, the value of a secure supply of water for municipal purposes is certainly understood. Today, many subdivisions in Aspen, and in the entire Roaring Fork Valley, sit on former agricultural land, whose water now fulfills municipal purposes. This process, in the lower Roaring Fork Valley, has been aided by the construction of Ruedi Reservoir, the development of which supplied thousands of acre-feet of augmentation flow, which can be purchased by developers to supplement the historic agricultural rights that they have transferred to municipal purposes. This is done by allowing them to dig wells into the tributary groundwater for domestic purposes, while using the augmentation flows to satisfy downstream users of the agricultural water that once flowed through ditches that are now abandoned (Ferril, 2004). Agricultural land that is for sale is almost always turned into housing developments and many subdivisions are called by the name of the ranch that it used to be, such as Cerise Ranch, Ranch at the Roaring Fork, River Valley Ranch and many more. This transformation of the use of the water resource effects both its quality and quantity, while also changing the culture of the community, and the correlating community values of water. These values are more and more in favor of environmental flows and recreational uses of water, such as kayak parks and fishing. These uses are the subject of the next section.

6.3 Environmental and Recreational Water

Environmental flows are a very recent edition to Colorado's water sphere. In the Colorado State Constitution, ratified in 1876, it was stated that "the right to divert the unappropriated waters of any natural stream to beneficial uses shall never be denied" (Wohl, 2001). Over the next 100 years this proclamation led to the over-appropriation of Colorado's water resources and the drying-up of its waterways (ibid). Only in 1979 did the Colorado Supreme Court declare that this statement from the constitution was not a mandate that all water rights include diversion but that it was a rejection of the riparian rights doctrine (ibid). With this declaration, and a request by the Colorado legislature in 1973 that the Colorado Water Conservation Board (CWCB) establish water rights that protect the natural environment, environmental flows became an option (ibid).

Still, the system favors diversions, as those wishing to create new diversions are not responsible for showing that they will not harm the riparian environment and instead, the responsibility lies with those wishing to limit diversions (Wohl, 2001). These riparian areas are of critical importance in the study area, as they are only 1-2% of the area, yet support 98% of all natural life (Poschman, Interview 5). As Greg Poschman put it "We cannot treat them merely as sewers and transportation corridors much longer. We must consider the riparian zones to be sacred

lands. Wildlife- dependent upon the riparian zones- always loses in the end." However, protecting these areas is very challenging. As Lisa Tasker (Interview 13) said,

> To be on the environmental side is extraordinarily challenging more than I think any of us ever thought… Originally we thought we are going to be buying lots of water rights and putting them in the river. No. It's just damn near impossible to do that… Its really frustrating.

This frustration is shared in the environmental field, but Heather Lewin (Interview 15) recognized that to have environmental flows acknowledged as beneficial use at all is a big step. The legal recognition of environmental flows as beneficial is in the form of in-stream flow rights. These rights can only be held by the CWCB, and are designed to preserve natural characteristics of the stream, such as aquatic and riparian habitat, and the physical characteristics of the stream channel (Wohl, 2001). Although these rights are very junior, only going back to 1973, Heather Lewin explained that they are still important "It seemed like when they first did [in-stream flow rights] they thought these are never going to come into use because they are so junior. But they actually do. It's good that we have those even though they are very much junior rights." Likewise, Lisa Tasker (Interview 13) reiterated "We couldn't start doing them until 1973. But yet, they are still an adjudicated legal water right. That in itself is important, this is a legal water right and it's just as much of a water right as yours is…They aren't just nothing".

Although environmental flows may be junior in the legal system, the growing population of the study area values them more and more. In explaining the history of the Pitkin County Healthy Rivers Program, Lisa Tasker detailed that over 70% of voters in Pitkin County were in favor of creating and funding the program, despite the vote happening in 2009, in the middle of the Great Recession. Likewise, at a community meeting discussing the upper Roaring Fork River, Ecological Integrity was the highest voted category among important water uses, as detailed in Table 5, section 6.2. However, implementing environmental flows has been a huge challenge. Lisa Tasker explained "…most people want to see healthy rivers, but the people who have the water are like, no way, don't come looking at my right. Don't come messing with my water rights."

This opposition from water right holders has forced environmentalists to become creative, and in the case of the Healthy Rivers Program, this creativity fostered the idea of a kayak park in Basalt. Kayak parks are artificially created waves in the river, which kayakers and stand up paddle boarders surf. For the wave to develop properly, there needs to be a certain flow in the river, and this flow is the basis for the legal right, called a Recreational In-Channel Diversion or RICD (Healthy Rivers Project). When the river drops below that level, the operators of the kayak park can put a call on the river requesting the water commissioner to turn off upstream junior users until the flow is high enough for the wave to function properly. Although it can be seen as purely recreational the flow for the wave is designed to be the minimum needed for the ecological health of the river (ibid). The kayak park has been controversial with opposition coming from the agricultural community, whose view has been that recreational rights are not as important as agricultural, as Bill Blakeslee (Interview 9) explained

> But as far as putting the water back in the river for somebody to paddle their kayak down the river, as opposed to raising enough grass to feed my cows, which feeds my kids, I think that's where the line of separation is going to come. The recreational people are only thinking about the fun they can have, my being says that's not fair if I'm taking away from somebody's table.

Also, environmentalists saw the impact of rearranging the river to create the wave, but as Lisa Tasker (Interview 13) defended "It took a long time for people to sign off in the environmental community because it took rearranging the river. But over time it's kind of like well, this is how you're going to get this kind of a water right in the river." Indeed, with options limited, the idea of kayak parks has been on the rise, so much so that the creation of additional ones has become very difficult. Greg Poschman (Interview 5) described:

> This one we put in Basalt may be the last one Colorado ever gets. Snuck it under the wire. [Colorado Water] Conservation Board and everyone else saw potential for what that can do, what if everyone else had one? Suddenly we would have to leave water in the rivers, so they shut it down. That's the last one.

Greg Poschman lamented that more kayak parks won't be created, "…imagine if you could say, we are going to put a Recreational In-channel Diversion at the base of the Crystal. Which gets dewatered completely in the summer, for the ditches in Carbondale." Others, such as Heather Lewin (Interview 15), described that this growing demand is based on the economic benefits of recreational flows. "More and more economic studies focus on tourism and recreation and how many people those actually bring into the state and how much money that creates. That does show that there's a benefit to having that water, an economic benefit." Chelsea Congdon Brundige (Interview 7) iterated that:

> …there is more and more an understanding on the part of water users and certainly on the part of regulators and policy makers that we have to figure out how to balance non-consumptive uses of water such as recreation and environmental needs, with the consumptive uses in agriculture and energy and industry and municipal uses because we really are in trouble. We really do need to rebalance water use to avoid the classic train wreck situation where you have to take water away from people and redistribute it to address all of these demands.


The Roaring Fork River flowing through the Basalt Kayak Park

This points back to agriculturalists and the tension described in section 6.1 between their overwhelming senior rights to water and their relationship with other water users. As Chelsea Congdon Brundige (Interview 7) continued, "Because they are irrigators and they take water out of the river, some environmentalists or reformers characterize them as "bad guys", but what they really are is stewards. Irrigators have a real relationship to the river and its important to them". With the option of using recreational in-channel diversions diminishing, some environmentalists are looking towards irrigators and the possibility of restructuring their diversion schedules to benefit the river. Brundige described the irrigators' response to such inquiries "They're response is justified, and it is look, if you want my water, you're going to have to pay me for it. You can't just have it." One such program on the Crystal River is run by the Colorado Water Trust. Brundige explained how it works "The Colorado Water Trust has developed a program where when [The Crystal] drops to a certain point, we can start a water market and offer to pay irrigators a certain amount per cfs of water they leave in the river instead of diverting it".

Although such programs exist, some believe that paying irrigators to leave water in the river sets the wrong precedent. Ken Ransford (Interview 14) illustrated this position:

> Here's the issue. If your diverting 23 acre feet per acre, what they are saying is I will sell you 2 acre feet. Right? If you say no, if you don't pay me, then I'm going to divert every last drop, I'm going to make you pay me. So the incentive is for them to take even more out. In my opinion, if you pay one rancher one time to leave excess diversion in the river, you're going to have to pay every rancher forever.

This working with agriculturalists or "treading lightly" Ken Ransford asserts, is not the right direction to take. As he put it "If environmentalists were abolitionists, we would still have

slavery today." In his opinion, the current legal framework does not support environmental flows to the point where it is actually possible to protect stream health. Instead, he proposes that beneficial use should be redefined as "…diverting the minimum amount possible to grow hay under efficient irrigation practices, not under historic irrigation practices." He goes on to assert that "we could leave 30-40-60% of the water we now divert out of rivers in the river and still irrigate the same number of acres of hay that we do now. We would have to use sprinklers and we would have to have efficient irrigation systems." However, current trends seem to be going in the opposite direction from this realignment of beneficial use. A statutory change in 2015 expanded beneficial use to include ditches that are run as private trout streams, which Ken Ransford lamented, saying "…last year's statutory change is now going to justify diverting the maximum amount possible to go through these private trout streams. The impact that it's going to have on rivers is bad."

Because of the challenge in redefining beneficial use, others see paying agriculturalists to leave water in the river as the best possible solution available in the present. Heather Lewin defended this strategy:

> We approached this right now in the idea that if we wait for legislation to change, we are waiting too long before we have a solution. Is it perfect? No. But it's one solution within the confines that we are dealt right now. Is it ideal? No.

This notion in the environmental community that waiting on the legal system to change will take too long is commonly held, and has led others to develop cooperative agreements that do not revolve around the legal system in order to lessen the negative effects on local streams. One such example is Snowmass Creek. Chelsea Congdon Brundige (Interview 7) explained that the Town of Snowmass Village has the water rights to drain the creek, and the population living in the watershed has no legal power to oppose this. However, after forming a group of concerned citizens, they began talking to the Town's water department, with the position that Brundige elaborated:

> …The Snowmass Capitol Creek Caucus realized that we can't fight about this anymore because Snowmass will win. We need a way to collaborate. So we did a lot of work together and came to an understanding of how Snowmass Village could manage their water more efficiently so that they could do a better job of maintaining healthy flows in Snowmass Creek. Even though they don't have to. We developed an engineering analysis that showed them that they could serve demands, have water in emergencies and protect the Creek and suggested that if they did, it would make them look better. They went from being a system where they lost 35% of the water they took from Snowmass Creek before they delivered it to people's homes. Now they lose 4%. They are probably one of the more efficient water agencies in the U.S. They did that because we collaborated.

Brundige also stipulated that this collaboration was coupled with good leadership and management goals within the Town of Snowmass, and that water reform within the Town was not solely caused by the Caucus. Whether these types of collaborations are lasting solutions remains to be seen, and there is skepticism within the environmental community as to whether

they can withstand significant drought periods (Ransford, Interview 14; Tasker & MacDonald, Interview 13).

Environmentalists walk the line between relying on weak legal rights, the creation of which is becoming ever-more challenging, and using emerging economic and collaborative solutions to protect in-stream flows. The common theme is creativity; doing what is possible with the current system while proposing changes to the legal system that could facilitate stronger environmental flows. The general conclusion is that the current legal system undermines the environment because environmental flow rights are very junior, meaning that in times of shortage, they are the first to be curtailed. With the challenges of changing this system some have turned towards options that involve paying agriculturalists to reschedule their diversions and creating voluntary collaborations that attempt to promote sharing of the resource with the goal of leaving more in the river. Whether these emerging solutions set the wrong precedent, and can withstand droughts are topics of discussion in the following chapter. However, the need for action is evident, as Ken Ransford, Interview 14) concluded: "We can't keep going this way because we are going to destroy everything. The current incentive is for everyone to use as much as they can. If you build all your systems to do that you end up with a horrible system, and we are seeing just how horrible it is."

In summary, this chapter has shown that Colorado water law favors agricultural use of water through the priority system described as "first in time, first in right" (Ferril, 2004). This system, along with related legal structures, has promoted the diversion of water and its consumptive use, despite a growing population that favors environmental and recreational flows. This has resulted in degraded aquatic and riparian habitat throughout the study area, and the difficulty in changing the legal system has led environmentalists to use creative solutions to remediate the negative impacts of agricultural water use. However, agriculturalists have their own challenges, faced with growing semi-urban populations throughout the study area that are rising land prices and pushing agriculturalists to sell their land and water to developers, while also increasing the perceived pressure for water from both municipalities and recreationalists. This growing and diversifying population is changing land values and transforming the culture of the area from agriculturally based to recreationally based, influencing the related values of water. This growing pressure on agriculturalists has, in some cases, prompted them to become more protective of their diversions, fearing that any reduction will be used as grounds to steal their water. This has also, in some cases, limited their willingness to participate in collaborative agreements.

Municipalities are not free from this struggle to secure water, as has been shown through the City of Aspen's attempt to perfect its right to build reservoirs in Castle and Maroon Creeks. However, as has been shown, public support for such dams is very low, and outdoor use of water accounts for the bulk of the municipal use within the City. The City's Sustainability Department has implemented a dryland landscaping pilot project which, in its first year, has already seen significant results. Why large municipal users respond to pressure to increase efficiencies in a positive way, while agriculturalists do not, will be explored in the following chapter, which will center on positioning these findings in the literature outlined in Chapter 2. This discussion will focus on the central theme of whether the current institutional arrangement is capable of solving related environmental problems such as the drying-up of rivers and whether the associated environmental risks are equally shared among the study area's stakeholders.

Chapter 7

DISCUSSION

This study was developed to investigate how western water resources are both valued and used, looking at how the high and diverse demands for water are coupled with a limited physical supply, and the sentiment within the water community that this misalignment of supply and demand might lead to a pending dramatic water shortage (Brundige, Interview 7; Blakeslee, Interview 9; Ransford, Interview 14). These sentiments have a deep historic background, as western water resources have always been viewed by European Americans as the chief limiting resource for development in the Western U.S. (Reisner, 1993; De Buys, 2001)

These forebodings were revealed by interviewing stakeholders in the major arenas of water use in the Roaring Fork River watershed, a prominent Upper Basin tributary of the Colorado River, and arguably one of the most over-allocated river system in the world. Through cross-checking these interviews with current and relevant literature on the Colorado River Basin, it became clear that water is indeed in high demand for agricultural, municipal and environmental purposes, and this high demand, coupled with a perceived inadequate supply, is causing tension between the different stakeholder groups. This chapter aims to investigate this misalignment of supply and demand, acknowledging on similar lines as Robbins (2011) and Kaika (2003) that scarcity is not a solely natural phenomenon, and instead is the product of human values, usage patterns and political and economic strategies, which may benefit certain stakeholder groups over others.

This investigation will be conducted by looking at the institutions available to stakeholder groups; in particular, focusing on institutions governing access to water resources and institutions governing the ability of stakeholders to change the rules of access. These institutions are the core of Vatn's (2015) resource regime, which he describes as "…the rules concerning access to environmental resources, and the […] rules concerning interactions within and between actors having access to such resources, as well as being influenced by decisions regarding them" (p. 181).

Colorado water law and cooperative agreements are key and sometimes conflicting institutions. For each, the benefits and drawbacks will be explored through input from interviewees, with the goal of answering two primary research questions: (1) Are the current institutions capable of handling environmental problems such as the drying-up of Colorado's river systems? (2) Do the current institutions incorporate complex equity in distributing access to water and granting recognition and participation to associated decision-making arenas?

Complex equity will be viewed through the lens developed by Arnold (2017), where he argues that complex equity is a form of justice that honors the multiple and diverse values of a resource such as water, beginning with official recognition of the complexity of water's values and uses in all relevant decision-making arenas. This, he argues, must lead to the protection of these diverse valuations, as water cannot be defined justly without incorporating all of the values that belong with it (pg. 67). He elucidated that this inclusion must extend to the distribution of the resource as well, where competing values of water may each gravitate towards very different distribution regimes (market-based as opposed to community- or environmentally-based), but that to achieve

distributive justice, the resource cannot be distributed using only one such regime. This, he argues, "…leads to a kind of tyranny, to the domination of every other sphere of value and meaning (community, for instance) by a principle of distribution (for example, commodity and market-based exchange) alien, if not hostile to it" (pg. 67).

These principles will be included in section 7.3, looking at the City of Aspen's municipal water situation with the purpose of exploring: (3) How has the City of Aspen approached its water situation? What strategies has the City used to balance supply and demand of municipal water? Do these strategies provide complex equity for the diverse uses and values of water that community members hold, while providing for the environment?

To answer these questions, the theoretical foundation outlined in Chapter 2 will be incorporated in discussing both the benefits and limitations of the current institutions.

7.1 The Legal Framework

Although often described as intricate and complex, the priority system of Colorado water law, according to Bill Blakeslee (interview 9), does provide stability. "…with the priority system there is some semblance of continuity and protection for the stream, protection of the water rights of all peoples" Ret. Chief Justice Hobbs (Presentation 1) also lauded the benefits of the priority system, saying "You have to have a law that tracks the hydrology…so that somebody coming along later cannot intercept it…We have such a law, and it's because our predecessors gave it to us from practical experience."

This stability comes with consequence however, in that the seniority that has been established over more than 150 years has heavily favored agricultural interests, accounting for as much as 80-90% of the consumptive use of water in the Southwest (Booker & Young, 1994, Schaible & Aillery 2017). When the study area was simply an agricultural area, this agricultural seniority, as Blakeslee put it: "I don't think it was hurting anyone. It wasn't causing any grief for anyone." However, with expanding and diversifying populations and economies, tension has become evident with other water users who feel that they do not have an equal say in how water is used. As Lisa Tasker (Interview 13) put it: "In the process of trying to get irrigators to the table, a lot of people start selling their souls because these guys have all the water and the power. So you are like, how do I have a conversation with them? How can I get them to act like I even exist?" Heather Lewin (Interview15) reiterated "The more that its placing blame on agriculture, people saying you guys are doing it wrong, you need to give more to the river, you need to be more efficient, the door slams closed, the heels dig in, the black hat pulls down and you're out of the conversation."

Indeed, this solidarity within the agricultural community and its exclusion of other water users who have different points of view is one of the drawbacks of social capital as described by Portes (1998) "…the same strong ties that bring benefits to members of a group commonly enable it to bar others from access" (pg. 17). However, this exclusion extends beyond the water itself, to membership in the historic culture in the area that is faced with its own extinction. Blakeslee elaborated:

> They are becoming more protective of their historic water rights. We see more of this in families that have had that piece of land for over 100 years… It's a way of life that you're born into, and you live with, but a lot of young people don't want to be involved in that… agriculture is a seven-day-a-week full time job. A lot of people in this day and age don't really want to invest their time in working seven days a week. We would like to believe ourselves to be an agricultural community, but we really aren't anymore. It's about recreation.

Thus, the institution of priority administration has produced a situation where over the past 150 years agriculturalists have gained control over access to the water resource, both in terms of consumptive use, but also in terms of their ability to exclude other interests from discussion about water reform. This is not to say that agriculturalists themselves are necessarily responsible for this process, but that the legal framework developed under Colorado water law has created a power dynamic where historic uses have more control.

Still, it isn't solely the institution of priority administration that has facilitated the capture of the water sphere by agriculturalists. Instead, it is only one legislative puzzle piece, put together under a vast western mindset that has seen the great deserts as places to be "reclaimed" and greened (Reisner, 1993; Fleck, 2016). As Fleck (2016) put it: "America plumbed the Colorado River to turn desert into farmland, both out of a philosophical desire to embody the Jeffersonian ideal of the yeoman farmer, and a practical need to feed itself" (pg. 112). This striving to green and make productive a decidedly harsh environment required the creation of institutions that promoted these efforts by making it as easy as possible for farmers to obtain water with the security that as long as they put it to beneficial use and continued to use it, it would be theirs. The state legislature has been in control of what is considered beneficial use, allowing the state legislature to dictate water uses, thereby giving increased power to those uses listed as beneficial, as they could secure earlier appropriation dates. In the study area agricultural rights date back to the 1880s, while the oldest environmental in-stream rights only go back to 1973, simply because they were not recognized as beneficial until then (Tasker & MacDonald, Interview 13; Lewin, Interview 15).

Indeed, a predominant mindset in Colorado has been as Greg Poschman (Interview 5) put it: "1890's philosophy is that if it's not being put to use, it's being wasted... In the river it's just 'wasted'". Only with the recognition of the value of water in the river in 1973 could environmentalists have any legal power. Hence, this imbalance in the priority system is not the fault of the agricultural community, but more is an outcome of 150 years of dominant western values. As Heather Lewin said, "…in the early indoctrinating pieces of water literature it says that any water that leaves the state is waste and so we are going to use every drop. To get environmental and recreational uses acknowledged as beneficial use is a big first step."

This control of the "narrative" or this power to define the value of water or the meaning of waste is the essence to answering Blaikie's (2001) question "Who holds the looking glass?" (pg. 136). The western ideals of greening for the sake of greening, and seeing water in its natural channel as wasted have been the dominant mindsets under which the laws and governing institutions have been created, going back to the start of western expansion after the Civil War. This has had, and continues to have, dire consequences for the riverine environment, as well as social

consequences, because those uses and corresponding values that require healthy rivers have been seen as wasteful and have had scant legal protection, and likewise, limited access to decision-making arenas.

Still today, western water law is acknowledged to be challenging for environmentalists and agriculturalists who want to conserve water. One such law is the Appurtenancy Doctrine, which stipulates that saved water cannot be applied to a new use such as in-stream flows by the rights holder while maintaining the priority date, and instead it becomes un-appropriated water, liable to be taken down the next headgate instead of increasing riverine health (Aiken, 1998). Lisa Tasker spoke to this challenge "It's really frustrating…there's an element of how do you shepherd the water? How do you keep it from not going down the next guy's headgate?" Other challenges include contending with narratives that limit dialogue like "use it or lose it," which is a notion that if you do not take your full diversion, your water right will be reduced. As described in Section 6.1, there is some clout to this notion in water court. However, in 2013, the Colorado State Senate passed SB 13-019, allowing irrigators in some parts of the state, including the study area, to reduce their diversions to ameliorate the effects of drought if they are enrolled in a water conservation program, without facing curtailments. However, this law has not prompted the water conservation that some had hoped for. Environmental proponents see this lack of receptivity as evidence that agriculturalists are worried that enrolling in such a program will reveal that they are using more water than they need, thus opening the door to reductions in their water rights (Tasker & MacDonald, Interview 13; Ransford, Interview 14).

This idea of wasting water was detailed in section 6.1, and can be understood in relation to Vatn's (2015) institutional framework in that establishing stable resource regimes requires that there are clearly defined property rights. Without clear property rights, potential common-pool resource regimes can devolve into open access, where stakeholders attempt to secure as much of the resource as they can, resulting in degradation of the resource state. Such has been the case in Colorado, where irrigators are unsure of the repercussions of limiting their diversions, thus driving them to divert as much as possible. Chelsea Congdon Brundige (Interview 7) explained:

> So there are a lot of opportunities for irrigators to line ditches, or have smarter headgates, or grade fields or manage irrigation timing to make the delivery and use of water more efficient. In districts on the West slope they can file a conservation plan that will protect their water rights when they make these changes, even when they leave more in the river. But I think that there's a lot of confusion, skepticism, fear. And often their water lawyers encourage irrigator to take their full diversion all the time, because you might lose it if you don't.

The origin and propagation of these contradictions is in the overall complexity of Colorado water law and a general skepticism from agriculturalists towards anyone who attempts to interfere with their operations, despite their intentions. As Blakeslee (Interview 9) described "They do operate as individuals because that's the western way, to be self-sufficient, self-sustaining. Saddle your own broncs, kill your own snakes. And that's the western way. That's what we were raised with." Portes and Landolt (1996) speak to this reluctance to integrate new knowledge as a risk that comes with social capital, where one group may dismiss new knowledge because it is presented as coming from an outsider, or another group. Further compounding this problem may

be reluctance from those who currently control the water to change their use, their values, and their culture when the current arrangement does not mandate such changes. When environmentalists and scientists hold meetings to attempt to inform agriculturalists about ways they can conserve water, the notion that the information is coming from outside the agricultural community may present significant blockage to its integration, while suggestions that involving changing how water is used may be seen as challenges to underlying values, culture, and power over the resource.

Dichotomies about the law and subsequent high diversions propel the water resource into a state of perceived scarcity, where near empty rivers are contrasted by marshy fields, some of which sport cattails and other wetland plants. As Ken Ransford (Interview 14) explained

> It's a precious resource and, like any precious resource, the lower the supply, the more valuable the resource is. So, if you can create this aura in people's minds, this belief that it's a limited resource and we are running out of it, it can't help but increase the value of it or the perceived value of it. Sometimes I think true value and perceived value are one and the same.

Vatn (2015) would agree, arguing that it is the perceived state of the resource that affects stakeholder's actions, as opposed to the actual state of the resource. Hence, whether agriculturalists realize it or not, their high diversions affect the general perception of the resource as scarce, increasing the value of land with water, which gives them more power as they control the resource. Such misrepresentations are responsible for pushing them out of the study area, and making way for wealthy speculators who buy agricultural land, divert their full allotment for hay, which can be argued to be the cheapest way to show beneficial use and maintain the water right, while waiting for water supplies to continue to drop, forcing land prices higher, so they can sell to real estate developers for a hefty profit (Ransford, Interview 14).

Scarcity in this instance is not solely a natural phenomenon dictated by a physical supply, but is more the result of deep-seated beliefs and values held by westerners about water and the benefits of irrigation, about what it means to be a steward of the resource, and misconceptions about the complex legal framework. This shows scarcity in similar lines of Aquilera-Klink, Pérez-Moriana and Sánchez-Garcia (2000), who proposed that water scarcity in the Canary Islands had to be understood in terms of the historic contextual social processes that dictated both the distribution and valuation of water. Here, these two components have been outlined to show that low water levels in rivers and reservoirs are not the result solely of low physical supply, but must be seen as a product of the western mindset that places a high value on greening the western landscape, and the laws and practices that have become acceptable because of that mindset. Further, scarcity is a powerful concept which can be harnessed to favor certain agendas, and repress others (Robbins, 2011). In this case, the concept of scarcity has increased both land and water prices, making farming almost uneconomical, while giving rise to land speculation and increased residential development, which holds the promise of changing the community and character of the West. In a certain sense, agricultural practices, which are dictated by Colorado water law, are responsible for creating the aura of scarcity in the West. However, agricultural communities are also facing the brunt of the effects of this scarcity, watching their communities and culture, transform into residential neighborhoods.

Although the law is adapting to provide economic strategies such as Alternative Transfer Mechanisms (ATM's) for farmers to lease their water to municipalities instead of selling their land, "buy and dry" is still the easiest method for municipalities and developers to secure both land and water (Castle et al. 2017) which under the threat of the Compact Call, municipalities, especially Front Range cities, are quickly doing (Kuhn, Presentation 4). Additionally, these new emerging economic strategies may fall into the same dilemma conservation programs face in reaching agriculturalists effectively. This difficulty in reaching agriculturalists has led toward developing cooperative agreements and acknowledging that new policies and reports are only effective if applied. This application requires building trusting relationships with the agricultural community. Heather Lewin argued, "I think the more that its approached as a collaborative solution, the more likely we are to see a solution. So it's more of a how do we work together… You can do studies until your bookcase is full, but unless you have the people, stakeholders, on board, those studies don't go anywhere." This strategy is the subject of the next section.

Applying this discussion of the legal framework to the research questions, it becomes obvious that the current legal framework is incapable of mitigating environmental problems associated with water use such as maintaining ecologically sustainable flows in the natural waterways. Although some legislation such as SB 13-019 attempts to provide a framework for conservation, barriers to incorporating these new mechanisms lie in the stalwart solidarity of social capital within agricultural communities that do not want to incorporate new knowledge or new practices because they may challenge underlying values and cultural norms. These barriers to change, based on long-standing cultural ties, are not easily overcome. Not only are agriculturalists reluctant to incorporating new knowledge, but the vast legal system, including the Water Bar, appears to support the current practice of diverting as much as possible, and legislation in 2015 extended beneficial use to ditches used as private trout streams. This seems to provide the perfect legal excuse to any irrigator who does not wish to reduce diversions because they can claim that reducing diversions would impact their ditches, or "trout streams" (Ransford, Interview 14).

Towards the second question, the basis of Colorado water law is priority administration, the essence of which is unequal access to water in times of shortage, based on seniority. Although some argue that seniority is the best delineator of who should receive water, it does not allow for changes in societal values or uses of water because new or emerging uses have no seniority and are thus the first to be curtailed in times of shortage. This effectively stagnates water use into remaining consistent with historic use patterns, despite the changes that may take place in society. An example is the majority of those at the Upper Roaring Fork River Management Plan meeting on November 13, 2017, listed Ecological Integrity as the most important use, while Colorado water law provides only scant protection to ecological flows in favor of agricultural consumptive use.

It is not the intention of this section to propose stripping agriculturalists of their ability to practice their lifestyle because the population is shifting away from that culture, but instead that the legal framework puts them in a position where their incentive is to use water in a way that results in poor ecological conditions in the river. Instead, protecting agriculture and riverine health may require redefining key tenets of Colorado water law such as beneficial use. Currently, beneficial use is defined as "a lawful appropriation that employs reasonably efficient practices to

put that water to use without waste" (Ferril, 2004, pg. 7). Redefining beneficial use, as Ken Ransford proposed, as a mandate for very efficient irrigation practices would require investment in upgraded technologies, moving away from historic flood irrigation and return flows. This shift would require public investment in irrigation upgrades, but as Ken Ransford argued, the alternatives may be more expensive.

> I think what you do is you basically tax the public to make fields efficient…. If the NRCS [Natural Resource Conservation System], which now pays for most sprinklers on the West, if they helped pay to convert everything to sprinklers, it would cost us $12 a year for 30 years. If we paid for all of it, it would cost us $23 a year for 30 years. If we wanted to pay farmers to leave the water in the river, it's going to cost $81 per person per year forever, going off into 300 years from now.

The magnitude of this proposed shift cannot be overstated. Return flows are protected under the priority system, and the conversion to efficient irrigation would decrease them by as much as 99% (Ransford, Interview 14). Although this water would be added to the river, thereby bolstering the watershed, return flows have been bringing water to areas that higher river flows would not influence. Additionally, making more water available to the rivers through efficiency upgrades raises a discussion around local control of the resource, as Bill Blakeslee pointed out:

> Well, if we keep more water in the river, you may get to use it for a short period of time here, but where does that water go? It goes to California, who has already used all of their share, and part of ours, for many years. Are we really compromising ourselves by giving it to the neighbor that wants more because they have become really greedy because of development?

Indeed, these changes would raise issues of water shepherding on a regional scale and would require reform not just in Colorado, but in all western states. That way water savings in Colorado wouldn't amount to added supply in California, but instead could allow the ecological integrity of the Colorado River and allow it to reach the Gulf of California. However, these changes, at their base, are realignments of values and corresponding property rights. As Vatn (2015) points out, the type of property right used for a resource has direct effects on the strategies and abilities of that resource to be governed effectively.

Compare the positive response to efficiency improvements of large users of municipal water to the negative response from the agricultural community. The discrepancy lies in the type of property right each attaches to water. Municipal users are not able to sell their share of water and they understand that they gain nothing from using exorbitant amounts of water except a larger water bill. Agriculturalists own a valuable water right that they can eventually sell for private gains and this stimulates a belief that recording higher diversions will, over time, show a water court that they need that much water to grow their crop, entitling them to that water and increasing the value of their water right (Ransford, Interview 14). Hence, municipal users function under a state property regime where no individual shares can be distinguished, and rules about use are developed and implemented by municipal representatives (Vatn, 2015). This is contrasted by agricultural use, which follows a private property regime, where each user has the ability to sell their share of the resource, stimulating competition and potential hoarding (ibid).

Municipal users have not been required to give up any part of their landscaping, only to use less water to achieve the same goal. This is the essence of realigning the property rights of agriculturalists. If they were entitled to the use, not the ownership, of the minimum amount of water required to grow their crop with efficient irrigation, then, like municipal users, they might welcome taxpayer support in increasing efficiencies. Currently, agriculturalists fear reduced diversion records will ultimately reduce their sellable water right, as it could show a water court that they are able to grow the same crop with less water (Ransford, Interview 14). If these realignments do not take place, it seems that the current legal framework does not honor the multiple values of water that support complex equity in access to water resources, nor does it provide equitable exposure to the associated environmental risks such as curtailments or access to decision-making arenas. Further, the distribution of water follows only one value system based on the doctrines of Colorado water law, failing, as Arnold (2017) stipulated, to include the multiple spheres of water in distribution, leading to poor distributive justice.

7.2 Cooperative Agreements

Cooperative agreements begin with a realization that relationships built on trust and reciprocity require less transaction costs than those built solely around formal legal institutions to accomplish goals (Adler & Kwon 2002; Vatn, 2012). In Colorado's water sphere, these relationships have become tantalizing due to the gridlock water law has created, coupled with an understanding that if nothing is done, administration of the law could cut some users out completely. Chelsea Congdon Brundige (Interview 7) expanded: "Collaboration and cooperation among water users is going to be a really important because having a water commissioner knock on your door and say turn your water down, or worse, ending up in water court, is the last thing you want."

Indeed, these relationships can go beyond simple administration of water by dealing with the deeper issues surrounding water. This is an important aspect, as Bill Blakeslee (Interview 9) said: "I don't think there is any way we can communicate about water on the long term without addressing the conflict. Because the water has always been a part of the conflict." This conflict is based on differing values of water, as Seth Mason (Interview 10) elaborated:

> Getting to a point where you can talk about values, you're really talking about value systems when you start any of these conversations about how water is used, what your using it for, how you could manage it differently. Those value systems are wrapped up in local economies, quality of life issues, etc. Navigating those conversations is really difficult and navigating them well is really critical to the success of any planning efforts.

It is in areas where there is high diversity of valuations of water that conflict seems most prevalent, and likewise, where the benefits of functioning cooperative agreements are highest. These watersheds are as Bill Blakeslee described, "There is a lot more conflict in Cattle Creek… you have a lot of different people from a lot of different walks of life… It's much more heavily administered because then the water commissioner becomes the referee." This heavy handed administration is both energy and time intensive, and Bill Blakeslee went on to postulate that if all watersheds required such administration in times of shortage, "…they would probably have to

hire a lot more people to do my job, because what we would have to do is start going out and shutting down junior water rights. It would create a lot of hate and discontentment."

Instead, the risk of such administration has led to the creation of a variety of types of cooperative agreements. In their most basic form, they exist between agriculturalists who share a ditch, where a senior user will allow junior users to irrigate out of priority while the senior rights holder dries their fields to put up their hay (Blakeslee, Interview 9). Although the relationship is solely between agricultural users, this type of relationship can make more water available to the river, benefiting downstream water users of all types.

Bill Blakeslee offered an example from the Crystal River where the town of Carbondale threatened to put a call on the river, ordering the administration of water law. Instead of simply fulfilling their request and shutting down junior upstream users, Bill Blakeslee hosted a meeting between upstream agricultural users and the town government, where agriculturalists explained that they had been coordinating to share the water resource, allowing more to flow down to the town, unbeknownst to them. As he concluded "they have helped each other through the summer, but they have also helped you." Such partnerships between agriculturalists can be seen in light of solidarity as described by Nelson (1989), who showed that groups that interacted frequently were able to deal with conflict quicker and had less lingering tension afterwards. However, the partnerships that include more diverse stakeholders, such as municipal and environmental interests, are not as easily formed, often include monetary exchange, and do not benefit from solidarity because these partnerships can be the first time stakeholders have really interacted.

Creating these relationships requires time and patience, and as Heather Lewin described, "And to tread lightly… over time building trust in that we aren't trying to blind side you, we aren't trying to steal any water rights, or take any." Building that trust is one of the risks Adler and Kwon (2002) describe of social capital, as it is an investment, the benefits of which may or may not outweigh the costs. This risk of losing an investment in a relationship is exemplified in relationships built around trust, as the "capital" does not reside with a party, but only between them (ibid). Hence, should one party walk away, the capital is lost for both parties, and thus, keeping agriculturalists invested in the relationship is key (ibid). Heather Lewin explained part of their motivation "if you hold a meeting and you say you're going to talk about water rights, and someone doesn't show up, they are probably going to talk about that person's water rights. It gets people into the room".

Still, Seth Mason didn't see the plausibility of creating these partnerships without some pre-existing internal motivation in the watershed.

> So there's a really important prerequisite for these types of planning efforts that look for collaborative opportunities to support non-consumptive uses, or meet non-consumptive uses. You need to have some sort of stakeholder group already kind of assembled and interested in the discussion… You are likely to be talking to people about different ways that they might use water, or ways they might alter their existing use, so you have to have them on board and open to conversation. I think you're going to have a much harder time to realize success if you use a top-down approach to do that.

The challenge of creating an interested stakeholder group is paramount in the study area because some watersheds have stakeholders who do not wish to participate in such conversations. Chelsea Congdon Brundige (Interview 7) explained that on the Crystal River, a newcomer who is more motivated by speculative investment in water and ranchland has made forming cooperative agreements much more challenging:

> I think you find in different watersheds tension between the people who are taking a speculative view and financial view about water and the people who have a lifestyle and cultural view about water. [Speculators] aren't going to come to a meeting where all of their neighbors are talking about how to do better by the river, because their lawyer told them not to.

This negative response from some, coupled with the hesitation from all agricultural users to talk about their water, can impede the strength of any agreements that are formed, as was the case with an agricultural efficiency program headed by the Pitkin Healthy Rivers and Streams Program. Lisa Tasker (Interview 13) explained:

> We wanted to start to engage with the irrigators up there and show that we can create a relationship, so we didn't want to put any kind of measureable outcomes. We had a lot of criticism that we didn't do that. The reason is that we were trying to just get in there and have conversations.

The trouble stems from the threat of irrigators walking away from the negotiating table, with the only traction to their staying coming from a somewhat obscure menace of the Colorado Compact and the growing cities on the Front Range of Colorado. Ken Ransford echoed this unreliability of cooperative agreements by explaining that irrigators measure their water rights as the amount they are diverting, and any agreement that attempts to limit their diversions will be seen as limiting their water rights, which will result in them walking away. This fear is one of the chief concerns of informal agreements, as Postel (1999) put it, "Unless the prevailing rules of water allocation in any society acknowledge the validity of informal customary water rights, these communal arrangements are at risk of losing their water to those with formal legal entitlements" (pg. 250). Thus, even with agriculturalists who are committed to improving riverine health, agreements focus on rescheduling their diversions instead of reducing them due to this fear of reducing their water rights (Ransford, Interview 14).

Still, on a regional scale, advocates of cooperative agreements see them not solely as specific problem solving agreements, but as the foundation for "…a resilient collaborative system that gives us the flexibility to adapt to an ever changing set of circumstances" (Fleck, Presentation 7). This flexibility is something that the legal framework does not provide (Blakeslee, Interview 9).

Whether agreements that protect both the riverine environment and diverse stakeholders can be fostered in conflict prone watersheds, and whether they can withstand low water years, remains to be seen. Although there is growing momentum to establish such agreements through both local initiatives and the Colorado Water Plan, success will come down to whether established perceptions of property rights can be shifted to promote sharing among diverse stakeholders and

the environment, and whether these agreements can deal with the problem of free riders, such as speculative interests who have no motivation to reduce their diversions.

Also key to success is establishing who can benefit monetarily from these agreements which, at its root, is the question. "Who has the right to water?" The agriculturalists, who should then be compensated for using less? Or, the environment, which would mean they should not be compensated for using less and instead should be paid to upgrade their irrigation technology?" The answer to this question rests on how water and the western landscape is valued by policy makers who may or may not be affected by broader societal values. If decisions are made valuing water solely for its ability to provide productivity for humans, and the western landscape is seen as a place to be "reclaimed" from desert to farmland, then it seems the rights will lie with irrigators who fulfill these missions. If, however, water is valued in its natural course, and the aridity of the West is respected, then the right may lie with the environment.

By and far cooperative agreements have allowed the right to reside with agriculturalists as the agreements do not have the power to keep them at the table if the agreements challenge the core assumptions around water use that are based on these competing value systems. This has the potential to set the precedent for years to come. Heather Lewin explained:

> It's like saying, you have all this water, I'm not sure your using it all, you should just give it away for free. They feel like somebody is taking something valuable without compensating them properly. I think that's where the payment piece comes in. Does it set a precedent? Maybe. But there's no obligation that you have to do it forever. But it might stop the gap until there's a better solution.

Some see cooperative agreements as the way forward, as Chelsea Congdon Brundige put it, "It's not the legal framework that is solving the problems... It's the things that you have identified: its neighbors, education, opportunity to get stakeholders together and talk about it." While on the other side, their robustness is highly questioned, as Lisa Tasker said, "I think when push comes to shove, those little lovely neighbor agreements are going to absolutely evaporate, so to speak."

Thus, in answering the research questions cooperative agreements, as they stand now, do not seem capable of handling environmental problems such as the drying up of Colorado's river systems, as they do not have any enforceable power. Mechanisms developed through these agreements to conserve water may fall victim to perceptions of the established legal framework that view these savings as new un-appropriated water to be put to some other beneficial use outside the natural river course.

Secondly, cooperative agreements hold the possibility of fostering greater complex equitability in both access to water and to associated environmental risks. However, promoting this equity requires bringing all stakeholders to the table with an equal voice. Creating this dynamic would entail both enticing speculative interests, which currently have no incentive to join, while also giving diverse voices equal opportunity to voice their opinions. Mechanisms such as ordinances that protect farm land from development, or redefining beneficial use to hamper speculation, could help bring speculators to the table. However, there are currently few incentives. Currently,

it appears that challenging agricultural interests results in being shut out of the conversation, thus diverse values do not have an equal say in these agreements.

The equitability of cooperative agreements also rests on the issue of who has the right to the water; The agriculturalists because they have been using it the longest, or the river, because initially, that's all there was? This reflects on how compensation should be handled. The issue is extremely incendiary, and agriculturalists, backed by the prior appropriations system, have far less incentive to discuss this issue as opposed to environmental advocates who are faced with either letting the right lie with agriculturists, and paying them to put the water back in the river, or risk getting shut out of the conversation (Ransford, Interview 14; Lewin, Interview 15). With this imbalance outstanding, cooperative agreements become more favorable towards those with greater seniority. They do not tackle the deeper values and rights issues, and thus do not achieve complex equity.

7.3 Political Scarcity and Soft Path Solutions

Looking at scarcity, or water shortages, as a human-defined phenomenon instead of as a natural condition, is at the basis of how this study approached the City of Aspen's proposal to build additional water storage. With this as the point of investigation, this section strives to answer these research questions: (3) How has the City of Aspen approached its water situation? What strategies has it used to balance supply and demand of municipal water? Do these strategies provide complex equity for the diverse uses and values of water that community members hold, while providing for the environment?

When, in 1965, the City Council voted in favor of applying for conditional water rights for two dams, one in Castle Creek and one in Maroon Creek, it created the possibility for future utility mangers to capitalize on water rights that grew more and more valuable the farther the 1965 priority date slipped into history. When, in 2016, the Council, as it had been doing every five years, submitted its due-diligence application, claiming that it was moving forward on developing these rights, it was faced with opposition. As Will Roush (Interview 12) explained, "Despite the fact that it's unlikely those dams would be built, this is a great time to try to remove that threat, when there isn't an active development proposal. If you could do that on all environmental issues, it would be a lot easier." However, these rights were by now valued highly by the City for a variety of reasons. First, because of its priority date. Second, because it had been investing resources in them by submitting due diligence applications every five years since 1965. Third, because having water storage would increase the security of the municipal water supply.

This third point was stipulated in the 2017 Headwater Study, which used probability analytical models which overlaid population growth and severe climate change scenarios, and predicted that there was a probability that the current municipal system would be insufficient (Headwaters Corp., 2017). However, these probabilities were based on data that had previously shown, in a study conducted by The Wilson Water Group (WWG) in 2016, that if the City continued to enhance its water conservation program and supplemented its supply with the addition of a few shallow tributary wells and one deep groundwater well, it could meet municipal demands no matter the possible future environmental conditions (Wilson Water Group, 2016). Both the firms

that conducted these studies are highly respected in the field, and water experts in the state have admitted that both the techniques used are sound (Gardener-Smith, Presentation 5). However, in the Headwater study, they argue that their use of probability analytics gives greater depth than the model building used by WWG (Headwaters Corp., 2017).

> Although more complicated than simply asserting whether supplies are adequate or not over a limited range of assumptions, expressing results in terms of probabilities is a realistic format more useful for decision-making. It focuses discussion to where it belongs: the impacts of inherent risks and uncertainties, and the willingness of decision-makers to accept these risks or take measures to hedge against them (Headwaters Corp., 2017, pg. 27).

The Headwater Study asserts that risk of a water shortage is "inherent" in the current system and as they argue, acceptance of this inherent risk should position the conversation around how to best mitigate it, such as by adding significant storage capacity (ibid). The representation of a water shortage as an inherent risk follows their findings that "…the uncertainties of climate change was the major driver behind uncertainties in the number of possible shortages, much more so than demand uncertainties" (pg. 27). This study aligned perfectly with the City's political agenda to protect and capitalize on the historic conditional storage rights from 1965, whereas the conclusion reached in the WWG (2016) study "…indicate the City can always provide sufficient potable and raw water supplies under these modeled demand and hydrology scenarios. Existing water supply infrastructure and water rights portfolio…do not appear to be limiting factors in this evaluation" (pg. 22). The City's choice to accept the definition that promoted their political agenda shows how seemingly natural phenomenon, such as water shortages are actually defined by, and can be harnessed to favor, certain political agendas, with both cultural and ecological ramifications. As Lankford (2013) points out

> … it is easier to blame a natural shortage of water than to accept the full liabilities related to the sharing of limited amounts… 'lack of water' allows for policies that are not so much related to how water can be managed and shared but more to concerns about how to fix or solve the lack of supply (pg. 195).

This process of describing the risk of a water shortage as a seemingly natural phenomenon that aligns with a political agenda, facilitating public support for projects that may otherwise have been negative, relates to Kaika's (2003) investigation of Athens' water shortage. There, water scarcity was portrayed as a natural condition and solutions that previously would have been socially contentious reoriented the water market to be more lucrative for its operators and favor large users.

The City of Aspen supported science that showed it faced a water shortage that could not be mitigated by curbing demand, and instead promoted the development of its valuable conditional water rights. It is not the intention of this section to challenge the legitimacy of the scientific method employed, but to highlight how one study's findings aligned with the City's water storage rights and were then adopted by the City as foundational facts that served as the basis for the rest of the conversation, while scientific findings that did not support storage were not highlighted by the City.

The City's challenge then became convincing the community to accept both the science and the development of its water storage in culturally and ecologically significant valleys. In this, the City was unsuccessful. Between a litany of negative press and equally negative public sentiment, plus ten opposing parties, including Pitkin County, with which the City has historically worked very closely, entering the legal fray with letters of opposition, the City found itself pitted against the public, respected governmental organizations, and environmental groups. Its tactic then was not to admit the incentive they had in accepting the Headwater Study over the WWG study, but instead to open the debate with the ten opposing parties and the public under the narrative developed in the Headwater Study, that as a community, it faced the risk of a water shortage that required additional supply infrastructure.

Instead of starting with a much more fundamental discussion about how water is valued as a community, and building from there to the type of uses and water supply strategies that should be prioritized, the City's starting point aligned with the Headwater Study by focusing on supplementing the current supply for the uses that exist today, as the models used by the Headwater Study did not incorporate the possibility of additional water conservation, nor the possibility of using groundwater to supplement, as the WWG study had (Headwaters Corp, 2017; Wilson Water Group, 2016). It also promoted the adoption of solutions that would allow the City to develop its storage right by simply moving it to a less contentious location.

The City had discovered, through the negative response to its storage rights in Castle and Maroon Creeks, that the community values those valleys in their current state more than they value the perceived added security of water storage. The City then began a search for a less-valued location, as Margaret Medellin (Interview 8) explained

> …the unfortunate thing is that they were located one in Maroon, one in Castle. Not only are they not supported places because the areas they are, geology wise it's not great either. But if it came to it, we would definitely build the reservoirs there, but part of what Counsel told us to do was to go out and find another area. And so we think we have found one that would be less damaging.

The area that has been identified is the Elam gravel pit in Woody Creek, eight miles down valley from Aspen. Although less culturally contentious, and less ecologically impactful, the proposal to use the gravel pit has further pushed the discussion away from articulating basic community values of water and whether the storage is needed at all to weighing the plusses and the negatives of different locations. As Margaret Medellin continued, "It's already dug out, when they are done mining, they need something to mitigate that. It feels like a place to store water and not degrade a natural area. It's downstream from Aspen, so you would have to pump it back up." The City is looking for ways to minimize pumping, including using tributary groundwater wells to boost the municipal supply and only relying on the dam to provide augmentation flows for the reductions these wells create (Medellin, Interview 8).

Aquildera-Klink, Pérez-Moriana and Sánchez-García (2000) showed from the Canary Islands that water scarcity is not best understood as a physical limitation of water, nor a natural environmental condition, but instead needs to be seen in light of the historic development of

values and distribution regimes concerning water. Here, the water right was initially approved during the dam building era in the American West when it was less contentious (Roush, Interview 12). Also, water has been made available for landscaping projects since the initial construction of Aspen's water infrastructure in the 1880s. Starting with miner's gardens, it has expanded under the guise of fire mitigation. Similarly, the municipal golf course has always received water since its completion in 1980, and its location at the entrance to Aspen conforms, similar to lawns, as a ubiquitous status symbol in the West (Hiskes, 2010; Robbins, Polderman, & Birkenholtz 2001). Indeed, the City has made the choice to continue with present water use instead of confronting the cultural necessity of both Kentucky bluegrass landscaping and the golf course under dire climate change scenarios.

This choice ignores the soft path, which Brandes and Brooks (2005) describe as looking beyond water as the end goal and instead seeing it for the services it provides, then asking in what other ways those services can be fulfilled using less, or no, water. This thinking can extend from water to landscaping and the golf course, asking what services does Kentucky bluegrass provide and what other landscaping options could provide that same service, while using less water or no water? Likewise, there may be ways to reduce the amount of grass and waterscape at the golf course while still giving people the possibility of golfing. Soft path thinking attempts to alleviate resource shortages on a broader time scale by changing the way people both value and use water, while the course the City has taken in propping up supply can be seen as operating on the shortest time scale because it requires constant additions to keep up with demand (ibid).

It is necessary to acknowledge that influencing value systems does not always lead to solutions that are equitable, but instead can allow the promotion of dominant cultural trends (Tyler 2007). To mitigate this risk, Brooks and Holtz (2009) argue that public participation is critical to the success of any soft path solution. The debate over water storage could have provided the perfect issue for a public forum around water values and uses, as it was widely contentious, and a large portion of the community was interested. As Margaret Medellin put it, "I think there are differences in how tied people are to the land, at least the people who live here are really engaged. If we have a public meeting people come, they want to be a part of the process." This public engagement could have facilitated the creation of solutions that were lasting, impactful, and supported by the community, had the conversation included soft path thinking.

It is true that the City has begun a dryland landscaping pilot project, which has, in its infancy, shown promise. However, where soft path thinking begins with the question "why?" as in why do we need to use water to achieve this service at all? The City's dryland landscaping project focuses on demand management, which centers on the question "how?" as in how can we deliver this service using less water (Brooks & Holtz 2009). Focusing on "how" instead of "why" limits the depth of the conversation from including values and likewise reduces the range of solutions that can be proposed, just as the City's focus on "where" to build storage instead of "why" limited the discussion concerning water storage (ibid).

These points of departure have the potential to set precedents for future water shortages where, instead of taking a hard look at water use, the City may again look for ways to increase the municipal supply and the community may see supply management as the only reasonable solution, having experienced that type of water planning in the past (Aquildera-Klink, Pérez-

Moriana & Sánchez-García, 2000). When asked whether these proposed dams were permanent solutions to Aspen's "water problem," Margaret Medellin turned the conversation towards the limits of conservation efforts.

> Storage is only a part of it. Another we talk about with conservation is that it doesn't help you if you don't have storage, you don't have anywhere to save the water you conserve. The endangered reach of the Roaring Fork that goes through town, conservation doesn't help that at all. It actually hurts it. If people put less water on their landscape, you will see a reduction in the return flows.

This argument supporting return flows is consistent with what Ken Ransford postulated, in that return flows stop any meaningful discussion of water reform. This use of return flows in rationalizing the City's storage, coupled with the lack of value of water left in the natural hydrological system, is consistent with the thinking of most water users. It is also consistent with historic western philosophies that have defined "waste" as water that is left in the river.

Without a departure from these dominant ways of thinking, Aspen's water situation, and that of all municipalities in the West that subscribe to this narrative, will constantly be in need of additional supplies while valuable community assets such as Castle and Maroon Creeks may be seen as the price to be paid, without really delving into why that price has to be paid. As Kelso, Martin and Mack (1973) concluded in Arizona, "…amelioration is a matter of reforming man-made institutional inefficiencies in water administration and management than reforming its nature-made physical scarcities. ... The problem and its solution are far more man-made problems… than they are nature-made problems of scant and declining supplies" (pg. 1).

As this study has shown, the City of Aspen has attempted to protect its water rights through the development of two culturally contentious dams, backed by one scientific method, but not another. When opposition became very strong, the City switched locations, without acknowledging a deeper discussion of water use. Favoring increasing supply is not unique to the City of Aspen, as Perry and Praskievicz (2017) argue that across the entire American West severe climate change models and growing demand are pushing policy makers to advocate for additional supply infrastructure, ignoring demand management, although the best sites for supply infrastructure have already been developed, and new areas carry heavier environmental and cultural prices.

The City followed this dominant paradigm instead of focusing on soft path solutions. By adopting science that presented water shortages as inherent risk, with the only means for mitigation being supply oriented, the City promoted the addition of water infrastructure with the related environmental impacts instead of facilitating public engagement that could have allowed all municipal users to have a voice in both how water is valued and how it is obtained and used. This reluctance to invite that deeper debate compromises the decision-making power of municipal users, the equity of the process, and thus, the equity of the solutions that are developed.

Adherence to the current governing institutions and historical valuations of water by any water user not only compromises the ecological integrity of the riverine environment, but also does not

promote equity in the process of reforming the rules of governance. Nor does it promote equity in the distribution of water resources and corresponding environmental risks.

This study seeks to make clear that change is needed in the legal arena of water, as no other institutions seem capable of breaking away from the legal framework. This change will have to be predicated on changing cultural values of water and cultural perceptions of the West. Likewise, public participation in the water sphere would greatly aid this process, as the diversifying population needs to have a say in how water is valued and should be included in deciding if the ecological and cultural price of adding water infrastructure is an appropriate direction given the natural aridity of the West.

Chapter 8

CONCLUSION

This study, based on empirical evidence collected through semi-structured interviews with diverse stakeholders in the Roaring Fork River watershed, has investigated the competency of the current institutional arrangements for governing water. This investigation is based on the political ecology foundation that natural resource governance is not neutral, and decisions that change access and control of resources generate winners and losers within society and within the natural environment. The chief current institutional framework is the legal system, although some water users are using cooperative agreements in an attempt to help both each other and the riverine environment, while avoiding legal curtailments.

The legal system has been developed over 150 years, starting with proclamations in the Colorado State Constitution and further refined through a litany of court rulings. The current legal system rests on four pillars: (1) public ownership of the water resource; (2) anti-speculation; (3) beneficial use; (4) priority administration. This study has found that these pillars do not promote a fair distribution of the resource, nor do they provide necessary protection for the environment. First, although the resource is said to be owned by the public, holders of a water right have the ability to sell that right for private gain, thus, the resource functions as a private property, which has influenced holders of water rights to protect their "investment" in that right by diverting the full amount they are entitled to. This has also created the potential for speculation, both in water and in land, by allowing individuals to purchase land with valuable agricultural water rights, grow hay as a cheap way to show beneficial use, while waiting for both land and water prices to increase so they can sell for a profit (Ransford, Interview 14; Brundige, Interview 7; Blakeslee, Interview 9). The pillar of beneficial use has also favored historic uses by limiting the priority date of environmental flows because they were only acknowledged as beneficial in 1973, while agricultural uses have been considered beneficial since the inception of water law in Colorado. Finally, priority administration places the risk of not having access to water with junior users, which, through a late development of legal rights, tend to be environmental flows. This unequal distribution of risk also hampers any possibility of significant water reform, as senior water rights holders, the majority of whom are agriculturalists, have less incentive to adopt comprises than do other stakeholders at the table.

Water reform has also been hampered by misunderstandings about the law on the part of irrigators who have operated with *de facto* rights for generations, meaning there may be significant variation between the actual law and common practices (Vatn, 2015, pg. 186). With the growing diversity of water uses and values, the idea that there is discrepancy between what is legal and what agriculturalists are doing is becoming a more heated topic (Ransford, Interview 14; Tasker & MacDonald, Interview 13). When water use was more singularly based in the agricultural sector, these *de facto* habits were not contested, and ranchers coordinated amongst themselves (Blakeslee, Interview 9). However, attempts to realign agricultural use with the *de jure* law would require heavy-handed administration, which water commissioners and the state engineer propose would cause widespread indignation among irrigators (Tasker & MacDonald, Blakeslee).

This indignation, Ransford (interview 14) asserts, is due to the challenge such administration would invoke around the agricultural community's value of water, water rights, and their role in the water sphere. Such administration, or any attempt to change the current system, Ransford iterated, would be felt by agriculturalists akin to how Southerners felt about abolishing slavery. The agricultural right to water is a symbol of prosperity, a symbol that has been imbedded in Western expansion since the beginning, when immigrants and settlers looked at the uninfluenced western landscape as something worthless, while they held the image of green fields of home to mean prosperity (Riesner, 2007). Water has always been seen as the key to achieving such prosperity, and thus, any challenge to agricultural water is a challenge to the image of prosperity in the West. Looking at the situation through the lens of political ecology, it becomes evident that the system has been developed to promote this value of water and this view of the western landscape. Conflicting values, such as the value of the natural environment, are much harder to manifest due to the system favoring this traditionally entrenched value set.

Likewise, navigating discussions of water reform necessitate working with the agricultural community, as they hold the senior water rights and also have substantial influence at the state legislature (Ransford, Interview 14). Challenging the values held by agriculturalists puts one in the position of being an "outsider" as Portes and Landolt (1996) explained, restricting access to decision-making arenas, and dissuading other stakeholders from inclusion, because they also risk being excluded should they associate with an outsider (Ransford, Interview 14).

Those who attempt to work within the system have to begin by declaring that they are not challenging agricultural water use and the values and image of the West that such use supports (Tasker & MacDonald, Interview 13; Lewin, Interview 15). These workings can take shape in the form of cooperative agreements, which attempt to bring diverse stakeholders together to build relationships based on trust and the commonality of wanting to improve riverine health, while not impacting the current arrangement of water rights that benefit agriculturalists. While these agreements benefit from increased efficiency by using trust and reciprocity derived from social capital, there is no concrete element that holds all stakeholders to any agreement, nor is there any mandate that stakeholders come to the negotiating table at all. Indeed, these agreements face a dual challenge. They first must break down the social capital formed from the common beliefs and values held by each group of water users (agriculturalists, municipalities and environmentalists) while also attempting to build social capital between user groups by inspiring the idea that they can benefit from information, resources and mutually beneficial changes in practice that such agreements can generate. These two processes are those outlined by Adler and Kwon (2002) as the two sources of social capital. Within the study area, there are conflicting viewpoints as to whether water users can be persuaded to leave behind their entrenched beliefs and values to come to the table with the inclination to compromise. Likewise, because cooperative agreements are not backed by legal mandates, it is unclear if, in times of shortage, they will persevere.

This dichotomy can be seen in light of Vatn's (2015) resource regime, where third party enforcement of rules of access and interaction are critical. Cooperative agreements face the challenge of conflicting third parties. There is the legal administration, which these agreements try to work around, and there is customary law based on social capital, generated through the idea that collaboration will have more information, resource and coordination benefits than not

collaborating. However, as Postel (1999) iterated, this emerging customary law can only succeed if it is acknowledged and respected by the prevailing legal system.

Due to the overriding legal structure, it is difficult for any cooperative agreement to promote the actual conservation of water, as water users fear legal curtailments from reduced diversions, regardless of the emerging norms based on social capital that promote such conservation. Indeed, because water rights are sellable, those who own them face the challenge of protecting their investment by diverting their full allotment without factoring in the impacts on the riparian environment. These agreements also suffer from the seniority system, which protects senior users from the risks of curtailment, while also giving them the power to control the conversation, as they have the legal right to the water, and hence, the power to walk away from collaboration. Thus, cooperative agreements do not necessarily push the governance of water into a more equitable realm, nor do they center the risk of losing access to water among stakeholders.

Municipalities are not free from the constraints of water either, and the City of Aspen has been the focal point for understanding strategies and challenges a municipality may employ and face concerning water. The City became the primary municipal focus when its conditional water rights in Castle and Maroon Creeks became contested, both legally, and, culturally within the local community. These rights were approved during an era more favorable towards dams, and their conditional nature presented their actual development as only a remote possibility. However, with contestation it became clear that the City intended to build dams for storage, having adopted science that presented its water situation as an inherent shortage that mandated increasing storage capacity, while an equally robust scientific study asserted that storage was not necessary.

Community approval of the dams has been very low, prompting the City to switch locations to an already impacted gravel pit. However, this was done without acknowledging a deeper discussion concerning how water is currently used in Aspen, specifically for outdoor purposes, and whether that use aligns with community values. As Arnold (2017) asserted, governing water with only one specific set of uses in mind, without taking into account the broader picture, invariably leads to the exclusion of other uses and corresponding values. This lack of recognition relates to Arnold's (2017) idea of complex equity, which requires formal recognition and inclusion of water's many different values in decision-making processes. Likewise, for fair decisions to be made, Arnold (2017) stipulates that the public needs to be included so that all voices may be heard, thereby centering the responsibility of governing water with those affected and the broader community. These aspects have not been at the center of the City's process concerning water storage.

Also, the idea of variance in use and supporting value systems is the basis for soft path thinking, which strives to change how people value a resource such as water, from viewing it as an end in itself to looking at the services it provides, then working towards finding ways that those services can be facilitated using less or no water. The City's dryland landscaping program is a move in this direction, but does not go far enough. Instead of asking "why are we using water to provide this service?" or "why do we need this service?" it only asks "how can we use less water to provide this service?" Whether this program can reduce outdoor use enough to make the construction of a dam irrelevant is yet to be seen, but the underlying strategy employed by the

City does not approach the situation from the soft path, and instead of calling into question the deeper motives for water use, it has focused on how it can increase the supply to support current uses. This lack of insight may set precedents for future water challenges, with the environmental and cultural price associated with supply oriented solutions.

8.1 Final Words

There is a smell in the bottom of desert canyons, and when your nose brushes up against it, your eyes pop open and you become more alert. It's the smell of water, and you don't realize how foreign that element is in the prevailing landscape until you smell it. Its earthy, ripe, almost like decay in some places. It is the smell of life. You don't see the green irrigated fields of hay, the lawns or the golf courses. Only the sudden and complete switch between a very dry expanse, and a thin, almost imaginary line of water, winding down the bottom of a gorge. Listening to a drip, a soft gurgle, hushed in the evening air, a respect, almost divine, can develop for water. The current institutional framework does not operate with that respect as its base. Instead, water is valued in its usefulness, in its ability to promote human achievement, human productivity. Even environmental flows are supported more and more with economic studies that show the high human value of recreational water.

There were Native Americans who, as early as A.D. 600, used these river systems of the Southwest for agriculture, whose diversion ditches can still be seen in Southern Colorado, Utah and Arizona (Diamond 1999). They too dealt with problems associated with water such as drought and the buildup of salt in the soil. They were, in the long term, unable to overcome these problems because their solutions, although brilliant, focused on the short term (ibid). Our modern solutions to these age-old problems likewise focus on the short term, perhaps striking a Faustian bargain with nature, as Postel (1999) proposes.

> In the classic German legend, Faust makes a pact with the devil, surrendering his soul in exchange for 24 years of occult power on Earth. Near the end of the term, the devil comes to claim his soul. Faust could have saved himself by acknowledging and repenting his excesses, but he does not, and the devil drags him into the underworld. Our modern society may have inadvertently struck a Faustian bargain as well, in our case with nature. In return for transforming deserts into fertile fields and redirecting rivers to suit human needs, nature is exacting a price in myriad forms (pg. 91).

Whether we can "repent" our excesses regarding water use will come down to where we begin the conversation. If we begin by taking for granted the dominant uses of water, and only discuss different strategies to achieve those uses, we will not realign the grounding values we predicate water use on, thereby condemning ourselves to short term solutions that protect senior rights holders and place risk on the environment and junior users.

Instead, the conversation needs to start by realigning societal values of water in the West with the reality of how water exists here: in thin ribbons, snaking down precipitous gorges, filling the air with the aroma of life.

The author taking in the aroma of life in a canyon within the study area

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APPENDICES

Appendix A: Interview list

Interviews

No.	Stakeholder	Date
1	Ken Ransford - Attorney; Colorado River Basin Round Table Reporter	1/11/17
2	Steve Wickes – Mediator for the City of Aspen	7/5/17
3	Michael Thompson – Architect; local food activist	9/18/17
4	Mark Fuller – Ruedi Water and Power Executive Director	9/22/17
5	Greg Poschman – Pitkin County Commissioner	9/22/17
6	Steve Childs – Pitkin County Commissioner; local rancher	10/2/17
7	Chelsea Congdon Brundige – Water Strategist, Public Counsel of the Rockies	11/4/17
8	Margaret Medellin – City of Aspen Utility Manager	11/30/17
9	Bill Blakeslee – Water Commissioner	12/1/17
10	Seth Mason – Principle Hydrologist with Lotic Hydrological, LLC	12/1/17
11	Ryland French – City of Aspen Department of Sustainability	12/4/17
12	Will Roush – Wilderness Workshop Director of Conservation	12/18/17
13	Lisa Tasker – Pitkin County Healthy Rivers and Streams Board of Directors Lisa MacDonald – Pitkin County Healthy Rivers and Streams Paralegal Staff	2/12/18
14	Ken Ransford – Attorney; Colorado River Basin Round Table Reporter	2/13/18
15	Heather Lewin – Roaring Fork Conservancy Watershed Action Coordinator	2/13/18

Meetings and Tours

No.	Description	Date
1	Aspen Business Luncheon on water issues	9/14/17
2	Aspen Waste Water Plant tour	9/19/17
3	Carbondale Ditch tour	9/19/17
4	Upper Roaring Fork River management plan meeting	11/13/17

Presentations

No.	Stakeholder	Title of Presentation	Date Published
1	Retired CO Supreme Court Justice Gregory Hobbs	Use it or Lose it – Separating Truth, Myth and Reality with Justice Gregory Hobbs	10/3/16
2	Bill Trampe – Rancher Don Schwindt – Rancher	Return Flows - Irrigation efficiency goes up, they go down	9/19/17

	Dave Kanzer – Colorado River Board Deputy Chief Engineer		
3	Paul Bruchez – Rancher Mely Whiting – Trout Unlimited Lurline Curran – Former Grand County Manager	Fixing the Upper Colorado River	9/19/17
4	Eric Kuhn - Colorado River Board General Manager	The 1922 Compact's 2nd 100 years – an Upper Basin Perspective	9/19/17
5	Sarah Tory and Brent Gardener-Smith – Aspen Journalism Radio Interview	Valley Roundup with Aspen Public Radio	1/5/18
6	Dick Wolfe – State Engineer Erin Light – Division Engineer	"Use it or Lose It" Perceptions and Reality	11/14/16
7	John Fleck – Author – Water is for Fighting Over Amy McCoy – Director of AMP Insights, a water consulting firm	We Are Rivers Podcast: Law of the River	8/2/17

Appendix B: Interview Guide

Introduction Questions:

- I would like to open by allowing you to briefly describe your background in the Roaring Fork Valley, why you're doing what you're doing etc.
- What's your educational background?
- How long have you lived in the area? Why did you move here?
- Why do you do what you do? What motivates you, what compels you?
- Do you have a personal connection to water? What is it?
- In your position, what is your connection to water? What are the issues that you are most focused on?

General Questions:

- Do you see increasing challenges concerning water in the area? What do you think the water challenges facing the area will look like in 20 years?
- What do you see as the role of the public, policy makers, business owners, farmers in the water arena?
- Role of education? What do you think an informed member of the public should know?
- Is the Roaring Fork River watershed more susceptible to water shortages today than in the past? Why?

- Do you see conflict between water users?

- Are there areas of high and low conflict in the watershed? What do you believe creates or antagonizes conflict in the watershed?
- How do you shift the mentality from "greed" to "need" in water users?
- Do you see clear information as actively changing how decisions are being made about water?

Position Specific Questions:

- As a newly elected Pitkin county commissioner, have there been any surprises about how the water system works in our area that you didn't recognize before taking the position?
- How did you come to be a water commissioner, what was the learning curve for the job?
- What do you see as the role of the water commissioner?
- Compare cities that you have worked for before with Aspen's water management.
- Avenues that you use to advocate for protection of natural lands and water?
- Can you outline how the Wilderness Workshop has come at the issue? What has been the course of action? Legal action, then talking?

Law and Policy Questions:

- Beneficial use – how do you interpret it?
- Water user education - Use it or lose it – how do water users interpret water law, how does this affect their usage, and your role?
- How does CO water law/ third party enforcement (water commissioner) affect the situation? As opposed to self-governance, such as is mostly the case in Capitol Creek?
- How do you navigate the complexities of water law in your position? How important is having an understanding of water law to your position? How do you cultivate that understanding?
- Was Colorado water law set up with the intention of including ecologically viable river systems under beneficial use?

    - How does that history affect how you operate? How does coming late into the prior appropriation system affect you? Does it feel like an uphill battle?

Stakeholder interaction Questions:

- Agriculturalists have the oldest and biggest water rights. Yet they are a tiny percentage of the population. Does their seniority translate to power? Do initiatives like Healthy Streams and Rivers show that the broader citizenry is gaining power?
- Recreationalists and environmentalists seem to have the least legal power – most junior water rights, ill enforced in-stream flows. What techniques do they use to influence water decisions due to their position?
- Do agriculturalists have a growing responsibility to share water more equitably?

- Biggest barriers to cooperation? Why is water so political?

- Free riders: Why don't they want to come to the table? What is the effect on the community?
- Is accurate information aiding in cooperation between water users? Maybe looking at the Crystal for example.
- You've worked a lot with water users in the Roaring Fork Valley. I'm curious what you see as drivers of conflict between water users, and conversely, drivers of cooperation.

Municipal Questions:

- What is the City's approach to municipal water? How does the city balance water and development projects? How does the current dam debate fit into this?
- Are these new dams a solution, or a Band-Aid for a bigger issue of how we treat water as a culture?
- Does the public hold misconceptions about water and what the city is trying to do? What are they?
- Have you seen a change or evolution in how water managers are thinking and/or operating since you've been involved in water here? What do you see as the most important happenings in water currently taking place?
- What does resilience mean in regards to Aspen's water situation?
- Does aspen have a water problem? What does that mean?
- I take it increasing demand means development. How is water approved for development? Who gets to OK it?
- If the public has to accept infrastructure such as reservoirs, and pay for them, should the public have a say in how water demand is dealt with?
- How does the city view and value water as a resource? Do you think that aligns with the physical realities of the resource?
- Aspen is at the headwaters, it appears to be water rich. How do you convince the public that we have a water problem?

Concluding Questions:

- What do you see as the optimal future in managing water resources in the West? What needs to happen to get there?
- If there was one aspect of water in the West that you could teach the public, or that you believe the general public should know but doesn't, what would it be?
- What do you see as the biggest challenges surrounding water that our community faces presently? What about 20 years from now?
- What do you see as the role of the public, policy makers, business owners, farmers in the water arena?
- What do you think an informed member of the public should know about water?
- Is there anything we haven't talked about that you want to add?