

TRANSBOUNDARY WATER JUSTICE IN THE COLORADO RIVER

A Thesis

by

UYEN H TRUONG

Submitted to the Office of Graduate and Professional Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MATER OF SCIENCE

Chair of Committee,	Wendy Jepson
Committee Members,	Gabriel Eckstein
	Kent Portney
Head of Department,	Ronald Kaiser

December 2019

Major Subject: Water Management and Hydrological Sciences

Copyright 2019 Uyen H Truong

ABSTRACT

Justice theories and perspectives are seldom included in transboundary water governance research. This research analyzes stakeholders' justice perspective and goals of in the Colorado River Basin over salinity governance using the Transboundary Water Justice Framework. The framework elevates narratives of justice in broader transboundary discussion by addressing unfair international transboundary negotiations and governance arrangements and focusing on the perspective of actors and their capacity to shape the processes that lead to the transboundary arrangement.

The Colorado River Basin has naturally high levels of salt in its water which is further enhanced by agricultural return flows and energy development. High levels of salinity impact agricultural lands, damages water supplies, and causes millions in economic damages; it is a major concern at the international, national and local scales. Salinity governance is the process of removing, regulating, and managing salinity in a river basin.

The Transboundary Water Justice Framework is applied on the Colorado River Basin and includes the U.S.-Mexican border and U.S. state borders. I systematically review news sources from Lexis Nexis, and state and federal legal cases and regulations from Westlaw. A keyword catalogue was created with relevant justifications using the Transboundary Water Justice framework and then coded into the MAXQDA program. A content analysis was performed on an international, national and local scale, investigating stakeholder claims and statements through news sources, legal cases, testimonies, regulations and policy.

Results indicate the U.S. federal government negotiated technical and infrastructural solutions to resolve the international salinity crisis to avoid basin politics over water allocation rights. These conditions and demands ultimately shaped the basis of the

negotiation and the efficacy of salinity control and management on a national level and at the local level. It is not an example of good transboundary water governance since there is an effective basin hegemon and evidence of procedural injustice through the lack of distribution in benefits, inclusion of stakeholders, and the antiquated tenets of the “Law of the River”. There can be instances of transboundary injustice within a basin hegemon’s sub basin which may impact into broader transboundary issues.

DEDICATION

To my cancer sun, rising and moon for almost standing in the way of my own success. We
made it through.

I also dedicate this research to all transboundary water researchers and their perseverance to
finding the most helpful answers.

ACKNOWLEDGEMENTS

I would like to thank my committee chair, Dr. Wendy Jepson, and my committee members, Dr. Kent Portney and Professor Gabriel Eckstein, for their guidance and support throughout course of this research.

I would like also like to thank my friends and colleagues for their encouragement during this endeavor.

Finally, I extend my gratitude to my parents and sisters, Aivy, Thuy, Victoria, Hien, and Maryann, and lastly to Michael and Momo. Thank you all for always believing in me.

CONTRIBUTORS AND FUNDING SOURCES

Contributors

This work was supervised by a thesis committee consisting of Professor Wendy Jepson and Professor Gabriel Eckstein of the Department of Water Management and Hydrological Sciences and Professor Kent Portney of the Department of Political Science.

All work conducted for the thesis was completed by the student independently.

Funding Sources

No funding was received to complete this research.

NOMENCLATURE

BOR	United States Bureau of Reclamation
CRB	Colorado River Basin
CRD	Colorado River Delta
EDF	Environmental Defense Fund
EPA	Environmental Protection Agency
GWP	Global Water Partnership
IBWC	International Boundary and Water Commission
IWRM	Integrated Water Resources Management
LCRB	Lower Colorado River Basin
MAF	Million-acre feet of water
MAXQDA	Software program
Mg/L	Milligram per Liter
MX	Mexico
NGO	Non-governmental Organization
OECD	Organization for Economic Cooperation and Development
UCRB	Upper Colorado River Basin
UNDP	United Nations Development Programme
UNESCAP	United Nations
US	United States
USBR	United States Bureau of Reclamation
USDA	United States Department of Agriculture
USGS	United States Geographical Survey
WMIDD	Wellton-Mohawk Irrigation Drainage District

TABLE OF CONTENTS

	Page
ABSTRACT.....	ii
DEDICATION.....	iv
ACKNOWLEDGEMENTS.....	v
NOMENCLATURE.....	vii
LIST OF TABLES.....	x
LIST OF FIGURES.....	xi
CHAPTER I: INTRODUCTION.....	1
CHAPTER II: LITERATURE REVIEW.....	5
What is Good Water Governance?.....	8
What is Good Transboundary Water Governance?.....	11
How is Transboundary Water Justice Different from Good Transboundary Water Governance?.....	16
CHAPTER III: STUDY REGION, OBJECTIVES, DATA AND METHODS.....	26
Transboundary Databases.....	28
Study Region.....	32
Data and Methods.....	33
Objective One.....	33
Objective Two.....	34
Objective Three.....	38
CHAPTER IV: DESCRIPTION AND STAKEHOLDERS IN THE COLORADO RIVER BASIN.....	40
Good but not Just Governance.....	41
Historical Use.....	45
Lower Colorado River Basin.....	46
Colorado River Delta.....	47
Transboundary Water Management.....	49

Future Challenges	59
Governing Salt	61
CHAPTER V: GOVERNING SALT- TESTING THE TRANSBOUNDARY JUSTICE	
PERSPECTIVE.....	71
International: U.S. and Mexico Salinity Negotiations	74
Transboundary Water Justice Analysis at the International Scale	82
National: Governing Salinity in the Colorado River Basin	85
Transboundary Justice Analysis at the National Scale	102
Local Scale: The Yuma Desalting Plant	105
Transboundary Water Justice Analysis at the Local Level.....	120
CHAPTER VI: DISCUSSION AND CONCLUSION	123
REFERENCES	128

LIST OF TABLES

Table 1. Definitions of Good Governance	6
Table 2. Definitions of Good Water Governance	10
Table 3. Transboundary Frameworks Comparison.....	27
Table 4. Comparative Framework of Transboundary Databases.....	31
Table 5. Data Results and Sources.....	35
Table 6. Keyword Catalogue	37
Table 7. International River Basin Specific Projects and Associated Minutes from IBWC. .	50
Table 8. Summary of Options and Potential Yields from the Bureau of Reclamation (Moving Forward, 2015).....	53
Table 9. Potential Yield of Other Type of Projects from the Bureau of Reclamation (Moving Forward, 2015).....	54
Table 10. Phase One of the Pilot System Conservation Program.....	57
Table 11. Salinity Stakeholders	68
Table 12. Transboundary Water Justice Framework & Analysis (Zeitoun et al. 2014)	73

LIST OF FIGURES

Figure 1. Methodology Flow Chart	39
Figure 2. Salinity Sources from a 1971 EPA Report via the Bureau of Reclamation Quality of Water Colorado River Basin Progress Report No. 25 (2015).	63
Figure 3. Salinity of Three Basin Compact Points via the Bureau of Reclamation Quality of Water Colorado River Basin Progress Report No. 25 (2015).	66

CHAPTER I: INTRODUCTION

The United Nations considers water security as one of its global sustainable development goals. Proper water security is defined as the “capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability” (UNWater 2013, pg 1). Water security can be achieved through good water governance, which concerns political, social, economic, and administrative systems that are in place to manage and deliver water at all levels of society (Rogers and Hall 2003; Akhmouch 2012). Effective water governance may be determined by an institution’s ability to remain transparent, inclusive, equitable, coherent, integrative, accountable, efficient, responsive, and sustainable (Global Water Partnership 2002). It is through these measures that goals such as efficiency, equitability, and sustainable water management can be achieved across scales and despite one’s outward access to water (UNESCAP 2009). In this research, effective governance can be considered good governance. Benefits from effective transboundary governance and their associated costs to stakeholders should be considered in transboundary benefits-sharing agreements.

Benefits-sharing agreements can increase water security within a transboundary basin and their impacts should especially be accounted for in multinational basins with an array of stakeholders. The Transboundary Water Disputes Database reports over 600 treaties, from 1820 to 2007, in around 310 transboundary river basins in the world. The database and subsequent research shows evidence of collaboration and opportunities for creating positive-sum agreements between nation-states (Transboundary Freshwater Dispute Database 2017).

A properly designed and implemented negotiation can result in benefits to at a minimum one sector or at least compensation to stakeholders that may not directly benefit from the agreement. There is a lack of literature on instances where there is a redistribution of benefits in benefits-sharing negotiations.

Tenets of effective benefits-sharing negotiations embody principles of distributive justice theories. However, justice theories and perspectives are seldom included in transboundary water governance research. There have been examples of good transboundary governance, but it is by no means perfect, there remains challenges that have yet to be adequately addressed in the basin. My research aims to evaluate the Lower Colorado River Basin in terms of justice perspectives held by both state and non-state stakeholders over salinity governance over the U.S.-Mexico border, and U.S. state borders. By doing so, a discussion of who should get water, when, how, and why can be interpreted through the lens of transboundary justice.

The Colorado River flows through seven states (Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming) with water rights split from a total of 15 MAF. The upper and lower basins each receive 7.5 MAF. Another 1.5 MAF is delivered to Mexico as stated in the 1944 Water Treaty Act with Mexico. The Colorado River is overallocated due to optimistic supply scenarios. It is also the most regulated river basin in the world due to prior appropriation laws and the “Law of the River.” The river has gone through many periods of flow but more notably major periods of drought. Flow has become less reliable over time contributing to issues such as rising salinity levels and concerns over riparian areas, habitat conservation, and endangered species are coming at the forefront of public concern. Through a bevy of agreements, projects, and negotiations, water quality has been

managed and litigations have ceased over water allocations. This positive development suggests some level of benefits to stakeholders and sectors in the basin. The public considers salinity management as a successful cooperative binational effort and yet high saline levels continue to result in economic damages, public health concerns, and habitat and land degradation in both the U.S. and Mexico. High levels of salinity impact agricultural lands, damages water supplies, and causes millions in economic damages; it is a major concern at the international, national and local scales. Salinity governance is the process of removing, regulating, and managing salinity in a river basin. Extensive research outlines governance in the Colorado River Basin, I contribute to that work by focusing on a relatively unreported challenge of salinity management.

This research examines the distributive efforts, justice perspectives, goals, and the extent of stakeholder participation in salinity governance in the Colorado River Basin using the Transboundary Water Justice Framework from Zeitoun et al. (2014). While Mumme and Taylor (2014) provide an excellent case study example of the international salinity negotiation in Colorado River Basin, I use the Zeitoun et al. (2014)'s transboundary water justice framework and expand on their findings. I systematically review news sources from Lexis Nexis, and state and federal legal cases and regulations from Westlaw. News sources, legal cases, and regulations were coded by (1) Scale (International, National, State, Local), (2) Stakeholder Justice Perspective (Egalitarian, Utilitarian, Libertarian), (3) Justice Goals (Equitability, Environmental Sustainability, Efficiency), (4) Means of achieving goals (Securitization or Politicization), (5) Legal mechanism (Laws, minutes, acts, treaties), and (6) Evidence of Participation and quality of Participation (None, structural, minimal). The

Transboundary Water Justice Framework is sensitive to distributional justice, tradeoffs, hegemonic actors, and addressing unfair transboundary negotiations (Zeitoun et al. 2014).

First, I outline the basic tenets of good environmental governance, good water governance, and good transboundary water governance. Second, I provide a brief overview of the case study by discussing basin governance, legal structures, and stakeholders that manage salinity in the Colorado River Basin. I then detail how stakeholders may or may not benefit with this type of governance, how their goals are achieved, and the extent of distributive justice within the basin. Lastly, I test the efficacy of the justice framework and determine if salinity management is considered a product of good transboundary water governance in the Colorado River Basin. I achieve this by identifying three representative case studies on salinity on the international, national, and local scale. The overall goal will be to understand who and how stakeholders may benefit or lose from transboundary water agreements in the Colorado River Basin.

CHAPTER II: LITERATURE REVIEW

Governance is defined by the United Nations as “the process of decision-making and the process by which decisions are implemented (or not implemented)” (United Nations 2009, pg 1). These processes are carried-out by both formal and informal actors through either formal or informal structures (United Nations Environment Programme 2009). The meaning and nuance of governance has been refined through considerable research (UNDP 2011, OECD 2006; World Bank 1994), but Karen Bakker (2010, pg 8) offers a clear definition that envisions governance as a “practice of coordination and decision making between different actors” and inevitably intertwined with political culture and power (Bakker 2010).

There are many yet similar definitions of both governance and good governance. The Organisation for Economic Co-Operation and Development (OECD) defines governance as, “the exercise of political, economic and administrative authority necessary to manage a nation’s affairs” (OECD 2006). It is the process by which decisions are made or not made. The OECD defines good governance as, “management of government in a manner that is essentially free of abuse and corruption, and with due regard for the rule of law,” which also includes participation, transparency, accountability, rule of law, effectiveness, equity and etc. (OECD 2006). Multiple definitions of “good governance” may have major implications in the international development community. Definitions of good governance from major development organizations are listed in Table 1.

Table 1. Definitions of Good Governance

UNDP 2011, pg 279	UN member states in the Millennium Declaration in 2000 define and include: participation; equity, non-discrimination and inclusiveness; gender equality; rules-based; transparency; and accountability and responsiveness. They are congruent with key human rights principles set out in a variety of UN declarations and conventions and can be summarized in three core principles: participation and inclusion, accountability and rule of law and equality, and non-discrimination.
OECD, 2006	Management of government in a manner that is essentially free of abuse and corruption, and with due regard for the rule of law. It must also include participation, transparency, accountability, rule of law, effectiveness, and equity, among others.
World Bank 1992, pg vii and xiv	<p>Governance is epitomized by predictable, open, and enlightened policymaking (that is, transparent processes); a bureaucracy imbued with a professional ethos; an executive arm of government accountable for its actions; and a strong civil society participating in public affairs; and all behaving under the rule of law.</p> <p>Good governance needs to have three aspects to society 1) type of political regime; 2) process by which authority is exercised in the management of the economic and social resources, with a view to development; and 3) capacity of governments to formulate policies and have them effectively implemented.</p>

In environmental governance, the role of the state may result in unintended challenges. For example, Bridge and Perreault (2009) define six types of environmental governance depending on the role of the state.

These six challenges include:

1. Spatial scale and its administrative reconfiguration – governance is not scale-free, state can validate or challenge the way water is organized;
2. Commodity chain coordination – consumers are the agent of change in a market system, the role of the state is to intervene in the background;
3. Management of common pool resource (collective action for resource management) – a decentralized, community-based natural resource system, polycentric, the role of the state is minimal;
4. Popular participation and democratic action- publicizing water, use of media and non-profits to influence decision-making;

5. Institutional re-regulation under capitalism – accepting industrialism, but through market mechanisms to provide incentives for corporations to participate, the state’s role is to regulate;
6. Production of social order – absence of a single, dominant authority, environmental governance rules society, implicit, self-regulated environmentalism (Bridge and Perreault 2009).

The authors identify two other fields in geography on environmental governance research: neoliberal governance (neo-Marxian) and eco-governmentality (Foucauldian-based). The authors interpret environmental governance as governance through nature, a reflection and projection of economic and political power on decisions related to design, manipulation, and control of socio-natural processes. When considering environmental governance, it is clear that special attention needs to be paid to the role of the state to determine different modes of governance.

Efforts to improve environmental services through modes of governance have also focused on the question of what is “good” governance. Several common themes run through the literature. *Good* governance must encompass the following eight characteristics: participatory, consensus oriented, accountable, transparent, responsive, effective and efficient, equitable and inclusive and follows the rule of law (World Bank 1994, OECD 2006, United Nations, 2009). When these eight characteristics are achieved, there is an expectation that corruption will be minimized, minorities and the most vulnerable are participants in decision-making, and reflect present and future needs (United Nations 2009). Additionally, in order for good governance to be effective, the needs of society should be met through the use of current resources at their disposal.

Good governance and the paths to achieve it are also a topic of debate in the academic community. For example, Gisselquist (2012) questions if good governance only holds the

public sector, public companies, public affairs, and resources accountable. They believe the term good governance lacks differentiation and theoretical utility especially in the formation of theory and hypothesis testing. The concept of good governance is not standardized, and thus allow researchers to create a definition that might best fit their research agenda and data (Gisselquist 2012). When discussing good governance it is important for the researcher to situate themselves and ask what ways governance should be improved exactly (Gisselquist 2012). Good governance remains elusive and may narrow only when considering the context of when governance is measured. For example, global, corporate and international and environmental governance are among the many types of governance that exist. This brings us to the point of environmental governance and ways careful considerations of good environmental governance can help us achieve good water governance and subsequently good transboundary governance.

What is Good Water Governance?

There are different definitions of good water governance in the international water community. The Global Water Partnership (GWP) defines water governance as “the range of political, social, economic and administrative systems that are in place to develop and manage water resources, and the delivery of water services, at different levels of society” (GWP 2002, informed by UNDP; Rogers and Hall 2003, pg 7). The approach must be transparent, inclusive, equitable, coherent and integrative, and the performance and operations within water governance must be accountable, efficient, responsive, and sustainable (Rogers and Hall 2003).

The OECD defines water governance as the set of systems that control decision-making in water resources development and management (Akhmouch 2012). Good water governance is especially concerned with the way decisions are made, with special considerations for whom, and under what conditions how governance is conducted (Moench et al. 2003; OECD 2011). It may consider who gets what water, when and how (Tropp 2007; OECD 2011). It also concerns how formal and informal institutions exercise their authority through design, regulation, and implementation in water management (Moench et al. 2003).

The OECD defines governance across multiple levels as the, “explicit or implicit sharing of policymaking authority, responsibility, development and implementation at different administrative and territorial levels” (OECD 2011). For example:

- I. Across different ministries and/or public agencies at central government level (upper horizontally);
- II. Between different layers of government at local, regional, provincial/state, national and supranational levels (vertically); and
- III. Across different actors at the sub-national level (lower horizontally) (OECD 2011)

There are multiple definitions of water governance within the international community (Table 2). Although the goals of each organization may resemble each other, the paths to good water governance may be differ depending on how the term is defined.

Table 2. Definitions of Good Water Governance

<p>UNESCO Website, Governance and Institutions, accessed June 2019</p>	<p>Water governance refers to the political, social, economic, legal, and administrative systems that develop and manage the various levels of water resources and water services delivery, while recognizing the role played by environmental services. Governance systems, it says, “determine who gets what water, when and how, and decide who has the right to water and related services.” Such systems are not limited to ‘government,’ but include local authorities, the private sector and civil society. They also cover a range of issues intimately connected to water, from health and food security, to economic development, land use and the preservation of the natural ecosystems.</p>
<p>GWP (2002) (informed by UNDP) (Rogers and Hall 2003, pg 7)</p>	<p>In 2003, the Global Water Partnership defined water governance as “the range of political, social, economic and administrative systems that are in place to develop and manage water resources, and delivery of water services, at different levels of society” (Rogers & Hall, 2003). The GWP’s twelve principles for effective water governance are: open, transparent, participative, accountable, effective, coherent, efficient, communicative, equitable, integrative, sustainable, and ethical.</p>
<p>European Union (Barreira 2006, pg 81)</p>	<p>The European Union uses the Water Framework Directive, a directive which introduces key elements to achieve effective water governance through a coherent and effective legal and institutional framework, water-pricing policies, public participation and an integrated water resources management system.</p>
<p>United Nations Development Programme Water Governance Facility and SIWI (Water Governance Issue Sheet, pg 1)</p>	<p>Water governance can be regarded as the “political, social, economic and administrative systems that are in place, and which directly or indirectly affect the use, development and management of water resources and the delivery of water service at different levels of society” (UNDP Water Governance Facility, n.d.). Essentially, who gets what water, when and how, and who has the right to water and related services, and their benefits. Water governance can also be conceptualized as “a means to an end”, the end being efficient, equitable and sustainable water management.</p>
<p>WWF Website, accessed June 2019</p>	<p>Effective water governance works through networks and relationships between government bodies, the private sector, NGOs, community groups and individuals. It will: encourage stakeholders to actively participate in designing, planning, managing and implementing water management activities; foster the ability of communities to innovate and adapt to changing circumstances (such as climate change); improve clarity and allocation of stakeholder roles and responsibilities through legislation and policies; create greater integration between water management efforts; and provide incentives for innovation and improved performance.</p>

Scholars have examined both critical and normative perspectives of water governance. For example, Woodhouse and Muller (2017) argue that water governance pivots on stakeholder-agency in decision-making. When tradeoffs occur, they question what formal

and informal institutions need to emerge, if actions need to be made, which actors and agencies effect those decisions, and for whom they will account for their performance. They recount a need for contextual based solutions using “problem-sheds” approaches rather than market-based mechanisms to achieve goals related to economic efficiency, as seen often in integrated water resources management (IWRM) approaches (Woodhouse and Muller 2017).

Overall, good water governance concerns political, social, economic, and administrative systems that are in place to manage and deliver water at different levels of society. It is through these systems, with local authorities, private sector, and civil society that key questions arise: water governance for whom, under what conditions, when, how, and for what kind of water? Thus, formal and informal institutions can be a part of water governance. The effectiveness of these systems may depend on the capacity of these institutions to remain transparent, inclusive, equitable, coherent, integrative, accountable, efficient, responsive, and sustainable. This includes public participation across government levels (horizontal), layers of government (vertical), and across local actors. With these measures in place, governance structures might also be able to adapt and respond to changing circumstances (i.e. climate change), and resolve issues based on contextual-based solutions rather than novel IWRM. Therefore, goals of efficient, equitable and sustainable water management can be enjoyed across scales and despite one’s outward access to receive water.

What is Good Transboundary Water Governance?

When considering good water governance for water bodies shared by at least two nation-states, a formal discussion on good transboundary water governance is pertinent. These discussions often aim at understanding what transboundary water governance has

looked like in the past, and defining principles and steps to achieve good transboundary governance. The OECD has outlined organizations, services, tools, and management schemes related to good transboundary water governance (Akhmouch 2012). The following programs and initiatives aim to improve transboundary water governance, as cited in Akhmouch (2012):

- International training program on IWRM and Transboundary water management, building-capacity, improving knowledge, networks and institutional processes (SIWI)
- International training program on IWRM define principles and steps for IWRM, develop tools to prepare transboundary basin management plans (IOWater 2011)
- Program on Water Governance at the University of British Columbia – Interdisciplinary research on water sustainability and dialogue on water-policy with communities and policy-makers; projects’ topics include water security, privatization, water in Canada, water and development, and US-Canada transboundary water (University of British Columbia)
- Law of transboundary aquifers – promote cooperation among states over shared aquifers (United Nations)

These programs and activities collectively signal a need for principles and guidelines to improve transboundary water governance; however, achieving *good* transboundary water governance remains elusive due to the difficulty of cooperation over shared sources. It is important to discuss the different narratives and approaches to good transboundary water governance and the barriers and complications that have risen out of those efforts.

There are four particular framework of water management that register within the transboundary water governance literature: (1) water wars, (2) benefits sharing (3) confliction and cooperation (4) and transboundary water justice. They are not mutually exclusive and can overlap but there are distinctive claims to achieving good water governance. Challenges to successfully sharing transboundary resources begin to emerge such as the IWRM watershed-based approach, the difficulty of scale, interpretations of conflict and cooperation, legality, and infrastructure.

Transboundary water research has historically been motivated by concerns for water conflicts as a proxy for water wars (Appelgren and Klohn 1997). These researchers believe successful transboundary water governance hinge on a developing trust during the negotiation phase (Appelgren and Klohn 1997). Researchers at Oregon State University debunked this claim through the transboundary disputes database (Wolf 2001). Their analysis found more instances of cooperation and found very little evidence for conflicts that resulted in warfare. There is also a movement to stay away from the IWRM approach in water management because it analyzes a water basin as a unit of analysis as opposed to a basin with complex politics (Zeitoun et al. 2016; Molle 2008).

Conflict and cooperation frameworks are promoted by some entities as a measure of good transboundary water governance and contested by others such as the London Water Research Group (LWRG), who examine transboundary moments as interactions with varying degrees of conflict and cooperation. There are also researchers that integrate water security in transboundary water governance as a concept that can achieve good governance. For example, Mirumachi (2013) defines effective transboundary water governance as a means to achieve water security goals, such as a country's ability to have the institutional capacity to adapt such as to allocate, reallocate or regulate waters. Transboundary water security is defined as the collective capacity to harmonize policies in a transboundary water basin. Mirumachi measures transboundary water governance and security by analyzing conflict and cooperation through perceptions of risk and trust (Mirumachi 2013). Other researchers have also traced periods of conflict and cooperation, finding cases of jurisdictional fragmentation in Ontario's portion of the Great Lakes in Canada (Cook 2014).

The consideration of scale in transboundary water governance is also of special concern on the US-Canada border and resulted in numerous researches on decentralization and uneven development (Norman and Bakker 2009; Cohen 2012; Cohen and Bakker 2014). The nuance of scale was used to find governance failures and complexities between diverse stakeholders. Norman and Bakker (2009) found that re-scaling transboundary water governance to the watershed scale did not lead to the empowerment of local actors on the U.S. and Canadian border. This approach is an emerging theme and supported by multiple case studies (Cohen and Davidson 2011; Molle 2009).

A mainstream approach to transboundary water management and governance is the benefits-sharing perspective (Sadoff and Grey 2002). The term was notoriously coined by Sadoff and Grey (2002) and describes four types of benefits. Type One benefits are benefits to the river and can improve ecosystem health; challenges are degraded water quality in watersheds, wetlands, and biodiversity, while opportunities include improved water quality. Type Two is increasing benefits from the river; challenges are increasing water demands and inadequate water management, while opportunities include improved water resources management in hydropower agricultural production, flood-drought management among others. Type Three benefits are reducing costs because of the river; challenges are tense regional relations and political economy; impacts and opportunities are to shift policy from conflict to cooperation, shifts from food/energy self-sufficiency to food/energy security. Type Four benefits are increasing benefits beyond the river; the main challenge is regional fragmentation and opportunities, integration of regional infrastructure, markets and trade. The authors also propose a shift from focusing on physical water allocations to thinking

about water benefits through dollars, the authors claim that economic benefits tend to have less political and psychological impacts (Sadoff and Grey 2002).

Benefits sharing negotiations emphasize economic benefits to various riparian states and stakeholders. Economic perspectives of benefit-sharing tend to yield projects that involve construction for reservoirs and infrastructure (Acquah and Ward 2017; Jalilov, Varis, and Keskinen 2015; Arjoon, Tilmant, and Herrmann 2016). These approaches are sometimes paired with welfare economic approaches and advocate for redistribution when benefits are not always even, however this assumes strong basin-wide authority to impose fees (Arjoon, Tilmant, and Herrmann 2016).

The emergence of infrastructure as a cooperative approach may not always follow benefits sharing norms or outcomes. For example, there are instances where desalination projects have resulted in potential transboundary consequences. Although desalination was perceived as a benefits mechanism, it was met with political issues between sovereign states and interpreted as a way to reinstate hegemony within the river basin (Feitelson and Rosenthal 2012). Others also find benefits sharing to have high transaction costs especially when benefits need to be redistributed between and within riparian states (Soliev, Wegerich, and Kazbekov 2015). These authors compare the benefits-approach as having a lack of historical and institutional perspectives much like the water-energy-food nexus framework (Soliev, Wegerich, and Kazbekov 2015). Additionally, benefits sharing was found to be effective at decentralizing water but also created zero-sum outcomes. When the Tigris-Euphrates River basin group discussed plans for infrastructure and the redistribution of benefits, upstream states interpreted this move as a threat to their hegemonic power and an endorsement for downstream states (Warner, Wester, and Hoogesteger 2014). The

installation of infrastructure was seen as a passage point to help benefit some more than others and perceived to result in inequitable distributions of benefits (Warner, Wester, and Hoogesteger 2014, pg 477).

When advocating for benefits sharing frameworks, it is worth considering who these measures will benefit and how. This practice will examine how these measures might benefit some actors and potentially exclude others. Benefits gained across a basin can be advocated but the distribution of those benefits can be uneven. If this were the case, the benefits sharing frameworks would need to promote compensation or redistribution of benefits to other riparian states (Zeitoun et al. 2014). Thus, it is pertinent to consider who benefits in cooperation schemes and how other sectors may not, and if not how and if they are being compensated. These practices are supported in Zeitoun et al. and their recent understanding of transboundary water security as the need to target those that are most vulnerable while others benefit from power asymmetries (Zeitoun et al. 2016). In these cases, the role of non-state actors become a larger priority in frameworks such as benefits sharing (Sadoff and Grey 2002), which may not consider these actors at large. The distribution of these benefits should be considered in tandem with environmental justice (Zeitoun et al. 2014; Zeitoun 2013).

How is Transboundary Water Justice Different from Good Transboundary Water Governance?

Environmental justice is emerging and challenging normative approaches to water management in transboundary water governance literature. Some of these issues have to do with distributional justice, justice for regional or local communities, and issues of access. These issues sometimes, but not always, arise from development projects within transboundary contexts where infrastructure might be involved as a benefits-sharing

arrangement. Most profoundly, infrastructure is heralded as a symbol and tool for cooperation in benefits sharing arrangements; however, these instruments have been used to create new scales of hegemonic power, and create conflict between riparian-states.

Researchers are beginning to consider whether stakeholders may benefit, or not, from these infrastructures, how they might benefit, and what types of benefit they might receive.

The concern of equity in international rivers inspire a new set of conversations in the Transboundary Water community. Environmental values and the human right to water principle in transboundary basins make the role of justice in transboundary water governance especially pertinent. For example, values such as uneven access within and across region, country, urban/rural, gender, age, class and ethnicity can deepen global water equity concerns (Gerlak and Wilder 2012). As a global issue, these concerns are valid in transboundary basins as well. Additionally, different interpretations of international law have made way for legal pluralism resulting in further disenfranchisement of indigenous groups and pollution of water due to inconsistency and coherence of international water laws (Gupta, Hildering, and Misiedjan 2014). The international water community emphasizes the need to go beyond just pursuing water access for all but also for the opportunity for individuals and collectives to participate in the decision-making arenas of water governance (Sultana and Loftus 2015; Jepson et al. 2017). At the local levels, claims for the human right to water are believed to be "necessary but insufficient to achieve access to water for all" and can benefit from the support of institutions and nation-states (Sultana and Loftus 2015). Whether to protect indigenous rights, or local equitable access to water, international law and codified law can stand to benefit from transboundary water governance embedded with justice values.

Concepts such as “hydrosolidarity,” proposed by Gerlak, Varady and Haverland (2009) seek social justice and human rights in international river basins and argue for more local efforts in transboundary negotiations such as safe household water, food production, and water pollution (Gerlak, Varady, and Haverland 2009). Often the mechanism of these normative values pivot on stakeholder participation, making it a bit easier to reduce corruption and infringement of human rights. The role of justice, ethics, and equity in transboundary water governance has begun to become a part of discourse but these frameworks are seldom actualized in transboundary research and analyses for actual basins and watersheds.

The move towards environmental justice in transboundary debates operates across theoretical approaches to transboundary water governance. For example, while providing a critical assessment for the Track II dialogue approach to transboundary water governance, Hanasz (2016) shows the difference between procedural justice and distributive justice. The Track II Dialogue approach was created by Petersen and Wolf (2012) as a way to create a series of engagements between government and non-government stakeholders through the use of a neutral third party (Hanasz 2017). It has been used internationally as an approach to improve transboundary water management. Hanasz’s critical discussion of the Track II Dialogue approach brings light to the concept of distribution and procedural justice, for example,

“distributive water justice refers to the allocation of water resources that is perceived as fair by stakeholders [...] and include the following: equitable sharing of benefits; avoiding unfair and involuntary risk bearing; protection of livelihood security; and

provision of compensation, insurance, where necessary, welfare support for project-affected people.” (Hanaz 2017)

In contrast, procedural water justice is the “process of allocating water resources that is perceived as fair by the stakeholders” (Hanasz 2017). Procedural process principles include: “inclusion of stakeholders in decision making; access to information and legal and other support demonstrable public acceptance; and free, prior and informed consent of affected indigenous and tribal peoples” (Hanasz 2017). In this sense, procedural water justice does not necessarily encompass equitability, where outcomes are considered balanced and fair (Zeitoun et al. 2014; Hanasz 2017). In conclusion, the author cautions practitioners to meticulously consider the impact of a third-party facilitator in transboundary water governance, while also advocating for distributional justice.

The London Water Research Group (LWRG), of which Zeitoun is a member, also recognizes the absence and importance of ethics and equity in transboundary water negotiations and outcomes, and admit that earlier analyses overlooked elements of water justice (Zeitoun et al. 2014). Their review of transboundary water justice literature offers a framework that seeks to elevate narratives of justice in broader transboundary discussions, finding it imperative for scholars to disclose the moral underpinnings of their judgments and analyses. They draw on arguments derived from the work of John Stuart Mill (utilitarianism), John Rawls (veil of ignorance), and Robert Nozick (limited role of governments in society). Going beyond calls for justice in transboundary basins, Zeitoun et al. (2014) offer the first framework to measure issues of justice perspectives, outlying goals, procedural justice, and hydro-hegemony.

Most recently, Zeitoun and colleagues (2014) have advanced new concepts and metrics of equity in a newly constructed “transboundary water justice” framework. Zeitoun (2013) looks at global environmental justice in transboundary rivers and defines it as a combination between justice theory and hydropolitical theory. His research shows that hegemonic actors could coerce the content of international treaties, employ soft power to present imposed-order regimes as cooperative, and act unilaterally obliging the non-hegemonic states to react (Zeitoun 2013). Zeitoun (2013) identified a set of literature that outlined the shift in international water law from territorial supremacy (Harmon Doctrine) to benefits sharing, which encapsulates notions of distributional justice efforts, although these often-required trade-offs tailored by the state to develop outcomes in their best interests. In the discussion, Zeitoun also states that social issues can seldom be considered separate from environmental justice issues, “considering the existence and influence of social justice activists in each country, analysts attempting to separate environmental justice matters from social ones would be as far off the mark as those who remain focused solely on the international” (Zeitoun 2013, pg 145-146). He also defines the difference between procedural and distributive justice as the inclusion or exclusion of the consideration of the effects of power asymmetry. So long as water negotiations are *perceived* as inequitable, social injustice allegations can potentially be the case.

Zeitoun et al. (2014) seeks to strengthen international transboundary water interaction analysis, diplomacy, and justice by creating a framework that looks at stakeholder justice perspectives and goals within transboundary agreements. They are able to analyze inequitable distribution between countries, control and use of water, fairness of international negotiations and treaties, the response of international water law, and uncoordinated

development of basins by political entities. This approach is valuable because it aims to address unfair international transboundary water treaties, use, and governance arrangements by focusing on the perspective of actors, and their capacity to shape the processes that lead to the transboundary agreement.

Zeitoun et al. (2014) define justice as an outcome that is fair, and injustice as outcomes that are not fair. Fairness in this case considers the perspective of affected actors and their capacity to participate and shape transboundary outcomes. This research favors equitability over equality, due to the fact that equitability is concerned with outcomes that are considered balanced and fair, and not necessarily equal; whereas equality assumes the capacity and rights of actors (Zeitoun et al. 2014). The goal is to advance water diplomacy by focusing on conflict resolution, equitability, and sustainability over conflict management. The latter approach tends to favor technical and programmatic approaches to reach efficient or expedient resolutions.

The Zeitoun et al. (2014) framework consists of steps, categories, and subcategories. First the framework advises researchers to map out transboundary arrangements such as policies and resolutions preferred by stakeholders' actors. Next, it interprets any assumptions of particular strands of justice to support such arrangements. Strands of justice include (a) Egalitarianism, particularly Amartya Sen's definition as seeking equitability in opportunity of distribution and access, (b) Rawlsian, which maintains that resources should be distributed as if under a veil of ignorance as to the eventual recipient, and tolerate inequity only if it favors the least advantaged (John Rawls, *Just Society*), (c) Utilitarianism defined as John Stuart Mill as seeking maximum benefit for society as a whole at the cost of a few (d) Individualism/Libertarian as justice meted out to those who have earned it and with limited

role of government in society; no re-distribution should be allowed as that is an example of impinging on an individual's rights (Robert Nozick). Libertarians may see more water devoted to the most efficient sector or user. If traits of these justice perspectives are identified during the coding process, it can be categorized into egalitarian, utilitarian, and/or libertarian.

Next, the authors take a critical examination at the assumptions behind these views, such as if they are perpetuated with goals of achieving equitability, efficiency, or environmental sustainability. This will lead to understanding the legitimacy and source of legitimization of those who hold particular strands of justice, the views on justice matter, "those that accompany the discourses and other processes which influence policy are those sanctioned by actors considered legitimate, and whose legitimacy is generated by the mainstream political economic institutions, discourses and thinking" (Zeitoun et al. 2014). When trade-offs between efficiency, sustainability, and equitability must be made, all incentives in our political economies favor efficiency. Often times, where tradeoffs must occur, efficiency overcomes environmental sustainability.

Next, the framework identifies ways in which view and principals are enacted, for example through either securitization or politicization, "in the view of egalitarians, the politicization of an unfair water-sharing arrangement is seen as a progressive step towards its resolution while attempts to simply manage the conflict (through securitization or de-politicisation) will lead away from its resolution" (Zeitoun et al. 2014). Not all issues will be accomplished through securitization or politicization, but if they are present, it serves to be included in the overall analysis.

Next, the framework scrutinizes the underlying structures and forces that enable these processes, "the so-called mechanisms of justice." Scrutiny is be applied to the way that

agendas are set, and how actors are de-legitimised or otherwise excluded. These mechanisms of justice can include law and formality in the basins such as minutes, treaties, and acts to understand the processes that lead to transboundary outcomes.

Finally, the framework determines if procedural justice is present or not present. In Zeitoun et al. (2014), “outcomes are equally, if not more important, than process. Procedural justice can shed light to actors often ignored, however, distributional justice (depending on moral perspectives) can be just as problematic. For example, trade-offs and environmental good/bads are simply quantified for ease of comparison and evaluation.” This can surface by looking at the participation and quality of participation of stakeholders involved in negotiations or outcomes.

Overall, the Zeitoun et al. (2014) transboundary justice framework is able to look at justice on a transboundary scale while considering the needs and perspectives of different stakeholders. Its usefulness comes in the work the authors made to outline what a justice framework would look like. If actualized, it has potential to assess justice in a transboundary basin.

In Zeitoun et al.’s (2014) Transboundary Water Justice Framework, the authors acknowledge the importance and significance of scale and how it has a significant contribution to understanding Transboundary Environmental Justice, however their analysis was unable to include the concept at the time. Mumme and Taylor (2014) and Norman and Bakker (2009) included elements of justice and scale in their research but did not explicitly use a transboundary justice framework where goals and justice perspectives were outlined especially as it relates to scale. There are also a multitude of stakeholders involved at different scales, with separate responsibilities and interests in the basin. It is not difficult to

assume that these interests and goals may at some point conflict with one another. Scale can have a major influence on the issue at hand, “a greater sensitivity to the multiplicity of definitions and strategies of environmental justice across scales helps capture more of the complex dimensions of transborder issues” (Mumme and Taylor 2014). They believe an understanding of politics of scale can shape the pursuit of environmental justice among diverse actors across multiple scales and can help elucidate what is at stake and for whom. In their discussion of the salinity crisis on the U.S.-Mexico border, they outlined how two cases studies, one at the local scale and one at the international scale, had goals and interests that interacted in unprecedentedly complex ways. This is a leading example of how tensions can exist in transboundary water management, despite being outwardly perceived as a success.

Following Zeitoun’s proposition to strengthen international transboundary interactions by looking at justice through stakeholder perspectives and goals, I seek to evaluate transboundary water management against the principles of water justice with sensitivity to scale, as demonstrated in Zeitoun et al. (2014) and Mumme and Taylor (2014). An emphasis on justice in research analyses have been proven valuable in determining situations where outcomes are unfair such as in Mumme and Taylor (2014) analysis of salinity and in Zeitoun et al.’s (2019) analyses of people displaced by a transnational dam. Their case study discussed tradeoffs in the case of a transnational dam Zeitoun et al. (2019). I contribute to the literature by empirically investigating water salinity management in the Colorado River Basin through a justice lens. This case study will be the first to apply the transboundary water justice framework in a basin and to operationalize the themes and concepts outlined in the framework.

This research aims to test the efficacy of the transboundary water justice framework and will then discuss if it can be used as a measure to ensure good transboundary water governance at large. It also emphasizes the role of non-state actors and their participation or lack thereof in transboundary water governance. A basin that might already be considered a “good” basin in transboundary water governance can be measured against the transboundary water justice. Also, a basin with multiple transboundary arrangements already in place will serve as a good case study since secondary materials are readily available. With these factors in mind, I choose the Colorado River Basin as a case study and specifically analyze how salinity was dealt with as a transboundary issue, how it is managed on the national level, and how it impacts individuals at the local level by engaging in politics of scale to determine what is at stake and for whom (Mumme and Taylor 2014). A thorough understanding of how salinity is managed in the Colorado River Basin from a justice lens will help determine “who decides who *should* get water, when, how and why” (Zeitoun et al. 2014, pg 176). This research seeks to hold those in power accountable and evaluate how benefits and costs are distributed on a basin wide scale.

CHAPTER III: STUDY REGION, OBJECTIVES, DATA AND METHODS

There are multiple frameworks that exist to evaluate transboundary water governance. These frameworks engage with topics of conflict and cooperation (Zeitoun and Mirumachi 2008; Petersen-Perlman and Wolf 2015), benefits sharing (Sadoff and Grey 2002, Phillips et al. 2008), and power structures (Zeitoun and Warner 2006; Zeitoun et al. 2014). I identify each methodology and framework by its purpose, data input, type of analysis, beneficiaries and scale, outcomes and justice perspective (if applicable) (Table 3).

Water reallocation in transboundary river basins can create intense conflict, especially when a hegemonic power is present. As a result, the term benefit sharing was created to encourage cooperation with positive sum agreements (Sadoff and Grey 2002). It was a way to promote peaceful, productive relationships amongst riparian states without broaching the topic of water quantity. This vein of management tends to rely on the implementation of infrastructure (dams, desalination, reservoirs) to find areas where benefits can be shared amongst riparian states. Many frameworks that exist (Table 3) are meant to design projects to maximize benefits in the overall basin. These frameworks focus on guidance for facilitation and implementation of transboundary negotiations and modes to consider stakeholder participation and engagement. A recurring theme is the encouragement to implement infrastructure as a method of cooperation and benefits sharing amongst riparian states and beyond the overall watershed. In contrast, Zeitoun et al. (2014) aim to understand where those benefits might be distributed or felt in the basin as a way to hold stakeholders accountable.

Table 3. Transboundary Frameworks Comparison

Name	Authors	Purpose	Data Input	Framework (Type of Analysis)	Beneficiaries and Scale	Outcomes	Justice Perspective
Benefits-Sharing (Framework)	Sadoff and Grey (2002)	Creates outcomes that will create a positive-sum outcome rather than a zero-sum negotiation	Water Sharing Arrangements	Maximize benefits by understanding water sharing arrangements by type of categorization: Type one benefits are benefits to the river and can improve ecosystem health; Type two is increasing benefits from the river; Type three of the benefits is reducing costs because of the river; Type Four of the benefit is increasing benefits beyond the river; the main challenge is regional fragmentation and opportunities are integration of regional infrastructure, markets and trade.	Environmental, direct economic, political and indirect economic	Redistribution to create positive-sum outcomes	Utilitarian; partially egalitarian
Enhancing Security by Initiating Cooperation in Transboundary River Basins	Petersen and Wolf (2012)	Addresses practices development partners can design to implement projects at the state level; data exchange and scientific collaboration can help enhance formal cooperation	Case studies have outside funding sources, include nonofficial, lack of formal agreements, a project that enhances hydropolitical relations	Evaluates in-depth project reports for each case study; reports objectives, successes, challenges, and lessons learned; identifies successful elements of the projects into four categories: jurisdiction, project design, stakeholders, and negotiating	State-level	Water security can be enhanced if countries respect participating riparian's autonomies; create basin-wide networks of scientists; allow for each partner to garner responsibility for project activities; consult a diverse group of stakeholders	Justice unacknowledged
Transboundary Water Interaction NexuS (TWINS)	Zeitoun & Mirumachi (2008)	Robust method to consider both conflict and cooperation jointly in terms of interaction, which is considered a political process subject to the whims of power	Transboundary water interactions are understood, examined, analyzed and explained by considering positions on a two-dimensional matrix rather than at discrete locations on a spectrum.	The matrix is a 5 x 4 cell derived from hydropolitical and security theory for conflict and cooperation scales. Incorporating methods of creating cooperation, and politicization, securitization and violisation.	Inter-state	Ability to consider the political context that allows different intensities of conflict and cooperation to co-exist	Justice perspective unacknowledged
Analytical Framework of Hydro-Hegemony	Zeitoun & Warner (2006)	Determines power and varying intensities of conflict through an analytical paradigm for hemonized riparians to move away from domination towards cooperation	Yoffe (2004) Water Event Database	Determines hydro-hegemony by measuring power position, riparian position and resource exploitation potential; outlines form of hydro-hegemony, form of interaction, outcome of interaction and intensity of conflict	River-basin level (Nile, Jordan and Tigris and Euphrates river basins)	The absence of war does not mean the absence of conflict. Control over water resources is not achieved through water wars but through a suite of power-related tactics and strategies.	Justice perspective unacknowledged
Transboundary Water Opportunity (TWO) Analysis Framework	Phillips et al. (2008)	Promotes sustainable and equitable use of transboundary water resources; clarifies trade-offs relating to development; suggests develop to optimize economic growth, political stability and regional integration	Data limitations do not need to be a fundamental impediment to progress on water cooperation. Best available data can be used from the public domain.	Consider development opportunities (hydropower and power trading, primary production, urban growth and industrial development, environment and ecosystem services, and others) by the type of water (new water, more efficient use of water, other sources in basins that are not closed)	Basin State Governments, Regional Economic Communities, and financing entities	Suggests development opportunities such as re-use of wastewater or multipurpose dams in optimal geographic locations in a river basin; create positive-sum outcomes.	Justice perspective unacknowledged
Transboundary Water Justice Framework	Zeitoun et al. (2014)	Addresses unfair international transboundary water treaties, use, and governance arrangements	Transboundary arrangements	Outlines stakeholder perspectives, underlying goals, mechanisms of justice, even if through securitization or politicization	State and nonstate actors, affected stakeholders	Seeks conflict resolution/transformation instead of conflict management; transboundary water arrangements can be informed by considering the alternative generated by counter-hegemonic movements, or justice analysis, because then can provide the basis for a strategy to alter the status quo.	Egalitarian

In this research, the Transboundary Water Justice Framework seeks to identify and highlight power structures in a basin and emphasize distributive justice in benefits sharing projects. This framework seeks to determine whether water is equitably distributed, and assesses the fairness of international negotiations, treaties, water use, and governance outcomes. This approach assesses whether the result of transboundary projects is procedurally just, and tends to distributive justice principles. With this approach, they are concerned with who decides who should get water, when, how, and why (Zeitoun et al., 2014). The framework aims to find the moral underpinnings and justice perspectives and analyze them as it relates to transboundary negotiations.

Transboundary Databases

A common methodology to understanding transboundary water governance is the use of primary and secondary sources such as news, law, regulations, environmental reports, and policy reports (Table 4). Legal mechanisms are central to transboundary water law because “the existence of an agreed legal regime contributes to water security by providing an operational system for addressing specific issues of shared water development and management” (Wouters, Vinogradov, and Magsig 2009). Researchers may also conduct interviews with stakeholders involved with transboundary governance, political actors, and local communities. Across transboundary water governance analyses, the collection of primary and secondary reports paired with interviews are common due to the emphasis on including stakeholders’ views and goals. This is known as a metrics plus approach, which is advantageous because it utilizes existing data and interviews to ground theory with practice.

Oregon State University created a database called the “transboundary freshwater dispute database” which maintains water “events” that show regions with conflict and cooperation (Wolf 1999). The database offers water-related treaties, US inter-state compacts, catalogued by basin, countries, date signed, treaty topic, allocation measures, conflict resolution mechanisms, and non-water linkages. A comparative analysis was done between the U.S.-Mexico border and Jordan River using this database (Wolf 1997).

Another transboundary database includes the Water Event database which provided events that measured violence conflict and/or cooperation for international river basins from 1948-1999 (Yoffe et al. 2004). The authors categorized events either by “interactions” or “events”. Other databases include the Mekong Legal database which pertained to land, water, and environment in an effort to analyze hydropower in Laos (Suhardiman and Giordano 2014; Suhardiman, Giordano, and Molle 2012), and the U.S.- Canada Transboundary governance database with governance mechanisms starting from the 1909 Boundary Water Treaties and include treaties, exchange notes, MOUs, MOAs, agreements, and orders (Bakker and Norman 2009).

Oregon State University has another database created specifically to look at transboundary water governance in the Upper Colorado River basin. The Water Events database is comprised of data from media reports of conflict or cooperative events, legal cases dealing with water conflicts, and geospatial data gathered from governmental and non-governmental agencies. Eidem (2008) coded the sources and created a database similar in nature to the Freshwater Transboundary Dispute Database based out of OSU with modifications. The database includes conflict-cooperation intensity, issue types (water quality, invasive species, conservation, drought, flood, ground water depletion, infrastructure

issues, fish passage, instream water rights, water rights, intergovernmental issues, water transfers, and navigation), federal cases, and geospatial data from the Environmental Protection Agency, the U.S. Geological Survey, NatureServe, the Drought Mitigation Center, the U.S. Bureau of the Census and others.

Media data was gathered from Lexis Nexis, while legal data was sourced from Westlaw. Geospatial data came from the sources listed above. The purpose of the database was to understand hydropolitics in the Upper Colorado River Basin, and determine if indicators of cooperation and/or conflict could help managers plan for future conflict.

Due to limitation of time and resources, my research was unable to use a metrics plus approach which utilizes existing data and interviews. I instead dedicate time and resources to collect data using Eidem (2008)'s methodology for the transboundary events database for the Upper Colorado River basin. I fill a data gap by collecting existing resources for the Lower Colorado River basin and sources on salinity in the basin. In the future, this research can be added to efforts to create a comprehensive database for the entire Colorado River Basin.

Table 4. Comparative Framework of Transboundary Databases

Name	Authors	Purpose	Data Input	Framework (Type of Analysis)	Beneficiaries and Scale	Outcomes	Critique(s)	Justice Perspective
Transboundary Freshwater Dispute Database	Wolf et al. (2003)	Better understand conflict and cooperation over international freshwater resources from 1948-1999; includes Yoffe (2004) methodology of assessing conflict and cooperation	Date; riparian countries, and actions associated; basin; summary of incident; intensity using COPDAB scale of cooperation and conflict; type of issue; source of information	The COPDAB scale differentiates categories of conflict and cooperation by an arbitrary set of numbers ranging from level 1, representing the most cooperative events, to level 15, representing the most conflictive events. Level 8 represents neutral events.	Array of spatial and temporal scales	Findings include a list of basins at risk; international water relations from 1948-1999 have been cooperative rather than just conflict; 2/3 of over 1,800 water-related 'events' fall on the 'cooperative' scale of the WEIS. Of the less than one third of events considered conflictual, most are rated only as 'mild' (Zeitoun and Mirumachi, 2008; Wolf et al., 2003).	Leaves no room for cases where cooperation is already established, actors are excluded from treaties, and grievances are ignored (Zeitoun and Mirumachi, 2008)	Justice unacknowledged
U.S-Canada Border Legal Database	Norman and Bakker (2009)	Looks at re-scaling of transboundary governance on US-Canada border	34 interviews and closed and open-ended questionnaires from water management professionals and local stakeholders from United States and Canada; facilitated workshop with 26 stakeholders from government and nongovernment; database with 100 years of formal and informal instruments related to binational water quantity and quality issues	Data was organized by geographical region, types of governance mechanism (treaty, exchange of notes, memoranda of agreement, agreements, orders), institutions, and temporally, 166 government instruments were identified; data was also peer-reviewed by 30 experts	Nation-state, and local actors	Although a significant increase in local water governance activities has occurred since the 1980s, this has not resulted in a significant increase in decision-making power at the local scale, nor has it been accompanied by a 'hollowing out' of the nation-state. Rescaling is not necessarily positive or empowering for its supposed beneficiaries due to lack of commensurate power and resources		Justice unacknowledged
Legal database for Mekong River	Suhardiman (2014)	Analyses how power structures shapes the dynamics of natural resource management in the Mekong; highlights existing inconsistencies and institutional discrepancies in land, water, and environmental policy related to hydropower and illustrates how they are manifested in multiple decision-making frameworks and overlapping legal orders	In-depth case study research was conducted from May 2010 to June 2011 in the Lao PDR, Cambodia, and Vietnam focusing on power interplay in Mekong hydropower development in Lao PDR; reviewed existing policies and legal frameworks in land, water, and environment related to hydropower development; looked at donor-driven policies and legal frameworks that can convey conflicting messages; interviewed 11 staff members from various donor agencies; reviewed existing procedures for hydropower project design, construction, and operation and interviewed 14 staff members from the key hydropower companies in the country; 15 reviewed Environmental Impact Assessments , 5 Resettlement Action Plans , and feasibility studies report, monitoring and evaluation reports; interviewed key staff in the electricity industry and ministries of forest and natural resources; used institutional analysis to map the national-level (sectoral) decision-making landscape; interviewed 38 government officials with direct links to private developers and 15 civil society groups working in Laos	Analyzes the process of state restructuring by looking at how the incorporation of international donors' development agenda into national policies and legal frameworks interferes with and "restructures" the power relationship between the central and the administrative states; discusses how legal plurality reshaped the state's boundaries, and provided room for the central state to facilitate and achieve its own development goals and objectives	State, international donor, and private-sector actors	The state used contradictory mandates and interests to further its goals. In order to meaningfully apply socioenvironmental safeguards in hydropower development, international donors must link safeguards with central state development objectives, and its strategic means to achieve those objectives, rather than imposing them through aid and efforts to build capacity.		Justice unacknowledged
Water Events Database	Eidem (2008)	Looked at spatial distribution and conflict and cooperation in the Upper Colorado River Basin from 1970 - 2005; range and change of water issues across space and time; if there were indicators of conflict or mechanisms that foster cooperation	Media data was gathered from Lexis Nexis and coded by cooperation and conflict intensity and events were classified by type of issue; legal data was sourced from Westlaw and coded by litigation or ruling. Geospatial was collected assigned to units related to population growth, drought frequency, water quality (EPA impaired waters), mean annual precipitation, number of endangered species, and ground water usage.	Summary statistics on variables, conflict-cooperation intensity, and stakeholders involved in events, then mapped with weighted average intensities in ArcMap to look at spatial patterns; non-parametric multiplicative regressions to test spatial correlations between independent variables and weighted average intensities; qualitative timeline analyses; and analysis of relationships between stakeholder groups	Upper Colorado River Basin (18 total), businesses, environmental groups, citizens, local government, state agencies and federal government, etc.	Interactions in the basin tend to be cooperative across scales and within the state of Oregon. Drought and groundwater withdrawals heavily influence conflict or cooperation.		Justice unacknowledged

Study Region

There are three major watersheds in these two regions, the Lower Colorado, Imperial Reservoir and Salton Sea Watersheds. There are two major border-states from the US and Mexico sides that are within the Colorado River Basin. The California-Baja and Arizona-Sonora borders. There are large cities in Baja California such as Tijuana, Mexicali, and Ensenada which will be included in this research. These cities are dependent on Colorado River flows and are considered stakeholders in the transboundary water governance regime.

The Colorado River Basin is a viable case study because it is a transboundary river basin between the United States and Mexico, and for its rich history and development in transboundary water governance. I detail the long history of binational work such as flow, salinity, ecological development, agriculture and various other issues. Entities within the basins have received millions of dollars so far, and are adept to receive more. These funds have been used in a multitude of projects with diverse stakeholders.

The US-Mexico border contributes to ongoing work at Texas A&M University on transboundary water science and management work. Since this is a secondary literature study, the extensive development already in place in the basin provided an abundance of primary and secondary sources from which to build a transboundary database.

I evaluate salinity management in the Colorado River Basin since it is a transboundary issue that has been considered a successful example of binational effort. However, salinity is a transboundary topic that continues to pose challenges in the future management of the river despite ongoing efforts. Through my preliminary search, I was able to identify multiple stakeholders and narratives that ran counter to the idea that salinity was being effectively managed. I was also interested in how the benefits of salinity management

was being distributed to stakeholders in the basin given the high cost of federal salinity control programs.

Data and Methods

My overall research objective is to test the efficacy of Zeitoun et al.'s (2014) transboundary water justice framework through an empirical analysis on how salinity is managed in the Colorado River Basin. I began by reviewing multiple transboundary frameworks and analyses to determine a methodology that will embody themes and concepts outlined in the transboundary water justice framework and to engage with the field at large. Next, I evaluated how databases have been created to aid transboundary research and review the methodology used to create these databases. In this chapter I outlined my objectives, study region, and methodologies to accomplish this analysis. I then outlined how I created my own database through the collection of primary and secondary data, performed a systematic search on terms related to salinity, and coded these documents using Zeitoun et al.'s (2014) framework.

Objective One

My first objective is to describe transboundary water governance in the Colorado River basin. In this section, I provide a timeline of transboundary water governance and outline current issues. I detail why the basin is touted as a case study of “good governance” that stands to be evaluated with a justice perspective. In this objective, I also identify transboundary arrangements, key stakeholders, institutions, and projects, which is the first step of Zietoun et al.'s (2014) Transboundary Water Justice Framework.

Through this preliminary search over all issues in the basin, I am able to pinpoint salinity as a representative case study to measure justice in the basin. Through my literature search, salinity was considered a successful cooperation between the U.S. and Mexico and yet there remains many unresolved issues as detailed in Mumme and Taylor (2014). My original intent was to study salinity management, Native American water rights, and the Colorado River delta restoration, however upon completing objective two the salinity case was determined to be so expansive it deserved its own analysis using the transboundary water justice framework.

In order to achieve this objective, I use archival, secondary data, and peer reviewed articles to understand why the basin is seen as a good example of water governance but why it should still be analyzed from a justice perspective.

Objective Two

My second objective is to apply the transboundary water justice analysis in the Lower Colorado River Basin using the Zeitoun et al. (2014) transboundary water justice framework. In order to achieve this objective, I systematically review news sources from *Lexis Nexis*, and state and federal legal cases and regulations from *Westlaw*. The systematic review process is similar to Özerol et al. (2018), which is useful when trying to synthesize trends and abstracts in large bodies of literature. The review is a multi-step process which includes data searching, data cleaning, and reviewing the full-text (Özerol et al. 2018). I frame a question related to my objective which entails identifying search terms that accurately and comprehensively search for all relevant data. I then consult with the Texas A&M Librarian to ensure I was accurately using the correct search terms and databases for this research.

objective and rely on databases similarly used in the transboundary database from Eidem (2008) and the transboundary freshwater disputes database from Wolf (2003). I then review all sources again and conduct a preliminary coding analysis to determine if a source should be entered into the database. I then create a keyword catalogue with relevant justifications using Zeitoun et. al's (2014) framework and code concepts using the MAXQDA program and then perform a content analysis on all materials determined relevant to my research objective.

I create my transboundary database through the following steps. My *first* step was to systematically identify news sources, legal cases, and regulations. I collected news, federal and state cases and regulations from *Lexis Nexis* and *Westlaw* and then coded documents using a direct content analysis approach in MAXQDA. I used specific search terms such as “Lower Colorado River AND Salinity” and found 154 news results from *Lexis Nexis*, 35 federal and state cases from *Westlaw*, and 51 regulations from *Westlaw* (Table 5).

Table 5. Data Results and Sources

Type of Source	Database	Total Cases	Verified	Timeline
News Results	Lexis Nexis	154	95	1979-2018
Federal and State Cases	Westlaw	35	11	1931-2018
Regulations	Westlaw	51	24	Presently Effective

My second step was to verify each document. I went through each source and identified the source by year, type of document, source, relevancy, and citation. During this step, keywords were searched in the document such as “lower Colorado” or “Colorado river” or “salinity” or “saline” or “salt,” to verify the relevancy of the document. Documents that

did not meet these criteria are not included in the case study research. Sources where the content was identical were deemed a replicate and removed from the dataset. After using this preliminary coding process there were 95 news results, 11 federal and state cases and 24 relevant regulations (Table 5).

My third step was to use Zeitoun et al.'s (2014) Transboundary Justice Framework and implement the steps outlined in the framework. News sources, legal cases, and regulations were coded by (1) Scale (International, National, State, Local) (2) Stakeholder Justice Perspective (Egalitarian, Utilitarian, Libertarian) (3) Justice Goals (Equitability, Environmental Sustainability, Efficiency) (4) Means of achieving goals (Securitization or Politicization) (5) Legal mechanism (Laws, minutes, acts, treaties). Additionally, stakeholders were identified as either farmers, businesses, tribes, citizens, academia & research, NGOs, local government, national government, international. A keyword catalogue was created to help guide coding and outline concepts, category, and justification for the code (Table 6). I used MAXQDA to code documents using the following keyword catalogue and organize key events and analyze the role and goals of stakeholders in the basin.

Table 6. Keyword Catalogue

Concept	Categorization	Justification
Timeline	Year	
Document Source	Primary/Secondary	
Relevant Information	Issue/Outcome/ Background Info	
Scale	International/National/State/ Local	
Means of achieving Goal	Securitization	Is a speech act that legitimizes a state to take exceptional measures over an issue by propelling it into the realm of security (Burzan et al., 1998, Zeitoun & Warner, 2006). Securitization facilitates politicians' ability to "construct knowledge" around any water-related issue to fit other political interests. Securitization is a discursive tactic that may serve to legitimize water resources development and lead to water-sharing agreements, though the quality of cooperation (in terms of equitable allocation of the flow or decision-making) can be questionable. Waging water conflicts states employ words and ideas ahead of actual violence, through securitization
	Politicization	Politicizing an issue can serve as a way to get an issue onto the agenda. In situations where there is real power asymmetry among formal equals, the capacity to exploit the asymmetry effectively towards unilateral or multilateral ends has been labelled the hegemon's prerogative (Zeitoun et al., 2011)
Stakeholder	Farmers, Businesses, Tribes, Citizens, Academia & Research, NGOs, Local Government, National Government, International	
Justice Perspective	Egalitarian	Defined by Amartya Sen as seeking equitability in opportunity of distribution and access
	Libertarian	Individualism/Libertarian in this case justice is meted out to those who have earned it and with limited role of government in society; no re-distribution should be allowed as that is an example of impinging on an individual's rights (Robert Nozick). Libertarians may see more water devoted to the most efficient sector or user.
	Utilitarian	Utilitarianism defined as John Stuart Mill as seeking maximum benefit for society as a whole at the cost of a few. Libertarians may see more water devoted to the most efficient sector or user
Type of Arrangement/Mechanism of Justice	Informal Agreement, Minute, Treaty, Act	

Table 6. Keyword Catalogue (continued)

Concept	Categorization	Justification
Goal Assumption	Efficiency, Environmental Sustainability, Equitability	
Participation Quality	None, Minimal, Structural	Procedural Justice
Participation	Required and Not Executed, Required and Executed, Not Required but Executed	Procedural Justice
Other	Upstream and Downstream Issue, Infrastructure, Redistribution of Benefits	

Objective Three

My third objective is to test the efficacy of the framework by applying content analyses to three cases pertaining to salinity on an international, national, and local scale. In order to achieve this objective, I conduct a content analysis to three representative cases on salinity using the MAXQDA program. I test the efficacy of the justice framework and determine if salinity management is considered a product of good transboundary water governance in the Colorado River Basin.

Focusing on each case study, I aggregate stakeholders, stakeholder perspectives, goals, types of participation, and mechanism of justice relevant to the case study and scale. Although scale was not explicitly identified in the Zeitoun et al. (2014) Transboundary Water Justice Framework, I found it relevant to my analysis based off of the findings from Mumme and Taylor (2014) when they analyzed salinity using two case studies from the international and local scale. My case studies are separate from the main analysis detailed in Mumme and Taylor (2014). In review, the methodology to accomplish objectives two and three are laid out in the flowchart (Figure 1).

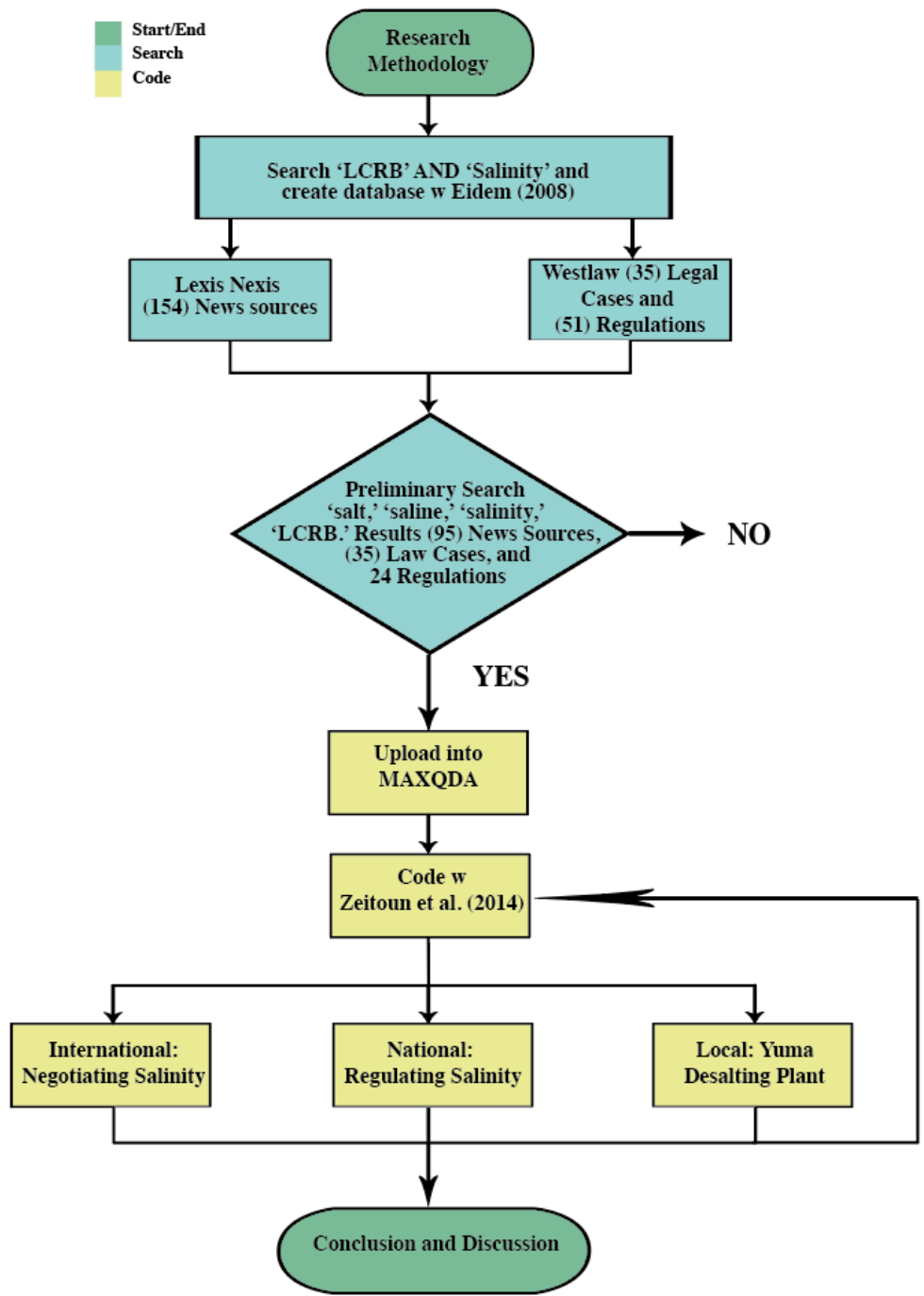


Figure 1. Methodology Flow Chart

CHAPTER IV: DESCRIPTION AND STAKEHOLDERS IN THE COLORADO RIVER BASIN

Previous research on transboundary issues between the United States and Mexico have addressed border environment, water allocations, climate adaptation, delta restoration, population growth and industrialization (Getches 1997; Brown et al. 2003; Garrick 2015; Gerlak 2015). Among these topics, it has been especially challenging to address issues related to declarations of indigenous and nonstate actors in decision-making processes and ecosystem management (Birdsong 2011; Starks and Quijada 2016). In the case of the Colorado River, optimistic supply scenarios were used, which results in allocation decisions with unintended locked-in consequences. Stakeholders within the basin deal with these issues till this day. This chapter reviews research previously done in the Colorado River basin.

In this chapter, I first argue that the Colorado River Basin serves as a unique and ideal case study transboundary water justice because: (1) there has been substantial research done already allowing the opportunity to understand dynamics between stakeholders; (2) there are multiple transboundary arrangements, stakeholders, and issues that remain challenges; and (3) there has been a lack of research done to understand justice in the basin in the context of the aforementioned studies and challenges, which is what this thesis intends to examine. Second, I provide an overview of the current state of the basin and future challenges, and in the final section, I review the water governance of the Lower Colorado River Basin in terms of salinity to place my analysis of transboundary justice in context of water quality.

Good but not Just Governance

Although there are substantial challenges in the Colorado River, it has been touted as a model for transboundary water governance. It is considered a model for mitigating extreme events through projects such as the “Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations of Lake Powell and Lake Mead,” which establishes specific guidelines for reducing water deliveries among the seven Colorado Basin states under drought and low-reservoir conditions (Cooley and Gleick 2011). Another example of collaboration includes the creation of the San Diego Association of Governments (SANDAG), organized of regional universities, staff at the Border Environment Cooperation and Commission, and non-governmental stakeholders (Brown et al. 2003). Additionally, the US-Mexico border is seen as an example of good governance due to resolved differences despite asymmetrical power and economic and cultural disparities (Milich and Varady 1999). For example, the Border Environment Cooperation Commission (BECC) and the North American Development Bank (NADB) are referred to as a model example to create a path toward sustainable development, transparency, promoting social equity, and looking beyond physical solutions (Milich and Varady 1999). Other binational successes have also included the creation of minute 318, to store water after infrastructure damage in the Mexicali Valley, and minute 319 to allocate water to the Colorado River Delta (Mumme 2016). There have been examples of good transboundary governance, but it is by no means perfect; there remains challenges that have yet to be adequately addressed in the basin.

The creation of the International Boundary Water Commission (IBWC) has gone through phases of effectiveness. Ingram, Whiteley, and Perry (2008) found that the IBWC has failed to address problems before becoming critical, being environmentally insensitive,

and excluding state and local governments and nongovernmental organizations from decision-making processes (Ingram and White, 1993). Another criticism of the IBWC is the use of technical/physical solutions versus regulatory/policy solutions. They have been called to be more responsive to the public and the changing environment as well coordinating with other domestic agencies (Mumme 1993; Mumme 2005). There is a need for internal reform on how the IBWC conducts its administrative operations and their mandate to creating binational water policy (Mumme and Little 2010). The issue of the All-American Canal (AAC) case also shows that power asymmetries still exist as sovereignty and claims under the 1944 Treaty were used in favor of the US (Mumme 2016).

The border remains a contentious issue from a hydro-political perspective as well, “considerable inter-governmental and intra-governmental challenges exist within a growing public awareness of regional water resource management issues” (Brown and Mumme 2000). In the U.S.’s early planning efforts, Brown and Mumme (2000) cited a high-ranking official’s worry of U.S. governmental agencies ““put[ing] a wall around our problems in Mexico.”” Sanchez (2014) also found that water problems at the border have outgrown the jurisdiction of IBWC due to their reluctance with accepting public participation. Mumme (2017) also outlines how equity and equitable obligations were achieved when water salinity was addressed in the Colorado River Delta using the substantive principles of reciprocity, fidelity, reliability, and flexibility. Mumme (2017) finds that equity is central to water governance, yet is elusive, contradictory and situational in practice. Although there have been many collaborative efforts between the two countries since this research, recent discussions of building a border wall brings concern back up in water-related issues.

Transboundary governance intersects with geopolitical concerns with the U.S. border management overall, environmental controls, and safety. U.S.-Mexico border disputes include economic, environmental, health, and safety issues, such as the disposal of wastewater within the Tijuana River Watershed in the Tijuana-San Diego section of the border. Through a binational effort, resources were used to help treat wastewater and dispose of it safely between the two countries, however it is reported that resources and capabilities were actually not divided equally on the border. Brown et al. (2003) noted that if water resource became scarce, San Diego would be well equipped to find other sources of water while Tijuana's options are much more restricted, which underlines the power asymmetries between the two countries. Another challenge pertains to Mexico's occasional inability to meet water deliveries on the Rio Grande (Fischhendler, Feitelson, and Eaton 2004). As per minute 308, Mexican emergency water deliveries in the Rio Grande are indeed tied to their ability to receive aid money from the North American Development Bank (NADB) (Fischhendler, Feitelson, and Eaton 2004). Researchers have recommended to Mexican institutions to strengthen community participation, openness, transparency, and accountability by water authorities to help deal with the power asymmetries between the U.S. and Mexico (Sánchez-Munguía 2011).

Other research in the Colorado River basin includes ways to bring ecosystem services across borders (López-Hoffman et al. 2010); restoring the Colorado River Delta (Postel, Morrison, and Gleick 1998; Pitt et al. 2000; Medellín-Azuara, Lund, and Howitt 2007; Glenn, Flessa, and Pitt 2013; Bark, Frisvold, and Flessa 2014); and the role of urban water conservation to adapt to freshwater scarcity and variability in US transboundary river basins in times of drought (Garrick 2017). Studies have also looked at water governance across the

borders of Mexico, Canada and the U.S. to understand adaptive measures for drought by recognizing the “level of centralization and institutional mechanisms for power sharing, conflict resolution, information gathering and sharing and fiscal arrangements” (Garrick 2017).

Castle et al. (2014) found that losses in freshwater during a 108-month study period were greater in the lower Colorado River basin than the upper basin and declined at a faster rate. The study also found significant interactions between surface water and groundwater depletion as many other authors have suggested (Sánchez 2006; Castle et al. 2014). The authors emphasized that in order to successfully manage the Colorado River Basin, a consideration of surface water supplies and groundwater depletion needs to be considered. Even beyond the border, management of transboundary resources become pertinent. Ecosystem services, particularly through the protection of the long-nosed bats and the North American Monarch Butterfly, serve as a foundation for potential transboundary conservation policy due to the mutual interests vested in each of these species (López-Hoffman et al. 2010). In order to create a framework for ecosystem-based policies, the mutual interested need to be aligned and new institutions, legal structures, and payments are needed for such services to be protected (López-Hoffman et al. 2010).

It has even been contested on whether a comprehensive river basin management is the most appropriate unit of scale for effective water governance (Huffman 2009). Instead, a “rights-based institutions scaled to the physical and social circumstances of particular water supplies are far more likely to succeed” (Huffman, 2009, pg 148). In these cases, individual and community rights will be more predictable allowing for economic development and environmental protection, and conflict resolution between private and public interests.

Thus, while many researchers acknowledge the excellent binational efforts already done in the watershed, there is still a need to better understand the role of infrastructure, surface and groundwater interactions, and issues of justice.

Overview

The Colorado River flows through seven states (Arizona, California, Colorado, Nevada, New Mexico, Utah, Wyoming) and supplies water to multiple major cities as well as areas outside the basin. The river is 1,450 miles long beginning from the headwaters in Colorado, fed by snowmelt from La Poudre Pass in the Rocky Mountains, and ends in the Gulf of California in Mexico. It is the most regulated river basin in the world through the use of prior appropriation laws, and more specifically “The Law of the River.” In addition to providing municipal supply, agricultural irrigation, and hydropower, there are multiple reclamation facilities on the river (Bureau of Reclamation 2015). The original apportionment of supply for use is 15MAF, however, a ten-year average from 1934 to 1984 showed major deficits between historical flow and actual flow (Law of the River Report Card, King 2012).

Historical Use

The Colorado portion of the Colorado River includes the mainstem Colorado River and headwater rivers: Eagle, Roaring Fork, Blue, Yampa, Green, and Gunnison. The basin is home to trout fisheries, paddling, and scenic landscapes. The resort areas of Winter Park, Breckenridge, Aspen, Steamboat Springs, Crested Butte, and Vail, as well as much of the urban Front Range (on the other side of the Continental Divide), all get some or all of their drinking water from these rivers. The Upper Colorado River Basin is home to 14 native fish

species, including several fish listed as endangered. (American Rivers 2018). Water rights are based on a total of 15MAF with upper basin states being allocated 7.5 MAF. The lower Basin states are allocated 7.5 MAF through the river of the law with 4.4 MAF for California, 2.9 MAF for Arizona and .3 MAF for Nevada. Indian reservations are allocated 1.0MAF which is, “counted against the shares allocated to the states in which the reservations are located” (Report Card 2012). Through the 1944 Water Treaty act with Mexico, 1.5MAF (1.7MAF in a year of surplus) is delivered to Mexico. In years of drought, the amount allocated is reduced in proportion to U.S. consumptive uses.

Lower Colorado River Basin

The transition from the upper basin to the lower basin is marked at the Lee Ferry below Lake Powell in northern Arizona (American Rivers 2018). Arizona, California, Nevada, and Mexico are considered the lower basin states. The Lower Colorado River Basin is allotted 7.5 MAF, however, with multiple water users, growing populations, and issues of less reliable flows in the past the lower basin overuses approximately 1.2 MAF per year (American Rivers 2018). The lower Colorado river includes the Salton Sea Watershed, the Lower Colorado Watershed, and the Imperial Reservoir watershed. Major cities in the lower basin depend on flows from the CRB such as Bullhead City, AZ, Needles, CA, Lake Havasu City, AZ, and the Southern California Metropolitan, which include the counties of Imperial, Kern, Los Angeles, Orange, Riverside, San Bernardino, San Diego, San Luis Obispo, Santa Barbara and Ventura. Additionally, there are two major border regions including the California-Baja California border and Arizona-Sonora border with communities and

landscapes that are also dependent on the flow of the river. There are also extensive irrigation agriculture, tourism, and Indian reservations in the Lower Colorado River Valley.

Previous relations between the indigenous nations and communities both within the basin and on the U.S.-Mexico border have been strained at best, since input has not been regularly solicited by these institutions. Indigenous groups in these areas do not have the same access to policymaking discussions on the border. Starks and Quijada (2016) found that U.S. institutions may have more opportunities for participation while Mexican indigenous groups are not allowed to cooperate. These authors caution the use of infrastructure, developing in the midst of Colorado River Basin (CRB) management plans, and its impact on indigenous and non-indigenous lands (Starks and Quijada 2016).

As flow became less reliable over time, issues such as rising salinity levels and concerns over riparian areas, habitat conservation, and endangered species are coming at the forefront of public concern. For example, the disruption of natural stream flows has led to rising salinity levels affecting the water retention of native riparian plants. Ultimately this results in a less natural riparian community and a change in the landscape to more invasive riparian species (Vandersande, Glenn, and Walworth 2001). Additionally, the changing landscape has resulted in loss of many endangered species (Minckley et al. 2003). The needs for environmental and recreational flows in addition to municipal and agricultural needs have presented management challenges that have yet to be solved.

Colorado River Delta

The Colorado River Delta begins when the river meets the Gulf of California. Once home to a burgeoning habitat, the delta is now less than 10% of its original size due to a

reduction in flows from upstream uses such as damming and water diversions for agriculture and municipal water uses (Gerlak 2015). In 1922 the delta was 3,000 square miles; it is now only 250 square miles with depleting populations of shellfish, shrimp and waterfowl and a landscape of invasive species such as salt cedar and cattails (Zielinski 2010). The deterioration of the delta became a binational concern, resulting in the creation of Minute 319 to the 1944 Treaty. The agreement dedicated 158,088 acre-feet of water, 52,696 acre-feet for base flows, to the riparian area and the delta (Gerlak 2015). In March 2013, a pulse flow of 105,392 acre-feet was released from Lake Mead through the Hoover Dam which allowed for restoration in riparian zones, groundwater recharge, and actual flow from the Colorado River to the Gulf of California (Howard 2014).

This pulse flow to the Colorado River Delta (CRD) is heralded as an example of good binational effort. However, Mumme (2016) has made it clear that the collaborative effort is not representative of the relationship with US and Mexico on matters of transboundary water management. During the same time period of the Colorado River Delta negotiations, ongoing disputes occurred over the proposal of the lining of the All American Canal. United States counterparts in Southern California were seeking to reclaim parts of the lower Colorado River flow by lining the All American Canal, however the seepages were claimed to have a big impact on water for Mexican farmers, wildlife, and waterfowl (Mumme 2016). Despite good relations over the Colorado River Delta, the All American Canal became the subject of a contentious debate resorting to sovereignty and “traditional water management politics north of the border asserting water allocations claims under the drawing on the 1944 Treaty” (Mumme 2016). Mumme’s (2016) comparative study highlights a system of water security dominated by sovereign defense through the use of legislative, executive, and judicial power

at the federal and state levels over surface freshwater rights, water development interests, urban and agricultural districts, state water agencies, federal water, develop, and financial agencies in the water policy sector. In this sense, environmental, natural resource agencies, and NGOs have limited roles in transboundary water policy (Mumme 2016). In both the case of the CRD and the All American Canal, non-traditional stakeholders played a significant role in the negotiations. It is questioned whether non-traditional stakeholders may have a larger role in transboundary water management in times of water scarcity and water insecurity on the US-Mexico Border (Mumme 2016).

Transboundary Water Management

The International Boundary Water Commission (IBWC) leads binational efforts in transboundary water management. The IBWC originated from the Convention of 1889 between the United States and Mexico to address water management in the Rio Grande and the Colorado River. Water Agreements between the U.S. and Mexico started during the Treaty of Guadalupe Hidalgo and was later constitutionally determined by the 1944 Water Treaty. The 1944 Water Treaty determined the “Utilization of Waters of the Colorado Rivers an the Rio Grande” and mandated an annual delivery of 1.5 million acre-feet of Colorado River to Mexico. It also established a hierarchy of use of water: (1) domestic and municipal uses, (2) agriculture and stock raising, (3) electric power, (4) other industrial uses, (5) navigation, (6) fishing and hunting, and (7) any other beneficial uses that may be determined by the Commission (Gerlak 2015). When the IBWC makes a decision under the 1944 Treaty, it is recorded as a minute. There are over 300 minutes to the treaty accepted by both the US and Mexico (Table 7).

Table 7. International River Basin Specific Projects and Associated Minutes from IBWC.

IBWC	Colorado River Salinity	218, 241, 242, 248, 316, 317, 318, 319, 322
IBWC	Morales Dam	189, 195, 197, 208, 209, 211, 221, 291
IBWC	All American Canal	185, 188, 191, 194
IBWC	Colorado River Clearing	217, 291
IBWC	Colorado River deliveries	185, 188, 189, 191, 194, 195, 197, 208, 209, 211, 21, 240, 243, 246, 252, 256, 259, 260, 263, 266, 267, 280, 287, 306, 310, 314, 317, 318, 319, 322
IBWC	Maritime boundary (Fishery Zone)	229
IBWC	Yuma desalting project	242
IBWC	Tijuana Emergency deliveries	240, 243, 246, 252, 256, 259, 260, 263, 266, 267, 281, 287, 310, 314, 322
IBWC	Tijuana Flood control project	225, 236, 258, 320
IBWC	Tijuana sanitation	222, 240, 270, 283, 296, 298, 311, 320
IBWC	Sanitation	206, 216, 220, 222, 227, 240, 261, 264, 270, 273, 274, 276, 279, 283, 288, 289, 296, 297, 298, 310, 311
IBWC	Border Sanitation	206, 216, 220, 227, 240, 261, 264, 270, 273, 274, 276, 279, 283, 289, 294, 295, 296, 297, 298, 299, 310, 311
IBWC	Wellton-Mohawk Bypass Drain in Mexico	248, 284, 316, 319
IBWC	Rosarito-Otay	319
IBWC	Puerto Penasco-Arizona	319

Under the 1983 La Paz Agreement, issues such as water quality, biodiversity, and border area conditions were developed. For example, the agreement on Cooperation for the Protection and Improvement of the Environment in the Border Area, created under the La Paz Agreement, further led to the Border 2020 initiative, which deals with the environmental and public health along the U.S.-Mexico border. Another example of cooperative effort includes the earthquake that damaged water infrastructure in the Mexicali Valley. The U.S. made an agreement to store the water in Lake Mead and was considered a successful treaty

negotiation with ecological concerns within the scope of the 1944 Water Treaty (Mumme 2016). The North American Free Trade Agreement (NAFTA) and the NAAEC (North American Agreement on Environmental Cooperation) also have measures to protect the environment and public health on the US Mexico border regions as well.

The Colorado River is governed by the 1944 Water Treaty but fundamentally, politically, and institutionally separate from the management of the Rio Grande River. For example, Mexico controls most of the deliveries on the Rio Grande whereas the U.S. control the deliveries to Mexico. The management of the separate basins showcases the weak linkage between the binational management of transboundary water in the two basins (Mumme 2016). The IBWC has been said to be secretive, monopolistic over border resources data acquisition, and unable to resolve environmental issues (Gerlak 2015). The IBWC continues to face economic asymmetry and social inequality over the U.S.-Mexico border, and additional complex water management challenges over the Colorado River and Rio Grande (Sanchez-Rodriguez and Mumme 2013; Gerlak 2015).

The Bureau of Reclamation

There are 20 infrastructure projects, three power plants and 17 dams in the Colorado River basin, which are managed by the Bureau of Reclamation. Basin wide projects include the Colorado River Basin Project, Colorado River Basin Salinity Control, Coachella Canal Unit, Yuma Desalting Complex Unit and Protective & Regulatory pumping units. These projects were implemented in two phases. The purpose of phase one was to document past projects and consider future projects to meet water demands and face water challenges in the basin.

The Bureau of Reclamation, in partnership with stakeholders and basin states, have begun to propose projects to help meet demands such as water banking, water supply augmentation, watershed management, the Colorado River Basin Ten Tribes Partnerships Tribal water study, climate science research, data and tool development. Other considerations also include agricultural water conservation, Municipal and Industrial (M&I) water conservation, energy water-use efficiency. These options have a potential yield of 1,238,00 AFY (table 8). Although much timelier and costlier, other supply side projects include ocean and brackish water desalination, wastewater reuse and water imports for more challenging water supply conditions. These options have a potential yield of 1,358,000 AFY (table 9). The Bureau of Reclamation has three major workgroups which serve to deal with municipal and industrial uses (M&I), agricultural uses, and environmental flows.

Table 8. Summary of Options and Potential Yields from the Bureau of Reclamation (Moving Forward, 2015)

SECURE Water Act Section 9503(c) Report to Congress

Table 3–1. Summary of Options and Potential Yields by 2035 and 2060

Modified from: Colorado River Basin Water Supply and Demand Study, Executive Summary, Table 2

Option Category	Representative Option	Years Before Available	Potential Yield by 2035 (AFY)	Potential Yield by 2060 (AFY)
Desalination	Gulf of California	20–30	200,000	1,200,000
	Pacific Ocean in California	20–25	200,000	600,000
	Pacific Ocean in Mexico	15	56,000	56,000
	Salton Sea Drainwater	15–25	200,000	500,000
	Groundwater in Southern California	10	20,000	20,000
	Groundwater in the Area near Yuma, Arizona	10	100,000	100,000
	Subtotal		776,000	2,476,000
Reuse	Municipal Wastewater	10–35	200,000	932,000
	Grey Water	10	178,000	178,000
	Industrial Wastewater	10	40,000	40,000
	Subtotal		418,000	1,150,000
Local Supply	Treatment of Coal Bed Methane-Produced Water	10	100,000	100,000
	Rainwater Harvesting	5	75,000	75,000
	Subtotal		175,000	175,000
Watershed Management	Brush Control	15	50,000	50,000
	Dust Control	15–25	280,000	400,000
	Forest Management	20–30	200,000	300,000
	Tamarisk Control	15	30,000	30,000
	Weather Modification	5–45	700,000	1,700,000
	Subtotal		1,260,000	2,480,000
Importation	Imports to the Colorado Front Range from the Missouri or Mississippi Rivers	30	0	600,000
	Imports to the Green River from the Bear, Snake ¹ , or Yellowstone Rivers	15	158,000	158,000
	Imports to Southern California via Icebergs, Waterbags, Tankers, or from the Columbia River ¹	15	600,000	600,000
	Subtotal		758,000	1,358,000

Table 9. Potential Yield of Other Type of Projects from the Bureau of Reclamation (Moving Forward, 2015)

Option Category	Representative Option	Years Before Available	Potential Yield by 2035 (AFY)	Potential Yield by 2060 (AFY)
M&I Water Conservation	M&I Water Conservation	5–40	600,000	1,000,000
	Subtotal		600,000	1,000,000
Agricultural Water Conservation	Agricultural Water Conservation	10–15	1,000,000	1,000,000
	Agricultural Water Conservation with Transfers	5–15	1,000,000	1,000,000
	Subtotal		1,000,000²	1,000,000²
Energy Water Use Efficiency	Power Plant Conversion to Air Cooling	10	160,000	160,000
	Subtotal		160,000	160,000
System Operations	Evaporation Control via Canal Covers	10	18,000	18,000
	Evaporation Control via Reservoir Covers	18	200,000	200,000
	Evaporation Control via Chemical Covers on Canals and Reservoirs	15–25	200,000	850,000
	Modified Reservoir Operations	15	0 – 300,000	0 – 300,000
	Construction of New Storage	15	20,000	20,000
	Subtotal		588,000³	1,238,000³
	Total of All Options		5,735,000⁴	11,037,000⁴

AFY = acre-feet per year

¹ Among the more than 150 options received by Reclamation and deemed responsive to the *Plan of Study*, additional importation of water supplies from various sources, including from the Snake and Columbia River systems, were submitted. Such options were appropriately reflected in the Basin Study but did not undergo additional analysis as part of a regional or river basin plan or any plan for a specific Federal water resource project.

² The two agricultural water conservation representative options derive potential yield from similar measures and are thus not additive.

³ Subtotal assumes 150,000 AFY for the Modified Reservoir Operations representative option.

Note that the potential adaptation strategies listed in the table are organized by category. Total does not account for several options that may be mutually exclusive due to regional integration limitations or are dependent on the same supply.

Municipal and Industrial Water (MI&I)

The Municipal and Industrial Water workgroup is tasked to understand water conservation and reuse in the basin. Since 2000, water use has remained stable or decreased due to ranging water conservation and reuse programs in major metropolitan areas, despite major population increases and future population project. Decrease in per capita water use

has significantly impacted these numbers including economic, social, and behavioral changes when the worst drought in 100 years happened in the last decade in the basin. Current and planned water conservation and reuse programs estimate around 700,000 AFY of water and an additional 400,000 AFY by 2030. Programs include metering and billing, public outreach, and residential indoor and outdoor landscape practices. Water reuse is also considered depending on geographic, legalities, and regulatory considerations. However, it is understood that conservation and reuse cannot solely be relied on to supplement additional water to displace water use in the Colorado River Basin, but rather these conservation measures are usually used to supplement future growth and demand. Cost of implementing these programs will depend on the extent of how much these programs have already been adopted, cost of the existing and new supplies, public acceptance, laws and regulations, and etc. Despite all this, it is known that municipal water users in the basin will more often than not use their full water entitlements from the Colorado River Basin.

Agricultural Water

Agricultural water use is approximately 70% of total use in the basin, and changes to the industry can be timely and costly. The workgroup has considered best management strategies such as conveyance system improvements, which may result in on-farm efficiency improvements and consumptive use reductions, however, the extent of implementation will vary across geographies and producers. Water savings are usually the result of increased productivity, “water use per acre has remained relatively constant historically while productivity has increased basin-wide by about 25 percent since 1980” (Bureau of Reclamation 2016). The bureau found that “increases in on-farm efficiency result in more

uniform application of water and may improve productivity” but may not result in consumptive use reduction if the water saved is used to increase productivity or by a downstream user. Thus, the potential for water savings varies highly by locations and can be in or out of the hydrologic basin itself (Bureau of Reclamation 2016).

Environmental and Recreational Flows

The Bureau of Reclamation has funded or participated in activities such as cost share programs, coordinating reservoir operations, participating in species recovery and habitat conservation programs, and conducting stakeholder engagement in the basin. An example of this type of activity includes the negotiation of minute 319 through the IBWC. Minute 319 established a concern over the sharing, conservation, and storage of the Colorado River. In agreement with Mexico, recognition was given to environmental flows for the Colorado River Delta. This resulted in a one-time event that realized 105,00 acre-feet of water from the Morelos Dam on the U.S. Mexico border resulting in groundwater filtration and flow in the Gulf of California (Bureau of Reclamation 2016). Other Bureau of Reclamation environmental programs include the Glen Canyon Dam Adaptive Management Program, an environmental impact statement (EIS) on the operation of the Glen Canyon Dam, the Upper Colorado River Endangered Fish Recovery Program, the San Juan River Basin Recovery Implementation Program, and the Lower Colorado River Multi-Species Conservation Program.

Ongoing Programs & Activities

A Pilot System Conservation Program (PSCP) was created to fund water conservation projects and studies in the basin. The program was created using \$3 million from reclamation

and \$2 million each from Central Arizona Water Conservation District, the Metropolitan Water District of Southern California, the Southern Nevada Water Authority, and Denver Water for a total of \$11 million dollars. Entitlement holders in the basin are the only ones who can use funds from the program. The overall purpose of the program was to create programs that could help offset declining reservoir levels in Lake Mead and Lake Powell. The program is implemented through two phases. The first phase cost \$9,335,400 to save 63,000 AF towards Lake Mead or \$136/AF (Bureau of Reclamation 2016) (Table 10).

Table 10. Phase One of the Pilot System Conservation Program

Entity	Purpose/Description	AF saved	Cost	\$/AF
Southern Nevada Water Authority	Nevada dedicates water normally used for agriculture from the Muddy and Virign River.	15,000	\$2,250,000	\$150/AF
Bullhead City (AZ)	Evaporation water is accounted for by injecting effluent water into the Colorado River Aquifer over a two-year period	4,400	\$520,000	\$118/AF
Tohono O'odham Nation (TON) (AZ)	Water normally used in the CAP aquifer project was put towards Lake Mead in 2015	10,080	\$2,550,240	\$253/AF
Coachella Valley Water District (CA)	Farmers received rebates for converting up to 667 acres/farmer from flood/furrow to drip irrigaiton. The program lasts for a five-year period in the beginning of 2016.	5,000	\$1,000,500	\$200.10/AF
Central Arizona Water Conservation District (CAWCD) (AZ)	CAP reduced water from their service areas and contribued 25,265 AF, this water will be made up by converting irrigation districts to fallowing, deficit irrigation, or increased use of ocal water supplies	22,265	\$2,509,660	\$99.33/AF
City of Needles (CA)	40 acres of turf will eb removed at the City's golf course resulting in 2,870 AF over a 10-year period	2,870	\$505,000	\$176/AF

Preliminary results show that phase 2 of the program saved \$35,369 AF in Lake Mead totaling to \$5,818,948 or \$164/AF. Other ongoing studies include the Colorado River Basin Water Supply & Demand Study, Climate Research & Development in the Colorado River Basin, Colorado River Interim Guidelines for Lower Basin Shortages, Colorado River Basin Natural Flow & Salt Data, and Open Water Data Initiative Drought Visualization.

Other Organizations

The National Fish and Wildlife Foundation uses public and private funds to restore riparian habitat and freshwater flows under Minute 319. They report to both USIBWC and MXIBWC to allocate funds to local conservation groups to restore the Delta. The goals of this group are to reduce air pollution, improve access to clean and safe water, promote material management and waste management, clean sites, enhance joint preparedness for environmental response, and enhance compliance assurance and environmental stewardship.

NGOs

There are a number of NGOs or organizations interested in the Lower Colorado River and Colorado River Delta. The Colorado River Water Users Association is a non-profit organization that includes member states, the Ten Tribes, and multiple water users interested in agriculture, environment, federal government, Law of the River, power, reclamation, recreation and urban uses. Another program includes the Lower Colorado River Multi-Species Conservation Program (Habitat-based Conservation), mandated through the Endangered Species Act, which includes activities such as habitat conservation, vegetation and habitat, wildlife, and fisheries. There are four fish, twelve birds, four mammals, two reptiles, one amphibian, one insect, two plants under the protection of the program. Another program is the Sonoran Institute, a partnership between the Pronatura Noroeste, The Nature Conservancy, University of Arizona, Mexican National Commission for Natural Protected Areas, Center for Research and Development, and Autonomous University of Baja California. One of the projects in this program is restoring the Colorado River Estuary by shoveling sand into the delta.

There are two other integral organizations that were allowed as non-state members to participate in the management of the Colorado River Basin. The Nature Conservancy helped restore the river delta with funds through the Raise the River project which includes bi-national efforts between ten U.S. and Mexico partnerships working on the timeline of the pulse flow release in the Colorado River Delta. They also helped negotiated Minute 319. Their participation was one of the first times NGOs were a part of the negotiations in binational efforts. Other efforts include monitoring hydraulic and ecologic responses to the pulse flow and the use of time-lapse photography with The Nature Conservancy (Howard 2014). Lastly, the Colorado River Delta Research Coordination Network is a partnership of natural scientists, social scientists and legal scholars interested in studying the Colorado River Delta. This NSF funded Research Coordination Network helped foster collaboration between state and non-state members (Gerlak 2015).

Future Challenges

The Colorado River is a primary source of water for 35 million people in the U.S. and 3.3 million people in Mexico and irrigation water for around 4.5 million acres of land in the U.S. and 500,000 acres in Mexico (Cohen 2011). Half of the amount of municipal water use are from users in southern California, and around 70 percent of all individuals in the basin receiving water from the Colorado River do not live in the watershed. In contrast, municipal water use makes 15 percent of total use, whereas agriculture makes up more than 70 percent in the U.S. (Cohen 2011). Agricultural water use in the Colorado River Basin supports around 15% of the nation's crop and 13% of its livestock (Colorado River Basin Salinity Control Forum 2014). The waters of the Colorado River are governed by the Law of the

River, which uses prior appropriation principles requiring states to either cite beneficial use of their allocation or lose the entitlement. This production yields billions of dollars in agricultural and economic benefits (Bureau of Reclamation 2016). In addition to consumptive needs, there are 22 federally recognized tribes in the CRB with federal reserved water rights in the basin, some of which have unresolved rights claims. The Colorado River Basin is also home to seven national wildlife refuges and 11 national park service units. The basin generates more than 4,200 megawatts to western states reducing fossil fuels through hydropower production. Additionally, a part of the Colorado river is apportioned to Mexico, resulting in annual water deliveries of 1.5 MAF (Gerlak 2015). In short, resources in the basin are extremely scarce.

There is a 10-year average of either no imbalance to an imbalance of 6.8 million acre-feet with a median of 3.2 MAF in 2060. There are also substantial temperature changes in spring and summer with most changes occurring in the Upper basin. Precipitation is expected to decrease in the lower basin but increase in higher elevations such as in the upper basin during fall and winter. Snowpack is expected to significantly decrease due to earlier melt or sublimation of snowpack. Runoff is expected to increase in the Rockies of the upper basin and decrease during spring and summer. Drought lasting 5 years or more is expected to occur 50% of the time over the next 50 years (Bureau of Reclamation 2016). An analysis by the Bureau of Reclamation also indicated shortages over the next 50 years to meet demands if no further management actions are taken in the basin (Bureau of Reclamation 2016). Demand for consumptive uses is expected to range between 18.1 to 20.4 MAF by 2060 due to increased population growth. The lower basin states are expected to have the highest

percentage of vulnerable years between 2041-2060 in comparison to upper basin states. It is clear that without action, demands will not be met especially in the lower basin states.

There is also discussion at both the federal and local levels on seawater desalination projects in Rosarito, Baja California and in Puerto Peñasco, Sonora. Given the water imbalance in the Colorado River and anticipated shortages, entities in Arizona and California have begun to initiate feasibility studies with Mexican counterparts and considered desalination in their water management plans (Wilder et al. 2016). It is unclear if water will be directly exported to upstream states or if water rights will be reallocated, regardless, these systems are beginning to be known as binational desalination systems (Wilder et al. 2016). International water exports are being prioritized even through Minute 319 and now Minute 323, indicating national interest in both Mexico and the U.S (Wilder et al. 2016; Mumme et al. 2017). The immense interest of desalination in the basin brings to light salinity challenges that continue to afflict the basin. Once major conflict between the United States and Mexico, salinity management and governance continue between the two countries. Salinity is uniquely managed by the federal government and impacts stakeholders on the international, national, and local scales.

Governing Salt

The Colorado River Basin has naturally high levels of salt in its water which is further enhanced by agricultural return flows and energy development. Salinity has been an international topic and continues to pose challenges in the future management of the river. High levels of salinity impact agricultural lands, damages water supplies, and causes millions in economic damages; it is a major concern at the international, national and local scales. By

using a justice perspective, we can begin to understand who and how salt is governed, which helps the public keep institutions and individuals accountable on how it is managed. A brief overview on water allocations, sources of salinity, salinity governance and stakeholders involved in salinity can provide insight on how salinity is managed in the Colorado River Basin.

There have been a precedent of decades of tension over the use of the Colorado River until the Colorado River Compact of 1922, which officially designated 7.5 maf for the upper basin states (Wyoming, Colorado, Utah and New Mexico) and 7.5 maf for the lower basin states (California, Arizona, and Nevada) (Nighthorse 1994). The Boulder Canyon Project Act of 1928 officially allocates water in the lower basin states, while the Upper Colorado River Basin Compact of 1948 allocates water in the upper basin states. Water was later allocated specifically between Arizona and California during the decision of *Arizona v. California* in 1963 (Linser 1994).

Sources of Salinity

There are both natural and human-induced sources of salinity that contribute to the overall levels in the Colorado River. Sources of salinity come from saline springs, erosion of salt geologic formations, and runoff; natural sources make up 47% of total salinity, with irrigation, reservoir evaporation and municipal and industrial (M&I) making up the rest (Figure 2) (Bureau of Reclamation 2015).

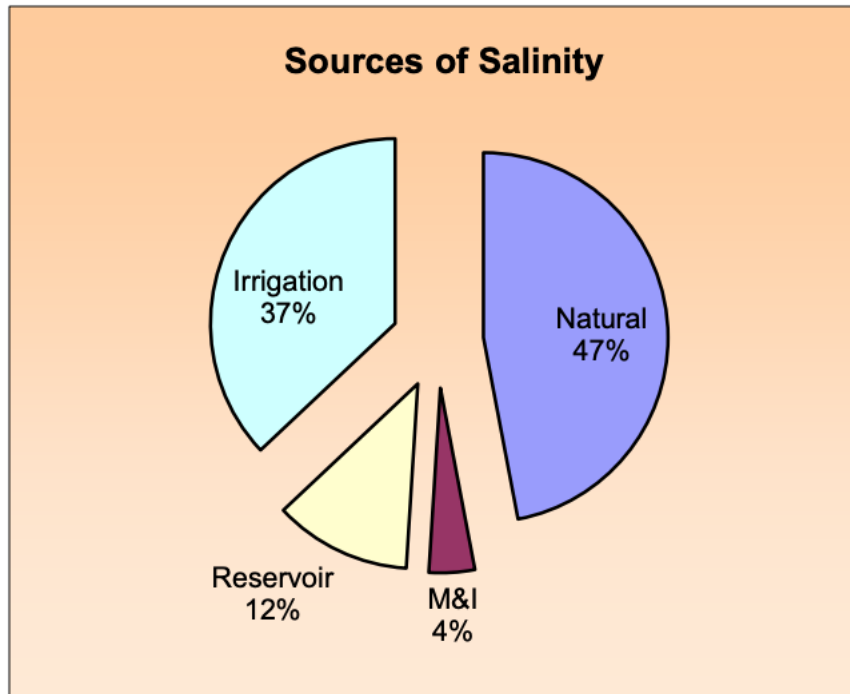


Figure 2. Salinity Sources from a 1971 EPA Report via the Bureau of Reclamation Quality of Water Colorado River Basin Progress Report No. 25 (U.S. Bureau of Reclamation, 2015).

The majority of salinity loading occurs from natural loading in the upper basin and throughout the basin via “salinity pickup,” wherein the amount of water used in irrigation for agricultural uses is less than return flows with the same level of salt, increasing the original salt concentration. Long periods of drought and increasing demand exacerbates the salinity issue. High saline levels in the Colorado River resulted in economic damages, public health concerns, and habitat and land degradation in both the U.S. and Mexico.

The Colorado River serves as an important source of water for agriculture in both the U.S. and in Mexico, since the U.S. is required to send 1.5 maf of water through the 1944 Water Treaty. At the time of the signing of the 1944 Treaty, there were no standards established for water quality. Much of the saline issues are caused by the understanding that Mexico would receive drainage water from the U.S. delivery of water, however in 1961 the

U.S. Bureau of Reclamation began draining a highly concentrated amount of saline irrigation drainage water from the Wellton-Mohawk Valley. This elevated the water delivery to unprecedented saline levels. In 1962, the Mexican government expressed a dissatisfaction with the quality of water it was receiving. The average annual salinity of water delivered at the time was 1,500 mg/L; the exact level of salinity ranges from 1,500-2,700 ppm depending on the source (Prairie et al. 2005, Snape 1998). The EPA estimated that the natural salinity of the Lower Colorado River is actually 334 mg/L (EPA, 1971).

The World Health Organization considers saline water above 1,500 ppm to be unsafe for drinking, meanwhile it was reported that the International Boundary and Water Commission (IBWC) knew that Mexico's water delivery exceeded 2,500 ppm salinity (Ward 2002; Mumme and Taylor 2014). The use of water with high levels of saline from 1961 to 1972 resulted in damages to hundreds of thousands of acres in the Mexicali Valley (Associated Press, Frazier 1979). With over \$100 million already spent by the Mexican government, salt levels remained an issue especially in agricultural lands. After years of negotiations, the U.S. and Mexican Governments agreed to Minute 242 in 1973, specifying an average salinity of no more than 115 milligrams per liter (plus or minus 30 mg/l) future U.S. water deliveries from the Colorado River. Additionally, the U.S. Government established the 1974 Colorado River Basin Salinity Control Act to ensure compliance to the standards set out in Minute 242.

Salinity Governance

Once Minute 242 was signed in 1973, there were many infrastructure and governance structures that had to be put in place in order to guarantee a significant salinity reduction:

1. The U.S. and Mexico agreed that the U.S. would construct a desalination plant to treat the drainage waters from the Wellton-Mohawk Drainage district, to be completed by December 1978.
2. The Wellton-Mohawk drainage would be extended 53 miles to the Gulf of California, to be completed by December 1976.
3. Lining or construction of a new Coachella Canal in California, to be completed by April 1877.
4. Reduction in the Wellton-mohawk district acreated and improved irrigation efficiency, to be completed by December 1978 (Holburt 1975).

The U.S. Congress created the Colorado River Basin Salinity Control Act in 1974 to regulate salinity levels on a national level. Through this program, the federal government has funded around 70% of the costs for salinity control (Getches 1997). As part of the act H.R.12165, the Salinity Control Act I authorizes and directs the Secretary of Interior to work with Mexico and programs downstream the Imperial Dam. These responsibilities included building and operating the Yuma Desalting Plant, extending the existing bypass drainage to carry the reject stream to Santa Clara Slough in Mexico, among other activities (H.R. 12165, 1974). While the Salinity Control Act II directs the Secretary of the Interior to implement salinity control policies with the basin states. The Salinity Control Act II enumerated the salinity control units, created the Colorado River Basin Salinity Control Advisory Council with no more than three members from each basin state, and authorized \$1,155, 500,000 to accomplish these mandates.

Through the Colorado River Salinity Act the advisory council or sometimes referred to as the Colorado River Basin Salinity Control Forum set standards at three key stations in the Colorado River. The current standards are Below Hoover Dam 723 mg/L, Below Parker Dam 747 mg/L, At Imperial Dam 879 mg/L. These numbers are reassessed every three years to ensure efficacy through the Clean Water Act. The Salinity Control Forum's purpose is to regulate salinity and does not set standards for any other pollutants, however it is noted that

federal funds are prioritized when projects can control both salinity and selenium (Regulation 17, 2019). There are increasing concerns due to growth in the development of energy and fuel. Practices used by the energy and fuel industry add to saline levels, and therefore are regulated on a state by state basis. For example, the state of Colorado’s Department of Public Health and Environment requires discharge permits to large operations and small operations if they are associated to larger company efforts.

A diversion canal was built to divert the saline drainage water from the Wellton-Mohawk project significantly reducing the amount of saline water Mexico once minute 242 was signed and actions were made in 1974 onward (See Figure 4).

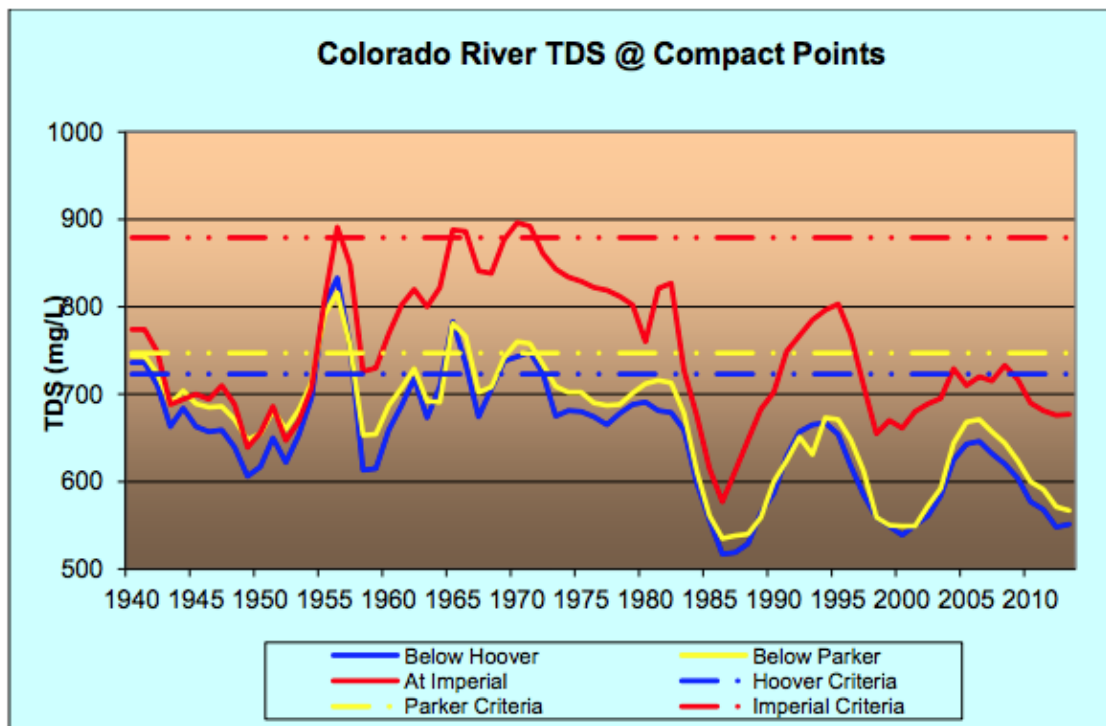


Figure 3. Salinity of Three Basin Compact Points via the Bureau of Reclamation Quality of Water Colorado River Basin Progress Report No. 25 (U.S. Bureau of Reclamation, 2015).

Additionally, various salinity control programs with private agricultural lands and landowners through the U.S. Department of Agriculture's Environmental Quality Incentives Program and the U.S. Bureau of Reclamation's Basin States Program has reduced saline levels as well. The Bureau of Reclamation and the U.S. Geological Survey monitor the flow and salinity of the river through 20 gauging stations (Bureau of Reclamation 2015). In 2002, it was estimated that around 800,000 tons of salinity per year is controlled for through various projects. The goal is to control 1,800,000 tons of salinity by 2020 (Bureau of Reclamation 2015).

Stakeholders, Scale, and Salinity Issues

At the international scale, the American and Mexican presidents dictate these responsibilities and ultimately negotiate treaties and amendments in the form of minutes. The International Boundary and Water Commission (IBWC) serves as the mediator between the two countries. Bernal and Solís (2000) provided a thorough history and lays out the responsibilities of IBWC; with partial roots in the 1848 Treaty of Guadalupe Hidalgo, the IBWC has long been established to mediate interests between the two countries. It was only in the 1889 convention that the responsibilities of applying the boundary was established and then later in the 1944 Water Treaty that water treaties and international agreements were included, effectively making up the responsibilities that IBWC serves today. More specifically they are mandated to preserve the Rio Grande and the Colorado River as an international boundary, protect the lands and rivers from floods, regulate and conserve waters used by the two countries through the construction, operation, maintenance of international

storage dams, reservoirs and hydroelectric plants. They also work to resolve border sanitation and water quality problems.

At the national scale, salinity is governed and regulated by a bevy of federal organizations, all of whom are responsible for controlling salinity levels in the basin (Table 11). The U.S. Secretary of State is responsible for meeting treaty obligations. Under the Secretary of State, the Secretary of Interior manages basin states and is in charge of controlling salinity levels. Representatives and senators of the basin states hold votes that may determine the management and allocation of sources available to manage salinity in the Colorado River basin. It is noted that in the House of Representatives the lower basin states hold 62 votes while the upper basin states hold 13 votes; however, the upper basin holds a majority of votes in the Senate (Getches 1994). The Colorado River Basin Salinity Control Advisory Council was created under Title II of the Colorado River Basin Control Act. The advisory comprises of three members from each basin state who are appointed by the governor of each state. They are to act as liaison between the Secretaries of Interior, Agriculture, and the Administrator of the EPA and states accomplishing the purposes of the Act (USBR, 2019). The council comments and advises on the implementation of the salinity control program.

Table 11. Salinity Stakeholders

International	National	Local
<ul style="list-style-type: none"> • US President • MX President • International Boundary Water Commission (IBWC) 	<ul style="list-style-type: none"> • US Secretary of the State • US Secretary of Interior • US Congress • US Senate • Bureau of Reclamation (BOR) • US Department of Agriculture (USDA) 	<ul style="list-style-type: none"> • U.S. Citizens • Mexican Citizens • Mexicali Valley Farmers • Cienega Wetland

Table 11. Salinity Stakeholders Continued

International	National	Local
	<ul style="list-style-type: none"> • The Colorado River Basin Control Advisory • The Colorado River Basin Control Forum • Environmental Protection Agency (EPA) • United States Geographical Survey (USGS) • Environmental Defense Fund 	

The Colorado River Basin Salinity Control Forum was created by the basin states when the Federal Water Pollution Control Act Amendments of 1972 went into effect. The Forum is separate from the advisory council. The Forum was created to develop water quality standards, numeric salinity criteria, and a basin-wide plan for implementation (USBR, 2003). The forum created the standards at the three key points in the basin, which is then interpreted by the EPA for regulation and USGS for monitoring.

Under the Salinity Control Act, the USDA created their own Colorado River Salinity Control Program and as such are able to receive funds to implement salinity control programs with private agricultural lands. They created the USDA Environmental Quality Incentives Program to provide cost share assistance to landowners to install control measures (Bureau of Reclamation 2019). Under the same act, the BOR were authorized to implement a basin-wide approach to salinity, taking in proposals and funding projects that can most cost effectively implement salinity control programs.

At the local scale, the operation of the Yuma Desalting Plant jeopardizes the existence of the Santa Clara Cienega Wetland. The most involved stakeholders in this case study involve U.S. Farmers and Mexican Farmers, U.S. and Mexican Citizens, researchers from the U.S. and Mexico, and NGOs who advocate and give agency to the local flora and

fauna of the Santa Clara Cienega Wetland. Additionally, although situated on the national and international scales, the IBWC and US Secretary of Interior operate at the local scale due to the maintenance and operation of the Yuma Desalting Plant and Wellton-Mohawk Drainage District.

Stakeholders are involved in management or considered an affected stakeholder of said management at virtually every scale. The proper management of salinity would have to consider stakeholders from all scales, the stipulations of the international negotiation, and meet the goals and expectations of affected stakeholders.

Salinity has been explored in the Colorado River Basin by Mumme and Taylor (2014) where they looked at the implications of decisions made at an international scale and how unintended consequences were felt at a local scale based on those decisions. This discovery brings to light the multi-scalar nature and interconnectedness of salinity in the basin. As stated in the overview of salinity, there are multiple stakeholders and institutions in the basin involved in the management of salinity. It is worth considering if there might be other relationships with unintended consequences, if there is proper representation of stakeholders, and who stands to benefit from salinity management. We can pursue these answers by using Zeitoun et al.'s (2014) Transboundary Water Justice Framework, since it is structured to understand stakeholders' goals through a justice perspective, looks at procedural justice, and can help guide discussions on hydro-hegemonies, securitization and politicization, and mechanisms of justice. Beyond understanding what happened between the U.S. and Mexico during the international negotiation, it is worth considering how those decisions permeated and impacted stakeholders across the diaspora.

CHAPTER V: GOVERNING SALT- TESTING THE TRANSBOUNDARY JUSTICE PERSPECTIVE

The transboundary water justice framework elevates narratives of justice in broader transboundary discussions by addressing unfair international transboundary negotiations and governance arrangements and focusing on the perspective of actors and their capacity to shape the processes that lead to the transboundary arrangement (Zeitoun et al. 2014). This framework takes particular aim at the role of hegemonic actors that can coerce the content of international treaties, employ soft power to present imposed-order regimes as cooperative, and act unilaterally obliging the non-hegemonic states to react (Zeitoun 2013). It is also keen on distributional justice and tradeoffs that might occur, especially if they are skewed in the interests of the state. Even with efforts of distributional justice, if negotiations are perceived as inequitable, social injustice allegations have a claim.

The focus of the first step in the framework is to focus on stakeholder perspectives, claims and goals in various transboundary arrangements. As such, I mapped out transboundary arrangements such as policies and resolutions preferred by stakeholders. Then, I interpreted any assumptions of justice that supported the arrangement. For example, are the arrangements supported by any of the following strands of justice: (a) Egalitarian which seeks equitability in opportunity of distribution and access, (b) Utilitarian which seeks maximum benefit for society as a whole at the cost of a few, or (c) Libertarian which determines justice as earned by those who have earned it and values a limited role from the government in society. I then examined if there are underlying goals behind these stakeholder views, such as equitability, efficiency, or environmental sustainability, and if trade-offs occurred in pursuit of any goal over the other.

The next step is focused on if and how stakeholder goals are enacted either through securitization or politicization, or if they are enabled by mechanisms of justice. Mechanisms of justice include law and formality in basins such as minutes, treaties, and acts which lead or shape transboundary outcomes.

Lastly, it is important to understand the capacity of these stakeholders to shape transboundary outcomes. I use theories of procedural justice and look for evidence of participation or the lack of participation through the following approaches: what is the quality of participation (none, minimal or structural) and the type of participation found (a) required and not executed (b) required and executed (c) not required but executed.

The steps above make up the coding catalogue I created for my analysis. I also coded each source by year, document type, background information, and scale. Motivated by Mumme and Taylor (2014), I wanted to understand if transboundary arrangements had any influence or unintended consequences across scales. All coding was done in MAXQDA and sources were compiled from *Lexis Nexis's* News Sources database and *Westlaw's* Legal Cases and Regulations databases using search terms such as “Lower Colorado River Basin,” “Salinity,” “Salt,” and “Saline.”

After coding commenced, I was able to identify three major case studies, investigating stakeholder claims and statements through news sources, legal cases, testimonies, regulations and policy. I found a broad story of justice that could also be interpreted by scale. I selected a case study from each scale because of the multiple interests and responsibilities found during the coding process. On the international scale, the international salinity negotiation with Mexico and the events leading up to it provided an array of diverse stakeholders' perspectives and goals. On the national scale, the regulation

and management of salinity in the Colorado River Basin, including efforts to comply with Minute 242, shows varying interests in comparison to outward goals. At the local scale, the decision to build the Yuma Desalting Plant and its subsequent consequences to the local community and environment shows countering interests between stakeholders. The selection of these case studies does not preclude the possibility of other issues, but for the purpose of analyzing solely salinity in the LCRB these will remain the focus of this chapter. In each case study, an overview of stakeholder goals and perspectives with their respective direct quotes will be stated followed by a justice analysis using Zeitoun et al.'s (2014) framework (Table 12). This chapter is focused on applying the framework, determining the extent of transboundary justice, and determining the efficacy of the framework.

Table 12. Transboundary Water Justice Framework & Analysis (Zeitoun et al. 2014)

Justice	Description
Transboundary arrangement	Issue and Outcome
Stakeholder interests and goals	Equitability, efficiency, environmental
Justice Perspective	Egalitarian, utilitarian, libertarian
Mechanism of justice - means to an end	Law and formality in basins such as minutes, treaties, and acts
Participation Quality	None, minimal or structural
Type of Participation	(a) Required and not executed (b) Required and executed (c) Not required but executed

International: U.S. and Mexico Salinity Negotiations

A series of events in the 1960s and 1970s surrounding the international negotiation of salinity between the U.S. and Mexico frame the primary issue and stakeholders at large. The Mexican government presented the U.S. with evidence of agricultural damages caused by the quality of water the U.S. was delivering as part of its mandate in the 1944 Water Treaty. The newly constructed Wellton-Mohawk Irrigation District in eastern Yuma, Arizona had begun to discharge irrigation return flows to the Colorado River. Since water quality had not been a stipulation of the 1944 Water Treaty government, the U.S. had no qualms with counting this water towards its water treaty deliveries. The irrigation return flows from the district led to an extensive increase in salinity which would eventually drain downstream to the Mexico border between 1961-1972 (Mumme and Taylor 2014).

The key stakeholders in this case include Mexican farmers and citizens who are the primary users of the 1944 Water Treaty deliveries. Additionally, government-led land reforms aggravated the issues Mexican farmers faced with their agricultural lands. The U.S. Congress, House of Representatives, and the president had varying interests and goals that prolonged the salinity negotiation and influenced the final contents of the negotiation. In 1961, after authorization by congress to deliver irrigation water for 75,000 acres in Yuma County, the district began to discharge saline water into the Colorado River and included it as part of the 1944 Water Treaty with Mexico. But the agricultural return flow was poor quality with, “a salinity of around 6,000 ppm which resulted in a sharp increase in the salinity of the water delivered to Mexico, from an average of around 800 ppm in 1960 to more than 1500 ppm in 1962” (Holburt 1975, pg 15).

Stakeholder Perspectives and Goals: The U.S.

In the 1960s, the U.S. government claimed that the additional water drainage would dilute the already saline waters, but it instead damaged agricultural lands in Mexicali and San Luis Valleys and polluted municipal water supplies (Ward 1999). The decision to build the irrigation district and discharge agricultural water to the Colorado River was an unintended consequence from Arizona's actions (Ward 1999). However, this can be slightly contested as this decision was not completely unintentional. Concerns were mentioned prior to the high salinity levels in the 1960s from California Senator Downey in 1945, who questioned the usability of the agricultural return flow and the ambiguity of water quality stipulations in the 1944 Water Treaty, stating that,

“Mexico would come back in 25 or 30 years and demand better quality water.

State Department representatives, their consultants, and Senate supporters denied that there was any ambiguity in the Treaty. They stated that water quality was extensively discussed, and that Mexico fully understood that the Treaty required them to take irrigation return flows irrespective of the salinity of those return flows” (Holburt 1975, pg 13).

Mumme and Taylor (2014) also remarked the different interpretations when it came to the quality of water to be delivered to Mexico. The U.S. interpreted the treaty as Mexico's acknowledgement to accept agricultural return flows of any quality, while Mexico contended that water received from the U.S. should at least be acceptable for ordinary use or at least equivalent to water quality of water distributed from the Imperial Dam, which serves U.S. citizens in the Imperial Valley (Mumme and Taylor 2014). It is through this narrative the

U.S. was able to claim that they were acting based off prior agreements in the 1944 Water Treaty and bore no legal fault.

Additionally, members within the U.S. State Department did not see the problem as a pollution issue that the U.S. had to deal with and felt agitated with the perspectives of environmental groups in the U.S.,

“Gantz presented a paper arguing that the salinity on the river should not be construed as pollution as commonly understood in international law [...] The department's discomfort with the interjection of environmental concerns into the diplomatic mix was evident in memoranda from the U.S. Embassy in Mexico City to Mexicali consul Arthur Feldman, which variously described the environmentalists' involvement as "unhelpful" and meddling (Mumme and Taylor 2014, pg 15).

Additionally, the U.S. National representatives and administrators at the Welton Mohawk Irrigation District thought that, “national leaders to [gave] precedence to cordial relations with Mexico over resolution of the valley's environmental and economic problem” (Ward 1999, pg 286).

From the executive office, President Richard Nixon appointed a special negotiator, Herbert Brownell, who attempted to nullify basin states by saying that the negotiation was based on dollars and not on water, “I told the Western States at the beginning of the negotiations that nothing would be done, and nothing has been done as a result of this agreement, which would adversely affect the orderly development of the Western States. There are no limitations in the agreement which would adversely affect any of the planned programs for the development of natural resources of the basin States” (Mann 1975, pg 113).

Despite attempts to outwardly deal with the salinity issue as an equity issue, internal promises were made so that basin states could retain autonomy to develop their own efficiency goals and their water rights would not be impaired: “the fundamental assumption of the negotiators was that any agreement made with Mexico would be virtually costless to those interests in the United States having a direct stake in the decision. Those interests are primarily irrigation farmers within and without the Colorado River Basin who depend on Colorado River water for their water supply” (Mann, 1975, pg 113).

With a libertarian approach and efficiency goals in mind, U.S. negotiators to relied on structural solutions rather than allocation changes to address water quantity concerns from basin states. For example, structural solutions such as a desalination plant, point and diffuse source control projects, and linings of canals were prioritized during legislation. Moves to change plans for then present and future projects, or elimination of the Wellton-Mohawk project as a major contributor of salinity were expressly avoided in legislation (Mann 1975, pg 126). The U.S. approach to salinity failed to impose serious financial burdens on those who benefited the most from salinity control. Programs such as subsidies to reduce water use, changes in the pricing system, incentives to alter practices or water use could’ve significantly reduced salinity and yet had not been considered by congress (Mann 1975, pg 126). These technical and infrastructural solutions were ultimately used so that the U.S. could avoid politics over water development and water allocations issues with basin states. Although costless to the interests of basin states, technical and infrastructural solutions such as the Yuma Desalting Plant ended up costing taxpayers millions of dollars. Originally pitched as a way to reduce salinity and stop further damage to Mexican Agricultural lands, the Yuma

Desalting Plant did not end up immediately benefiting the farmers as evidenced in the next section.

Stakeholder Perspective and Goals: Mexico

Mexican farmers and citizens expressed outrage from spiked levels of salinity in the 1960s, however several events heightened their qualms with their land from a quality and ownership perspective. A land reform led by president Lázaro Cárdenas del Río broke up land monopolies which redistributed lands to *ejidos* or small private owners. This led to a natural migration of farmers to the Northern Mexico Valley (Furnish and Ladman 1975). Then, when faced with agricultural losses, Mexicali leaders threatened to boycott business from California, and held two marches in front of the American consulate in Mexicali, first with 8,000 Mexicans and the second with 35,000 Mexicans. Before a negotiation was finalized with the U.S., Mexico had begun their own rehabilitation program in 1968, through a \$97.8 million loan from the World Bank to rehabilitate lands and increase water use efficiency. Finally, by enacting elements of the Helsinki Rules of the Uses of the waters of International Rivers, Mexico was able to cite equitable use and the no-harm principle to put U.S. under pressure. Despite the rehabilitation program and water deliveries with less salinity, Mexican farmers had continued to bear the burdens on their damaged agricultural land. Had the U.S. not intervened an economic study found that a net income reduction of 76 million pesos to farmers, making the international agreement warranted on the basis of efficiency and equity (Oyarzabal-Tamargo and Young 1978).

In a news article printed in 1979 by the Associated Press, reporter Joe Frazier details the events leading up to the salinity negotiation and the aftermath through his interviews with Mexican farmers. After years of accepting drainage water from the Wellton-Mohawk

irrigation district, damages of over \$100 million remain. When asked if President Jose Lopez Portillo would seek reparations from the monetary damages, it was said that no international law existed for Mexico to press claims against (Frazier, The Associated Press, 1979).

Additionally, despite a decrease in salinity levels in the water accepted by Mexico, high levels of salt remained in the soils and subsoils, rendering the agricultural lands less productive, “specialists here say that 375,000 acres of the valley grew cotton before the salinity, but that the number fell to 112,500. It has returned to 187,500 (Frazier, The Associated Press, 1979). Interviews with Mexican Farmers such as Esequiel Franco, a cotton farmers from Mexico, gave light to the remaining damages,

“I was six years without a harvest [...] Nothing grew. I planted, but it didn't pay” (Frazier, The Associated Press, 1979, pg 1).

He said his farm and others are gradually recovering from the salt damage because of Mexican government-funded projects that wash the salt out of the soil. But farmers say the process makes such a heavy demand on scarce water that they have to reduce their plantings (Frazier, The Associated Press, 1979).

The Mexican federal government played a role in the rehabilitation of agricultural land. An interview from Gilberto Gutierrez Banaga, president of the Mexican Farmer's cooperative reported that,

“Thousands of farmers [had] received low-interest, 25-year loans to get them through the salt years. We are deeply in debt, we get everything on credit” (Frazier, The Associated Press, 1979). Additionally, the farmers had decided to, “not to act independently, and to leave the issue of indemnity up to the federal government” (Frazier, The Associated Press, 1979, pg 2).

Despite negotiations with the U.S. to control salinity at an international level and rehabilitative work and loans from the Mexican government, agricultural lands remained unproductive through the 1970s and 1980s leading some Mexican farmers to immigrate to the U.S.

In the same report, Mexican farmers were reported to have crossed the border looking for more economic ways to sustain their future, “thousands of small farmers gave up and went to the United States, legally or otherwise, they say, and while a few have come back, many more have not” (Frazier, The Associated Press, 1979, pg 3). The association between high salinity levels and immigration again came up when a horticulturist from the University of Arizona’s Environmental Research Lab, Dr. Merle Jensen, suggested her finding of the salt tolerant plant, Halophyte, as a grain substitute could help Mexicans,

“‘move back out’ to farmland destroyed by salt buildup, and to deserts near seacoasts [...] Halophyte production in Mexico could make that nation an exporter of grain products once again [...] If we don't take this kind of approach, people from Third World countries are going to keep pouring into the United States, legally or illegally” (San Diego Union Tribune 1984, pg 3).

Despite the signing of minute 242, there were lasting consequences to Mexican Farmers which have led to the decision to migrate to seek better opportunities from land damaged by U.S. water deliveries. However, regardless of blame, there is a sentiment in the U.S. that acknowledges the salt buildup as an issue but one that should be resolved for the sake immigration conversations. The rehabilitation of agricultural lands is seen as either too expensive or unlikely to happen, resulting in the suggestion of salt tolerant crops instead. Thus, reparations to Mexican farmers who originally received the highly salinized drainage

waters remain unseen and unresolved into the 1970s and 1980s, well after the negotiation was signed.

Politicization and Securitization

Although the specificities in the salinity negotiation were largely influenced by conditions set by basin-states, the negotiation itself fed into an international relations strategy as well. For example, the Mexican Water Treaty of 1944 negotiation helped resolve issues over the Rio Grande River and Colorado River but was also used as a proxy to maintain good relations with Mexico during a time of war (Mann 1975, pg 117).

In 2006, Mary E. Kelly, then co-program director of the Environmental Defense Fund, published in the American Bar Association's Natural Resource and Environment how international relations can impact progress and protection of resources in waters shared by the U.S. and Mexico. Kelly noted that in 2000, relationships between the U.S. and Mexico were cooperative resulting in multiple pending projects, however in light of September 11, 2001, U.S. priorities went to the middle east leaving those projects at a standstill, including cooperative efforts in the Colorado River basin. Her discussion emphasized the importance of interdependency, with decisions in one country often reverberating in the other, "how we manage our transboundary rivers is a vital component of a stable, cooperative relationship between our two countries" (American Bar Association 2006, pg 1).

Additionally, as evidenced during the salinity negotiation, basin states supported structural technologies to avoid dealing with seemingly political issues such as water quantity, an example of securitization. As a result, infrastructure such as the Yuma Desalting plant were used as a resolution to the salinity crisis to avoid politics within the U.S. The use

of infrastructure is commonly used by the IBWC as a solution rather than policy-based solutions (Mumme and Moore 1990). The desire to stay apolitical, however, does not always lead to proper-based solutions.

Participation

An idealized version of the international agreement claims beneficiaries from both sides, however costs bred from the negotiation were namely felt by U.S. citizens. Mann (1975) found that the agreement was made with a promise that U.S. interests would not be negatively impacted from the negotiation, but that if any negative effects were to be felt at all, that it would be to taxpayers who had no effective voice or participation in the international salinity negotiations.

The negotiation was clear that costs to ensure reduced salinity levels would be paid by the U.S. These infrastructural projects include the installation of a tile drainage in the Mexicali Valley in Mexico, support to Mexico to improve and rehabilitate the Mexicali Valley, and a concrete-lined canal constructed in Mexico to discharge the saline water from the Yuma Desalting Plant (Holburt 1975).

Transboundary Water Justice Analysis at the International Scale

Efforts behind the negotiations were made to seem as a concern towards equity, however benefits were largely not seen from Mexican Farmers years after the negotiation was made and salinity standards were met. Hardened by the basin-states demand that water allocations were left alone; technical resolutions were made instead to keep negotiations apolitical and to keep peace between the two countries. A justice analysis helped explain

these decisions and how they were the result of power asymmetries, the pressure of a basin hegemon, and procedural injustice.

The U.S. federal government negotiated technical and infrastructural solutions to resolve the international salinity crisis to avoid basin politics over water allocation rights. I consider this a *utilitarian* approach, which seeks to maximize benefits for society at the cost of a few (Zeitoun et al. 2014). The decision to negotiate salinity standards on the U.S. side of the Colorado River aimed at addressing equity concerns with Mexico, however the approach to remain apolitical came at the cost of U.S. tax dollars and with marginal benefits to Mexican farmers who continue to suffer from damaged agricultural lands. Zeitoun et al. (2014) emphasize that in situations where water negotiations are perceived as inequitable, *social injustice* may continue to exist.

The underlying goals of the federal government was an attempt to achieve environmental sustainability, efficiency and equitability, but *tradeoffs* occurred at the behest of the interests of more influential actors, such as the basin states. For example, the decision to use technical solutions was not an efficient use of resources due to the steep operation costs of a desalination plant. This decision was a form of *conflict management* since the basis of the negotiation stemmed from the desire to reach efficient of more readily achievable goals (Zeitoun et al. 2014). Despite having elements of environmental sustainability and equitability the negotiation was not cognizant of the impact of the outcomes as the result of *imbalanced power plays* (Chupp 1991; Zeitoun et al. 2014).

The U.S. Government attempted to use the absence of water quality conditions in the 1944 as a *mechanism of justice*, which is defined as the “pathway in which unfair situations are created and replicated” (Zeitoun and McLaughlin 2013, pg 190). This approach was

ultimately illegitimate, especially when rivalled against the UN Convention which states that shared use over a water body should be equitable and with reasonable utilization. The outward appearance of having a good relationship between the U.S. and Mexico by resolving the salinity crisis was also a motivation behind the negotiation.

Despite having strong customary legal claims in the salinity negotiation, the Mexican government's participation was minimal and Mexican farmers' participation as affected stakeholders were minimal if not absent. This lack of procedural justice proved to be consequential as farmers had to contend with economic losses or resort to leaving their lands altogether. Another absent stakeholder group in the negotiations were U.S. Citizens who are ultimately left with the costs of the technical/structural solutions. Participation from the U.S. Government and the Mexican Government by law were not necessary and not required but still executed leading to the salinity resolution in the form of Minute 242. Participation from U.S. citizens and Mexican citizens and farmers, as beneficiaries and as impacted stakeholders, should've been required but were not executed. These conditions and demands ultimately shaped the basis of the negotiation and the impact it could've had in salinity control and management. It shaped how salinity is managed on a national level and how it impacts entities at the local level.

National: Governing Salinity in the Colorado River Basin

After the international negotiation of Minute 242 in 1972, U.S. Congress created the Colorado River Basin Salinity Control Act in 1974 to ensure that the U.S. could meet the goals agreed with Mexico. The purpose of this program was to regulate salinity at a national level through the cooperation of the basin states and funding from Congress. The Salinity Control Act I authorizes and directs the Secretary of Interior to work with Mexico, while the Salinity Control Act II directs the Secretary of the Interior to implement salinity control policies with the basin states. It also created the Colorado River Basin Salinity Control Advisory Council which is made of no more than three representatives from each basin state and who designated the current standards Below Hoover Dam at 723 mg/L, Below Parker Dam at 747 mg/L, and at Imperial Dam 879 mg/L. The efforts of this program are also to regulate salinity through monitoring the energy and fuel industry. Other programs through the U.S. Department of Agriculture and the U.S. Bureau of Reclamation work with private agricultural lands and landowners to reduce salinity as well. Since before the international water salinity agreement was negotiated, it was clear that the basin states and the Wellton-Mohawk Irrigation and Drain District would not agree to any agreement that would impact their existing water rights (Bernauer 2002). Despite the basin states significance as important stakeholders in the management of the basin, their insistence that their water rights be left alone remains apparent and has resulted in the type of programs that exists to manage salinity in the basin.

Stakeholder Perspectives: Federal Government

As stated in the 2017 Quality of Water Colorado River Basin Progress Report No. 25, “the goal of the Water Quality Criteria for the Colorado River Basin and the Salinity Control Program is to offset (eliminate/reduce) the salinity effects of additional water development” (Bureau of Reclamation 2017, pg 6). In a 2014 review conducted by the Bureau of Reclamation, 1.68 million tons of salt per year of prevention was required by 2035 to keep economic damages minimized. Thus far, 1.31 million tons of salt per year has been prevented from entering into the Colorado River and an additional 370,000 of new controls are required to meet the 2035 goal. Proposed measures include on-farm and off-farm delivery system and irrigation improvements (Bureau of Reclamation 2017, pg 16).

In a testimony by Lorri Lee, Lower Colorado Regional Director with the Bureau of Reclamation, the Bureau of Reclamation acts on behalf of the Secretary of Interior and, “manages the operation of the Colorado River in the capacity of Water Master to enable the holders of water entitlements to divert that water for beneficial uses,” but its statutory authorities only include salinity control and reduction, effectively ignoring the management and regulation of other water quality issues (Lee 2009, pg 1). A statement from another Bureau of Reclamation representative also motioned that the goals of the Bureau were to focus less on

“big-government designed and constructed partnerships” and move toward a grant application program wherein an applicant would design, construct and held responsible of the costs for salinity control, effectively allowing nonfederal groups to apply such as industry, local and state governments, water districts and similar entities (Salt Lake Tribune 1996, pg 1).

The role of the government in salinity reduction is to designate salinity control standards and fund federal or individual projects. The goals of the federal government are to comply with international agreement Minute 242 and mitigate at best the economic damages as a result of high salt in the waters.

The effort to include more efforts at the state and local levels is further supported from a testimony from the Colorado River Basin Salinity Forum in 1995 before the Subcommittee of the House of Resources Committee to amend the Colorado River Basin Salinity Control Act. In this testimony, the forum supported the reclamation's efforts at the state and local level to create USDA on-farm programs at a 30% cost share,

“Currently, there is strong local support in areas where the program is being implemented, and this is required as local sponsors participate only on a volunteer basis. This legislation would allow for local support to be accepted on an expanded geographic basis such as in the Uinta and Price-San Rafael Rivers Units in Utah and the Hammond Unit in New Mexico previously mentioned” (Testimony from the Colorado River Basin Salinity Forum 1995, pg 2).

A local voluntary program was also supported by local actors such as John R. Wodraska, General Manager of the Metropolitan Water District in Southern California, who believes that the program could help supplement the Reclamation's program. In a 1994 testimony in front of the Senate to the Subcommittee on Water and Power of the Committee on Energy on Energy and Natural Resources, Wodraska supported an amendment to Title II of the Colorado River Basin Salinity Control Act which would allow individuals to receive funds to control salinity barring approval of the program from the Congress, the Colorado River Basin

Salinity Control Advisory Council, and Governor of the State respective to the local actor's location (Wodraska 1994, pg 4). These motions suggest a departure from the understanding that salinity control is the sole responsibility of the federal government. However, this approach is not duly supported at the national of basin-state scale.

Stakeholder Perspectives: Basin States

The basin states, Wyoming, Utah, Colorado, New Mexico in the Upper Basin and Arizona, California and Nevada in the Lower Basin, are important stakeholders in the management of the Colorado River basin for several reasons. Funds used to implement the federal salinity programs must be approved by Congress, where the lower basin states hold 62 votes while the upper basin states hold 13 votes and the upper basin holds a majority of votes in the senate (Getches 1994). Basin states are also represented in the Colorado River Basin Salinity Control Advisory Council and the Colorado River Basin Salinity Control Forum, a liaison to federal institutions and designators of the salinity control standards respectively. During the content analysis phase, there were key stakeholder perspectives that were identified during various testimonies in the Senate and House of Representatives.

In 1994, Larry Linser, Deputy Director of the Arizona Department of Water Resources, testified before the Senate's Subcommittee on Water and Power on salinity in the Colorado River basin. Linser (1994) acknowledged the impact of salinity on local, state, national and international scales and how the federal government is the only entity to be involved with salinity management on a basin-wide level. Linser commented on the federal government as the entity to finance and to be the receiver of the majority of funds towards salinity control and ultimately responsible to meet federal salinity standards through the

water treaty, Minute 242, the IBWC, Salinity Control Program and other authorized salinity projects. He however also cautioned the role of the federal government to that of solely quality and not quantity,

“Arizona does not object to the Bureau of Reclamation considering alternatives to the fulfill scale operation of the Yuma Desalting Plant. However, we cannot support an alternative that would result in additional water demands on the Colorado River system. Alternatives that would adversely affect the quality or the quantity of water in reservoir storage necessary to satisfy existing water service contracts will be opposed. We could support alternatives that would encourage greater efficiencies in water uses and in water conservation” (Linser 1994, pg 6)

A shift in political priorities was also noted in his testimony, “the policy of further river development to meet local needs has been replaced by an understanding of the need to preserve and protect a desert environment that is also dependent upon the flows of the Colorado River system,” which acknowledges the change from using the river for development purposes to understanding the nuances of water for environmental uses (Linser 1994, pg 1). Years later the degree in which salinity was managed was considered successful by successor Herbert Guenther, Director of the Arizona Department of Water Resources in 2009,

“the Salinity Control Program is a great example of a successful cooperative effort between federal agencies and the seven Colorado River Basin states to meet state, national and international water quality objectives (Guenther 2009, pg 3),”

which effectively left out local needs and concerns. From testimonies in 1994 and 2009, the role of the federal salinity program is to address international concerns and its success will be measured on its ability to meet the international treaty.

The role of the federal government was reemphasized in testimonies of basin states representatives where it is reiterated that the role of the federal state is in salinity management so long as it does not infringe on water rights. For example, Colorado Senator Ben Nighthorse testified to the Senate Subcommittee on Water Quantity and Quality within the Committee of Energy/Water and Power in the Colorado River in 1994 and said that the,

“resolution of salinity issues on the Colorado River in compliance with Minute 242 ultimately has water quantity implications. Continued funding for, and reasonable and responsible implementation of, salinity control measures is critical to meeting our international water quality obligations in a manner that allows for full development and use of water in the United States” (Nighthorse 1994, pg 3).

This statement refers to the Secretary of Interior’s commitment in the Salinity Control Act I which stated that salinity control programs would not infringe upon development projects or change allocation rights. The federal government is bound to this agreement, and as a result creates programs that exclusively involves salinity without further consequences, however concerns were express by basin states on whether this could hold true.

In 1994, another testimony from Gerald R. Zimmerman, Executive Director of Colorado River Board California to the Senate Subcommittee on Water and Power again emphasized the role of the federal government and raised concerns,

“the Title I salinity control program is a federal obligation to carry out the international agreement between the United States and the Republic of Mexico. In meeting the mandates of Title I, there was a clear understanding that the water supplies to the Basin states would not be impacted, as the terms of the agreement are satisfied. We are concerned that the mandates of Title I may not be met in the future and we urge you to ensure that they are met” (Zimmerman 1994, pg 8).

Although a water development had not yet been hindered, Zimmerman later went on to remark that,

“with all due respect, California, the other Basin states and the water-using community cannot afford to have the Congress, the Administration, or the courts solely dictate how our urban, agricultural and environmental water needs will be met. We must address these needs through a partnership that starts at the state and local levels. This is not to say that the Federal government does not have a role to play. It must be an integral part of the discussions as innovative-joint programs, to address the urban, agricultural and environmental needs are developed and implemented” (Zimmerman 1994, pg 8).

He later went on to emphasize that the focus of the federal government should be on the obligations of the 1944 Water Treaty, Minute 242, IBWC, and the Salinity Control Program. This testimony resembles the testimony made from Larry Linser in 1994, and in both testimonies, a fear of whether the salinity program would encroach on water rights was clear and the insistence that the federal government stay out of water quantity issues was similarly expressed. Although the management of water quantity and quality are tied, the

basin states maintain that the federal government's role and commitment to the international salinity negotiation were separate to their water issues.

The next testimony provides an example of how basin states might react should quantities of Colorado River be necessary to mitigate salinity issues. Although this example is not directly tied to salinity in the main body of the Colorado River, it concerns the Salton Sea which receives Colorado River and is at risk for its highly saline levels. The hearing was focused on solutions to dilute salinity levels in the Salton Sea such as allowing quantities of freshwater from the Colorado River or building a desalination plant to remove salt. In a testimony from Ted Steward, Executive Director of Utah Department of Natural Resources, in 1998 before the House Subcommittee on Water and Power, Steward discussed the ramifications of supplying either additional water for dilution purposes or for use in a desalination plant as a supply issue that should not affect the Upper Basin states:

“The Lower Colorado River Basin states, particularly California, are currently using in excess of their full allocation from the river. If the legislation is not carefully crafted it could result in Upper Basin water being used to freshen the sea. This would not only be unfair but it would disturb the delicate balance that currently exists between the Upper and Lower Colorado River Basin states. Utah has no problem with stabilizing the Salton Sea, whether in terms of volume or salinity. We believe, however, the water used for this purpose, if it comes from the Colorado River, must come from the state of California's compact allocation. We think this is consistent with the current interpretations of the ‘Law of the River’” (Steward 1998, pg 1).

California has the largest water allocation (4.4maf) among the lower basin states, and benefits when upstream basins such as Colorado, Utah and Wyoming, who have yet to fully develop their water allocations, do not use all their water rights. Among the basin states, there is a fierce need to protect water rights and this sentiment is continually expressed whenever water salinity is discussed. Although dealt with in a separate manner by the federal government, it is clear that quantity and quality are tied matters with future implications to water rights in the basin.

Stakeholder Perspectives: NGOs

In a testimony from Thomas C. Jensen, Executive Director of the Grand Canyon Trust, to the Senate Subcommittee on Water and Power in 1944, a concern of the distribution of benefits from the salinity program were raised. Jensen stated:

“The protection of water quality, particularly with regard to salinity, is an international obligation of the United States. Current and projected future demands preclude the United States from meeting that obligation much of the time under the present entitlements. How can use of Colorado River water be adjusted to protect water quality not only at the international boundary but throughout the river's length?” (Jensen 1994, pg 3).

The national salinity program was first and foremost created as a response to the commitments made to Mexico in Minute 242. However, the benefits of salinity reduction come second to the benefit of basin states and local stakeholders at the expense of tax dollars.

Stakeholder Perspective: David Getches

David Getches is an important stakeholder to the management of the Colorado River Basin. A legal expert, he served as a law faculty at the University of Colorado School of Law in 1979 until his death, served as the Executive Director of the Colorado Department of Natural Resources from 1983 to 1987, and then as a special consultant to the United States Secretary of the Interior in 1996 (University of Colorado Boulder Law School). In 1997, Getches published several points in the University of Colorado Law Review related to the role of the federal government in managing salinity such as issues with participation, the nature of the salinity reduction program, and the lack of equity within the program itself.

First Getches (1997) makes note of the role of the basin states as one that is a courtesy, and their permission for the federal government to control over salinity as a way to keep their water rights,

“There have been two themes in the history of the Colorado River: legal and political combat over entitlements to quantities, and concentration of great authority over the Colorado River in the federal government. Yet the states generally resist any fundamental change in the law of the river as it stands. They have grudgingly accepted federal control of the water as a Faustian consequence of accepting tax dollars collected elsewhere to develop water projects for their use. Moreover, in practice, states have been included in some policy-making for the Colorado River. The Secretary has consulted with them in major policy issues, partly as a matter of comity; the law requires consultation with states and other parties in setting operating criteria for the federal facilities” (Getches 1997, pg 574).

This is problematic since basin state representatives are meant to serve their constituents on all matters including quantity and quality. Getches's use of the word "Faustian" consequences indicates tradeoffs maintaining their water rights at the expense of effectively managing salinity levels. When discussing participation and the inclusion of affected stakeholders in Colorado River Basin management, Getches observes that,

"When they have acted, they have addressed single problems but not comprehensive solutions, with all issues on the table, that enable trade-offs and mutual problem-solving. Most significantly, other affected interests have been left out of decisions, their "participation" relegated to responding to Federal Register notices. If they are displeased they must mount collateral attacks through lawsuits and lobbying. Presumably everyone would benefit if an equitable means were found to eliminate the uncertainty that results from the exclusion of other affected interests from decision making. Traditionally excluded interests such as tribal governments, recreationists, environmentalists, and scientists could cooperate in comprehensive efforts to solve Colorado River basin problems" (Getches 1997, pg 581).

The efforts of the basin states to keep salinity tied solely to the federal government effectively excluded the stakeholder perspectives of local groups, environmentalists, and tribal governments who by law are supposed to have their basin representatives serve their interests. Besides the lack of effort to include affected stakeholders, Getches remarked on the nature of having a one-point source quality plan rather than a comprehensive watershed approach to the problem, resulting in the use of engineering solutions such as the desalination

plant. Another point Getches made was the lack of the redistribution of costs to those that benefit the most,

“The federal government has shouldered seventy percent of the costs of salinity control, effectively subsidizing water users. Thus, as the marginal cost of new structural salinity control measures increases, it is timely to consider shifting more of the financial burdens of salinity control measures to water users. For instance, lower basin interests (especially southern California, where much Colorado River water is used) have the greatest need to reduce salinity, but a principal source of salt-loading is the irrigation of saline soils in the upper basin” (Getches 1997, pg 604).

The redistribution of benefits and costs is seen as an important step to pursue justice and an equitable agreement (Sadoff and Grey, 2006). To further understand equity in the basin, Getches further discusses how water development in the Colorado River Basin can be evaluated in the perspectives of efficiency, equity, and sustainability, which directly align with Zeitoun et. al’s (2014) Transboundary Water Justice framework. In relation to these perspectives, Getches believes that the Colorado River policy lacks efficiency since federal subsidies allowed water projects that were inefficient,

“Ultimately, federal subsidies enabled the development of water projects that were inefficient even by traditional cost-benefit accounting standards, which do not consider environmental and other social costs. The initial allocations of rights to consume Colorado River water were designed not to pursue efficient water uses but to achieve a politically acceptable division [...] The development and management of

the river's resources have been in the hands of a few, with ultimate responsibility falling on the Secretary” (Getches 1997, pg 584).

When remarking on whether there is equity in the Colorado River Basin, Getches (1997) asserts that since costs and benefits are not shared, participation is inadequate, and that the concerns for future generations are not met, “the history of governance of the Colorado River basin fails her tests for equity.”

Mechanisms of Justice

The West’s Colorado Administrative Code under the Department of Public Health and Environment states a clear distinction of the state’s role in managing salinity,

“The Commission recognizes that excessive salinity and suspended solids levels can be detrimental to the water use classifications. The Commission has established salinity standards for the Colorado River Basin (“Water Quality Standards for Salinity including Numeric Criteria and Plan of Implementation of Salinity Control”, Commission Regulation No. 39) but has not established or assigned other standards for salinity or suspended solids control practices to be developed through 208 plans, coordination with agricultural agencies, and further studies of existing water quality” (West’s Colorado Administrative Code, pg 1, Regulation 17, current through April 10, 2019).

Besides regulating emerging energy and development industries on discharge units, any other efforts to reduce salinity are left to the federal government through their respective programs. Despite acknowledging the impact it can have on the state and local stakeholder it remains out of the state’s purview.

There have been legal efforts to spread the responsibility of salinity control beyond the federal government to the basin states. A federal lawsuit went to the United States District Court in the District of Columbia between the Environmental Defense Fund (EDF) v. Costle (Representation for the Environmental Protection Agency (EPA)) wherein the EDF sought to make basin states more accountable for salinity management. EDF made six claims against the EPA; (1) that the salinity standards set by the Colorado Salinity Control Act had not met the requirements of the Federal Water Pollution Control Act, insinuating that the Director of the EPA had not acted responsibly in accordance to his mandatory duties; (2) that the federal entity be compelled to establish acceptable salinity standards; (3) that the EPA take over the state's tasks of identifying point sources where salinity standards are not being met and establish daily maximum load levels; (4) that the planning process assigned to the states under section 1313 be closely monitored by the EPA; (5) EDF sought to compel the Department of the Interior to implement the water quality policies promulgated by the basin states in their 1972 Conference and adopted by the Colorado River salinity Control Act of 1974; and that (6) EDF sought to compel the federal defendants to seek alternate ways to deal with the salinity problem (EDF v. Costle, 79 F.R.D. 235).

The claims made in the case were ultimately dismissed by the court since it possibly implied that the upper basin states might not have been able to completely realize their compact allotments. Should the regulation of salinity be updated according to the EDF's claims, "the imposition of state-line numeric limits on each interstate stream, which would likely have resulted in serious restrictions to the potential for Upper Colorado River Basin states to realize their compact allotments. The court, however, rejected EDF's attack, essentially allowing the EPA's more lenient standards to stand" (Harrison 1981, pg 7).

Ultimately, the EPA was allowed to continue business as usual and was not required to enact stricter salinity standards in basin states.

The creation of the federal salinity program to meet international goals allows basin states to circumvent a customary and federally mandated approach to regulating pollutant sources as is the norm in surface water rivers. By keeping management at a national level, accountability, benefits, and gains are not realized at state and local levels.

Participation

There is a historical tension between the upper basin states and lower basin states in regards to water rights that continues to be clear even in issues related to salinity. In the previous section, Getches (1997) indicated areas where affected stakeholders were absent during times of crucial participation. This is further evidenced during a testimony in front of the senate. In 1994, Wyoming Senator Malcolm Wallop testified in front of the Senate Energy/Water and Power hearing on Colorado River Water, and raised serious concerns on the lack of representations from Upper Basin states while discussing salinity issues,

“This is at best a curious hearing. While described as a hearing to examine water quality and quantity problems and opportunities facing the Lower Colorado River area, the hearing clearly intends to address concerns involving the entire Colorado. Although some of the issues, such as the use of tributary water in the Lower Basin clearly involve all the States of the Lower Basin, only the States of the Lower Division were invited to testify. For the record I want to point out that parts of both Utah and New Mexico are part of the Lower Basin although they are States of the Upper Division. If we are to have

a discussion of the use of tributary water, which I assume means the Virgin River, a complete record should involve the State of Utah and not just Arizona and Nevada” (Wyoming Senator Malcolm Wallop 1994, pg 1).

Senator Wallop went on to indicate that despite having a hearing on salinity issues, the subcommittee had rejected the request of the Colorado River Basin Salinity Control Forum, the very mechanism created to represent basin states in the federal salinity programs, to testify in front of the subcommittee. Other major issues were to be discussed during the hearing such as changes to the administration following feedback from an Inspector General Report, and changes that had already been made such as, “the Department seems to have done is mothball the Yuma plant and fire all the technical people who would be needed to reactivate it,” and the slashing of the request of \$22 million dollars for Title H of the program to \$12 million dollars. Senator Wallop went on to say,

“The Bureau of Land Management has been more interested in harassing ranchers than trying to deal with the 700,000 tons of salt which federal lands contribute to the Colorado, and the only action taken by the Bureau is a strange memo from its Director of Policy asking the Glen Canyon mailing list what should be done. The suggestion by the IG [Inspector General] that we increase the ceiling and provide greater flexibility in selecting projects seems to make a lot of sense. We could have a very useful bearing on the implementation of the 1974 Salinity Control Act, but we do not have the witnesses” (Senator Malcon Wallop 1994, pg 1).

The lack of inclusion from key basin states, and the federal approach to salinity control simply does not lend to benefits to local users of the Colorado River. Despite tax-payers

dollars being used for the federal program, there remains economic damages of \$330 million per year. A testimony in 2009 from Herbert Guenther, Director of the Arizona Department of Water Resources indicated,

“Increased salinity levels affect agriculture by reducing crop yields and adding labor and chemical treatment costs. Urban water users must replace plumbing and water-using appliances more frequently and industrial water users and water and wastewater treatment facilities also experience reduced useful life of equipment. (Guenther 2009, pg 2).

There are means in which basin states can be involved in this process, albeit only as an advisory team,

“By taking a basin-wide approach, it’s been great for unity and inclusiveness, however this approach to the solution of the salinity problem that promises extensive benefits to traditional beneficiaries of such an approach with very little cost. [...] Thus, intraregional trade-offs of costs and benefits are ignored while the general taxpayer pays the bill. Unfortunately, at the national level there is seldom a careful assessment of whether paying that bill compares favorably with paying other bills that might realize greater national welfare in return for the investment” (Mann 1975, pg. 127-128)

Though seemingly inclusive, this process perpetuates an environment of following the status-quo, minimally controlling a pollutant to meet quality standards at the international border, and with benefits going mostly to downstream users at the cost of upstream basin states.

Transboundary Justice Analysis at the National Scale

The creation of the Colorado River Basin Salinity Control Act was primarily a political tool to assure basin states that the management of salinity would not infringe on their quantity rights. It is also a way for basin states to feel like they were managing salinity within their own border lines, without putting any efforts such as creating water quality management plans, working with the EPA, or working with stakeholders. Because of this governance structure, basin states are able to circumvent standard EPA guidelines when dealing with water pollution issues, making accountability towards managing salinity at the state or even local level non-existent. Federal salinity programs operate on tax-payer's dollars, yet basin states leave the planning and management of salinity reduction solely to the federal government. As such, there was evidence of lack of participation in areas where basin states should be included in the discussion of management. This is largely in part due to the fear that by overly involving or giving credence to quality concerns, that it might affect quantity concerns as well. The lack of accountability and a feigned ignorance towards treating salinity as a water pollution is driven by the basin states' largely libertarian perspectives towards quantity concerns. This in fact leads to a libertarian perspective to managing salinity, despite outward suggestions that salinity management is seen as a cooperative success from an international and interstate scale.

The federal government attempts to pursue a utilitarian approach to salinity management through attempts to include state and local stakeholders although those efforts are thwarted by the libertarian view of the basin states. Despite evidence that salinity is largely a pollutant that impairs the Colorado River Basin, the basin states refuse to change their approach to salinity management. They instead cling to their water rights through the

“Law of the River” and use that as a basis for their salinity management approach. The basin states can be categorized as a basin hegemon which holds influence over what types of issues are important in a transboundary basin and what form the issue will take, “those that accompany the discourses and other processes which influence policy are those sanctioned by actors considered legitimate, and whose legitimacy is generated by the mainstream political economic institutions, discourses and thinking” (Zeitoun et al. 2014, pg 183). The basin state used methods of securitization to maintain their water allocation rights, effectively shaping the discourse of water salinity management. This is proved to be consequential since the implementation of the salinity control act is based off the approval of congress, whose core goals are to act based off of efficiency goals. Despite having a heavy hand in the international negotiation over salinity, the outcomes of the negotiation are not considered efficient the eyes of the basin states especially over time, as evidenced in the next case study.

NGOs have effectively questioned the equitability of the negotiation and overall management of salinity in the basin emphasizing the lack of benefits throughout the basin as opposed to solely at the international border. This goes against the tenets of distributive justice wherein benefits are distributed throughout the basin. In *EDF v. Costle*, the EDF took the EPA to federal court to decentralize the responsibility of salinity control to basin states but was ultimately dismissed over water development concerns. When discussing mechanisms of justice over salinity, I assert that the “Law of the River” effectively thwarts efforts to effectively control salinity, impacting the effectiveness of Minute 242 and title I and II of the Salinity Control Acts, and as such can be categorized as a mechanism of *injustice*. Basin states also use tenets of the “Law of the River” to circumvent federal law surrounding the management of pollutants in surface waters.

There was evidence of procedural injustice through the exclusion of tribal governments, recreationists, environmentalists, and scientists (Getches 1997). There was also uneven participation within basin states as evidenced in Senator Malcolm Wallop's testimony when Upper Basin States representatives' testimonies were not included in a discussion over the comprehensive management of the basin. In the management of salinity, local stakeholders' participation were required but not executed.

Overall, the management of salinity was not considered an example of good water governance since it does not adequately maintain transparency, inclusiveness, equitability, coherency, integration, accountability, efficiency, responsiveness, and sustainability. There was a lack of public participation across government levels (horizontal), layers of government (vertical) and across local actors. By Zeitoun et al.'s (2014) framework, it is not an example of good transboundary water governance since there is an effective basin hegemon and evidence of procedural injustice through the lack of distribution in benefits, exclusion of stakeholders, and the antiquated tenets of the "Law of the River".

Local Scale: The Yuma Desalting Plant

The international salinity crisis peaked when the U.S Bureau of Reclamation decided to discharge saline irrigation water from the Wellton-Mohawk Valley in 1961. Before negotiations started with Mexico on saline water, one of the largest contributors to salinity came from the Wellton-Mohawk Irrigation District. At the time, highly salinized groundwater was sent down to Mexico and was being used as part of the 1.5 maf of water delivery. The Wellton-Mohawk Irrigation District is mostly agricultural land and built to receive discharge water from Gila, Arizona.

The farmlands in the Mexicali and San Luis Valleys in Mexico were severely destroyed and resulted in damages and losses in millions of dollars. Eventually, a solution to the salinity crisis came in the creation of the Yuma Desalting Plant, the largest in the U.S. and second largest in the world, to divert discharge water which otherwise had been formally a part of the water delivery per the 1944 Water Treaty agreement. Replacement water to operate the Yuma Desalting Plant was negotiated into an international agreement added to the 1944 Water Treaty. The water diverted from the Wellton-Mohawk Valley soon formed the Santa Clara Cienega Wetland, which had dried up from lack of upstream water when the Hoover Dam and Glen Canyon dams were built in 1936 and 1963 respectively (Greenwire 2012). The wetland is now part of a thriving ecotourism industry and home to migratory birds and other aquatic species and receives 110,000 acre-feet of water per year (Guenther 2009).

The Yuma Desalting plant treated salinized Colorado water until it incurred technical damages that outweighed the costs to operate the plant. The creation of the Yuma Desalting plant was controversial from inception, and laid dormant until renewed interest in operating

the plant came from different stakeholders. There are stakeholders who want to operate the Yuma Desalting Plant for the potential supply it can create, concerned parties over the threatened existence of the Santa Clara Cienega Wetland, and irrigators in the Wellton-Mohawk Irrigation District that continue to operate despite critical claims against its efficiency.

A partnership including the U.S. Bureau of Reclamation and lower basin states-Arizona, Nevada, and California was formed in 2008 to operate the Yuma Desalting Plant at a 1/3 capacity (The Sun, 2008). The operation came from the collaboration between the Central Arizona Water Conservation District, the Southern Nevada Water Authority, Metropolitan Water District of Southern California, U.S. Bureau of Reclamation, the environmental organizations of Pronatura, Sonoran Institute and Environmental Defense Fund, CONAGUA, Mexico's Water Commission, SEMARNAT, Mexico's ministry of the environment, and IBWC (University of Arizona News 2012). The pilot run cost \$23 million dollars and was expected to cost \$55 million dollars at full capacity. In order to operate the plant, 25 percent of flows or 107,000 acre-feet of agricultural runoff water otherwise sent to the Cienega Santa Clara Wetland, was instead used by the Yuma Desalting Plant. Under a binational agreement, replacement water was sent to the Cienega Santa Clara Wetland from both Mexico through water rights purchased from Mexican Farmers and overflows from the United States (Greenwire 2012). In a 2011 research study, no major changes were determined to the wetland and the pilot run successfully treated 29,000 acre-ft of water.

The project was determined a successful binational effort although the future of the project is undetermined. Researchers, such as Dr. Karl W. Flessa from the University of Arizona, involved in the study believe the plant can be fully operational with a healthy

Cienega Santa Clara Wetland if brackish groundwater from Yuma is used to supply the plant instead of discharge agricultural water from the Wellton Mohawk Irrigation District (Greenwire 2012). Groundwater is already being politicized on the U.S. Mexico Border, as seen in the Octoillo Water Case study (Mumme and Taylor 2014; Sanchez and Eckstein 2017). Additionally, the Brock Dam has been completed upstream and will likely complicate the United States's ability to send replacement water to the Yuma Desalting Plant (Greenwire 2012). There are many stakeholder perspectives in reaction to the creation of the Yuma Desalting Plant, in addition to perspectives even before and after the desalination plant came into reoperation. These perspectives bring to light the impacts of the Yuma Desalting Plan on a local scale, and whether the Yuma Desalting can be used as a viable resource to augment Colorado River supply in the future.

Justice Perspective: Federal Government

Besides facilitating the operation of the desalination plant, the federal government and its subsequent agencies must continue to meet salinity control standards while meeting the water development demands and requests from basin state representatives. In a 2015 testimony from Mr. Estevan Lopez, the commissioner for the Bureau of Reclamation, to the House Committee on Appropriations-Subcommittee on Energy and Water Development and Related Agencies, there were tensions between the Bureau of Reclamation and the basin states on water development and infrastructure. The exchanges between House Members and the Commissioner capture the delicate relationship between maintaining water for environmental purposes such as for endangered species and reducing salinity in the Colorado River Delta against the interest of states for further water development. In an exchange with

Representative Ken Calvert, Republican-Calif., issues were raised from water capture restrictions for environment purposes such as the preservation of endangered species and the Colorado River Delta. Representative Calvert pressed Mr. Lopez on whether the biological opinion of specific endangered species was the biggest impact to California's water deliveries. Mr. Lopez responded that indeed the newly implemented water quality standards in the Colorado River Delta to reduce salinity and protect wildlife impacted water deliveries.

CALVERT: Well, as you know, we had spent a significant amount of money through this committee over the last 20 years in supposedly improving the water quality in the Bay Delta. And doing significant amount of environmental projects that were frontloaded in order for us to move toward what we believe was a long term solution in bringing both -- growth, health to the -- to the delta and at the same time being able to meet our obligations for delivery of water.

LOPEZ: Congressman, I know there's a lot of frustration over the water that's going out and not -- and not being captured. But let me take a few of the things that you've said. In the current situation, right now, we're not constrained by storage in terms of -- we're actually constrained at, I believe, by how much we're able to pump away from the delta. And that is being driven in part -- in large part by the endangered species. But, the other thing is, making sure that there's enough water going out of the delta -- out of the delta to keep salt water from encroaching into it which would create a totally different set of water quality issues. (Simpson 2015, pg 8).

In the exchange between Mr. Lopez and Representative Jeff Fortenberry, Republican-Neb. on the difficulty of protecting the environment while maximizing water availability to farmers and municipalities in his district, the term "making water" was controversial. Despite constraints for water for the environment, drought, and growing populations, Representative Fortenberry was not content with restrictions to pumping additional water.

LOPEZ: Congressman, there is -- as you know, we're in -- it is a crisis. There is -- there is no water and we can't make water. We've got -- we have responsibilities for certain priorities of delivery and we're doing our best to make sure that we meet the -- the health and safety requirements first and foremost. But --

FORTENBERRY: I'd like you to be really careful with that statement because I hear that a lot with, "We can't make water." We all know we can't make it

rain. We all know that we can't produce water here. But, back to the comments made by a lot of members here, there have been ideas, alternatives out there to allow for more pumping flexibility and those things would produce real water for my constituents and for many south of me. So it's something that whenever we fall back on that line of trying to make water, there is ways that we can produce safe -- and produce some water for our constituents. So I'd appreciate it if you just take that comment a little more to heart and careful with that line in the future. So, thank you. (Simpson 2015, pg 12)

In his closing remarks, Mr. Lopez offered the use of technologies such as desalination to augment water supply in the wake of difficult scarcity and pumping restrictions. What was also captured in this exchange is the positioning of California as a hydro-hegemon in the basin.

LOPEZ: The problem that you -- that you highlight, the fact that the last few years there's been so little water that you've had to go more and more towards groundwater is obviously a huge problem. I think to the extent that any -- that communities are able to find alternatives, potentially desalination, reuse, things of that nature, those are obviously much preferred.

SIMPSON: Thank you. I decided, I -- I've -- I think I kind of see how this committee is going to break out now after this just being our second hearing is that we're going to have California water as the main issue and with four Californians that don't always agree on the -- on the best solution to everything, and it's going to be the rest of us trying to protect ourselves from California with where -- with representatives where are about to turn us because they want our water. (Laughter.) (Simpson 2015, pg 17).

Zeitoun et al. (2014) define a hegemon as one who, “exerts power over others beyond that accounted for by coercion or law,” a leadership buttressed by authority. California benefits from years of overflow. The dependency on the overflow water causes anxieties in years of drought and especially when that water is considered for other purposes.

In this testimony, it is clear that Mr. Lopez was especially pressed by representatives in states that were particularly hit with drought. The meeting was on appropriations for the Bureau of Reclamation's next fiscal year's spending. It was reported that the Bureau's budget

had not changed in the last seven years despite increasing demand and ailing infrastructure. Despite not being tied directly to the Yuma Desalting Plant, the response from representatives on water for the environment showed a frustration over pumping restrictions and water deliveries. These frustrations were met by the message that alternative water sources such as desalination among other technologies would be a key solution to future water demands.

Justice Perspective: Basin States

The inception of the Yuma Desalting Plant came as a technical solution to a political problem to resolve the international salinity crisis between the federal government and basin state members. At the time of negotiations, “the seven US states in the Colorado River basin, as well as the Wellton-Mohawk irrigation and drainage district, rejected demands for a reduction of their salinity input because of high costs and alteration of existing water rights in favor of Mexico” (Bernauer 2002). Despite using the treatment plant as a tactic to satiate basin states concerns, it was met with fierce criticism due to high operation costs, effectively removing it as an inefficient way to deal with salinity. This sentiment is seen in a 1994 testimony from Gerald R. Zimmerman,

“I concur with the assessment of the Bureau of Reclamation and the Department of the Interior that it makes absolutely no sense to operate the Yuma Desalting Plant at a cost of over \$30 million a year just to prove that salt can be taken out of the water. However, the Federal government selected the Yuma Desalting Plant as its preferred plan in 1974. To date, the Bureau of Reclamation and the Department of the Interior have failed to come forward

with a plan for the inoperative Plant that will not have an impact on the existing and future water supplies of the Basin states, including those of Nevada and California” (Zimmerman 1994, pg 4).

While meeting international equity goals, the Yuma Desalting Plant did not meet efficiency goals among basin states.

Long after the negotiation were made salinity control remains an ongoing issue, and the Yuma Desalting Plant is seen as a potential opportunity to claim additional Colorado River supply. The U.S. Congress operates on achieving the most cost-effective and efficient plans, however, basin states remain staunch on their water rights. From a testimony from Larry Linser,

“Arizona does not object to the Bureau of Reclamation considering alternatives to the fulfill scale operation of the Yuma Desalting Plant. However, we cannot support an alternative that would result in additional water demands on the Colorado River system. Alternatives that would adversely affect the quality or the quantity of water in reservoir storage necessary to satisfy existing water service contracts will be opposed. We could support alternatives that would encourage greater efficiencies in water uses and in water conservation” (Linser 1994, pg 6).

This testimony is restated from the national case study since it emphasizes the reluctance of representatives to re-operation the Yuma Desalting Plant.

This perspective is fairly libertarian by definition, but unsurprising given the state’s reliance on Colorado River Water. Later when plans to re-operate the Yuma Desalting plant

surfaced, a more accepting tone was identified in a testimony from Herbert Guenther, the Director of Arizona Department of Water Resources in 2009,

“Title I of the Act authorized the construction of the Yuma Desalting Plant, which was intended to capture and treat the drainage water flowing to the Cienega, and return most of it to the River for delivery as part of the Treaty obligation. [...] The ADWR and the ADEQ support efforts to foster a regional collaboration at the federal, state, and local levels using existing tools and exploring new ones so that we can address current and emerging challenges to the health of the River in the most sustainable manner possible (Guenther 2009, pg 2 and 4).

The change in tone and interest is likely due to the potential benefit lower basins would have in the operation of the plant. Chuck Collom, Colorado River Programs Manager with the Central Arizona Project, finds the project to be a “unique and fruitful collaboration [which] exemplifies the new spirit of binational cooperation and collaboration in monitoring and evaluating different environmental resources in the Colorado River system” (Space Daily 2012, pg 1). Areas such as Las Vegas would gain since less water might be released from Lake Mead if downstream demands can be met by the Yuma Desalting Plant at the expense of the Cienega Santa Clara Wetland (Birdsong 2011).

In an opinion published by April Reese with Greenwire, a publication that reports on national environmental and energy action, “the Yuma Desalting Plant has come to symbolize the region's unquenchable thirst. (Greenwire 2012, pg 1). As to why the operation of the plant might have renewed interest,

“While the amount of water the desalting plant can treat is small, every drop that can be sent to Mexico from treated irrigation runoff is a drop that can be kept upstream in Lakes Mead and Powell to supply Las Vegas, Phoenix and other cities. Currently, those reservoirs release the water needed to meet the U.S. obligation to Mexico. The amount of treated water released into the river during the yearlong trial run was enough to supply the needs of about 116,000 people for one year” (Greenwire 2012, pg 2).

The reoperation of the Yuma Desalting plant provides a potential supply to offset flows that would otherwise be released downstream from states such as California, Arizona, and Nevada. Although originally built to meet international salinity goals, the desalination plant’s use has transformed into a securitization tool to claim more Colorado River water.

Justice Perspective: Wellton-Mohawk Irrigation and Drainage District

The Wellton Mohawk Irrigation and Drainage District (WMIDD) continues to be an agricultural land that produces alfalfa hay, barley, sorghum, wheat, bermuda, specialty seeds, cotton, citrus, lettuce, melons, nuts, safflower and manages cattle and sheep (WMIDD 2004). The positioning of the WMIDD is intricate because it has long been used as an agricultural land and was at one point the very source for the international salinity crisis. Their positioning as a stakeholder was made in a testimony by Wade Noble, an attorney in Yuma, Arizona for the WMIDD in 2010 to the House Committee on Natural Resources, Subcommittee Water and Power. In his testimony, he emphasized the need for lower basin states to cooperate with upper basin states on methods and programs to augment more water for downstream needs in the basin. When renewed interest for the Yuma Desalting Plant

occurred and the pilot run began, Noble, on behalf of the WMIDD, emphasized that the cost of operating the plant would be shared by the lower basin states who stand to benefit from the water output. The plant would be a way for the lower basin states to augment their own water needs without the cooperation of the upper basin states.

He also emphasized that although salinity has been a major concern in the basin, there are other quality concerns that have yet to be addressed,

“There are other water quality concerns including nitrates. Several communities along the river have inadequate sanitation systems. These communities need, and deserve, assistance to provide for sewer systems which adequately treat sewage. It is important that these communities receive grants or other financial assistance with which to develop appropriate systems for collection and treatment of sewage. (Noble 2010, pg 3).

The salinity program has been and continues to be a federal led program to meet international water obligations. This however does not evade other quality issues at the local scale. In his closing statement, Noble remarks on the libertarian approach from stakeholders in the river,

“The allocations of water and power, and the priorities established by the Law of the River should not be circumvented but used as a basis for developing responses to current and future needs. Each entity, local, state or federal, with an interest in the water or power on the river, will act in their self interest in order to meet their needs. This will result in cooperation and conflict.” (Noble 2010, pg 3).

There has been outward cooperation over the river, but there remains a tension over developing water for each entity’s own needs. If and when the burden of managing salinity

encroaches on water allocations, or if the Yuma Desalting Plant becomes fully operational again, the benefits will go to lower basin states and not to Mexican farmers who were the original benefactors of the plant.

Justice Perspective: NGOs

In a 1998 testimony from William J. Snape, Legal Director of the Defenders of Wildlife to the House Subcommittee on Water and Power Resources, issues of inequity and injustice arise over the international salinity negotiation and the decision to build the Yuma Desalting Plant. Snape believed that the decision to divert agricultural discharge from the Wellton Mohawk Irrigation Drainage District remains a wrong decision since finding water in place of the discharge water would remain difficult (Snape 1998). Snape also found that the decision to divert the salinity water was a decision that had not adequately consulted key stakeholders in the basin,

“The Federal Treasury must be protected, all state and federal laws must be complied with, interstate compacts must be protected, the Secretary's trust responsibilities must be met toward recognized Indian tribes, international agreements must be fulfilled, and public aspects of the project must be protected. All six of these criteria are implicated by the Wellton-Mohawk transfer and remain unresolved by H.R. 3677. 6 I also want to emphasize that these are major issues, implicating the Constitution of the United States. Congress should carefully examine a bill that impacts revenue, commerce, interstate cooperation, and international treaty obligations as H.R. 3677 does. Furthermore, my relatively quick outreach with impacted Indian tribes in the area indicate that they have not been consulted adequately (Snape 1998, pg 2).”

Along with the lack of procedural justice attempted by the federal government during the international salinity negotiation, Snape also addressed the lack of efficiency in allowing farmers in the Wellton-Mohawk Irrigation Drainage District to continue their agricultural practices,

“Wellton-Mohawk has received close to \$1 billion worth of federal subsidies to grow water intensive crops such as alfalfa and cotton in the middle of the hot Sonoran Desert. This money has been used to bring Colorado River water to the irrigation district, to channel and levy the Gila River so that it does not interfere with farming, to build drainage systems powered by federal plants that remove Wellton-Mohawk's saline water caused by irrigation, and for countless other associated projects (Snape 1998, pg 2).”

Snape believes that private industry might help resolve some of the O&M costs associated with the WMIDD, and that privatization might be an answer to all of the long term economic and ecological problems residing in places such as Arizona. The lack of consultation from key stakeholders such as the Native American tribes also shows another instance of procedural injustice in the Colorado River Basin.

Justice Perspective: David Getches

There are stakeholders who have taken a more critical approach to the decision to build the Yuma Desalting Plant, as well as the international negotiation itself. David Getches testified to the US Senate Committee on Energy and Natural Resources on, “Problems and Opportunities in the Management of the Lower Colorado River.” In his testimony he believed that the Yuma Desalting Plant was a wrong decision in the 1974 Colorado River Basin salinity Control Act since it costed \$260 million to build and bears high maintenance costs of \$7 billion dollars annually to produce only 68,000 acre-feet annually. The plant went dormant in 1994 despite being built in 1992. Getches believed an alternative solution would’ve been to buy out unproductive agricultural lands in the Wellton-Mohawk District. Less land to irrigate, the amount of salt entering the district would’ve been reduced, and it would’ve been a “least cost” policy,

“The most logical and economical solution would involve buying out the least productive lands in the Wellton/Mohawk District. Retiring Wellton-Mohawk lands was always the cheapest, simplest, and most obvious way to reduce salinity of water delivered to Mexico under our treaty obligation (Getches 1994, pg 3).”

At the time of the negotiation, the decision to retire agricultural lands in the WMIDD was controversial and seen as an infringement of state’s water rights and goals. As stated by Getches, the decision to take a most costly apolitical decision had major financial and equity consequences,

“Perhaps it could be dismantled and sold (or given under a foreign aid program) to others who could use it to produce domestic water from salt water instead of our using it to pour \$290 per acre-foot water back into the river for Mexican farmers so that Wellton-Mohawk farmers can continue flooding their farms with \$7 per acre-foot water (Getches 1994, pg 4).”

Getches offers an equitable and efficient solutions which includes eventually retiring agricultural lands in the WMIDD and in other areas using Colorado River,

“This must be done equitably, in light of where the benefits are enjoyed and where the burdens am felt. Thus, if farm lands are retired in the upper basin and the benefits of reduced salinity are in the lower basin, then the costs of the solution, including economic benefits forgone by the upper basin, should be compensated by the beneficiaries (Getches 1994, pg 4).”

Out of all the solutions offered this is perhaps the most egalitarian, which seeks equitability in opportunity of the redistribution of benefits. In summary, Getches believes that congress

and the Bureau of Reclamation did not make an economic, equitable, or environmental decision. The decision also did not account for environmental consequences, their relations with Mexico, or the interests of affected stakeholders (Getches 1997).

Justice Perspective: Local Stakeholders

Salinity issues not only affect Mexican stakeholders downstream, but also afflict communities that receive Colorado River water for municipal purposes. The inclusion of local stakeholders' needs has been absent in many of the conversations had over the management of salinity. In an opinion in The San Diego Union Tribune, residents in Moab, Utah continue to deal with salinity issues,

“Moving Moab's radioactive mountain is not Metropolitan's only concern about Colorado River water quality. The Colorado's high levels of salinity continue to cause us, and urban residents in other states, great concern. (San Diego Union-Tribune 2000, pg 2).

The City of Moab lies upstream in the Colorado River Basin where the majority source of salinity dwells. In the downstream areas of the river, cities such as Yuma, Arizona also deal with high salinity. In a 1985 article from The Associated Press, the residents of Yuma dealt had plenty of water but suffered on quality water for consumption use,

“Many Yuma residents only use the local water to fill their swimming pools, water their lawns, and take baths. They buy bottled water, at upwards of 65 cents a gallon at the grocery store, and drink that instead of tap water because of the high salinity (The Associated Press 1985, pg 6).”

In response to the inadequate quality of water, other sources such as groundwater were being sought after to secure water supplies,

“Despite Yuma's present comfortable consumption rate and extra allocation of Colorado River water, Hunt is still searching for future water from underground wells, and by buying up agricultural water rights. "The cliché is 'Arizona grows where water flows,'" says Hunt. "To get the growth we deserve, we may have to have more abundant water supplies. "But all the votes are in Phoenix and Tucson. Our wildest projected growth is 125,000 permanent residents in Yuma by 2010. By then, Phoenix will have millions. (The Associated Press 1985, pg 6).

The lingering salinity issues on a local level have created household level water insecurity issues and exasperated securitization attempts for groundwater to keep up with growing demands.

In regard to the Cienega Wetland, the future of the Mexican community of Ejido Johnson, who has had a successful ecotourism business off the wetland, remains unknown. In a 2019 series on the Colorado River Delta, concerns on the future of the wetland in light of the re-operation of the Yuma Desalting Plant has raised worries from environmentalist,

“The wetland does have some protections. The Mexican government has designated the Ciénega as a biosphere reserve in the Colorado River Delta. It’s also been recognized for having “great ecological significance” by the Ramsar convention, an intergovernmental treaty on the value of wetlands. If the U.S. were to run the Yuma Desalting Plant, it likely would trigger a

consultation of previous agreements between it and Mexico (KUNC 2019, pg 4).”

The article reports that the latest drought contingency plan signed by all seven basin states are committed to conserve 100,000 acre-feet of water in the Colorado River. Although this is the same amount of water the Cienega Santa Clara Wetland needs to receive, it is unsure of that water will be used to serve environmental purposes or the purposes of basin state needs.

Politicization

In regards to the reoperation of the Yuma Desalting plant, Jennifer Pitt from the Environmental Defense Fund, has seen it as a success and also a political triumph between the United States, Mexico, and basin states, while preserving the environment (Greenwire 2012). The success of the project was seen as a way to alleviate other issues on the border as well; “the University of Arizona's Flessa called the effort ‘a good example of where ... cooperation can get you.’ ‘This is much better than tying things up in courts,’ Flessa said. ‘We have enough problems along the border. We don't need more problems’” (Greenwire 2012, pg 3). The reoperation of the Yuma Desalting Plan, in this way, is seen as a political tool to remediate and maintain relations between the US and Mexico, despite problems in other international relations.

Transboundary Water Justice Analysis at the Local Level

Now that there is a renewed interest in operating the plant, a change in tone and the appearance of new justice perspective and goals have come to light. First, the resurgence of the plant has major implications on the Santa Clara Cienega Wetland, which depends on the

water the plant would otherwise receive. Second, although once heralded as a way to address salinity issues in the basin, it would instead be used to meet upstream water securitization goals. Although there are new interests in operating the desalination plant, it remains tied to quantity issues. In the past, basin state members in the senate have reacted abrasively to major changes in their allocation. As such, the path forward for the Yuma Desalting plant remains bleak. Lastly, despite negotiations, programs, and management plans on the international and national levels, there remains evidence of actual beneficiaries on a local level. Residents in Moab, Utah and Yuma, Arizona are looking to securitize other water resources such as groundwater due to the high levels of salinity in the Colorado River water they receive. It is clear that when dealing with the Colorado River, a libertarian approach remains wherein stakeholders will act on their own self-interests.

The federal government holds a fairly utilitarian approach having to maintain the demands of basin states while caring for environmental concerns such as endangered species, salinity, and delta restoration. In the 2015, the Bureau of Reclamation attempted to meet the interests of environmental sustainability against the efficiency goals of the basin states. The basin states maintained their libertarian justice perspective in dealing with salinity management and in the operation of the Yuma Desalting Plant. Once touted as a failed expense, a renewed interest in the plant is mainly led by securitization attempts at claiming additional Colorado River water. The reoperation of the plant is a concern for environmental and local stakeholders who understand the reliance of the Santa Clara Cienega Wetland on water that would be used for the Yuma Desalting Plant. Their goals are primarily expressed over concerns of environmental sustainability and equitability.

As part of Zeitoun et al.'s (2014) justice framework, a consideration of alternatives by counter-hegemonic entities can be a way of strategizing more sustainable and equitable solutions or changing the status quo. Taxpayers paid greatly for the decision to build the plant, which was also seen as negligent given the alternatives, such as retiring lands in the Wellton Mohawk Irrigation Drainage District (Getches 1997). Environmental justice takes into consideration (1) equity in distribution (2) recognition of the diversity of affected people, and (3) participation in environmental policy-formulation (Schlosberg 2004; Zeitoun et al. 2014). An efficient alternative, it was ultimately ignored making it an example of injustice in the international negotiation of salinity since there was a lack of participation from counter-hegemonic entities. An unequitable distribution of benefits is apparent since there are multiple communities that remain impacted by high salinity, causing instances of water insecurity. The lack of recognition of the diversity of affected people also occurred in the basin when there was evidence that the Native American Tribes were not adequately consulted or able to participate in the decision making of the international salinity negotiation. Their participation was required but ultimately not executed. In the case of the Yuma Desalting Plant, there were many factors which contributed to evidence of transboundary water injustice.

CHAPTER VI: DISCUSSION AND CONCLUSION

By employing the Zeitoun et al. (2014) framework on salinity governance in the Colorado River basin, multiple stakeholder perspectives were emphasized and areas of injustice were learned. A thorough understanding of how salinity is managed in the Colorado River Basin from a justice lens helped determine “who decides who should get water, when, how and why” (Zeitoun et al. 2014, pg 176). This research held those in power accountable and evaluated how benefits and costs were distributed on a basin wide scale.

The U.S. federal government negotiated technical and infrastructural solutions to resolve the international salinity crisis to avoid basin politics over water allocation rights. These conditions and demands ultimately shaped the basis of the negotiation and the efficacy of salinity control and management on a national level and at the local level. It is not an example of good transboundary water governance since there is an effective basin hegemon and evidence of procedural injustice through the lack of distribution in benefits, exclusion of key stakeholders, and the antiquated tenets of the “Law of the River”. Even today, basin state members refuse to reevaluate the Salinity Control Act partly due to the potential impact it may have on water quantity allocations. It is unlikely the basin will change its salinity governance since the basin states serve as an effective basin hegemon. Although basin states insisted that water quantity and quality remain separate in the Colorado River basin, testimonies from basin state representatives suggest a deeper understanding of the overall function of the Colorado River basin wherein the two are intricately tied.

This decision was ultimately top-down, however had a bottom-up decision been considered desalination would likely not been brought into consideration (Getches 1994). Whether or not the plant can continue to operate in the present, it is likely that it will be

unable to perform at full operation since topics of water quantity and the “law of the river” will likely impede further development.

Salinity is an issue not only on the border but in the entire basin, benefits should go to basin states and local communities since their tax-dollars pay for the program itself. Benefits that are seen are limited to projects that would not impact development projects, which greatly diminishes the overall effectiveness of salinity governance. As for the future, it is unlikely that smaller cities dealing with issues at the tap can be able to motivate the Colorado River Salinity Program on a national level. If the status quo continues along with worsening drought, municipalities and smaller cities may find themselves in need of alternative resources as seen in Moab, Utah and Yuma, Arizona. This is in part due to the way salinity is being monitored at only three key checkpoints and the type of salinity reduction programs that exist; they are only suited to accomplish water quality goals at the border. Salinity governance in the Colorado River basin circumvents normative water quality approaches which demands more rigorous water quality monitoring, set milestones and goals, and a plan similar to a watershed protection plan or total maximum daily loads plan.

If salinity is not properly managed from a basin-wide perspective at the international or national level, there will inevitably be unintended consequences at the local levels. This supports Mumme and Taylor (2014) notion that decisions made at the international level are intrinsically tied to the local level.

It seems like on the international scale, equality is important due to the UN international laws on equitable use. On the national scale, there appears to be a dichotomous effort to both be efficient while trying to protect water allocation rights. The need to protect water rights led to a fairly inefficient technical solution, however after a couple years in

operation this solution was abandoned due to efficiency concerns. On the local scale, environmental sustainability is important because the impacts of high saline levels are felt more to those who experience them i.e. Mexican farmers, US farmers, citizens, communities.

In terms of the framework itself, there was difficulty in assigning a singular justice perspective to a stakeholder; the framework does not allow for pluralism. The nature of this research emphasized only salinity, however in cases where multiple topics were discussed it would be difficult to assign only one justice perspective to a stakeholder that may hold multiple views for various topics. It may not be productive to put stakeholders and their motives into categories – utilitarian, libertarian, and egalitarian, which narrows the complex nature of transboundary water governance. Even when a singular topic was broken down into three different scales, it proved difficult to consistently assigned one perspective to each stakeholder. In some cases, I was unable to.

However, a strength of the framework was the concept of understanding stakeholder goals and motivations. By mapping out stakeholder goals, it was easier to recognize power dynamics. For example, it was evident that overall salinity governance was written according to the needs of basin states by following their narratives, goals, and motives. Another strength of the framework is the intent to understand injustice through participation or lack thereof. This forces the researcher to be deliberate about understanding power structures and the capacity of various stakeholders to change transboundary processes. I do not think I was able to comprehensively understand all stakeholder perspectives, goals, and participation through the use of a database alone. The data I collected (news reports, law, and regulations) would be further validated if used in tandem with interviews from key stakeholders. This is a practice that can be found in the work of Norman and Bakker (2009) and Suhardiman et al.

(2014). Stakeholder perspectives are most appropriate when given the opportunity and platform to share them themselves.

The Zeitoun et al. (2014) framework would be even better suited in cases where water quantity is a predominant concern. This case study could be strengthened if the database expanded to issues related to the overall governance of the basin. For example, issues related to the Colorado River delta restoration, Native American Water Rights, Law of the River, drought and climate adaption, among other topics, would strengthen some of the claims made in this research and provide a broader understanding of water justice in a transboundary water basin. Isolated research topics in a basin can be a detached understanding of the overall function and health of a basin. The next step would be to build out the database to include more topics, stakeholders, and dialogues.

Moving forward, there is a nuanced discussion to be made about the transboundary water research in general. This research is best used if shared with stakeholders with the capacity to change the processes of transboundary governance, namely the federal government. This work is unlikely to make their desk. Transboundary work operates as such a large scale, it is difficult to find a solution for everyone and everything. There are also many factors to take into consideration including diplomacy, prior water rights, customary water rights, among others.

In the case of transboundary water aquifers, there is an opportunity to implement a transboundary water justice framework and see if there are instances of injustice in these cases.

Lastly, there was a recurring concern on the relationship with U.S. and Mexico and whether it can impact work done on a transboundary water governance level. These concerns

are regularly expressed however work done on transboundary rivers have largely remained separate over these discussions. It will be interesting to see if there are any impacts in light of the new NAFTA negotiation, and the eroding relationship between the U.S. and Mexico currently in peril.

REFERENCES

- Akhmouch, A. 2012. Good Governance. Synthesis Report for the Condition for Success 1.
- Acquah, S., and F. A. Ward. 2017. Optimizing Adjustments to Transboundary Water Sharing Plans: A Multi-Basin Approach. *Water Resources Management* 31 (15):5019-5042.
- Appelgren, B., and W. Klohn. 1997. Management of transboundary water resources for water security; principles, approaches and State practice. *Natural Resources Forum* 21 (2):91-100.
- Arjoon, D., A. Tilmant, and M. Herrmann. 2016. Sharing water and benefits in transboundary river basins. *Hydrology and Earth System Sciences* 20 (6):2135-2150.
- Bakker, K. 2010. *Privatizing water: governance failure and the world's urban water crisis*: Cornell University Press.
- Bark, R. H., G. Frisvold, and K. W. Flessa. 2014. The role of economics in transboundary restoration water management in the Colorado River Delta. *Water Resources and Economics* 8:43-56.
- Barreira, A. 2006. Water governance at the European Union. *Journal of Contemporary Water Research & Education*, 135(1), 80-85.
- Bernal, J. M., and A. H. Solís. 2000. Conflict and Cooperation on International Rivers: The Case of the Colorado River on the US-Mexico Border. *International Journal of Water Resources Development* 16 (4):651-660.
- Bernauer, T. 2002. Explaining success and failure in international river management. *Aquatic Sciences* 64 (1):1-19.
- Birdsong, B. C. 2011. Mapping the Human Right to Water on the Colorado River. *Willamette L. Rev.* 48:117.
- Bridge, G., and T. Perreault. 2009. Environmental governance. *A companion to environmental geography*:475-497.
- Brown, C., J. Castro, N. Lowery, and R. Wright. 2003. Comparative analysis of transborder water management strategies: Case studies on the United States-Mexico border. *Binational Water Management Planning: Opportunities, Costs, Benefits, and Unintended Consequences*.
- Brown, C. P., and S. Mumme. 2000. Applied and theoretical aspects of binational watershed councils (Consejos de Cuencas) in the US–Mexico borderlands. *Natural Resources Journal*:895-929.

- Castle, S. L., B. F. Thomas, J. T. Reager, M. Rodell, S. C. Swenson, and J. S. Famiglietti. 2014. Groundwater depletion during drought threatens future water security of the Colorado River Basin. 41 (16):5904-5911.
- Chapter 3: Colorado River Basin. U.S. Department of the Interior Bureau of Reclamation. March 2016. SECURE Water Act Section 9503(c)—Reclamation Climate Change and Water 2016.
- Chapter 3: Municipal and Industrial Water Conservation and Reuse. Moving Forward: Phase 1 Report. May 2015
- Chapter 4: Agricultural Water Conservation, Productivity, and Transfers. Moving Forward: Phase 1 Report. May 2015.
- Chapter 5: Environmental and Recreational Flows. Moving Forward: Phase 1 Report. May 2015.
- Chupp, M. 1991. When mediation is not enough. *Conciliation Quarterly* 10 (3):2-13.
- Cohen, A. 2012. Rescaling environmental governance: watersheds as boundary objects at the intersection of science, neoliberalism, and participation. *Environment and Planning A* 44 (9):2207-2224.
- Cohen, A., and K. Bakker. 2014. The eco-scalar fix: rescaling environmental governance and the politics of ecological boundaries in Alberta, Canada. *Environment and Planning D-Society & Space* 32 (1):128-146.
- Cohen, A., and S. Davidson. 2011. The watershed approach: Challenges, antecedents, and the transition from technical tool to governance unit. *Water Alternatives* 4 (1):1.
- Cohen, M.I. June 2011. *Municipal Deliveries of Colorado River Basin Water*. Pacific Institute, Oakland, CA.
- Colorado River Basin Stakeholders Moving Forward to Address Challenges Identified in the Colorado River Basin Water Supply and Demand Study. Phase 1 Report: Executive Summary. May 2015.
- Cook, C. 2014. Governing jurisdictional fragmentation: Tracing patterns of water governance in Ontario, Canada. *Geoforum* 56:192-200.
- Cooley, H., and P. H. Gleick. 2011. Climate-proofing transboundary water agreements. *Hydrological Sciences Journal* 56 (4):711-718.

- Eidem, N. 2008. The Western Water Institutional Solutions-Western Water Information Network Collaboration: An Analysis of the Social, Economic, and Biophysical Environments Supportive of and the Historic Trends in Conflict and Cooperation in the Bureau of Reclamation's Upper Colorado Region 1970-2005. Reclamation: *Managing Water in the West*.
- Environmental Defense Fund, Inc. v. Costle, 79 F.R.D. 235 (1978)
- Environmental Defense Fund, Inc. v. Costle, 657 F.2d 275 (1981)
- Feitelson, E., and G. Rosenthal. 2012. Desalination, space and power: The ramifications of Israel's changing water geography. *Geoforum* 43 (2):272-284.
- Fischhendler, I., E. Feitelson, and D. Eaton. 2004. The Short-Term and Long-Term Ramifications of Linkages Involving Natural Resources: The US – Mexico Transboundary Water Case. 22 (5):633-650.
- Furnish, D. B., and J. R. Ladman. 1975. The Colorado River Salinity Agreement of 1973 and the Mexicali Valley. *Nat. Resources J.* 15:83.
- Garrick, D. E. 2015. *Water allocation in rivers under pressure: Water trading, transaction costs and transboundary governance in the Western US and Australia*: Edward Elgar Publishing.
- . 2017. Water Security and Adaptation to Climate Extremes in Transboundary Rivers of North America. In *Water Policy and Governance in Canada*, eds. S. Renzetti and D. P. Dupont, 121-137. Cham: Springer International Publishing.
- Gerlak, A. K. 2015. Resistance and Reform: Transboundary Water Governance in the Colorado River Delta. *Review of Policy Research* 32 (1):100-123.
- Gerlak, A. K., R. G. Varady, and A. C. Haverland. 2009. Hydrosolidarity and International Water Governance. *International Negotiation* 14 (2):311-328.
- Gerlak, A. K., and M. Wilder. 2012. Exploring the textured landscape of water insecurity and the human right to water. *Environment: Science and Policy for Sustainable Development* 54 (2):4-17.
- Getches, D. H. 1997. Colorado River governance: Sharing federal authority as an incentive to create a new institution. *U. Colo. L. Rev.* 68:573.
- Gisselquist, R. M. 2012. *Good governance as a concept, and why this matters for development policy*: WIDER Working Paper.
- Glenn, E. P., K. W. Flessa, and J. Pitt. 2013. Restoration potential of the aquatic ecosystems of the Colorado River Delta, Mexico: Introduction to special issue on "Wetlands of the Colorado River Delta". *Ecological Engineering* 59:1-6.

- Governance: the World Bank's experience. Washington (DC): World Bank; 1994: vii, xiv
- Gupta, J., A. Hildering, and D. Misiedjan. 2014. Indigenous people's right to water under international law: a legal pluralism perspective. *Current Opinion in Environmental Sustainability* 11:26-33.
- Hanasz, P. 2017. A Little Less Conversation? Track II Dialogue and Transboundary Water Governance. *Asia & the Pacific Policy Studies* 4 (2):296-309.
- Harrison, D. L. 1981. Federal Regulation of Appropriations of Water in the Name of Protecting Water Quality.
- Holburt, M. B. 1975. International problems of the Colorado River. *Nat. Resources J.* 15:11.
- Howard, B.C. (2014) Saving the Colorado River Delta, One Habitat at a Time. The National Geographic.
- Huffman, J. L. 2009. Comprehensive River Basin Management: The Limits of Collaborative, Stakeholder-Based, Water Governance. *Natural Resources Journal* 49 (1):117-149.
- IBWC Minutes Chart. International Boundary Water Commission Website.
- Ingram, H., J. M. Whiteley, and R. Perry. 2008. The importance of equity and the limits of efficiency in water resources. *Water, place and equity* 1.
- Jalilov, S.-M., O. Varis, and M. Keskinen. 2015. Sharing benefits in transboundary rivers: An experimental case study of Central Asian water-energy-agriculture nexus. *Water* 7 (9):4778-4805.
- Jensen, M. 2012. Ciénega de Santa Clara Unchanged After Pilot Run of Desalting Plant. UANews. <https://uanews.arizona.edu/story/ci-nega-de-santa-clara-unchanged-after-pilot-run-of-desalting-plant>
- Jepson, W., J. Budds, L. Eichelberger, L. Harris, E. Norman, K. O'Reilly, A. Pearson, S. Shah, J. Shinn, and C. Staddon. 2017. Advancing human capabilities for water security: A relational approach. *Water Security* 1:46-52.
- King, W. 2012. Laws of the Colorado River Basin: Obsolete or Flexible for a Sustainable Future. The 2012 Colorado College State of the Rockies Report Card- The Colorado River Basin: Agenda for Use, Restoration and Sustainability for the Next Generation.
- López-Hoffman, L., R. G. Varady, K. W. Flessa, and P. Balvanera. 2010. Ecosystem services across borders: a framework for transboundary conservation policy. *8* (2):84-91.
- Lower Basin of the Colorado River. American Rivers Website. Assessed 6/30/18

- Mann, D. E. 1975. Politics in the United States and the salinity problem of the Colorado River. *Natural Resources Journal* 15 (1):113-128.
- Medellín-Azuara, J., J. R. Lund, and R. E. Howitt. 2007. Water Supply Analysis for Restoring the Colorado River Delta, Mexico. 133 (5):462-471.
- Milich, L., and R. G. Varady. 1999. Openness, Sustainability, and Public Participation: New Designs for Transboundary River Basin Institutions. 8 (3):258-306.
- Minckley, W. L., P. C. Marsh, J. E. Deacon, T. E. Dowling, P. W. Hedrick, W. J. Matthews, and G. Mueller. 2003. A conservation plan for native fishes of the lower Colorado River. *AIBS Bulletin* 53 (3):219-234.
- Mirumachi, N. 2013. Transboundary water security: Reviewing the importance of national regulatory and accountability capacities. In *Water security: Principles, perspectives and practices*, 166-179: Routledge.
- Moench, M., A. Dixit, S. Janakarajan, M. Rathore, and S. Mudrakartha. 2003. *Fluid mosaic: Water governance in the context of variability, uncertainty and change; a synthesis paper*: Nepal Water Conservation Foundation, Kathmandu, NP.
- Molle, F. 2008. Nirvana Concepts, Narratives and Policy Models: Insights from the Water Sector. *Water Alternatives* 1.
- . 2009. River-basin planning and management: The social life of a concept. *Geoforum* 40 (3):484-494.
- Mumme, S. 1993. Innovation and Reform in Transboundary Resource Management: A Critical Look at the International Boundary and Water Commission, United States and Mexico. *Natural Resources Journal* 33 (1):93-120.
- Mumme, S., and P. L. Taylor. 2014. The Ocotillo Water War and the US-Mexico "Salinity Crisis": An Examination of Transitivity and Scale in Environmental Justice. *Journal of the Southwest*:1-28.
- Mumme, S. P. 2005. The international boundary and water commission under fire: Policy prospective for the 21st century. *The Journal of Environment & Development* 14 (4):507-524.
- Mumme, S. P. 2016. Scarcity and Power in US–Mexico Transboundary Water Governance: Has the Architecture Changed since NAFTA? *Globalizations* 13 (6):702-718.
- Mumme, S. P., and D. J. Little. 2010. Leadership, politics, and administrative reform at the United States Section of the International Boundary and Water Commission, United States and Mexico. *The Social Science Journal* 47 (2):252-270.

- Mumme, S. P., J. McEvoy, N. Pineda, and M. Wilder. 2017. Shipping water across the US–Mexico border: international governance dimensions of desalination for export. *Water International* 42 (7):777-793.
- Mumme, S. P., and S. T. Moore. 1990. Agency autonomy in transboundary resource management: the United States section of the international boundary and water commission, United States and Mexico. *Nat. Resources J.* 30:661.
- Norman, E. S., and K. Bakker. 2009. Transgressing Scales: Water Governance Across the Canada–U.S. Borderland. *Annals of the Association of American Geographers* 99 (1):99-117.
- OECD. 2006. DAC Guidelines and Reference Series Applying Strategic Environmental Assessment: Good Practice Guidance for Development Co-operation, OECD, Paris.
- OECD. 2011. Water Governance in OECD Countries: “A Multi-Level Approach”, OECD Publishing, Paris
- Oyarzabal-Tamargo, F., and R. A. Young. 1978. International external diseconomies: the Colorado River salinity problem in Mexico. *Nat. Resources J.* 18:77.
- Ozerol, G., J. Vinke-de Kruijf, M. C. Brisbois, C. C. Flores, P. Deekshit, C. Girard, C. Knieper, S. J. Mirnezami, M. Ortega-Reig, P. Ranjan, N. J. S. Schroder, and B. Schroter. 2018. Comparative studies of water governance: a systematic review. *Ecology and Society* 23 (4).
- Petersen-Perlman, J. D., and A. T. Wolf. 2015. Getting to the First Handshake: Enhancing Security by Initiating Cooperation in Transboundary River Basins. *JAWRA Journal of the American Water Resources Association* 51 (6):1688-1707.
- Phillips, D.J.H., Allan, J.A., Claassen, M., Granit, J., Jägerskog, A., Kistin, E., Patrick, M., and Tur-ton A. 2008. The TWO Analysis: Introducing a Methodology for the Transboundary Waters Opportunity Analysis. Report Nr. 23. SIWI, Stockholm.
- Pitt, J., D. F. Luecke, M. J. Cohen, and E. P. Glenn. 2000. Two Nations, One River: Managing Ecosystem Conservation in the Colorado River Delta Water Issues in the US - Mexico Borderlands: Section 1: Dimensions of Borderland Water Conflicts: Past, Present, and Future. *Natural Resources Journal* 40:819-864.
- Postel, S. L., J. I. Morrison, and P. H. Gleick. 1998. Allocating Fresh Water to Aquatic Ecosystems: The Case of the Colorado River Delta. *Water International* 23 (3):119-125.
- Prairie, J. R., B. Rajagopalan, T. J. Fulp, and E. A. Zagona. 2005. Statistical nonparametric model for natural salt estimation. *Journal of environmental engineering* 131 (1):130-138.

“Product of the Transboundary Freshwater Dispute Database, College of Earth, Ocean, and Atmospheric Sciences, Oregon State University. Additional information about the TFDD can be found at: <http://transboundarywaters.science.oregonstate.edu>.”

Rogers, P., and A. W. Hall. 2003. Effective Water Governance.

Sadoff, C. W., and D. Grey. 2002. Beyond the river: the benefits of cooperation on international rivers. *Water policy* 4 (5):389-403.

Sánchez, A. 2006. 1944 Water Treaty between Mexico and the United States: present situation and future potential. *Frontera norte* 18 (36):125-144.

Sanchez, R., and G. Eckstein. 2017. Aquifers shared between Mexico and the United States: Management perspectives and their transboundary nature. *Groundwater* 55 (4):495-505.

Sánchez-Munguía, V. 2011. The US–Mexico border: Conflict and co-operation in water management. *International Journal of Water Resources Development* 27 (3):577-593.

Sanchez-Rodriguez, R., and S. Mumme. 2013. Protecting the environment. *Mexico and United States: The politics of partnership*:139-159.

Schlosberg, D. 2004. Reconceiving Environmental Justice: Global Movements And Political Theories. *Environmental Politics* 13 (3):517-540.

Soliev, I., K. Wegerich, and J. Kazbekov. 2015. The costs of benefit sharing: Historical and institutional analysis of shared water development in the Ferghana valley, the Syr Darya basin. *Water* 7 (6):2728-2752.

Starks, R. R. and A. Quijada-Mascareñas. In press. Indigenous peoples and the wall-Mexico border. In Cordova, A. and C. de la Parra (Eds.) *The border fence between Mexico and the United States. Spaces, instruments and actors for constructive dialogue*. El Colegio de la Frontera Norte. Tijuana, Mexico. pp. 337- 349.

Stockholm International Water Institute. 2016. Water Governance. Issue Sheet.

Suhardiman, D., and M. Giordano. 2014. Legal Plurality: An Analysis of Power Interplay in Mekong Hydropower. *Annals of the Association of American Geographers* 104 (5):973-988.

Suhardiman, D., M. Giordano, and F. Molle. 2012. Scalar Disconnect: The Logic of Transboundary Water Governance in the Mekong. *Society & Natural Resources* 25 (6):572-586.

Sultana, F., and A. Loftus. 2015. The human right to water: Critiques and condition of possibility. *Wiley Interdisciplinary Reviews: Water* 2 (2):97-105.

- Tropp, H. 2007. Water governance: trends and needs for new capacity development. *Water policy* 9 (S2):19-30.
- UNDP. 2011. Chapter 8. Governance Principles, Institutional Capacity and Quality. Published 2011.
- UNESCO Website, Governance and Institutions, accessed June 2019.
- United Nations Economic and Social Commission for Asia and the Pacific. 2009. What is Good Governance. UNESCAP Website, Published July 10, 2009.
- United Nations Environmental Programme. 2009. Environmental Governance. UNEP Factsheet.
- UNWater. 2013. Water Security & the Global Water Agenda: A UN-Water Analytical Brief. *United Nations University*. <http://www.fao.org/3/a-i2930e.pdf>
- Vandersande, M. W., E. P. Glenn, and J. L. Walworth. 2001. Tolerance of five riparian plants from the lower Colorado River to salinity drought and inundation. *Journal of Arid Environments* 49 (1):147-159.
- Ward, E. R. 1999. SALINE SOLUTIONS: Arizona Water Politics, Mexican-American Relations, and the Wellton-Mohawk Valley. *The Journal of Arizona History* 40 (3):267-292.
- Ward, E. 2002. *Border oasis*. Tucson: University of Arizona Press.
- Warner, J. F., P. Wester, and J. Hoogesteger. 2014. Struggling with scales: revisiting the boundaries of river basin management. *Wiley Interdisciplinary Reviews: Water* 1 (5):469-481.
- Wellton-Mohawk Irrigation and Drainage District. 2004. History: Early History of the Area. WMIDD Website. <https://www.wmidd.org/history.html>
- West's Colorado Administrative Code: 5 CCR 1002-31:31.12, 5 CO ADC 1002-31:31.12 SALINITY AND SUSPENDED SOLIDS.
- Wilder, M. O., I. Aguilar-Barajas, N. Pineda-Pablos, R. G. Varady, S. B. Megdal, J. McEvoy, R. Merideth, A. A. Zúñiga-Terán, and C. A. Scott. 2016. Desalination and water security in the US–Mexico border region: assessing the social, environmental and political impacts. *Water International* 41 (5):756-775.
- Wolf, A. T. 1997. International water conflict resolution: lessons from comparative analysis. *International Journal of Water Resources Development* 13 (3):333-366.

- Wolf, A. T. 1999. The Transboundary Freshwater Dispute Database Project. *Water International* 24 (2):160-163.
- Wolf, A. T. 2001. Water and human security. *Journal of contemporary water Research and Education* 118 (1):29-37.
- Woodhouse, P., and M. Muller. 2017. Water Governance—An Historical Perspective on Current Debates. *World Development*.
- Wouters, P., S. Vinogradov, and B.-O. Magsig. 2009. Water Security, Hydrosolidarity, and International Law: A River Runs Through It.... *Yearbook of International Environmental Law* 19 (1):97-134.
- WWF Website, Promoting good water governance, accessed June 2019.
- Yoffe, S., G. Fiske, M. Giordano, M. Giordano, K. Larson, K. Stahl, and A. T. Wolf. 2004. Geography of international water conflict and cooperation: Data sets and applications. *Water Resources Research* 40 (5):n/a-n/a.
- Zeitoun, M. 2013. Global environmental justice and international transboundary waters: an initial exploration. *The Geographical Journal* 179 (2):141-149.
- Zeitoun, M., A. Dirar, A. El Moghraby, and M. J. Hashim. 2019. A “justice” reading of the trans-national struggle of the people displaced by the Merowe Dam. *Local Environment* 24 (2):129-145.
- Zeitoun, M., B. Lankford, T. Krueger, T. Forsyth, R. Carter, A. Y. Hoekstra, R. Taylor, O. Varis, F. Cleaver, R. Boelens, L. Swatuk, D. Tickner, C. A. Scott, N. Mirumachi, and N. Matthews. 2016. Reductionist and integrative research approaches to complex water security policy challenges. *Global Environmental Change* 39:143-154.
- Zeitoun, M., and K. McLaughlin. 2013. Basin justice: using social justice to address gaps in river basin management. *Just Ecosystem Management*. Routledge, Abingdon and New York.
- Zeitoun, M., and N. Mirumachi. 2008. Transboundary water interaction I: reconsidering conflict and cooperation. *International Environmental Agreements: Politics, Law and Economics* 8 (4):297.
- Zeitoun, M., and J. Warner. 2006. Hydro-hegemony—a framework for analysis of trans-boundary water conflicts. *Water policy* 8 (5):435-460.
- Zeitoun, M., J. Warner, N. Mirumachi, N. Matthews, K. McLaughlin, M. Woodhouse, A. Cascão, and T. J. Allan. 2014. Transboundary water justice: a combined reading of literature on critical transboundary water interaction and ‘justice’, for analysis and diplomacy. *Water policy* 16 (S2):174-193.

Zielinski, S. 2010. The Colorado River Runs Dry. Smithsonian Magazine.

Citations for Sources from Lexis Nexis

By JOE FRAZIER, Associated Press Writer. The Associated Press. November 4, 1979, Sunday, BC cycle.
<https://advance.lexis.com/api/document?collection=news&id=urn:contentItem:3SJ4-H7G0-0011-3345-00000-00&context=1516831>.

Richard Louv. "Plant thriving on saltwater could ease alien problem". The San Diego Union-Tribune. October 7, 1984 Sunday.
<https://advance.lexis.com/api/document?collection=news&id=urn:contentItem:4PCY-FRF0-TWDC-M4RV-00000-00&context=1516831>.

"Copyright 2006 American Bar Association Natural Resources & Environment". Natural Resources & Environment. Summer, 2006.
<https://advance.lexis.com/api/document?collection=news&id=urn:contentItem:4MBS-CVY0-00DB-50D3-00000-00&context=1516831>.

"House Natural Resources Subcommittee on Water and Power Hearing; Oversight Field Hearing on "Water Quality Issues in the Lower Colorado River"; Testimony by Lorri Lee, Lower Colorado Regional Director, Bureau of Reclamation, Boulder City, NV". Congressional Documents and Publications. May 27, 2009.
<https://advance.lexis.com/api/document?collection=news&id=urn:contentItem:7VT3-DVH1-2R7X-V154-00000-00&context=1516831>.

"Program Keys On Salinity in the Colorado". Salt Lake Tribune (Utah). December 27, 1996, Friday.
<https://advance.lexis.com/api/document?collection=news&id=urn:contentItem:3SD5-87S0-0093-G283-00000-00&context=1516831>.

"PREPARED TESTIMONY OF THE COLORADO RIVER BASIN SALINITY CONTROL FORUM BEFORE THE WATER AND POWER RESOURCES SUBCOMMITTEE OF THE HOUSE RESOURCES COMMITTEE IN SUPPORT OF H.R.930". Federal News Service. MAY 11, 1995, THURSDAY.
<https://advance.lexis.com/api/document?collection=news&id=urn:contentItem:3SJF-WJG0-009K-H4CT-00000-00&context=1516831>.

"TESTIMONY JUNE 9, 1994 JOHN R. WODRASKA GENERAL MANAGER METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA SENATE ENERGY/WATER AND POWER COLORADO RIVER WATER". Federal Document Clearing House Congressional Testimony. June 9, 1994, Thursday.
<https://advance.lexis.com/api/document?collection=news&id=urn:contentItem:3SJ4-N310-0003-1433-00000-00&context=1516831>.

"TESTIMONY JUNE 9, 1994 LARRY LINSEY DEPUTY DIRECTOR DEPARTMENT OF WATER RESOURCES SENATE ENERGY/WATER AND POWER COLORADO RIVER WATER". Federal Document Clearing House Congressional Testimony. June 9, 1994, Thursday.

<https://advance.lexis.com/api/document?collection=news&id=urn:contentItem:3SJ4-N370-0003-146G-00000-00&context=1516831>.

"House Natural Resources Subcommittee on Water and Power Hearing; Oversight Field Hearing on "Water Quality Issues in the Lower Colorado River"; Testimony by Herbert Guenther, Director, Arizona Department of Water Resources, Phoenix, AZ". Congressional Documents and Publications. May 27, 2009.

<https://advance.lexis.com/api/document?collection=news&id=urn:contentItem:7VT3-DVH1-2R7X-V157-00000-00&context=1516831>.

(June 9, 1994, Thursday). TESTIMONY JUNE 9, 1994 BEN NIGHTHORSE CAMPBELL SENATOR SENATE ENERGY/WATER AND POWER COLORADO RIVER WATER. Federal Document Clearing House Congressional Testimony. Retrieved from Nexis Uni.

"TESTIMONY JUNE 9, 1994 GERALD R. ZIMMERMAN EXECUTIVE DIRECTOR COLORADO RIVER BOARD OF CALIFORNIA SENATE ENERGY/WATER AND POWER COLORADO RIVER WATER". Federal Document Clearing House Congressional Testimony. June 9, 1994, Thursday.

<https://advance.lexis.com/api/document?collection=news&id=urn:contentItem:3SJ4-N310-0003-143B-00000-00&context=1516831>.

"TESTIMONY March 12, 1998 TED STEWART EXECUTIVE DIRECTOR UTAH DEPARTMENT OF NATURAL RESOURCES HOUSE RESOURCES WATER AND POWER RESOURCES SALTON SEA INITIATIVES". Federal Document Clearing House Congressional Testimony. March 12, 1998, Thursday.

<https://advance.lexis.com/api/document?collection=news&id=urn:contentItem:3SFT-0KS0-0003-113N-00000-00&context=1516831>.

"TESTIMONY JUNE 9, 1994 THOMAS C. JENSEN EXECUTIVE DIRECTOR GRAND CANYON TRUST SENATE ENERGY/WATER AND POWER COLORADO RIVER WATER". Federal Document Clearing House Congressional Testimony. June 9, 1994, Thursday.

<https://advance.lexis.com/api/document?collection=news&id=urn:contentItem:3SJ4-N310-0003-1432-00000-00&context=1516831>.

"TESTIMONY JUNE 9, 1994 MALCOLM WALLOP SENATOR SENATE ENERGY/WATER AND POWER COLORADO RIVER WATER". Federal Document Clearing House Congressional Testimony. June 9, 1994, Thursday.

<https://advance.lexis.com/api/document?collection=news&id=urn:contentItem:3SJ4-N300-0003-142Y-00000-00&context=1516831>.

"WATER: Future of Ariz. desalting plant, major Mexican wetland unclear after test run".
Greenwire. June 14, 2012 Thursday.
<https://advance.lexis.com/api/document?collection=news&id=urn:contentItem:563K-XBP1-DY7N-F3F5-00000-00&context=1516831>.

Staff Writers. "Cienega de Santa Clara unchanged after pilot run of Yuma Desalting Plant".
Space Daily. July 16, 2012 Monday.
<https://advance.lexis.com/api/document?collection=news&id=urn:contentItem:5648-56B1-DYJG-N21D-00000-00&context=1516831>.

"REP. MIKE SIMPSON HOLDS A HEARING ON THE BUREAU OF RECLAMATION".
Financial Markets Regulatory Wire. February 12, 2015 Thursday.
<https://advance.lexis.com/api/document?collection=news&id=urn:contentItem:5F9W-D9M1-JDPT-T1WJ-00000-00&context=1516831>.

"COLORADO RIVER; COMMITTEE: HOUSE NATURAL RESOURCES;
SUBCOMMITTEE: WATER AND POWER". CQ Congressional Testimony. April 9, 2010 Friday.
<https://advance.lexis.com/api/document?collection=news&id=urn:contentItem:7V27-3P71-2SD8-N1S4-00000-00&context=1516831>.

"TESTIMONY JUNE 9, 1994 DAVID H. GETCHES FORMERLY EXECUTIVE
DIRECTOR STATE OF COLORADO DEPARTMENT OF NATURAL
RESOURCES SENATE ENERGY/WATER AND POWER COLORADO RIVER
WATER". Federal Document Clearing House Congressional Testimony. June 9,
1994, Thursday.
<https://advance.lexis.com/api/document?collection=news&id=urn:contentItem:3SJ4-N370-0003-146P-00000-00&context=1516831>.

"Protecting our tap water in Moab, Utah". The San Diego Union-Tribune. January 16, 2000,
Sunday.
<https://advance.lexis.com/api/document?collection=news&id=urn:contentItem:3YKT-FR40-00RR-W416-00000-00&context=1516831>.

From AP Newsfeatures, TAD BARTIMUS, Associated Press Writer. The Associated Press.
November 10, 1985, Sunday, BC cycle.
<https://advance.lexis.com/api/document?collection=news&id=urn:contentItem:3SJB-23D0-0011-74P0-00000-00&context=1516831>.

"TESTIMONY April 30, 1998 WILLIAM J. SNAPE, III LEGAL DIRECTOR
DEFENDERS OF WILDLIFE HOUSE RESOURCES WATER AND POWER
RESOURCES PUBLIC WORKS PROJECTS". Federal Document Clearing House
Congressional Testimony. April 30, 1998, Thursday.
<https://advance.lexis.com/api/document?collection=news&id=urn:contentItem:3SV9-J080-0003-12JN-00000-00&context=1516831>.