Water UCI Colloquium

April 5, 2018

Public Perceptions of Urban Water Sustainability Transitions for the Colorado River Basin

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Presentation Overview

1 ASU Decision Center for a Desert City
2 Water and Climate in the Colorado River Basin
3 Theory of Urban Water Sustainability Transitions
4 Western Urban Water Survey
5 Discussion & Implications for Research and Policy

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Transformational Solutions for Urban Water Sustainability Transitions

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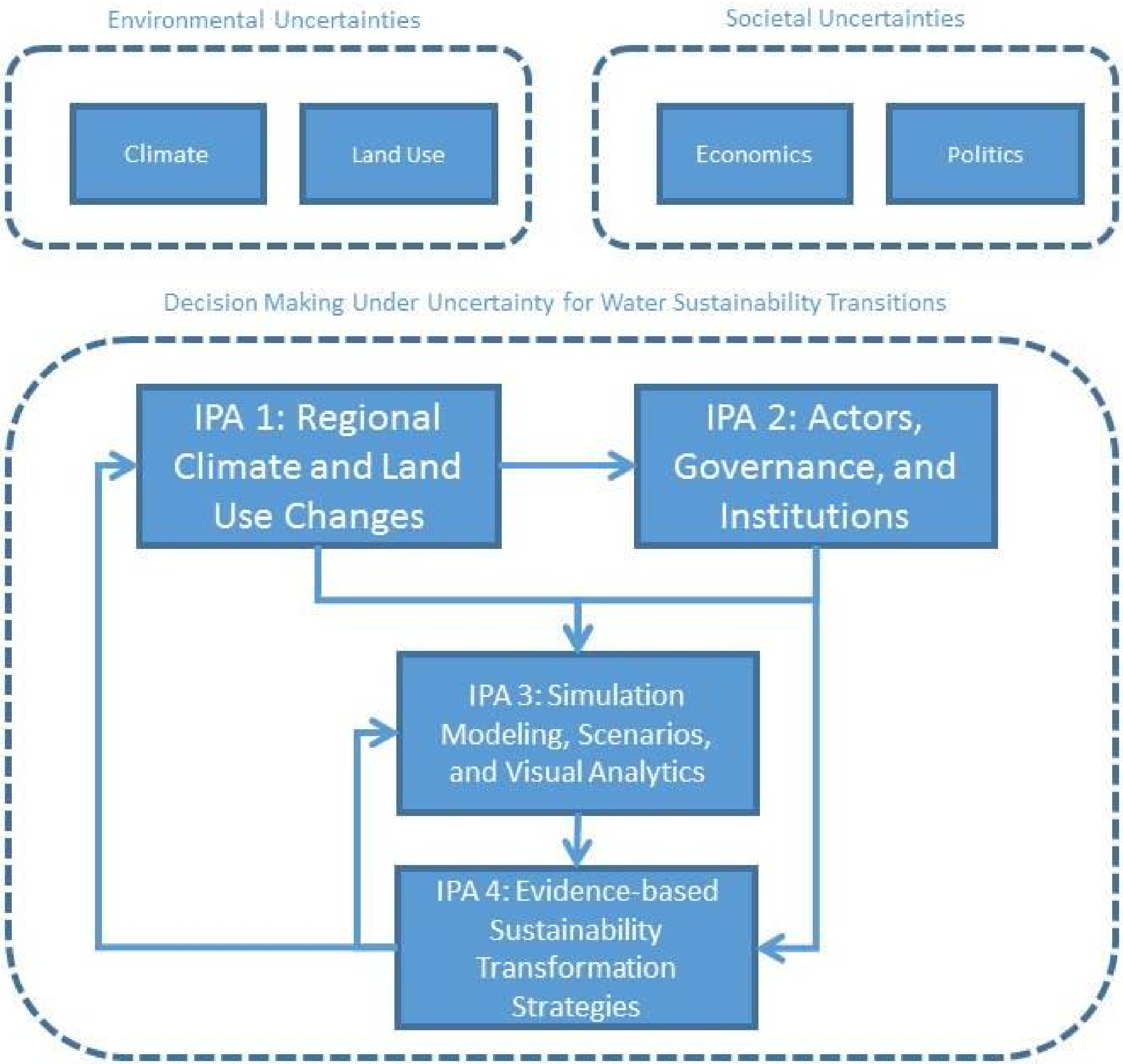
WaterSim America
WaterSim America is an interactive water management game where people explore how our water choices and changes in the world around us can impact future water sustainability.
Inspiring Arizona's future community leaders to become aware of future water challenges in the face of growth and drought, and the policy implications and trade-offs needed to sustain our water future.
Engaging teachers & students to consider the role water plays in human society.
STEM activity to introduce students to data driven models and provide an understanding of how dynamic variables interact.
dcdc.asu.edu/watersim
Smithsonian Institution



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Water and Climate in the Colorado River Basin

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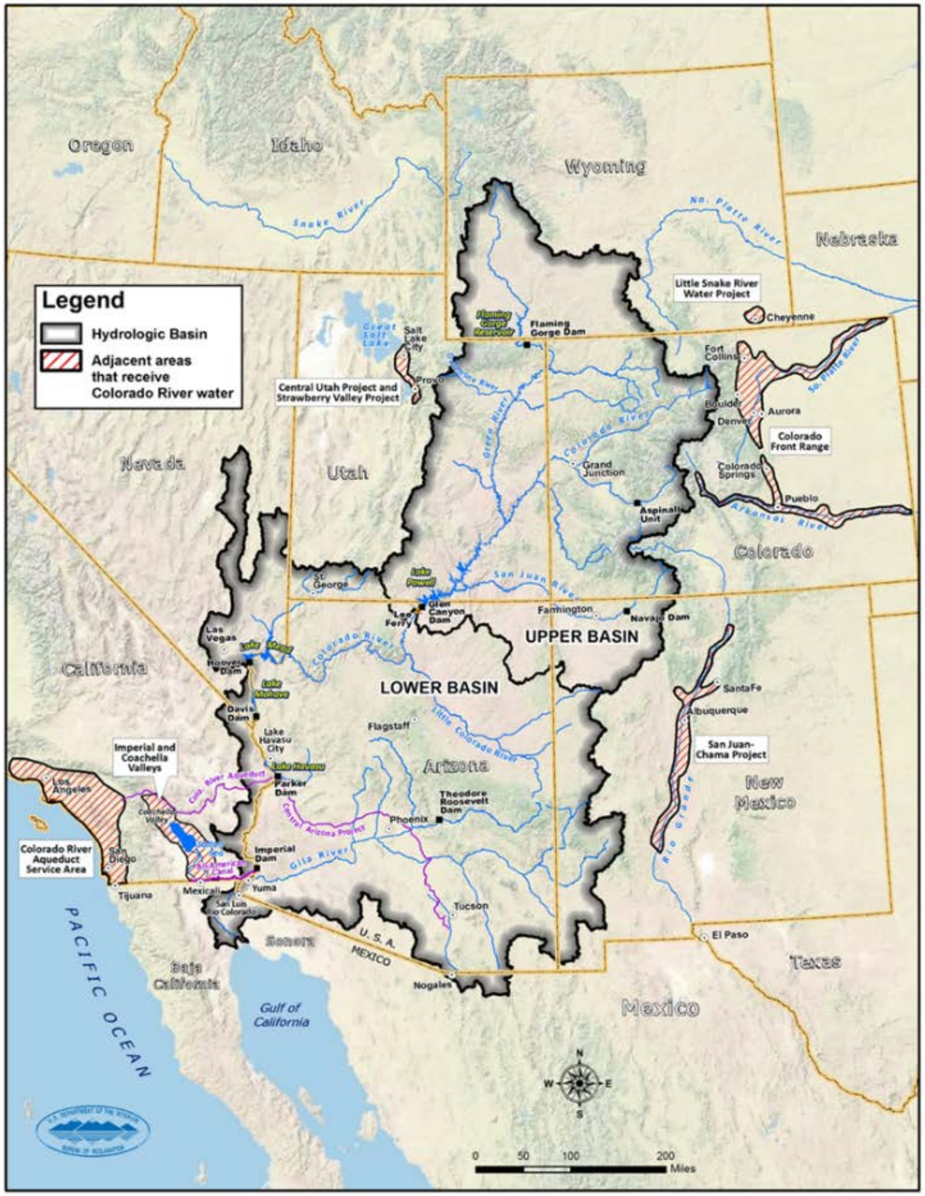


Colorado River Basin

Supplies more than 1 in 10 Americans with water for municipal use

Irrigation water for 22248 km^2

Physical, economic, and cultural resource to at least 22 federally recognized Tribes

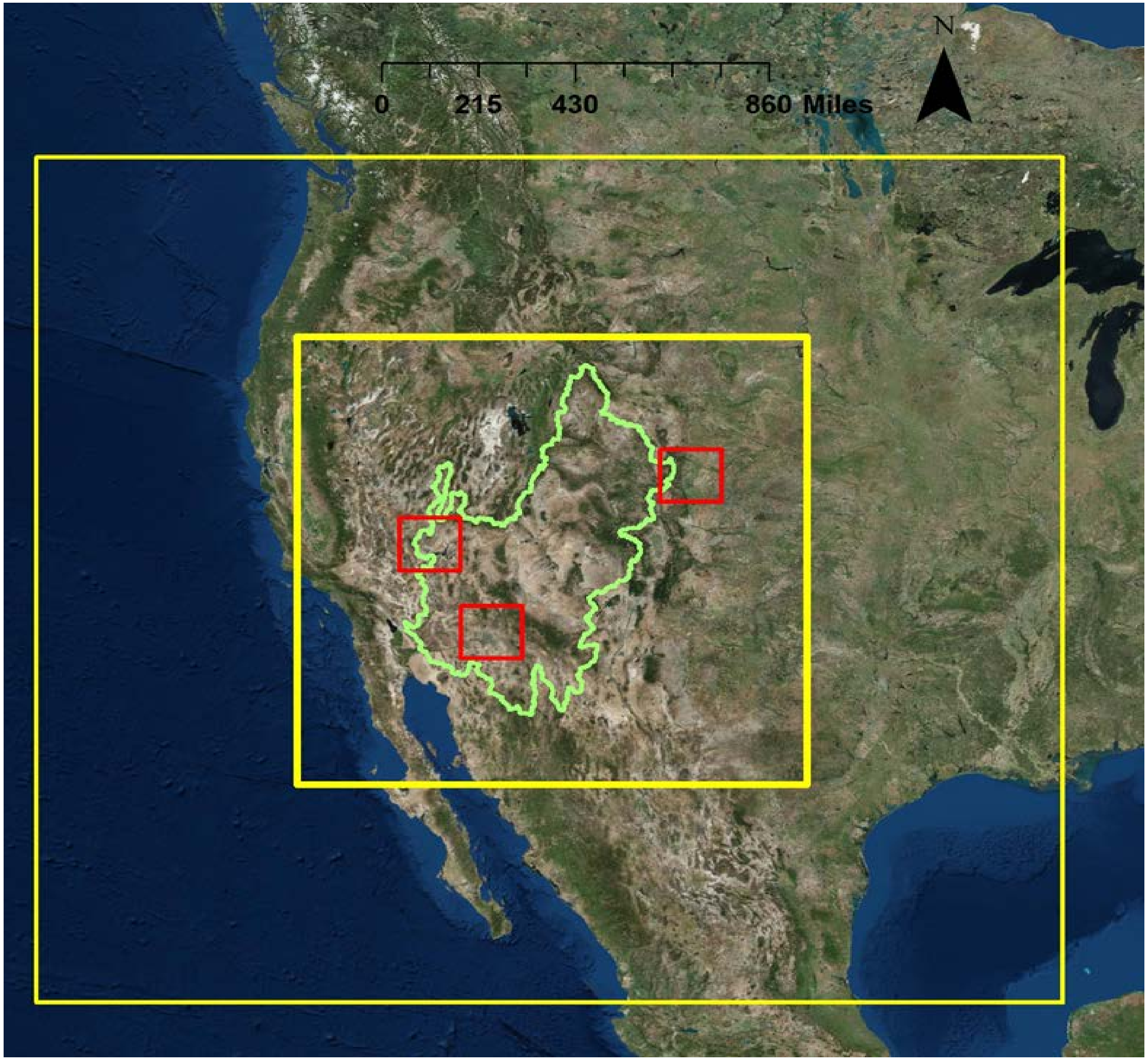
4,200 MW of electrical generating capacity

Linked to nine National Park Service units and seven National Wildlife Refuges, supporting over $1 billion in tourism revenue

Habitat for a wide range of species, including threatened and endangered species

https://www.doi.gov/water/owdi.c

Social and Environmental Drivers of Change in three Cities dependent on the Colorado River



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- Population dynamics
- Land use / land cover change
- Urbanization
- Market forces
- Technological change
- Public policy
- Technological change
- Formal and informal institutions

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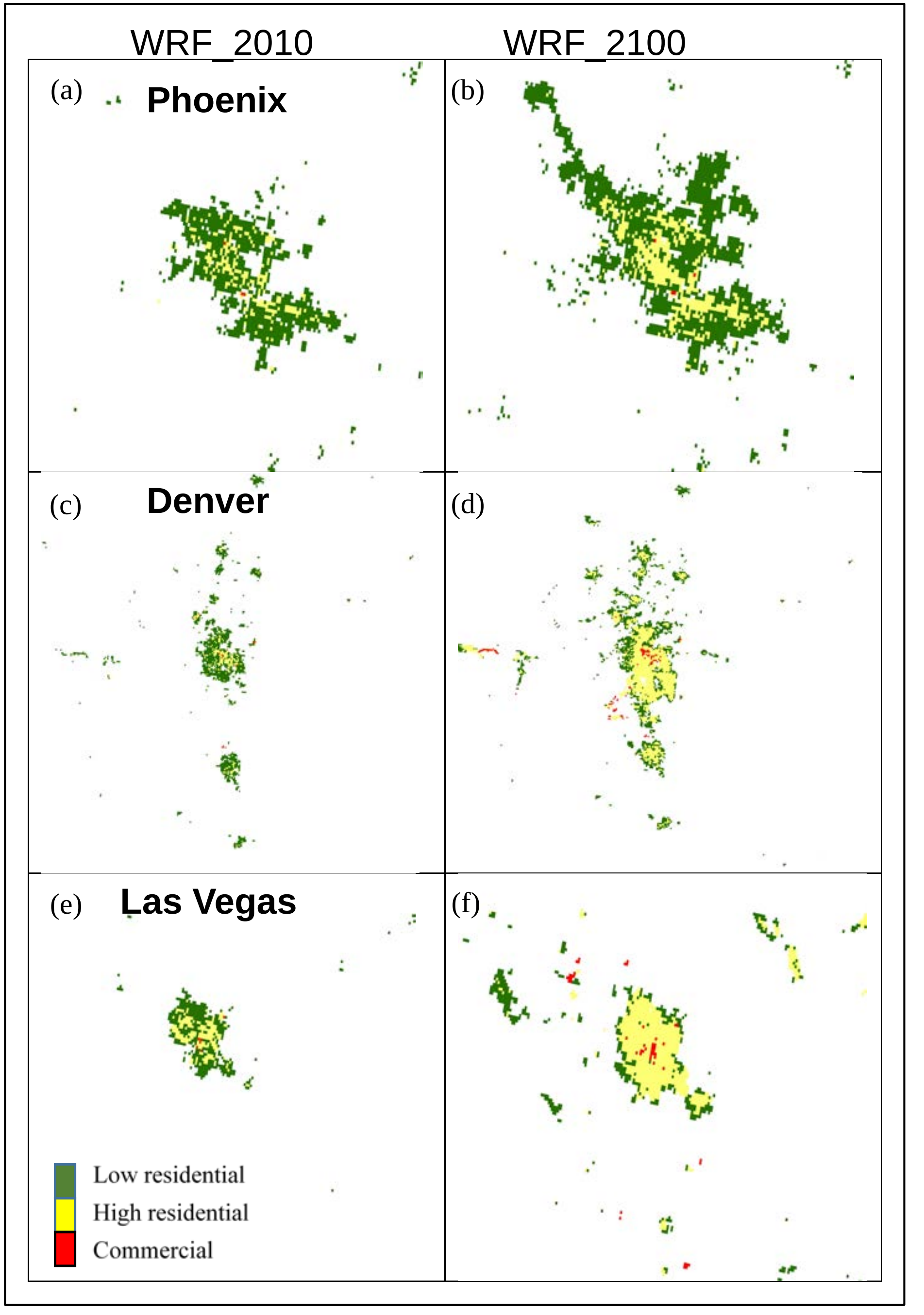

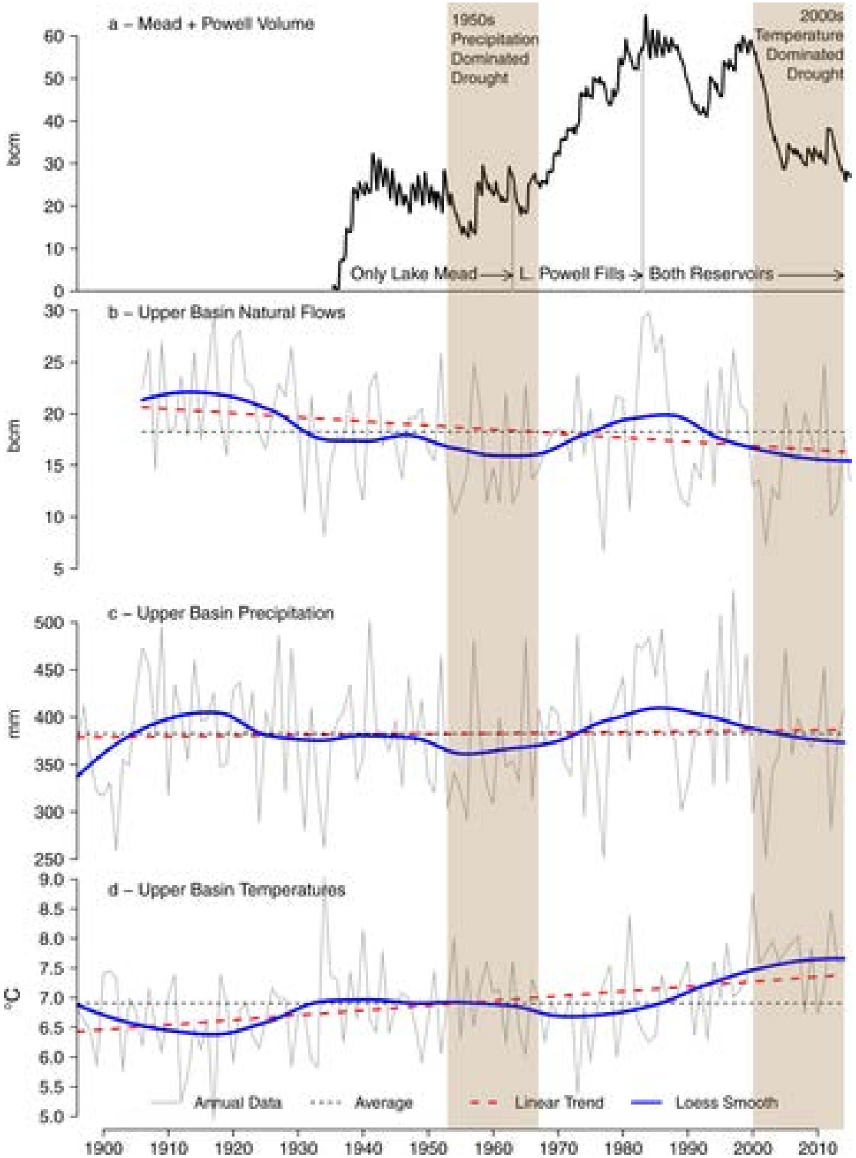

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CRB Drought

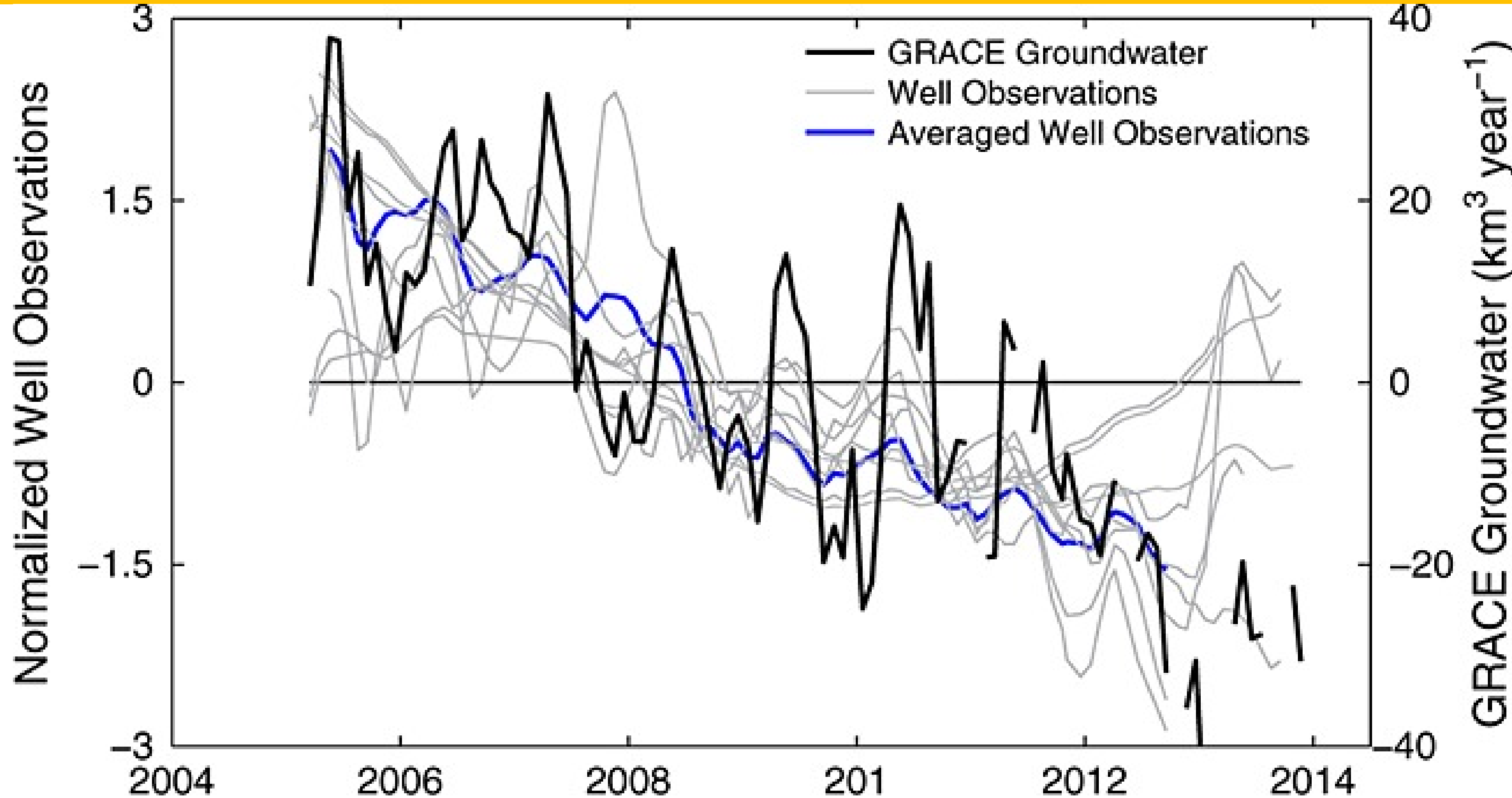
Two major recent droughts

1950s **precipitation-dominated** drought

2000s **temperature-dominated**

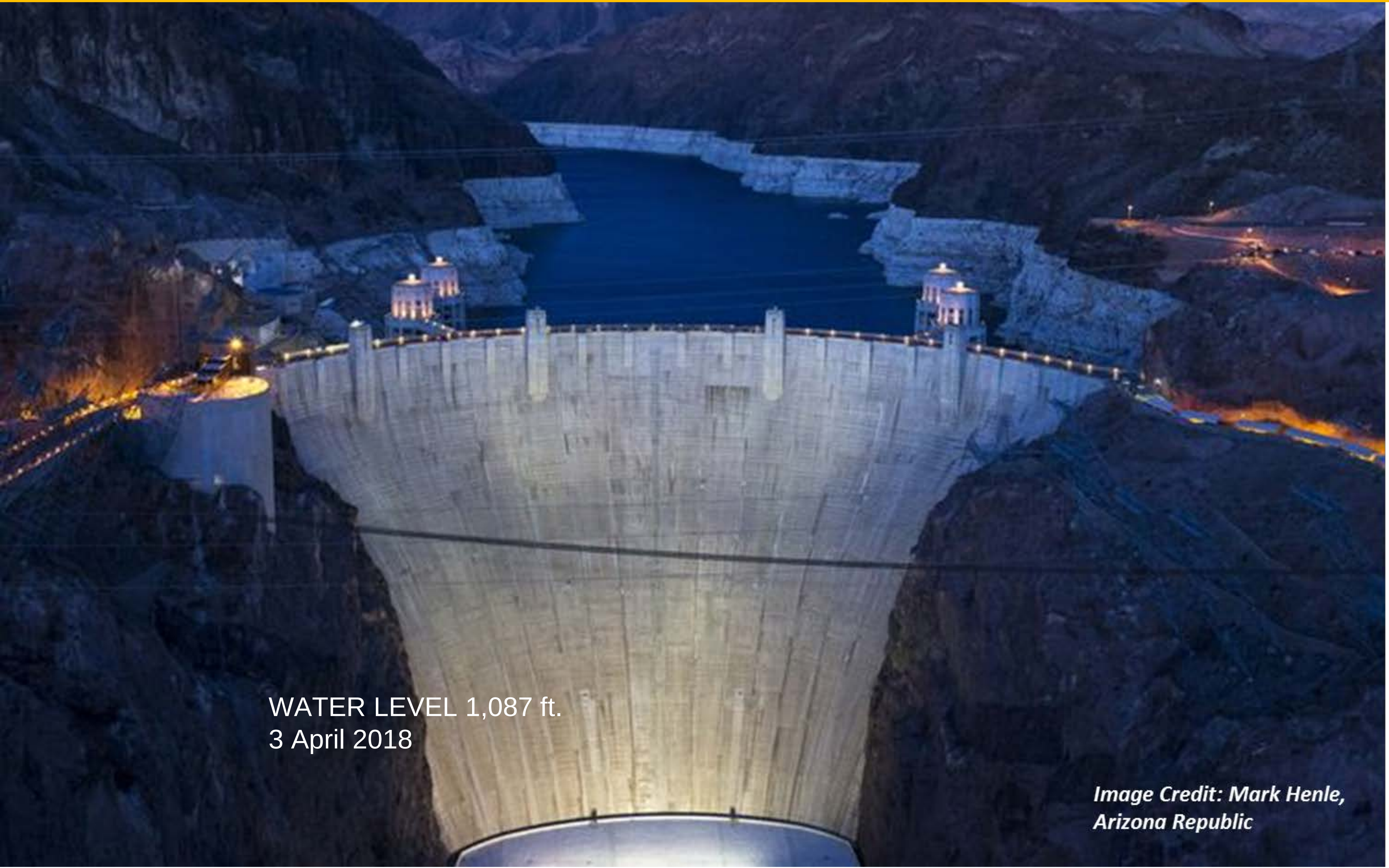
The twenty-first century Colorado River hot drought and implications for the future, Volume: 53, Issue: 3, Pages: 2404-2418, First published: 17 February 2017, DOI: (10.1002/2016WR019638)

The present drought in the West is the most extreme in over a century (Cayan et al. 2010), affecting not only surface-water storage but also groundwater reserves (Castle et al. 2014).



Geophysical Research Letters
Volume 41, Issue 16, pages 5904-5911, 29 AUG 2014
DOI: 10.1002/2014GL061055

Water levels in the major Colorado River reservoirs have been at historic lows



hydrologic effects of climate change in the West will be negative and significant

(Jiménez Cisneros et al., 2014)

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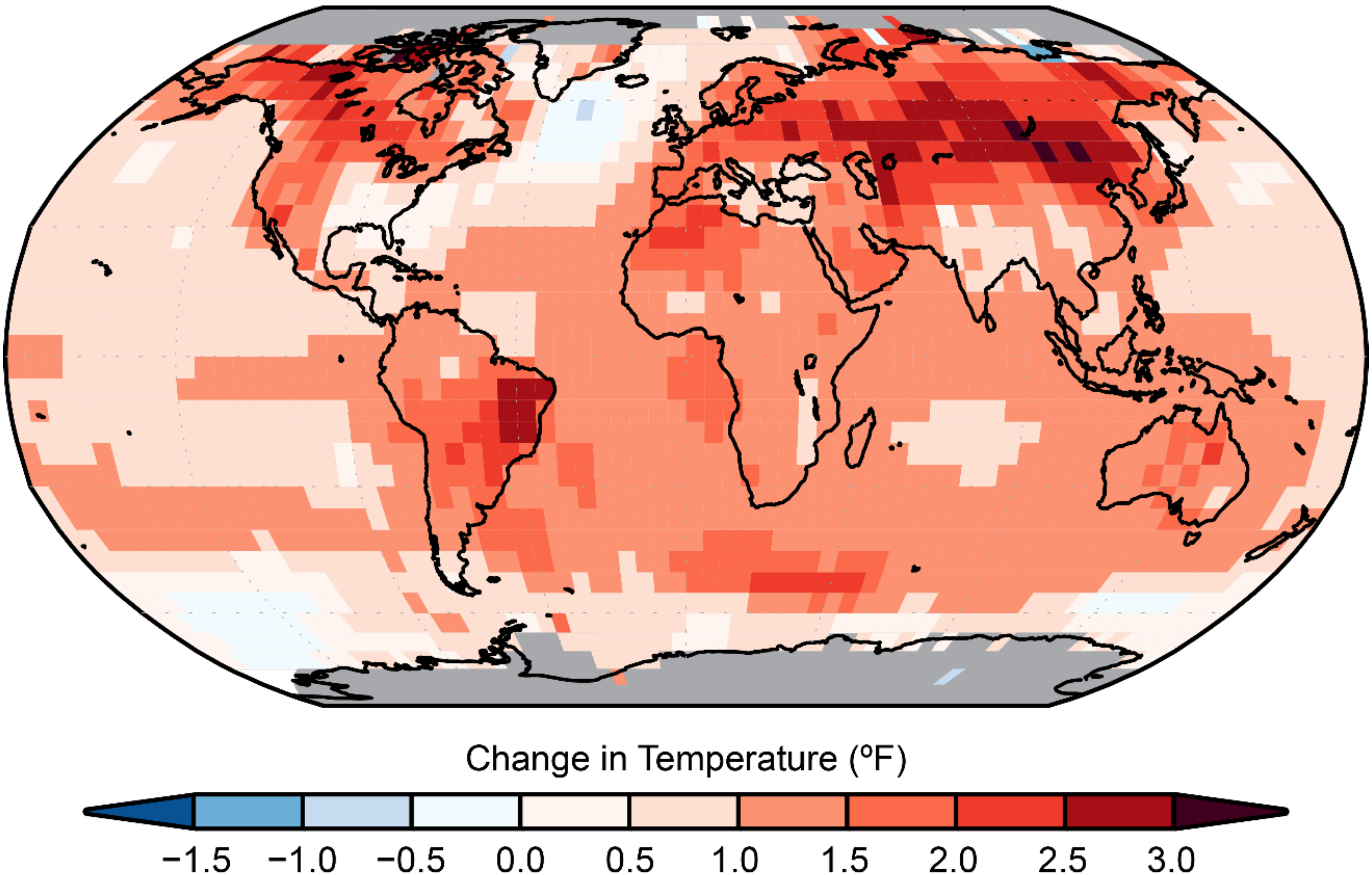
Intergovernmental Panel on Climate Change. (2014). *Climate Change 2014–Impacts, Adaptation and Vulnerability: Regional Aspects*. Cambridge University Press.

Surface Temperature Change



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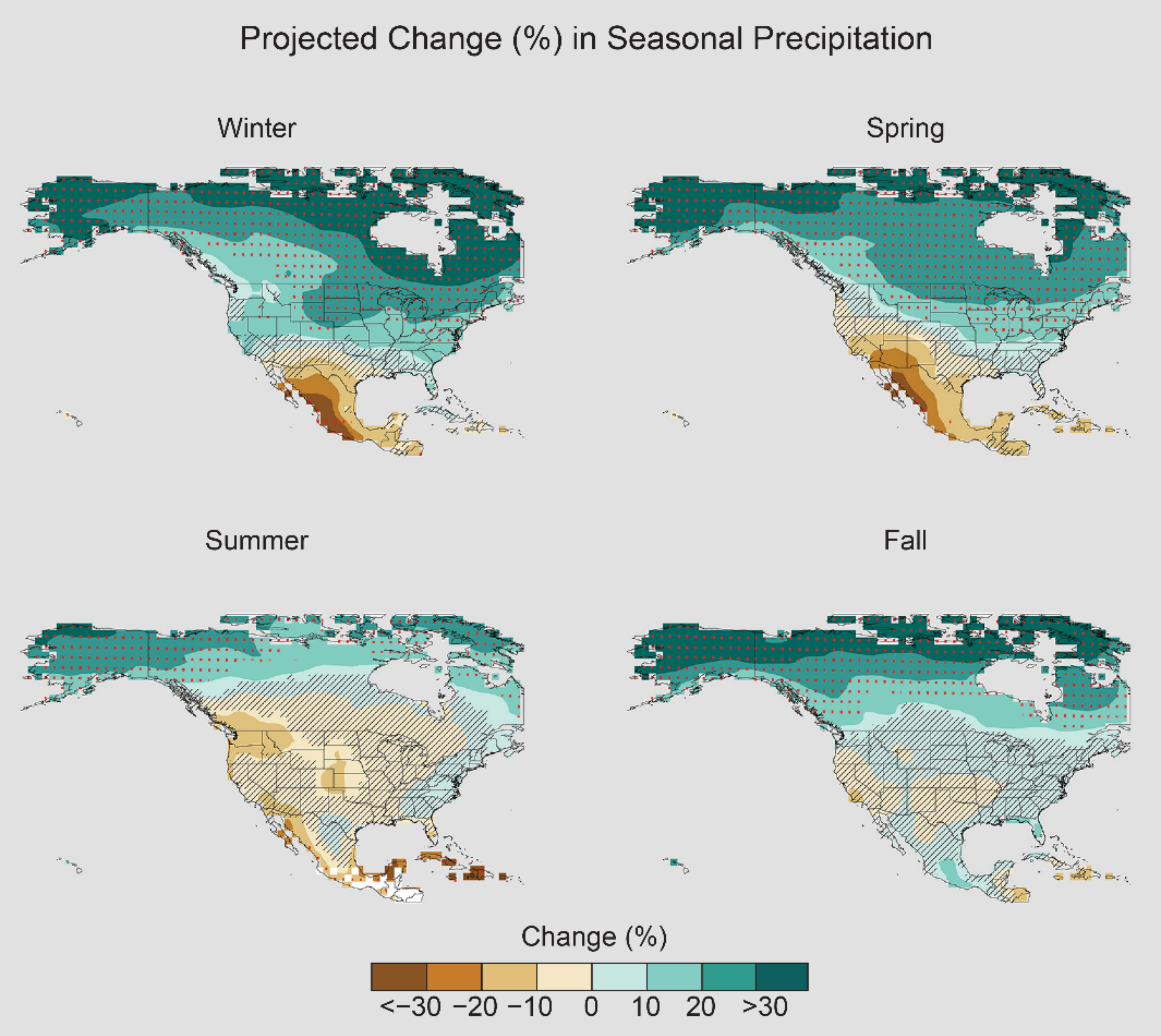

Projected change (%) in total seasonal precipitation from CMIP5 simulations for 2070–2099 (RCP8.5).

https://science2017.globalchange.gov/chapter/7/

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Future drought may exceed even the driest centuries of the Medieval Climate Anomaly, leading to unprecedented drought conditions (Cook et al., 2015)

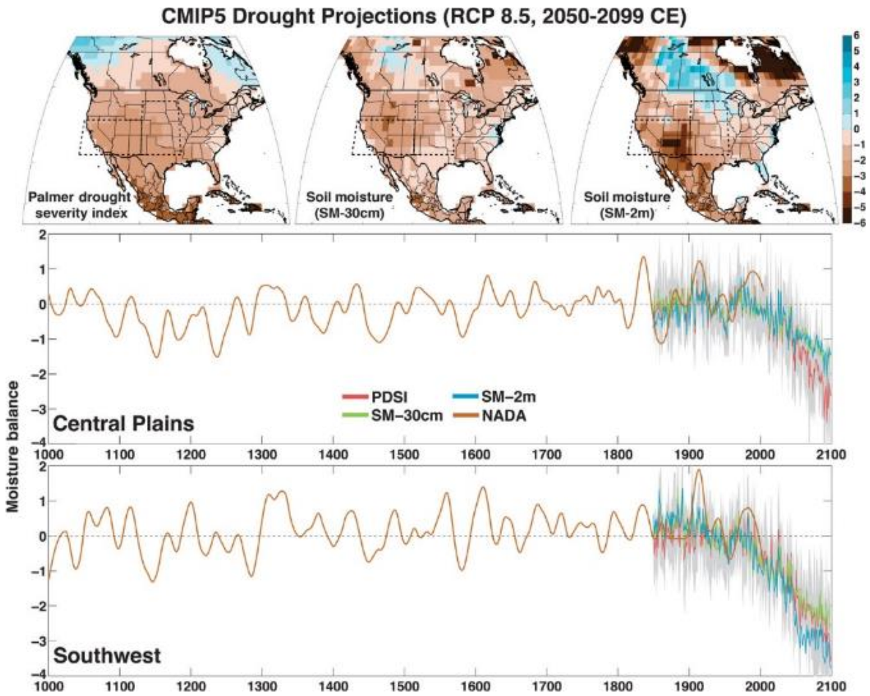

Fig. 1 Top: Multimodel mean summer (JJA) PDSI and standardized soil moisture (SM-30cm and SM-2m) over North America for 2050–2099 from 17 CMIP5 model projections using the RCP 8.5 emissions scenario.

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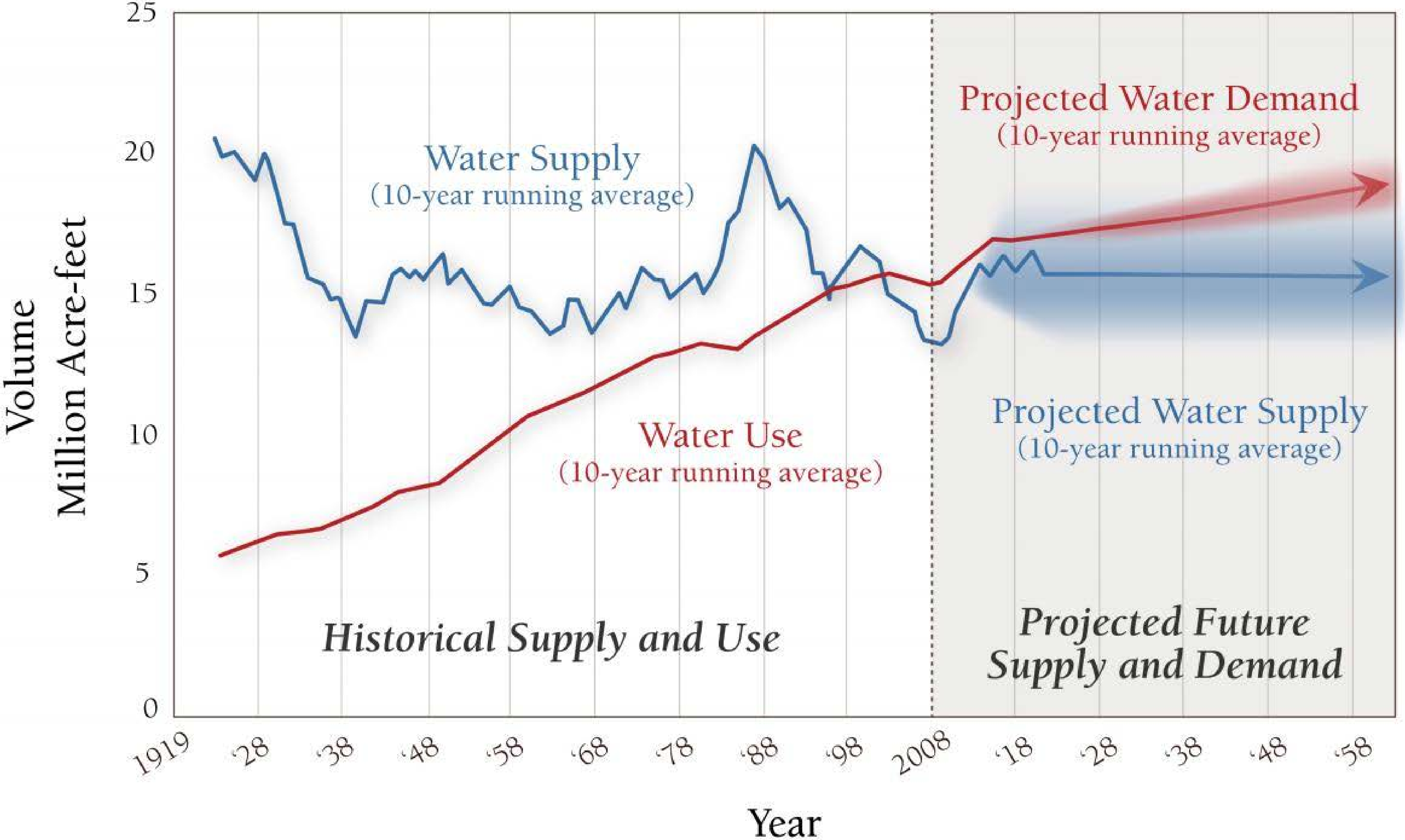
Historic and Projected Water Supply and Demand [1]



[1] U.S. Department of the Interior. Bureau of Reclamation. "Reclamation Managing Water in the West: Colorado River Basin Water Supply and Demand Study." (Executive Summary). Dec 2012

Theory of Urban Water Sustainability Transitions

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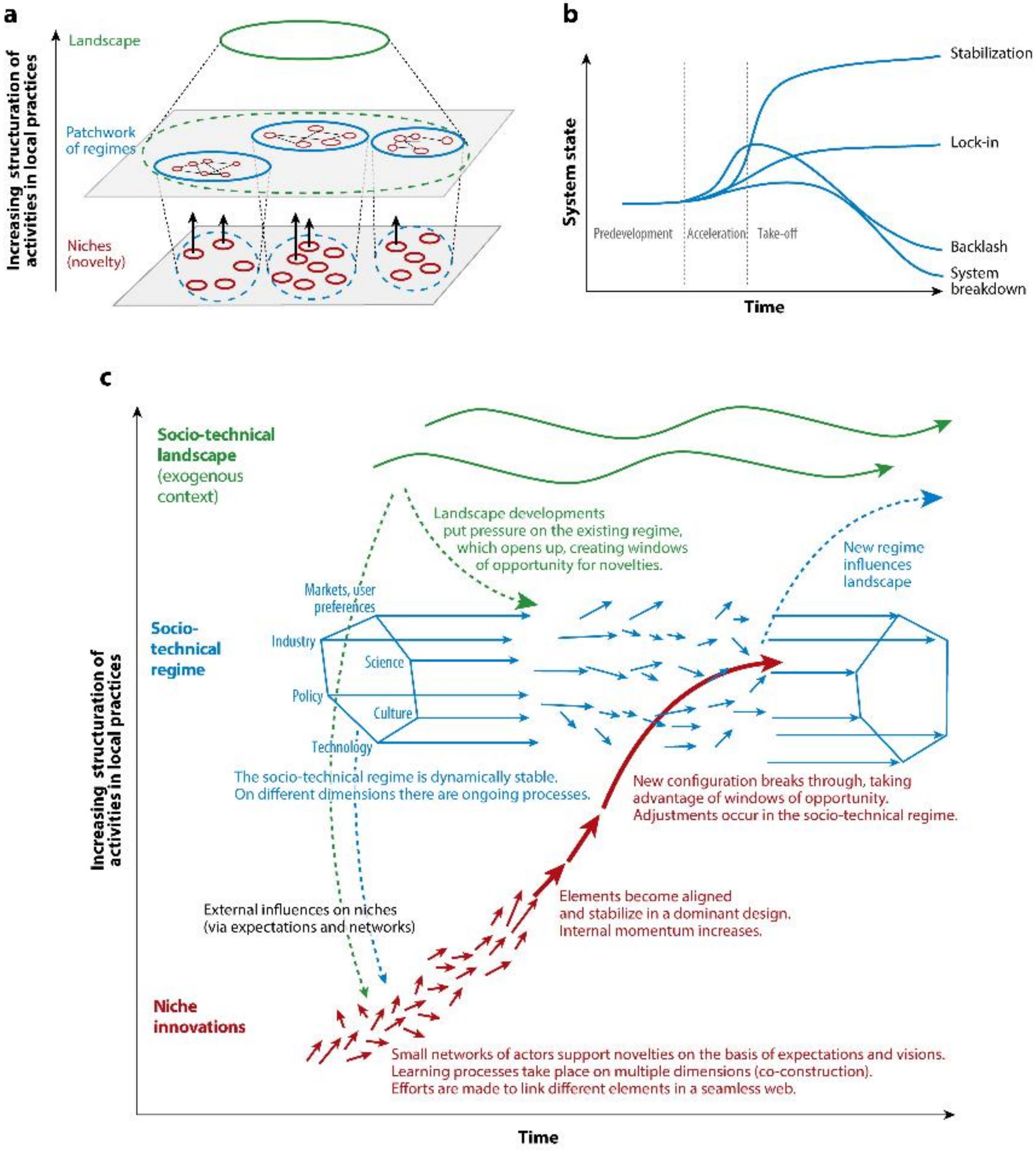
- Large-scale changes in societal systems that emerge over a long period of time (decades)
- Emerged from innovation research, environmental studies, and sustainability sciences
- Systematic approach to understanding and addressing grand societal challenges
- Limited empirical work on the role of public perceptions in facilitating or constraining transitions



Loorbach D, et al. 2017. *Annu. Rev. Environ. Resour.* 42:599–626

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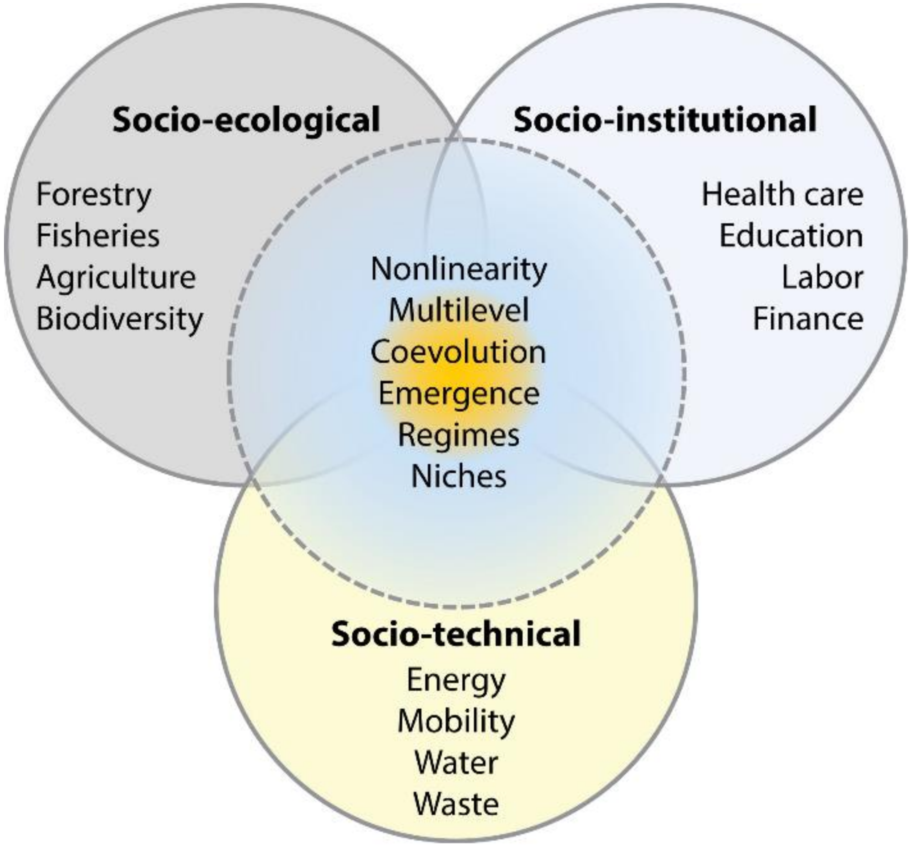

Loorbach D, et al. 2017.
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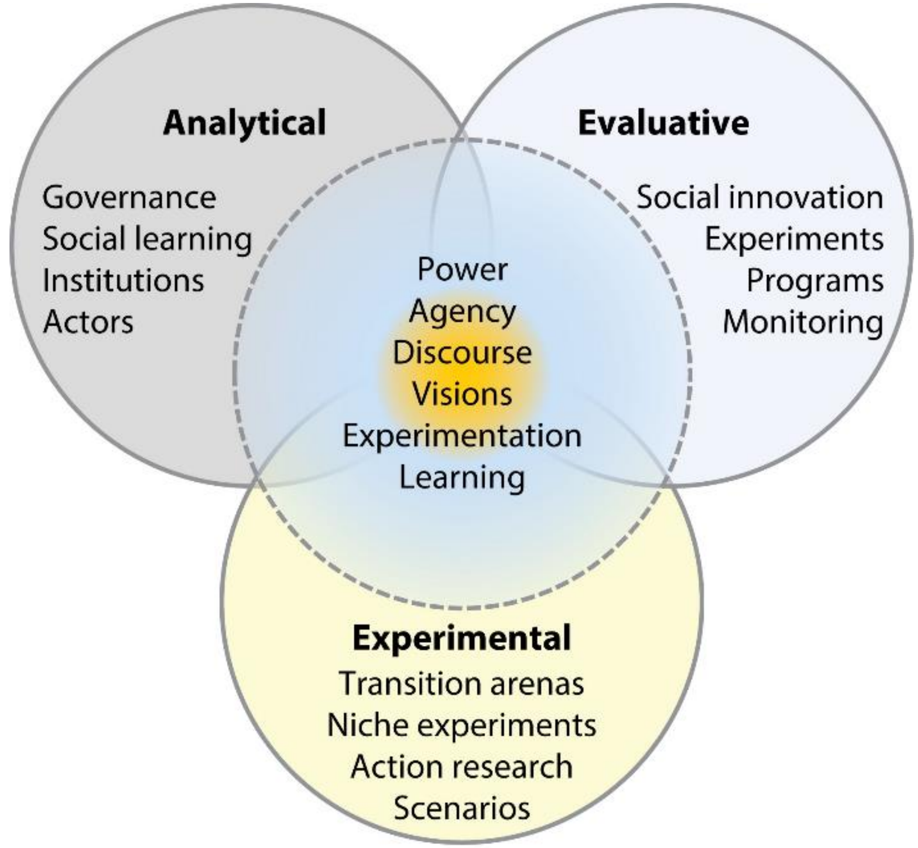

Loorbach D, et al. 2017.
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Historical Analysis of Water Transitions

"Understanding the circumstances surrounding takeoff in past transitions is critical to learning how to catalyze and influence the breakthrough of future transitions. Given that the breakthrough period is often preceded by a period of crisis, it is relevant to question whether breakthrough can occur without a state of political and/or social disorder."

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sustainability

MDPI

Article

Towards Water Sensitive Cities in the Colorado River Basin: A Comparative Historical Analysis to Inform Future Urban Water Sustainability Transitions

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Academic Editor: Md. Kamruzzaman
Received: 29 March 2017; Accepted: 3 May 2017; Published: 6 May 2017

Abstract: Many population centers in the American West rely on water from the Colorado River Basin, which has faced shortages in recent years that are anticipated to be exacerbated by climate change. Shortages to urban water supplies related to climate change will not be limited to cities dependent on the Colorado River. Considering this, addressing sustainable water governance is timely and critical for cities, states, and regions facing supply shortages and pollution problems. Engaging in sustainability transitions of these hydro-social systems will increase the ability of such systems to meet the water needs of urban communities. In this paper, we identify historical transitions in water governance and examine their context for three sites in the Colorado River Basin (Denver, Colorado, Las Vegas, Nevada, and Phoenix, Arizona) to provide insight for intentional transitions towards sustainable, or "water sensitive" cities. The comparative historical approach employed allows us to more fully understand differences in present-day water governance decisions between the sites, identify past catalysts for transitions, and recognize emerging patterns and opportunities that may impact current and future water governance in the Colorado River Basin and beyond.

Keywords: transitions; water; governance; historical analysis; sustainability

1. Introduction

A growing number of disciplinary and interdisciplinary scholars have concluded that transitions towards comprehensive sustainable natural resource management are necessary as human-environment systems face grand challenges such as global climate change and political and economic instability [1]. Transitions have been defined in the sustainability literature as a gradual process of societal change leading to structural differences in major social-ecological-technical systems such as water, energy, or agriculture [1,2]. Water governance is one area of natural resource management that has been the focus of attention for sustainability transitions. The history of water management in the western United States has been marked by episodes of significant conflict, but also innovative collaboration [3]. As the population in the western U.S. steadily increased over the past century, conflicts over water allocation emerged, especially in places with large population centers and competing interests between domestic, agricultural and industrial uses. This has led to calls for water governance transitions in the Colorado River Basin [4]. Identifying patterns and understanding the context of historical transitions within a system can inform future efforts to intentionally transition

Western Urban Water Survey

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How does public support of transformational water management strategies and transitions vary across **Phoenix, Las Vegas, and Denver?**

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What factors influence public support for transitions and transformational strategies among the three cities, and what are the implications of those differences for urban water sustainability?

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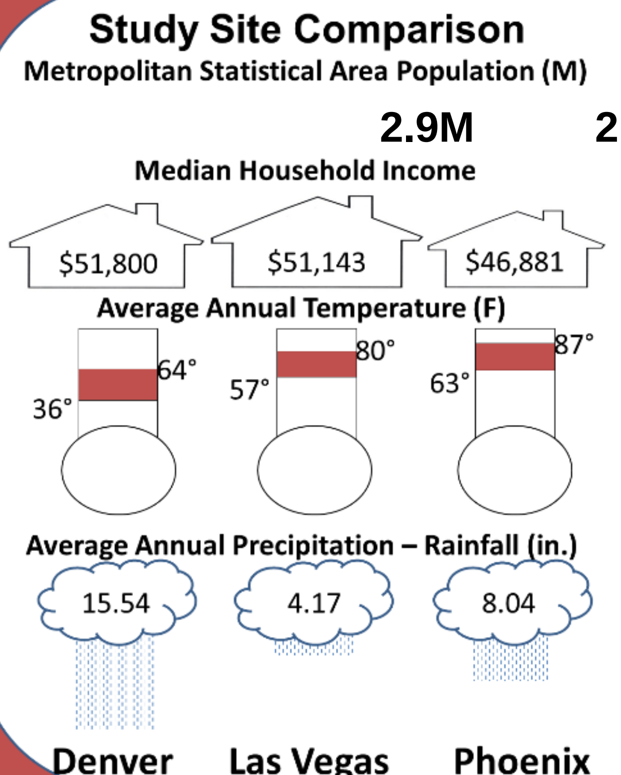
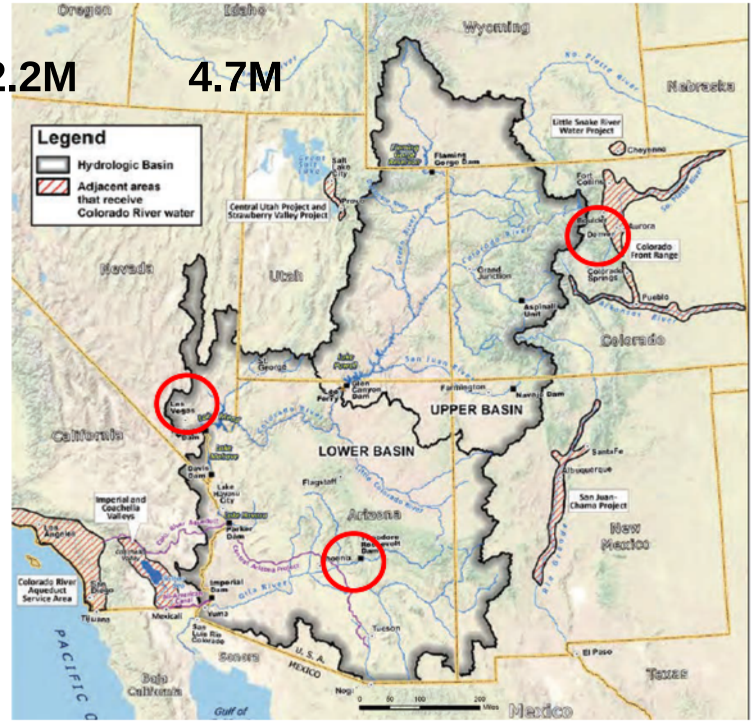
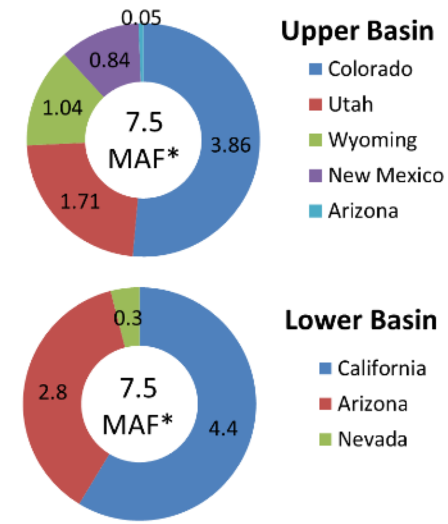
Study Sites



Colorado River Basin



States of the basin & their water allocations



*Million Acre Feet per Year
Upper Basin allotments established by the Upper Colorado River Basin Compact if 1948.
Lower Basin allotments established as part of the Boulder Canyon Project in 1928

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Survey Research Design

- Random sample of 1000 addresses each in PHX, DEN, and LVA MSAs
- Four page English-language questionnaire administered Jan 8-Feb 21, 2018
- Four wave administration with initial mailing + $2 pre-incentive, follow-up postcard, and two additional full mailings

MSA including city of..	Completed Surveys	Response Rate
Denver, CO	253	27%
Phoenix, AZ	309	33%
Las Vegas, NV	224	24%
Total	**786**	**28%**

Overall, residents perceive that water resource management *needs to change "somewhat" to "quite a bit"* over the next 30 years, to ensure equitable, adequate, safe water to support a thriving economy and healthy environment.

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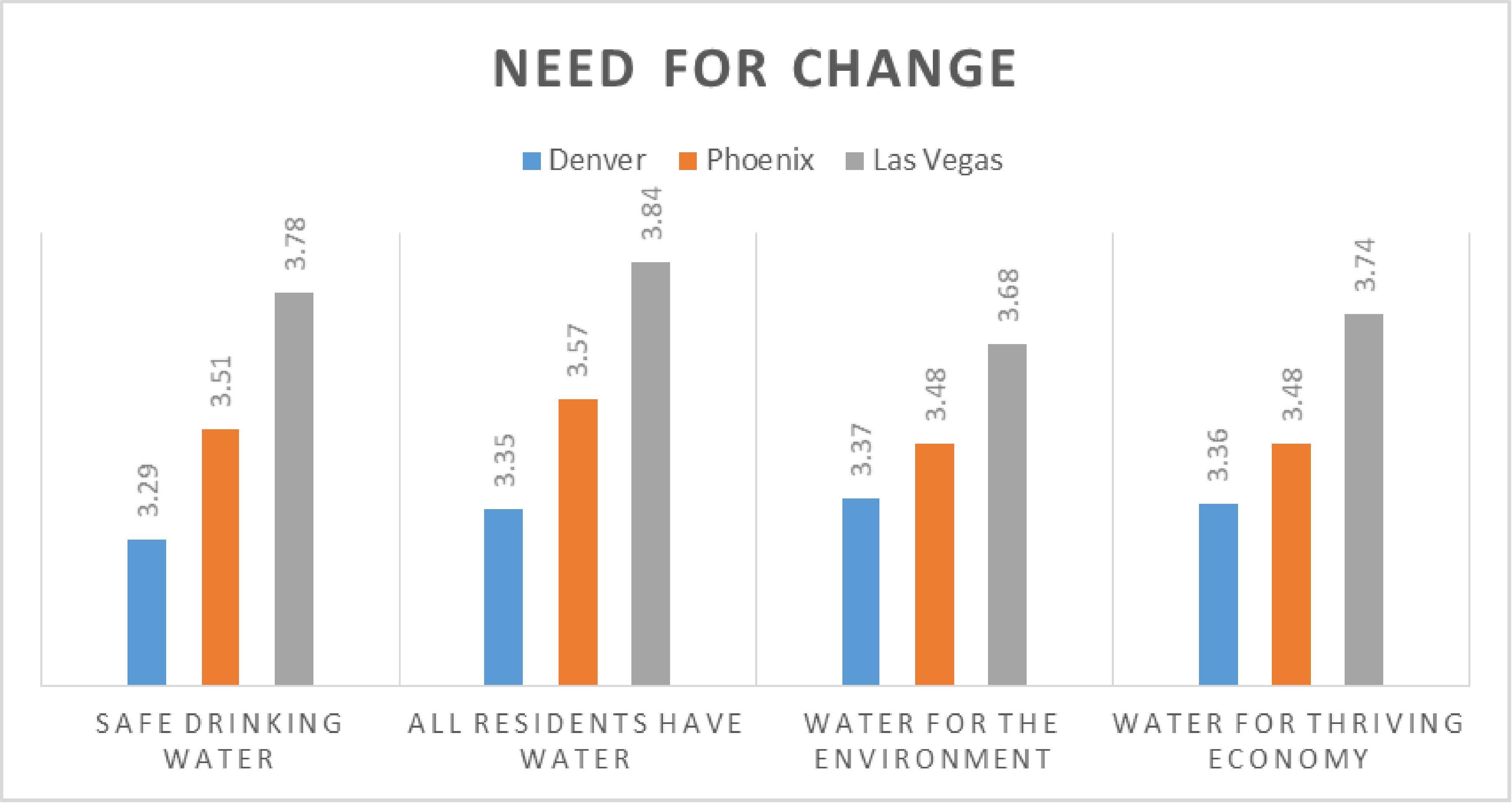

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Nearly half of all respondents support "wastewater being treated to meet drinking water standards and delivered directly to residents such as yourself."

	Denver		Phoenix		Las Vegas	
	Oppose	Support	Oppose	Support	Oppose	Support
…residents, such as yourself, working with local water managers to make decisions?	2.4%	69.2%	4.9%	70.4%	4.1%	71.2%
…your town or city using resources that might impact you, such as tax revenue, to invest in technology to deliver water using 100% renewable energy?	13.5%	72.9%	12.1%	71.3%	10.9%	70.0%
…residents, such as yourself, and businesses gathering and storing rainwater to irrigate landscaping?	4.4%	84.9%	8.9%	75.4%	9.1%	69.9%
…wastewater being treated to meet drinking water quality standards and delivered directly to residents such as yourself?	25.4%	55.2%	32.7%	42.6%	29.0%	49.8%
…using only existing water sources in your area without importing or getting new supplies?	30.5%	31.3%	38.2%	31.3%	32.9%	36.5%
…everyone in your town or city, including you, contributing to reducing overall water usage by 25%?	14.4%	70.0%	15.0%	65.4%	12.2%	70.3%

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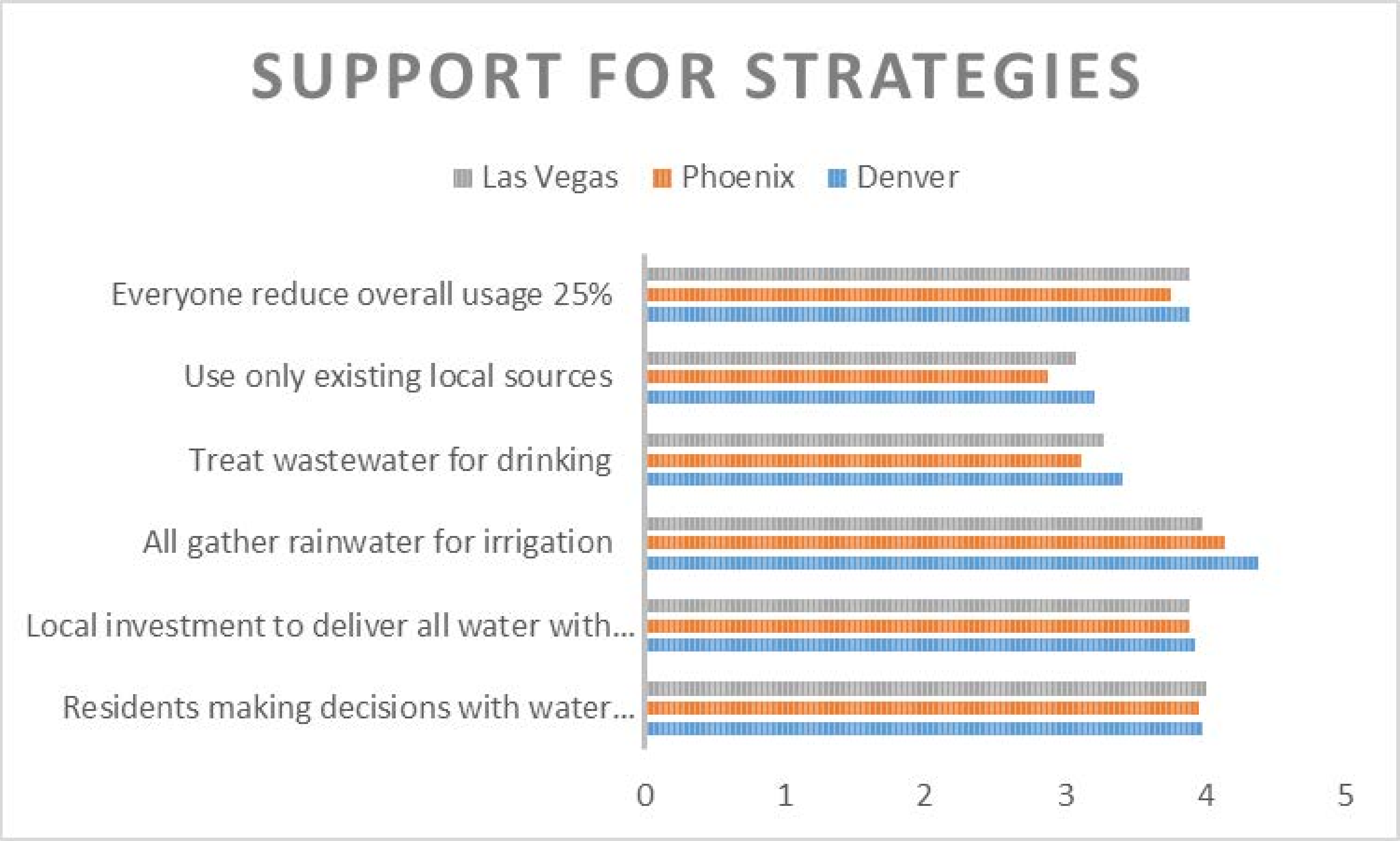

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City Comparisons

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
MGT CHANGE NEEDED SCALE	Between Groups	19.497	2	9.748	8.799	.000
	Within Groups	834.274	753	1.108		
	Total	853.770	755			
STRATEGIES SCALE	Between Groups	4.080	2	2.040	4.925	.007
	Within Groups	313.581	757	.414		
	Total	317.661	759			

MGT CHANGE NEEDED SCALE

	SAMPLE GROUP	N	Subset for alpha = 0.05 1	2
Tukey HSD[a,b]	DENVER	243	3.3447	
	PHOENIX	301	3.5108	
	LAS VEGAS	212		3.7583
	Sig.		.186	1.000

STRATEGIES SCALE

	SAMPLE GROUP	N	Subset for alpha = 0.05 1	2
Tukey HSD[a,b]	PHOENIX	299	3.6243	
	LAS VEGAS	216	3.6914	3.6914
	DENVER	245		3.7980
	Sig.		.476	.155

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While residents of all three cities perceive some need for water sustainability transitions, Las Vegas residents' scores are statistically higher than residents in Phoenix and Denver.

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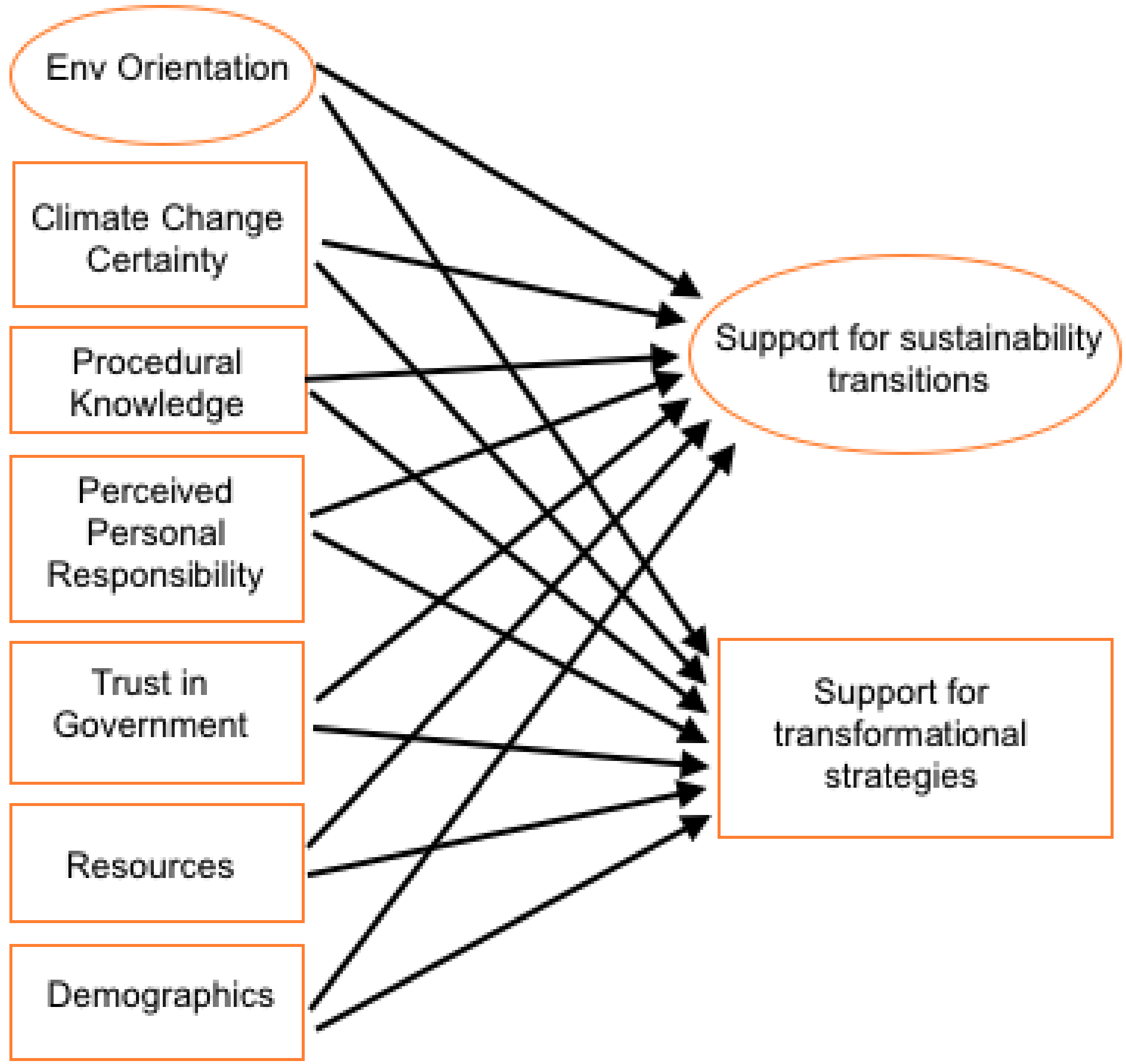
While residents of all three cities show support transformational strategies, Denver residents expressed significantly higher levels of support than Phoenix residents.

Factors Influencing Public Support for Transitions and Transformational Strategies

Hypotheses: Public support for water sustainability transitions and transformational strategies is predicted (+) by factors including values, beliefs, informal rules, knowledge, and resources, per Wiek and Forrest (2017), socio-technical cause-effect framework



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Factors Influencing Public Support for Transitions

Model	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
(Constant)	2.267	.282		8.037	.000
EDUCATION	-.054	.024	-.097	-2.316	.021
MINORITY RACE OR ETHNICITY	.106	.089	.045	1.184	.237
NEP SCALE	.174	.047	.146	3.714	.000
PERSONAL KNOWLEDGE SCALE	-.048	.043	-.045	-1.104	.270
PERSONAL RESPON SCALE	.313	.049	.273	6.319	.000
TRUST SCALE	.005	.054	.003	.092	.926
INCOME	.000	.025	.000	-.009	.993

a. Dependent Variable: MGT CHANGE NEEDED SCALE

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R^2: 12% variability explained

Factors Influencing Public Support for Transformational Strategies

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	1.786	.155		11.484	.000
EDUCATION	.028	.013	.083	2.180	.030
NEP SCALE	.309	.026	.424	11.933	.000
PERSONAL KNOWLEDGE SCALE	-.025	.024	-.039	-1.068	.286
PERSONAL RESPON SCALE	.147	.027	.212	5.486	.000
TRUST SCALE	.056	.030	.064	1.883	.060
INCOME	.005	.014	.013	.345	.730

a. Dependent Variable: STRATEGIES SCALE

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R^2: 28% variability explained

Factors Influencing Public Support for Transitions and Transformational Strategies

- Higher pro-environmental value orientation and greater perceived personal responsibility positively predict greater support for water sustainability transitions, while education has a weak negative effect (R^2=.12).

- Higher pro-environmental value orientation, and greater perceived personal responsibility positively predict greater support for transformational water management strategies and education has a weak positive effect (R^2 =.28).

- Next steps: Include climate change certainty scale and political orientation in models, weight sample data, conduct CFA on latent variables (NEP, strategies), conduct SEM modelling to account for measurement error, SEM models by group (city)

Discussion and Implications for Research and Policy

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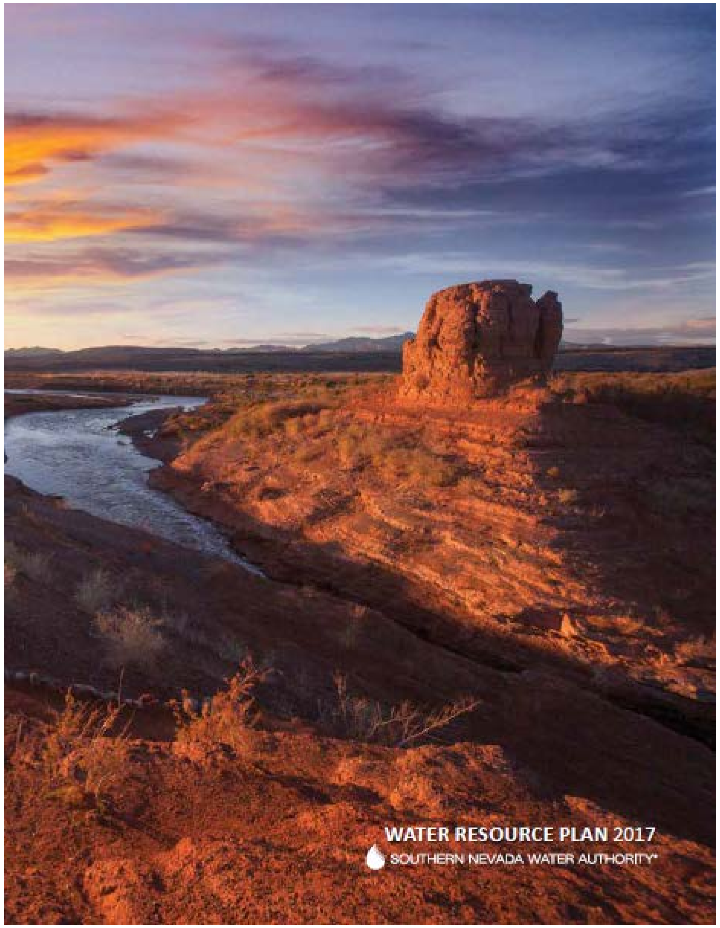
Discussion and Implications for Research and Policy

- Our study contributes to the transitions literature
  - a) empirical assessment of theoretical hypotheses about antecedents of public support for transitions and specific strategies
  - b) development and initial evaluation of two new multi-item questionnaire scales to measure public support for transitions and specific strategies
  - c) comparative analysis will determine robustness of general findings across three cities with some similarities and some differences in environmental, social, and economic context

Discussion and Implications for Research and Policy

2017 Water Resources Plan
Southern Nevada Water Authority



- Findings provide contextual information to inform policy processes regarding appropriate intervention scales and policy reform types that will be socially acceptable
- Mix of generic innovation policies and targeted sectoral (and technology-specific) policies is important to create integrated policies
- Results show an opportunity to engage public as there fairly widespread recognition about need for change but very little awareness of how to engage in process

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The take home point...

Public support for urban water sustainability transitions and transformational strategies in Denver, Phoenix, and Las Vegas may enable managers, policy makers, and citizens to explore novel innovations in support of large-scale societal change.

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Questions

Supported by the National Science Foundation under award numbers SES-1462086, SES-0951366 and SES-0345945. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.