

**Water Management
in the American Southwest**
Lessons for an Age of Climate Change



ASP

American Security Project



-Perspective Paper-

Andrew Holland
June 2014

BOARD OF DIRECTORS



The Honorable Gary Hart, Chairman

Senator Hart served the State of Colorado in the U.S. Senate and was a member of the Committee on Armed Services during his tenure.



Admiral William Fallon, USN (Ret.)

Admiral Fallon has led U.S. and Allied forces and played a leadership role in military and diplomatic matters at the highest levels of the U.S. government.



Norman R. Augustine

Mr. Augustine was Chairman and Principal Officer of the American Red Cross for nine years and Chairman of the Council of the National Academy of Engineering.



Raj Fernando

Raj Fernando is CEO and founder of Chopper Trading, a technology based trading firm headquartered in Chicago.



The Hon. Donald Beyer

The Hon. Donald Beyer is the former United States Ambassador to Switzerland and Liechtenstein, as well as a former Lieutenant Governor and President of the Senate of Virginia.



Vice Admiral Lee Gunn, USN (Ret.)

Vice Admiral Gunn is the President of the Institute of Public Research at the CNA Corporation, a non-profit corporation in Virginia.



Lieutenant General John Castellaw, USMC (Ret.)

John Castellaw is President of the Crockett Policy Institute (CPI), a non-partisan policy and research organization headquartered in Tennessee.



Lieutenant General Claudia Kennedy, USA (Ret.)

Lieutenant General Kennedy was the first woman to achieve the rank of three-star general in the United States Army.



Brigadier General Stephen A. Cheney, USMC (Ret.)

Brigadier General Cheney is the Chief Executive Officer of ASP.



General Lester L. Lyles, USAF (Ret.)

General Lyles retired from the United States Air Force after a distinguished 35 year career. He is presently Chairman of USAA, a member of the Defense Science Board, and a member of the President's Intelligence Advisory Board.



Lieutenant General Daniel Christman, USA (Ret.)

Lieutenant General Christman is Senior Vice President for International Affairs at the United States Chamber of Commerce.



Dennis Mehiel

Dennis Mehiel is the Principal Shareholder and Chairman of U.S. Corrugated, Inc.



Robert B. Crowe

Robert B. Crowe is a Partner of Nelson Mullins Riley & Scarborough in its Boston and Washington, DC offices. He is co-chair of the firm's Government Relations practice.



Stuart Piltch

Stuart Piltch is the Co-Founder and Managing Director of Cambridge Advisory Group, an actuarial and benefits consulting firm based in Philadelphia.



Lee Cullum

Lee Cullum, at one time a commentator on the PBS NewsHour and "All Things Considered" on NPR, currently contributes to the Dallas Morning News and hosts "CEO."



Ed Reilly

Edward Reilly is CEO of Americas of FD International Limited, a leading global communications consultancy that is part of FTI Consulting, Inc.



Nelson W. Cunningham

Nelson Cunningham is President of McLarty Associates.



Governor Christine Todd Whitman

Christine Todd Whitman is the President of the Whitman Strategy Group, a consulting firm that specializes in energy and environmental issues.



About this Report:

The American Southwest is seeing the worst span of drought in a generation, lasting since 2000 in some regions. However, this has not held back economic development.

This paper argues that key adaptations, including dams, legal title, and effective regulations, have allowed the region to thrive even in the face of water shortages.

The lessons from the American Southwest can prove to be a model for the rest of the world, as climate change makes the world's drylands more prone to drought and unpredictable precipitation. However, some climate effects simply cannot be adapted to; if there is not enough water, all the legal rights, regulatory oversight, or poured concrete cannot distribute anything.

Interact:

**Join our discussion as we visit the Southwest with the hashtag #ASPTexas
Discuss the role of water management and the broader implications of climate change with Andrew at @TheAndyHolland**

IN BRIEF

- Precipitation in the American Southwest is highly variable, whether looking year-to-year, decade-to-decade, or century-to-century.
- Climate change is likely to make droughts in the region longer, more intense, and more unpredictable – similar to other drylands regions around the world.
- The current drought has lasted for 14 years so far, but three key adaptations to a dry, unpredictable climate have allowed the region to continue to thrive:
 1. A Clear Legal System for Water Rights
 2. A Regulatory Framework for Managing Water
 3. Investments in Infrastructure for Water Utilization
- These adaptations can provide a model for the rest of the world in a future with unpredictable climate change – but could be some climate effects that simply cannot be adapted to. If there is not enough water, all the legal rights, regulatory oversight, or poured concrete cannot distribute anything.

About the Author

Andrew Holland is Senior Fellow for Energy and Climate at the American Security Project. This report is the result of a study trip with the Emerging Leaders in Energy and Environmental Policy (ELEEP), of which he is a part, taken in July, 2013. Holland is an expert on energy, environment, and infrastructure policy. More detail, including contact information is available at:

<http://www.americansecurityproject.org/about/staff/andrew-holland/>

Introduction

Arizona and Nevada are seeing the worst span of drought in a generation. It has lasted since 2000 and in some areas has gotten progressively worse. The U.S. Bureau of Reclamation emphasizes that this is the worst 14-year drought period in the last hundred years. The water levels of Lake Mead, the lake created by the Hoover Dam, have dropped more than 100 feet since 2000.

Up to now, however, drought conditions have hardly impacted the people of Arizona or Nevada at all. Agricultural production remains strong. The golf courses are still green and watered. Population growth has been hampered by the economic recession, not by water availability.

In the Southwest, droughts are not new. Water availability has been decisive to habitation since the Anasazi and Hohokam peoples built towns and farms fed by massive irrigation works in the centuries around 1150 AD – a wet period. When drought returned in the centuries before the Spanish arrived, the civilization collapsed.

The Equation to Best Utilize Water – and Prevent Collapse

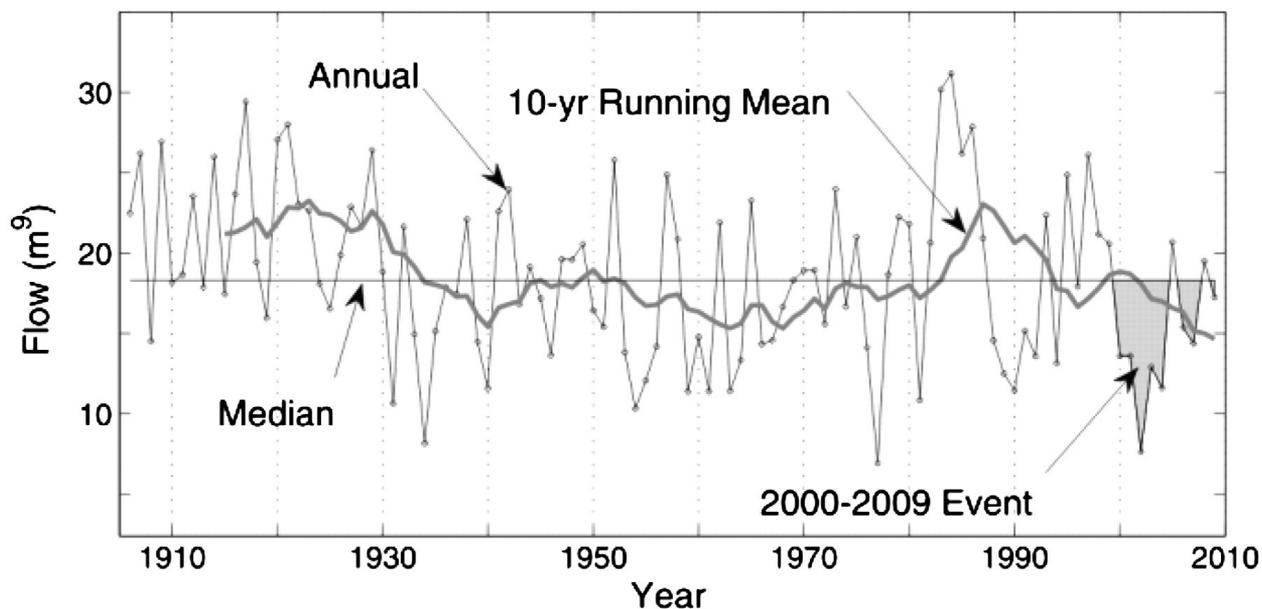
Precipitation in this region is highly variable, whether looking year-to-year, decade-to-decade, or century-to-century.¹ When rains do come, they fall in torrents, while droughts can parch the region for years. That means that it is important to utilize and preserve the water when it does come.

The equation that the American Southwest has developed to utilize their small amount of water has served it well. They first comprehensively document the legal ownership of the water, then they regulate how it is used, and then build the infrastructure necessary to store and channel it to best use.

As the world faces an increasingly inevitable future of a changing climate, this equation can provide important lessons to drylands regions around the world. Climate change will have different effects on different regions, but a broad generality is that already hot and dry regions should expect to become hotter and more dry, with what had previously been extreme droughts becoming both more regular and less predictable. Most of the Mediterranean region, for example, is expected to become drier and more prone to droughts as the climate changes.

As a region that has faced water challenges throughout its history, the American Southwest has evolved in the face of sparse water availability and extended droughts. It has been largely successful in the face of drought for three reasons: a legal structure that assigns clear property rights to water, a regulatory system that prioritizes water management, and the large scale infrastructure necessary to store and divert much needed water. Each of these aspects is important – and work in concert with one another.

This paper discusses each, and seek to offer lessons for the rest of the world. As drought becomes more pervasive, unpredictable, and deeper around the world in the age of climate change, lessons from the American Southwest can help the rest of the world.



Annual flow of water along the Colorado River, 20th Century, in billion cubic meters. Horizontal Line is the median of the 1906–2006 observed flows (18.32 billion cubic meters). Light Gray line is the 10-year running average. (PNAS, 2009)

A Clear Legal System for Water Rights

In the face of water scarcity, a legal regime to define who owns what water is critical to governance. One of the reasons that the first governments started in the Fertile Crescent region over 5,000 years ago was to define water rights. The legal right to water is important because it provides an incentive to improve water retention and save water.

In the region, water, both when its flowing in rivers and underground in aquifers, is clearly allocated to uses. The states of the region have adopted the doctrine of “prior appropriation” – which is based on the legal tenet of “first in time, first in right.”² Under this doctrine, then, a water right with legal authority is asserted by putting water to ‘beneficial use’ – which can include agricultural irrigation, domestic use, municipal, water power, recreation, or mining. Even wildlife can hold a water right. Those who have the longest title to a right have the highest priority, if the quantity of water fails to meet allocations. In practice, this means that the water rights of the Southwest are generally prioritized first to the Native American tribes, followed by hereditary Spanish farmers, then traditional agriculture, and only then to municipal systems.

As for the size of the amount allocated, surface water rights are based on the historical flow of the river, and underground water rights are determined by an accounting of the size of the aquifer.

These water rights are determined and governed within each state. However, when water crosses borders,

individual states have to determine among themselves how to allocate flows. In that case, both Congress and the Supreme Court have [repeatedly determined](#) that each State is sovereign in terms of determining water rights within its borders. Along the Colorado River, the largest and most important river in the Southwest, the seven states sharing the basin negotiated the Colorado River Compact to share the water rights.

A Regulatory Framework for Managing Water

If there are water rights, but no regulation, then the only recourse for enforcing rights is litigation. The high transaction costs of litigation would ensure that water rights holders would attempt to push the limits of their rights and non-rights holders would try to cheat the system.

For those reasons, it is important to regulate and manage water effectively. One of the best examples of this is the 1980 Groundwater Management Act of Arizona that quantifies and regulate all water within the state. The act created the Arizona Department of Water Resources. This agency has broad authority for regulating development within Arizona (because there would be no development without water) has required that the development of any new property demonstrate that they have secured physical, legal, and continuous access to a 100 year water supply before approval is given for building. This ensures that water is considered at every level of development.

The state has determined that the total water usage of all sectors is 14.5 million acre feet per year, and they claim that is sustainable.

The result is that, since passage of the act, Arizona's water usage has returned to its 1955 levels, despite a population growth of over 5 million people.³ This system is effective because there a defined tally of all water usage and all development over the long term is pre-determined for how water will be used. This enables sustainable growth in a region which does not appear sustainable on first look.

Building the Infrastructure for Water Utilization

Although the legal and regulatory systems for water management are important, the population still has to physically control the water. The dams and water systems of the Southwest are remarkable feats of engineering. They use concrete to shape the water, and the electricity generated by hydroelectricity (mostly) to move the water up and over mountain ranges. In a system without clear legal rights or effective regulator management, there would be no legal framework to guide these investments.

The Federal Bureau of Reclamation was created by the Reclamation Act of 1902 in order to provide the water necessary for homesteading farmers to settle the West. At



the time, the Administration of Theodore Roosevelt believed that only the Federal Government had the resources in which to build these massive public works, and the authority to share its benefits widely. All Bureau of Reclamation projects are designed in order to pay for themselves. The Hoover Dam, for example, was completed in 1936 and over the next 40 years used the sale of the electricity it generated to pay off the bonds used to finance it.

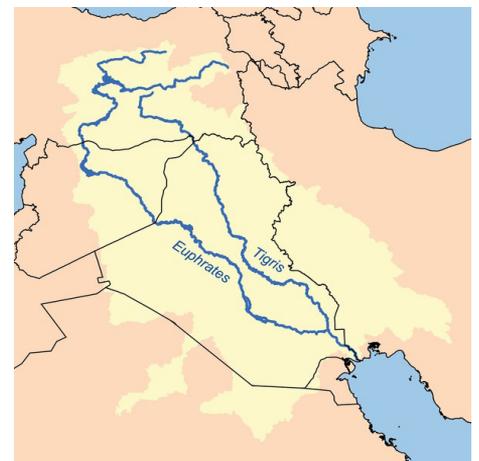
The most recent of Reclamation's massive public works is the Central Arizona Project (CAP), which diverts 1.5 million acre feet of water from Lake Havasu on the lower Colorado River across the state to Phoenix and ultimately as far as Tucson. Over its journey, it stretches 336 miles across the state, and lifts the water more than 2,900 vertical feet.⁴ Without this project, the development of Phoenix into the 5th largest city in the country would not have been possible.

Global Lessons for the Era of Climate Change

The North American Southwest has a similar climate to parts of the Middle East – desert, but with major rivers fed by waters upstream passing through. They are expected to see some of the same effects of climate change: drier and more unpredictable weather.

In much of the Middle East, surface and ground water are not privately held, instead they are a declared public resource. That puts a higher burden on public regulators to ensure that water is allocated to the end-users chosen by law. The results are reportedly unsuccessful, as farmers have over-allocated scarce (but subsidized) groundwater from deep aquifers. It is impossible to plan for a projected future with less water when current allocations of water are unknown.

In Iraq, there are similar problems of uncertain regulation and a lack of property rights. In addition, however, the Tigris and Euphrates river valley is a region with spare capacity that could be developed for hydroelectricity. It is estimated, for example, that Iraq has over 67,000 GWh/year of hydroelectric capability, but only has installed very little of this.⁵ Such large hydroelectric capacity can be used for irrigation – important in an unstable, post-conflict country.



What Happens When the Water Runs Out?

The Southwest has experience with a climate of year-to-year and decade-to-decade variability. The legal and physical structures of the Southwest appear to be well evolved to handle future variability within the historical average. However, there is also emerging evidence that the region has experienced so-called ‘mega-droughts’ in the interglacial time period – between 370,000 and 550,000 years ago – that lasted for centuries or millennia.⁶ In such an extreme climatic event, it is unlikely that the current level of water use, and hence the current level of human exploitation of the region, could be sustained.

We do not know the future, but we can see trends. In the age of climate change, regions are likely to see more extreme volatility in rainfall. The legal, regulatory, and physical structures controlling water in the Southwest were not built in the name of ‘climate adaptation,’ but it turns out that they are fulfilling that role. There are few places in the world that are better prepared for climate change than this region because the climate already features extremes.

However, this region also shows that there could be some climate effects that simply cannot be adapted to. If there is not enough water, all the legal rights, regulatory oversight, or poured concrete cannot distribute nothing. In that way, the Southwest also points to the future: there is a certain amount of climate change that we can adapt to, but at a certain point – which is different for every region and country – unmitigated changes in climate will overwhelm a society’s ability to adapt.



Further Reading:

www.NationalSecurityandClimateChange.org

[Climate Security Report](#)

[Protecting the Homeland – The Rising Costs of Inaction on Climate Change](#)

[Critical Security Challenges in the Arctic](#)

[The Global Security Defense Index on Climate Change](#)

[Pay Now, Pay Later, ASP’s Report on the 50-state impact of Climate Change](#)

Endnotes

1. Fraser, Caroline, “Megadrought in U.S. Southwest: A Bad Omen for Forests Globally” June 20, 2013. Available at: <http://e360.yale.edu/feature/mega-drought-in-us-southwest-a-bad-omen-for-forests-globally/2665/>, accessed May 23, 2014.
2. U.S. Department of the Interior, Bureau of Reclamation, “Bureau of Reclamation Forecasts Lower Water Release from Lake Powell to Lake Mead for 2014” August 16, 2013. Available at: <http://www.usbr.gov/newsroom/newsrelease/detail.cfm?RecordID=44246>, accessed May 23, 2014.
3. Johnson, Terrell, “Dwindling Colorado River Forces First-Ever Cuts in Lake Powell Water Releases” The Weather Channel, August 20, 2013. Available at <http://www.weather.com/news/science/environment/drought-lake-powell-lake-mead-climate-change-20130818>, accessed May 23, 2014.
4. [Connie A. Woodhouse, David M. Meko, Glen M. MacDonald, Dave W. Stahle, and Edward R. Cook, A 1,200-year perspective of 21st century drought in southwestern North America, PNAS 2010 107 \(50\) 21283-21288; published ahead of print December 13, 2010, doi:10.1073/pnas.0911197107. Available at: http://www.pnas.org/content/107/50/21283.abstract](#), accessed May 28, 2014.
5. [Arizona Department of Water Resources, “Surface Water Rights” March 27, 2014. Available at: http://www.azwater.gov/AzDWR/SurfaceWater/SurfaceWaterRights/SurfaceWater_FAQ.htm](#), accessed May 23, 2014.
6. [Arizona Department of Water Resources, “A History of Water Management in Arizona” 2014. Available at: http://arizonaexperience.org/remember/history-water-management-arizona](#), accessed May 23, 2014.
7. [Central Arizona Project, “CAP Background” 2014. Available at http://www.cap-az.com/index.php/cap-background](#), accessed May 23, 2014.
8. [Iraq Hydropower, “Hydroelectric Power” 2014. Available at http://www.renewablefacts.com/country/iraq/hydro](#), accessed May 29, 2014.
9. [Fawcett et al. “Extended megadroughts in the southwestern United States during Pleistocene interglacials.” Nature, Vol 470, pp 518-521. Available at: http://text-science.org/water/Nature_2011_Fawcett_Extended_Megadroughts_Southwest.pdf](#), accessed May 29, 2014.

The American Security Project (ASP) is a nonpartisan organization created to educate the American public and the world about the changing nature of national security in the 21st Century.

Gone are the days when a nation's security could be measured by bombers and battleships. Security in this new era requires harnessing all of America's strengths: the force of our diplomacy; the might of our military; the vigor and competitiveness of our economy; and the power of our ideals.

We believe that America must lead in the pursuit of our common goals and shared security. We must confront international challenges with our partners and with all the tools at our disposal and address emerging problems before they become security crises. And to do this we must forge a bipartisan consensus here at home.

ASP brings together prominent American business leaders, former members of Congress, retired military flag officers, and prominent former government officials. ASP conducts research on a broad range of issues and engages and empowers the American public by taking its findings directly to them via events, traditional & new media, meetings, and publications.

We live in a time when the threats to our security are as complex and diverse as terrorism, nuclear proliferation, climate change, energy challenges, and our economic wellbeing. Partisan bickering and age old solutions simply won't solve our problems. America – and the world - needs an honest dialogue about security that is as robust as it is realistic.

ASP exists to promote that dialogue, to forge that consensus, and to spur constructive action so that America meets the challenges to its security while seizing the opportunities that abound.



American Security Project

www.americansecurityproject.org