A Water-Induced Economic Collapse of California?

Figure 1. The Los Angeles aqueduct system

By Mark Bird

Introduction

Given current trends, an abundance of evidence points to a probable economic collapse of California. Metro Los Angeles is the likely epicenter of the collapse, but ripples of havoc are likely to spread throughout the Golden State.

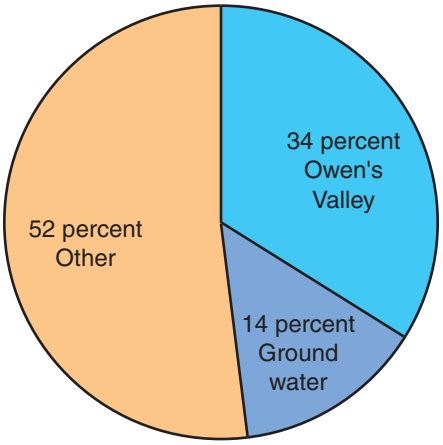
As depicted in Figure 1, water for Los Angeles is derived from the Mono Lake region 250 miles away, from the San Francisco Bay delta region 400 miles away and from Wyoming and northern Colorado via the Colorado River 1,000 miles away. These aqueducts have the appearance of three predatory armies triangulating on a vulnerable urban foe.

As depicted in Figure 2, a mere 14 percent of the water used by the Los Angeles Department of Water & Power (LADWP) derives from local groundwater. 'Other' in the pie chart represents water from the State Water Project and the Colorado River. According to the San Diego County Water Authority (SDCWA), a modest 21 percent of their water derives from within the county; most of SDCWA's water derives from the same sources as LADWP.

Background

Lakes Mead and Powell on the Colorado River are by far the largest reservoirs that supply water to southern California. Diamond Valley Lake, 90 miles southeast of Los Angeles, is the largest reservoir in Southern California. By comparison, Lake Mead's designed storage capacity is 35 times larger than the capacity of Diamond Valley Lake. (Lake Mead is also the largest human-made reservoir in North America.)

Figure 2. Water sources for LADWP



SOURCE: Los Angeles Department of Water and Power

Relative to its storage capacity in May 2006, Lake Mead was 15 percent silt, 39 percent water and 46 percent empty. The corresponding data for Lake Powell was 10 percent silt, 37 percent water and 53 percent empty.

While a mild collapse could commence if the water levels in these two Colorado River lakes do *not* further decline, as these lakes supply water to 25 million people, a collapse *will* commence if both lakes lose as little as another 20 percent of storage capacity.

Hydrological factors

While two-thirds of the people in the state live in southern California, water there is notable only by its absence: there is no large natural lake in the region, nor any large river that begins and ends there. Essentially all of southern California is desert or semi-arid. The vast majority of rainfall does not arrive in the growing season. Even Los Angeles is semi-arid with an average rainfall of 15 inches per year. The city's image is that of an oasis; that image is a mirage.

The word drought connotes a temporary condition; it implies normalcy—and plentiful water—will soon resume. All of the following hydrological and sociological factors are permanent conditions; global warming and some of these other factors are certain to intensify.

A second factor is that California has been using over 100 percent of its Colorado River water allotment for most of the past quarter century. Given current lake levels and recent rapid growth in upstream states, California is now being compelled to live within its allotment.

California has the dubious distinction of regularly using over 100 percent of its annual renewable groundwater. Hundley[1] notes that California's annual overdraft is equal to the annual water use of eight million people. As groundwater levels decline, this will exacerbate tensions among water users around the state.

Due to the urban heat island effect, those expanding California cities will be warmer than ever before in the next decade. The greater heat means grass and other vegetation will need more water.

Urban heat islands cause more water to evaporate and less water to percolate into the ground for reuse.

In 1922, Colorado River water was allocated to southwestern states on the assumed basis of the average annual flow of the river. But water experts did not have access to the tree-ring measurements at that time. The tree-ring record of rainfall goes back around 500 years and indicates the real average annual flow of the river to be around 33 percent less than was believed in 1922. In this context, the tree-ring record suggests the 20th century was a wet century. Further, it indicates that there have been periods when drought persisted for decades. This and other antiquated water laws impede solutions to today's—and tomorrow's—problems.

Several significant wetland areas are showing signs of severe stress, if not outright collapse. These areas include the Salton Sea, the San Francisco Bay delta, Mono Lake, the Colorado River delta and a few riparian locations along the Colorado River. If these areas are all to be restored to healthy conditions, they will require water equivalent to the annual water needs of a few million people.

California has aging water infrastructure, including canals, subject to leaks and other disruptions. Water from Owens Valley first flowed to Los Angeles in 1913, the Colorado River aqueduct was finished in 1941 and the State Water Project commenced deliveries to Los Angeles in 1972. With over 1,000 miles of vulnerable levees in northern California, some state officials have publicly wondered if the region could be subject to Hurricane Katrina-type devastation.

Last and probably most significant of these hydrological factors is global warming. As Table 1 depicts, in over a century of measurement, the 10 warmest years have all occurred after 1989. Statistically, the odds for this pattern continuing are over a million to one. Science now holds as fact that the world's more than 40,000 airports, a billion vehicles, a billion animals and over six billion humans *daily* contribute to global warming gases.

According to the US Bureau of Reclamation[2], for the six years from 2000-2005, the average inflow into Colorado River reservoirs was 59 percent of average historical inflow. This 41 percent reduction vividly correlates to the warmest years ever recorded.

Naomi Oreskes[3] analyzed 928 refereed climate change abstracts in scientific journals published between 1993 and 2003. Oreskes reports that in none of those papers did any researcher disagree with the consensus position that global warming is occurring.

Why is global warming so potentially devastating for California? As summarized in Table 1, an answer might be called the hydro-domino theory. Global warming causes less snow to occur in the Sierra Nevada and

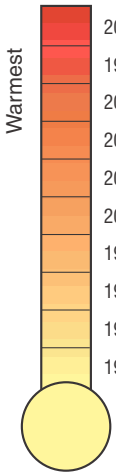


Table 1. How global warming impacts California

- Less snow is created
- Upstream soil absorbs more water
- Upstream vegetation needs more water
- Less water enters upstream reservoirs
- More water evaporates from upstream reservoirs
- Less water enters downstream reservoirs
- More water evaporates in downstream reservoirs
- Less water enters concrete canals
- More water evaporates from concrete canals
- Downstream vegetation needs more water
- Farms need more water to grow food

Rocky Mountains. Less snow means the soil absorbs more water and there is less snow run-off. Since it is warmer, upstream vegetation needs more water. All of which means less water enters upstream reservoirs. Since it is warmer, more water evaporates from those reservoirs and less water enters the downstream reservoirs. Warmer weather means more water evaporates downstream so that less water enters the over 2,000 miles of canals supplying water to southern California. The concrete canals are warmer than the air surrounding them, so they evaporate yet more water. Global warming, at the same time, means warmer weather, which means all the farms in southern California need more water to grow the same amount of crops.

For Los Angeles, this hydro-domino theory translates to potentially less water flowing to homes from all aqueducts supplying water to the city. It means a one-tenth of a degree (F) increase would not be insignificant. And global warming models predict a 10-degree increase in temperatures in the 21st century.

For decades, southwestern water professionals have referred to the seven Colorado River states. In a global warming context, there are now 50 states and 200 countries that use the river. Because each and every non-river location contributes global warming gases which contribute to increased evaporation. It would be difficult to quantify, but perhaps the 43 non-river states are now annually using an amount of California water equal to Palm Springs and the world is annually using an amount equal to Anaheim. Perhaps in 20 years, non-California locations will be annually using an amount of water equal to San Diego.

According to a recent news magazine's[4] story on global warming, "The debate over whether Earth is warming up is over. Now we're learning that climate disruptions feed off one another in accelerating spirals of destruction. Scientists fear we may be approaching the point of no return."

Considering the eight preceding hydrological factors, a prime location for this destruction is California.

Sociological factors

As depicted in Table 2, California's population will increase by 29 percent between 2000 and 2030. But the previous hydrological factors suggest the water supply may decrease by over 29 percent by 2030. The Colorado River is the most critical water source not only for southern California but also for Arizona and Nevada. This river supplies water for Phoenix, Tucson and over a dozen other Arizona communities. About 90 percent of the water used by metro Las Vegas derives from the river. These two states will be using more Colorado River water in the future. Another sobering implication of this article is that Arizona and Nevada are also subject to collapse.

Another factor is a multiplicity of new water needs by the four upper Colorado River states. Utah has plans for a pipeline from Lake Powell. Colorado is considering a plan to pipe water from the west side of the Rocky Mountains to Denver on the east side. There certainly will be more claims from Native Americans for water, while potential oil shale development in the vicinity of the Utah-Colorado border will require a large quantity of water. Speculators have been buying water rights in many southwestern states. Any—or all—of these circumstances, along with normal growth, will translate into less water for California.

While per capita water consumption is expected to remain near current levels in California in the next decade, this does not account for increased indirect water usage. Bigger houses require more water to build and the manufactured contents of those houses requires more water.

Table 2. Population growth of California, Arizona and Nevada

	Pop. in 2000 (millions)	Pop. in 2030 (millions)	Percent change
California	33.9	46.4	29
Arizona	5.1	10.7	109
Nevada	2.0	4.3	114

SOURCE: US Census Bureau

More people have second homes. More people go regularly to restaurants. The extra car requires more water for car washing, for its radiator and by the oil industry.

Southern California's water supply system is likely the most complex on Earth. Around 1,000 water districts and other entities are involved. Usage is regulated by dozens of local, regional, state and federal agencies. Complexity begets complications.

In the first year or two of a collapse, agency and political inertia is likely to reign. Agencies may be in a state of denial; some politicians will imply the drought will soon end. Some will have an anti-science disposition and others will choose to ignore long-range water solutions. There is a tendency in such situations to seek mild compromises and weak solutions.

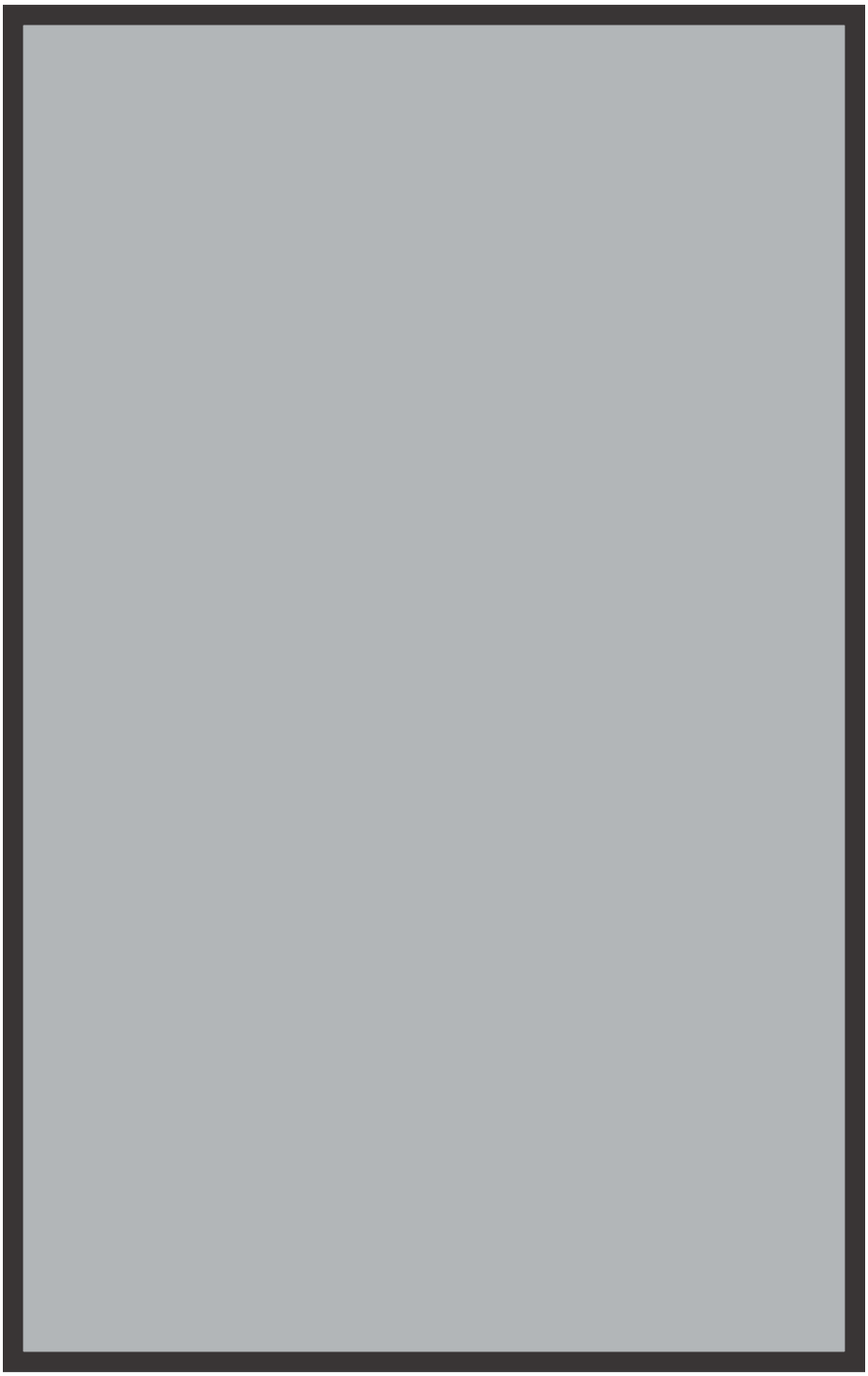
Last and probably most significant of these sociological factors is the specter of litigation. In 2005, a judge ordered Los Angeles to reduce the amount of water taken from Owens Valley. Also in 2005, a Mexican organization renewed international water tensions by filing a suit regarding the All-American Canal in southern California. A couple of years ago, several Native American tribes in California were awarded water rights. California has had serious water disputes between environmentalists and developers, between San Diego and Los Angeles and between northern and southern state interests. Water was a key motive in efforts to split California into two states.

Yet this litigation may be minor compared to other looming water tensions. Arizona and Nevada have both suggested they may need to go to the courts to obtain more California water from the Colorado River. Arizona started to build a million- dollar fund for future litigation. Upper basin Colorado River states have taken action to retain more water for their residents. Despite decades of opportunities, there is a distinct lack of regulations for shortage conditions on the river. However shortage regulations are resolved, there is a virtual certainty there will be aggrieved parties. Such litigation may take a long time to resolve.

Two experts

Hundley stresses the closely intertwined nature of California history and water, the "persisting despoliation of water supplies," and how, "conflict, rivalry and localism" have permeated state water issues. A couple key facts he cites are that agriculture uses 77 percent of the state's developed water supply and wasted farm water is, "enough to meet the annual needs of approximately three million city dwellers." After low precipitation years, he notes Californians have a pattern of reverting to high water use. Other collapse-related factors Hundley alludes to are water withdrawal induced land subsidence, aquifer contamination in multiple locations, ongoing salinity problems in multiple other locations and several precedents of negotiating water entities ignoring water deadlines.

Jared Diamond's[5] expertise is in determining why successful societies disintegrate. As depicted in Table 3, Diamond developed a five-point framework for examining past and present civilizations and their vulnerability to collapse.



These five factors have a striking relevance for California. As previously noted, the state has several major water ecosystems showing signs of severe environmental damage. Climate change is now afflicting the state in terms of water; other climate change impacts include prospects of more forest fires, soil damage and seawater seeping into coastal aquifers. Hostile neighbors include Mexico, all six other Colorado River states and powerful interests within the state. Unfriendly trade partners include agribusiness, the six other river states and opposition from northwestern states to divert some of their water to California. The societal response to the problems can be described as dismal at best.

Table 3. Diamond's five factors

1. Environmental damage
2. Climate change
3. Hostile neighbors
4. Unfriendly trade partners
5. Societal response to the problems

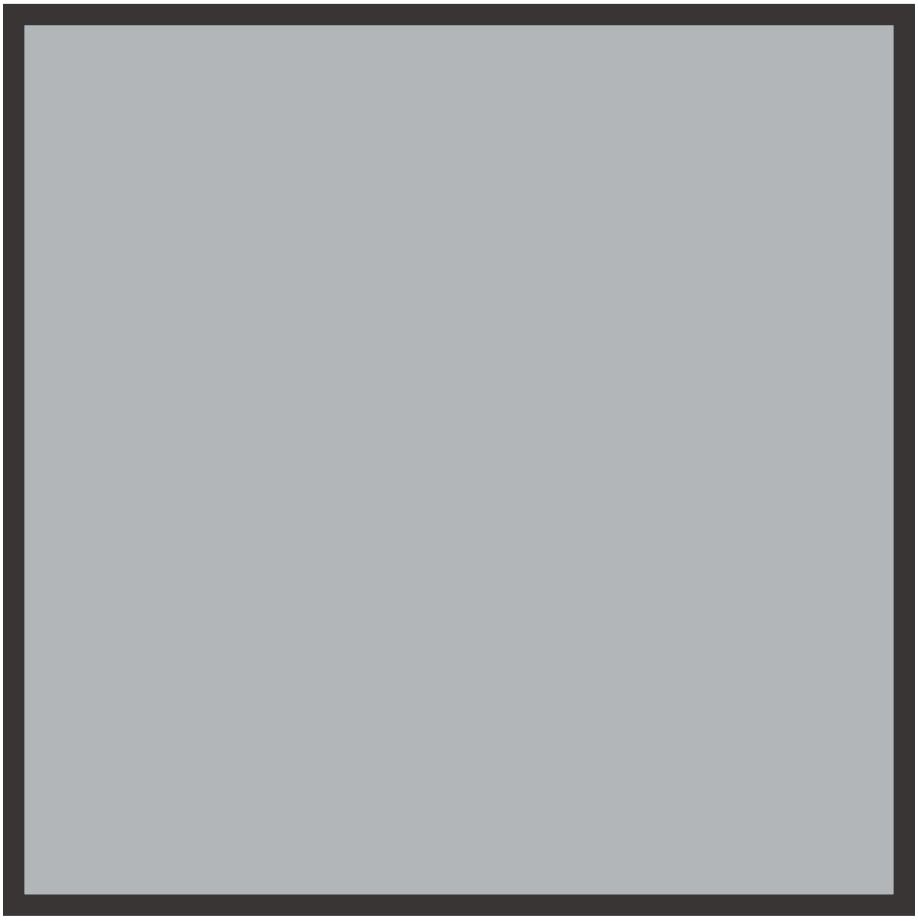
Solutions

For decades, *WC&P* has published multiple solutions for water scarcity. A complete archive can be found on the website. Solar energy, desalination, air-to-water technology, irrigation control systems and more can all be used to significantly lower water use in California. Solutions include the following articles: "$000: Current Seawater Desalting Costs?" by Mark Bird, April 05; "Using Solar Energy to Solve Water and Power Problems" by Anand Rangarajan, October 05 and "Southwestern Water Conservation Using Mobile Technology" by Laura Drangmeister, December 05.

All urban and farm water districts in California can pursue more vigorous water conservation measures. Dozens have been identified. One of the most fruitful solutions may be a significant cost increase via a progressively tiered price structure for water.

Local and state government can more actively monitor usage. Water districts with best practices can be identified and incentives for prudent water conservation can be legislated.

Media and state politicians can remind urban voters that most California water is used for agriculture; that much of this irrigated water is used for non-food crops and urban users frequently pay 20 times as much for the same quantity of water as agribusiness while hydroponic and/or greenhouse farming uses much less water to grow the same crops.



The primary responsibility for implementing major solutions may lie with the federal government. Perhaps the most immediate solution would be for the Secretary of the Interior (the 'water master' of the Colorado River) to promptly reduce water deliveries by five percent for all seven river states. This could be in effect until water levels of Lakes Mead and Powell reach, say, 75 percent of capacity. This action sends a conservation message to every state, preserves power, improves lake recreation, assists wildlife and enhances water quality. Farm subsidies can be legislatively changed or eliminated on the basis that an impending emergency exists and farms have failed to initiate sufficient water conservation measures.

The Feds could at least triple funds for desalting research and development, with a focus on desalting powered by solar, wind, tidal or other sources. Ample justification for such funding exists insofar as there has been a tenfold decrease in desalting costs in the past half century. There are very realistic prospects that desalting costs may decrease 50 percent in the next decade. Current seawater desalting now costs $0.01 (one cent) per five gallons. Desalting funds further deter foreign desalting investment in the US, can assist US foreign policy, improve international relations and help prevent future water wars.

Uncle Sam could strive for an agreement with Mexico whereby the US builds a state-of-the-art desalting plant for any Atlantic or Pacific Mexican city in exchange for a comparable amount of Mexican water in the Colorado River. (Mexico has legal entitlement to more Colorado River water than is used by San Diego.) Such an agreement has clear signs of being a win-win situation for both countries.

Furthermore, the federal government could assume an energetic leadership role in pursuing remedies to reduce global warming gases at both national and international levels.

Conclusion

California has been using over 100 percent of its allocation of the Colorado River. Two neighboring states that also use this river will each increase by 100 percent in 30 years. California has been using over 100 percent of its annual renewable groundwater. Close to 100 percent of the water for its largest city flows from hundreds of miles away. There is a virtual 100 percent probability global warming is occurring and will intensify.

And there is a near 100 percent certainty litigation will thwart any solution.

A massive confluence of evidence unambiguously points to a looming catastrophe. A collapse could occur even if half of the above hydrological and sociological factors are totally erroneous. Even if modest solutions are implemented, a collapse seems more probable than not. A collapse is also probable because all these factors were somewhat present at least a decade ago and major solutions have not been implemented.

So what are the probable contours of the collapse? Declining water levels will trigger 10-50 percent increases in all urban water bills. A year or two later, water bills will again increase by 50-100 percent. A year or two later, still declining water levels will cause a 50 percent increase in power bills and hydroelectric shortages. Prices for southern California food will increase by 50 percent. There will be frequent $500 fines for home water waste. Cities will charge a $10,000 fee for new home water connections. Declining water quality will instigate a variety of health problems. Thousands of water-intensive businesses will close. Unemployment, crime and civil unrest will increase. Hundreds of thousands will flee the state.

Such a collapse could start as early as 2008. In terms of damages measured in 'Katrina units' the costs might be a third of—or even three times the costs of—Hurricane Katrina. (A California collapse could get progressively worse for a decade and California in 2004 had eight times as many people as Louisiana.)

This collapse scenario acknowledges a fair degree of uncertainty. Human non-intervention may accelerate the collapse—or prudent human intervention may still prevent it.

Footnotes

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2. U.S. Bureau of Reclamation website

3. Oreskes, Naomi; "Beyond the Ivory Tower," *Science* magazine, December 3, 2004

4. "Special Report: Global Warming," *Time* magazine, April 3, 2006

5. Diamond, Jared; *Collapse*, Viking, 2005

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3. Starr, Kevin; *California*, The Modern Library, 2005

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6. Norton, Gale: "Growth Loads Strain on Arizona Water Supply," *Arizona Republic,* July 7, 2003

7. Rake, Launce; "Colorado River Drought Not Rare," *Las Vegas Sun*, May 28, 2006

8. Los Angeles Department of Water and Power website

9. Metropolitan Water District of Southern California website

10. San Diego County Water Authority website

11. U.S. Bureau of the Census website

About the author

♦ *Mark Bird, a professor at the Community College of Southern Nevada, is an author of over 30 water-related articles including "$000 Cost Desalination" in WC&P, April 2005. In 1993, he wrote an article on the collapse of another state entitled "How Global Warming Will Impact Louisiana." Bird can be reached at email: mark_bird@ccsn.edu.*