



DROUGHT MANAGEMENT UNDER A CHANGING CLIMATE: USING COST-BENEFIT ANALYSES TO ASSIST DRINKING WATER UTILITIES

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PROJECT TEAM

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DISTRIBUTION OF DROUGHT ACROSS THE U.S.

Lack of universal trend in overall extent of drought since 1900.

Widespread drought in the Southwest resembles projected changes due to:

- Precipitation deficits
- Increased temperatures

Short-term (seasonal) droughts are expected to intensify almost everywhere in the continental US

Long-term drought conditions are expected to increase in parts of the Southwest and possibly Hawaii and Pacific Islands.

SOIL MOISTURE TRENDS

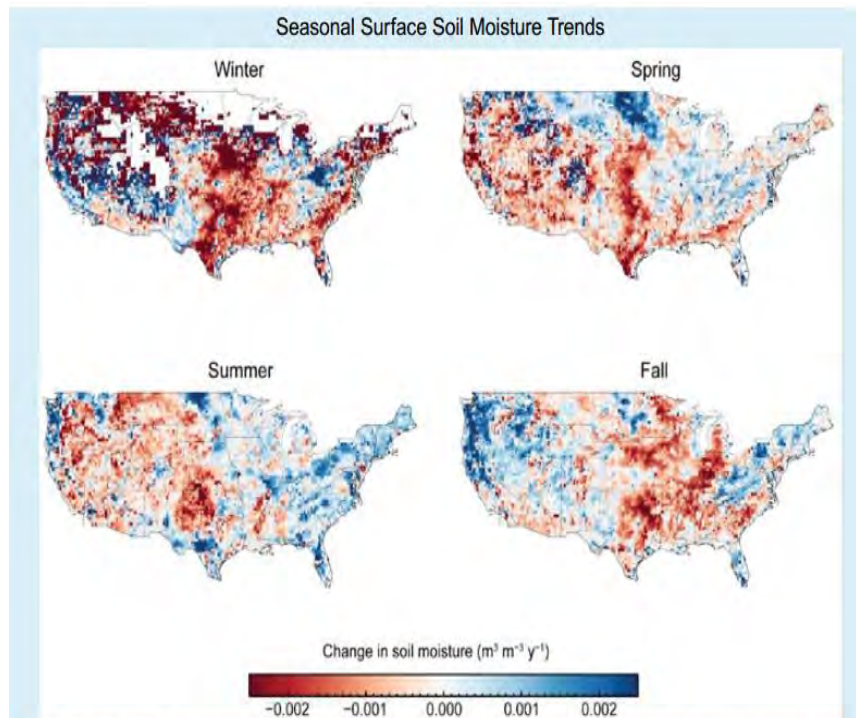


Figure 3.3. Changes in seasonal surface soil moisture per year over the period 1988 to 2010 based on multi-satellite datasets.³⁵ Seasonal drying is observed in central and lower Midwest and Southeast for most seasons (with the exception of the Southeast summer), and in most of the Southwest and West (with the exception of the Northwest) for spring and summer. Soil moisture in the upper Midwest, Northwest, and most of the Northeast is increasing in most seasons. (Images provided by W. Dorigo).

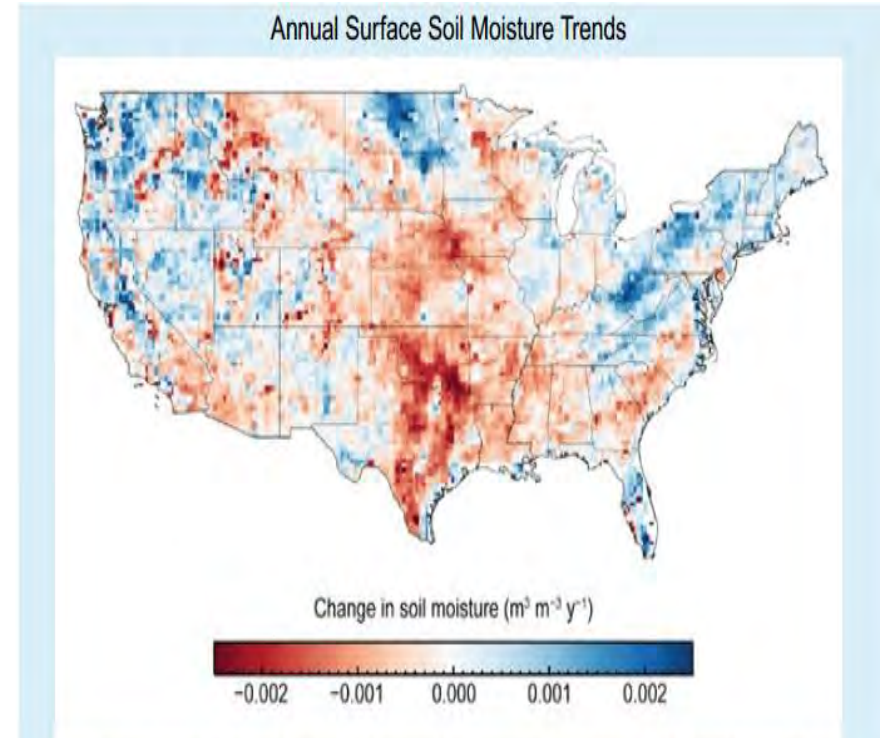
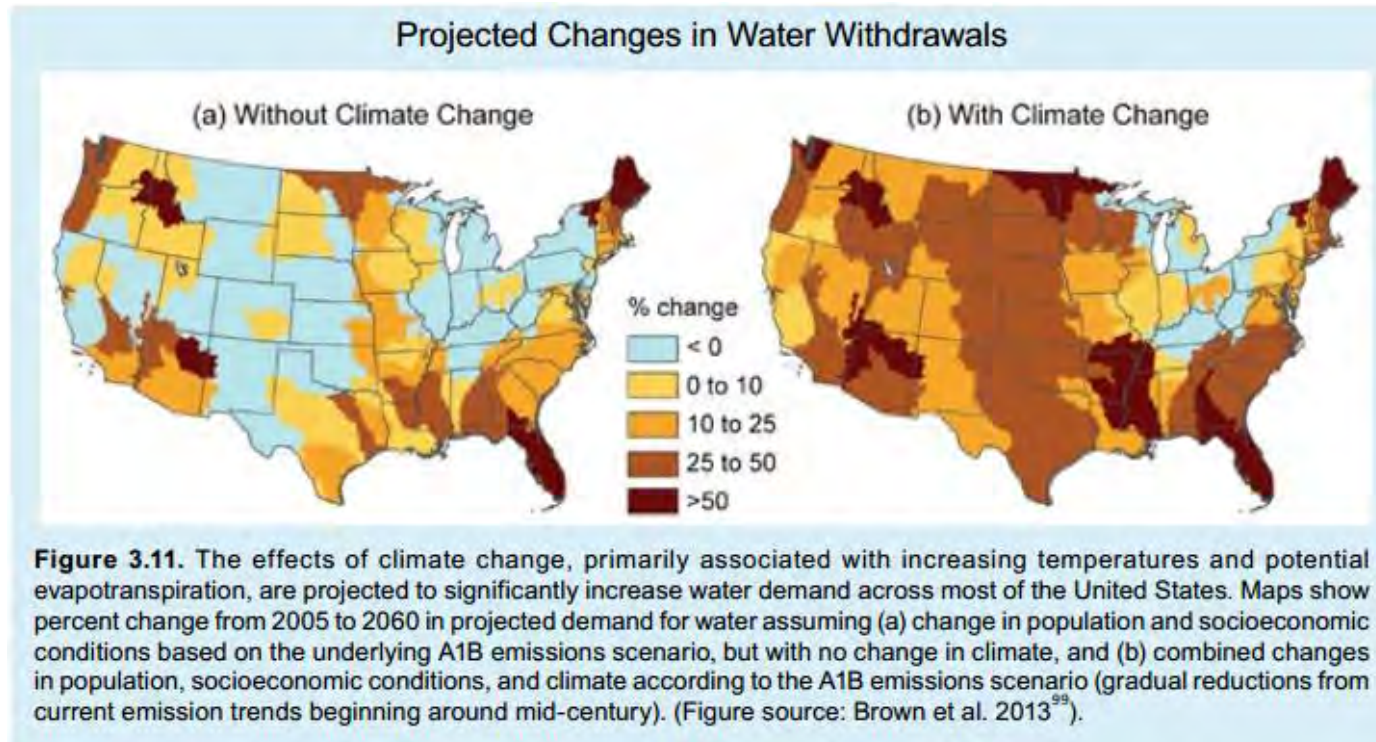


Figure 3.2. Changes in annual surface soil moisture per year over the period 1988 to 2010 based on multi-satellite datasets. Surface soil moisture exhibits wetting trends in the Northeast, Florida, upper Midwest, and Northwest, and drying trends almost everywhere else. (Images provided by W. Dorigo³⁵).

CHANGES IN WATER DEMAND



- Drier conditions in western and southwestern US
- Larger reductions in runoff are expected over some watersheds in the next 50 years
- With the effects of climate change, water withdrawals across the US are projected to increase
- Changes in streamflow timing lead to larger discrepancy between supply and demand

IMPACTS OF DROUGHT

Key water system impacts:

- Reduction in/unreliability of supply
- Changes in demand
- Unreliable revenue
- Damage to infrastructure
- Water quality degradation

Extent and costs of impacts depend on:

- Duration and severity of drought
- Utility's vulnerability: degree to which demand for water exceeds supply

Example Costs

Louisiana, 2012: \$6 million to build underwater sill to prevent saltwater from migrating inland; \$30,000 per day

Colorado, 2011: \$34.2 million to address water quality issues from wildfire-related sediment

Estimated average costs to society of a water main failure: \$1 million

DROUGHT MANAGEMENT PRACTICES: OVERVIEW

DEMAND MANAGEMENT

- **Public outreach** to encourage conservation
- **End-user conservation** by providing incentives for conservation
- **Water loss reduction** through improved maintenance of distribution systems
- **Conservation and drought pricing** to discourage excessive consumption

SUPPLY MANAGEMENT

- **Short-term supply augmentation** to provide supply during drought emergencies
- **Long-term supply augmentation** to improve water supply reliability during future droughts
- **Other supply augmentation strategies**

DETERMINING COSTS OF DROUGHT PLANNING PRACTICES

Cost data include:

- Hypothetical scenarios/modeled costs
- Case study examples from single utilities
- Aggregated utility data

Normalized to 2014 dollars

Cost data are evaluated to determine whether they are situation-specific or regionally or nationally applicable

Benefits can be uncertain and case study examples are difficult to find

DEMAND MANAGEMENT PRACTICES

PUBLIC OUTREACH

- Youth and adult education programs
- Publication and distribution of informational materials; targeting specific uses (e.g., irrigation)
- Feedback on individual uses
- Free in-home water audits/consultations

Utility	Activity	Cost (to utility)
Metropolitan Water District, CA	Radio, TV, and print media outreach to promote conservation	\$5.5M
Monterey Peninsula Water Management District, CA	“Save Water, Go Blue” customer outreach, including workshops and educational materials	\$76,216
Santa Clara Valley Water District, CA	Public outreach on water use reduction	\$1.1M

DEMAND MANAGEMENT PRACTICES

END-USER CONSERVATION

Encouraging conservation by providing incentives such as:

- Rebates for water-saving devices (e.g., washing machines)
- Xeriscaping rebates
- Payments to agricultural customers

Utility	Activity	Cost (to utility)
City of Hays, KS	Water-efficient product rebates	\$50-150/toilet; \$100/washing machine; \$300/urinal
El Paso Water Utility, TX	Replacement of lawn with gravel, cement, or desert plants	\$1/ft ² , \$11M total (since 1979)
Edwards Aquifer Authority, TX	Voluntary irrigation suspension program	\$8M anticipated during 2015 calendar year

DEMAND MANAGEMENT PRACTICES

WATER LOSS REDUCTION

Controlling water losses due to aging infrastructure.

- Utility-level water audits
- Metering
- Leak detection programs
- Reducing pressure in the distribution system

Utility	Activity	Cost (to utility)
City of Sacramento, CA	53% of customers have been metered	\$452M (as of 2014)
City of Fresno, CA	All unmetered single-family homes; resulted in 25% water reduction	\$77M (2008-2012)
Kirtland Air Force Base, NM	Leak detection survey using acoustic listening devices, estimation of the size and volume and leaks, and determine a priority order for repairs	\$649,947 (in 2006)

DEMAND MANAGEMENT PRACTICES

CONSERVATION AND DROUGHT PRICING

Using water rates to manage demand and improve efficiency.

- Rates designed to encourage efficient water use.
- Temporary drought surcharges or fines to enforce mandatory water restrictions.
- Charge different rates for different customer classes.

Location	Activity	Cost (to customer)
Lower Colorado River Authority, TX	1 year drought rate in effect	\$471 to \$546 per million gallons (starting 2015)
Santa Cruz Municipal Utility, CA	Customers assigned monthly water allotments based on account type (single-family, business/industrial, etc.)	Excessive water use penalties: \$3.34 per gallon for 10% exceedance; \$6.68 for 20% exceedance
Santa Cruz Municipal Utility, CA	Penalties for outdoor watering restrictions	1 st offense written warning; 2 nd offense \$100; 3 rd offense \$250; 4 th offense \$500

SUPPLY MANAGEMENT PRACTICES

SHORT-TERM AUGMENTATION

Augmenting supplies primarily during emergencies.

- Purchasing water
- Hauling water

Location	Activity	Cost (to utility)
Plaquemines Parish, LA	Existing supplies affected by saltwater intrusion due to drought; purchased water from New Orleans Sewage and Water Board	\$3.04/1000 gallons or \$30,000/day
El Dorado Irrigation District, CA	Trucking water from one system to another	\$0.04/gallon; \$30,160 between 9/9/14 and 10/4/14

SUPPLY MANAGEMENT PRACTICES

LONG-TERM AUGMENTATION

Augmenting supplies primarily during emergencies.

- Interconnection
- Accessing new sources; enhancing access to existing sources
- Regionalization
- Reallocation between customer types

Location	Activity	Cost (to utility)
City of West Goshen, CA	Interconnection to CA Water Service Company	\$3.05M
Lower Colorado River Authority, TX	Construction of 5 new wells and a reservoir	\$15.2M for wells; \$254M for reservoir
Southern Nevada Water Authority, NV	Construction of lowered intake to access Lake Mead's low water levels	\$830M

SUPPLY MANAGEMENT PRACTICES

OTHER SUPPLY AUGMENTATION STRATEGIES

- Reuse/recycling
- Desalination
- Cloud-seeding

Location	Activity	Cost (to utility)
Colorado River Municipal Water District, TX	Construction of a water reclamation facility	\$14.4M
City of Wichita Falls, TX	Construction of direct potable reuse plant	\$13M
City of Santa Barbara, CA	Construction of reverse osmosis desalination plant	\$63M
Las Vegas Valley Water District, NV	Groundwater recharge project that stores 104 billion gallons of water	\$987/million gallons
City of Wichita Falls, TX	Cloud seeding to increase rainfall probability by 10-15%	\$300,000

CASE STUDIES

Case Study	Key Findings
El Dorado, CA	Due to comprehensive planning and ongoing forecasting efforts, EID can anticipate and adjust to the financial variability caused by the costs of response and decreased revenue during drought.
Cobb County, GA	Despite the termination of drought restrictions in 2009, post-drought water demand and associated revenues did not rebound to pre-drought levels.
City of San Diego, CA	During the 2014 drought, the city worked collaboratively with its wholesale supplier, neighboring utilities, and the state to launch a larger, regional-level conservation outreach campaign.
Aurora Water, CO	Water management practices have led to a 20 percent decline in water use since 2002.
Denver Water, CO	Due to the utility's conservation efforts, water use has declined by 21 percent since 2002, despite a 10 percent increase in the city's population.

BASIC STEPS OF A COST BENEFIT ANALYSIS

1. Identify and measure program costs
 - Capital expenditures
 - Operating costs, e.g., labor, power, chemicals, routine maintenance
 - Other opportunity costs, e.g., foregone revenue, environmental damage
2. Identify and measure program benefits (may not have monetary value)
 - Increased revenue
 - Increased reliability of service
 - Avoided costs, e.g., importing water, loss of service, new infrastructure
3. Discount future costs and benefits and calculate the net triple bottom line impact of the program
 - Timing of costs and benefits can impact net value
 - Accounting for the impact on the environment and society, not just the utility and its customer.
4. Analyze the sensitivity of the results

COST-BENEFIT: AN EXAMPLE

Evaluate a portfolio of programs.

Compare costs and benefits and contrast with the avoided cost of purchasing water.

Look at impact on triple bottom line.

Evaluate the sensitivity of the results to the discount rate.

COST-BENEFIT: PROGRAMS CONSIDERED

Water Storage

Leak Detection/Repair
Program

Rebate Programs

Rainwater Harvesting
Program

Reclaimed Water

Desalination

Ongoing Outreach

Emergency Outreach

Commercial Conservation
Program

The Residential Retrofit
Program

Landscaping Program

Conservation Rate Design

COSTS AND BENEFITS FOR THE UTILITY

Drought Management Practice	Water Supplied or Saved (MG)	Present Value of Costs	Present Value of Benefits	Net Present Value
Water Storage (Reservoir)*	2,498	\$8,366,458	\$8,432,078	\$65,620
Leak Detection/Repair	23,880	\$4,541,983	\$95,608,044	\$91,066,061
Rebates	20,346	\$7,570,670	\$79,860,522	\$72,289,852
Rainwater Harvesting*	24	\$121,131	\$95,066	(\$26,065)
Purchase Reclaimed Water*	49,075	\$39,876,459	\$187,963,104	\$148,086,645
Build Water Reuse*	22,119	\$172,135,190	\$85,706,230	(\$86,428,960)
Purchase Desalinated Water*	3,469,537	\$2,123,156,781	\$13,286,782,005	\$11,163,625,224
Ongoing Outreach	6,096	\$760,666	\$23,346,028	\$22,585,362
Emergency Outreach	2,345	\$43,890	\$8,318,663	\$8,274,774
Commercial Conservation Measures	56,505	\$122,526	\$226,231,893	\$226,109,367
Residential Retrofit	1,894	\$78,664	\$7,040,798	\$6,962,134
Landscaping	385	\$2,681,512	\$1,298,900	(\$1,382,611)
Conservation Rates	30,358	\$152,433	\$116,259,343	\$116,106,909

*Practices providing additional water supply. The other practices conserve water.

ENVIRONMENTAL IMPACTS

Drought Management Practice	Water Supplied or Saved (MG)	Present Value of Costs	Present Value of Benefits	Net Present Value
Purchase Reclaimed Water	49,075	\$15,075,691	\$0	(\$15,075,691)
Build Water Reuse	22,119	\$3,198,908	\$0	(\$3,198,908)
Purchase Desalinated Water	3,469,537	\$56,020,675	\$0	(\$56,020,675)

SOCIAL IMPACTS

Drought Management Practice	Water Supplied or Saved (MG)	Present Value of Costs	Present Value of Benefits	Net Present Value
Rebates	N/A	\$1,395,964	\$0	(\$1,395,964)
Purchase Reclaimed Water	8,939	\$7,263,535	\$7,263,535	\$0
Build Water Reuse	19,936	\$0	\$26,780,693	\$26,780,693
Landscaping	N/A	\$759,665	\$0	(\$759,665)

OTHER IMPACTS OF DROUGHT

	Service Reliability	Employ- ment	Aware- ness	Environ- mental Sustain- ability	Implemen- tation Costs
Water Storage	●	●	●	●	●
Leak Detection/Repair	●	●	●	●	●
Rebates	●	●	●	●	●
Rainwater Harvesting	●	●	●	●	●
Purchase Reclaimed Water	●	●	●	●	●
Build Water Reuse	●	●	●	●	●
Purchase Desalinated Water	●	●	●	●	●
Ongoing Outreach	●	●	●	●	●
Emergency Outreach	●	●	●	●	●
Commercial Conservation Measures	●	●	●	●	●
Residential Retrofit	●	●	●	●	●
Landscaping	●	●	●	●	●
Conservation Rates	●	●	●	●	●

SENSITIVITY OF NET PRESENT VALUE TO THE DISCOUNT RATE

