Chapter 1. Context and Research Objectives

Urban water scarcity is an ongoing reality in California, especially, in Southern California with its arid climate and cyclical droughts. Southern California relies on upstate water imports provided by the Metropolitan Water District of Southern California (MWD) for a significant portion of its water supply. MWD also imports water from the Colorado River, conveyed through the Colorado River Aqueduct. Key to the transportation of water from the mountains in Northern California to the south is the Sacramento-San Joaquin River Delta, vulnerable to aging levees, subsidence and saltwater intrusion. In addition, the environmental deterioration of the Sacramento-San Joaquin River Delta, habitat to several endangered species, has led to ongoing restrictions on MWD water deliveries to Southern California water agencies. This has renewed efforts to both provide for the environmental improvement of the Delta ecosystem, as well as to find a solution for water conveyance, either through a canal (Lund et al. 2007), or more recently, through twin tunnels (Boxall and York 2012). In addition, the susceptibility of the Sacramento-San Joaquin River Delta to a major Bay Area earthquake[1] increases the threat of disruption of water imports for Southern California.

The reliability of water supply for Southern California is thus already precarious. Climate change impacts will further aggravate water scarcity throughout the State. According to the State's Climate Adaptation Strategy (2009), snowpack in the Sierra Nevada mountains, a major state source of water storage, is already decreasing and climate change models indicate that precipitation in the mountains will be increasingly in the form of rain, not snow. The State relies on the runoff from the snowpack in the Sierra Nevada to provide water during the warmer months from late spring to early autumn, especially for the southern part of the State. The Climate Adaptation Strategy estimates that the snowpack may be reduced from its mid-20th century average by 25-40% by 2050 (82). Climate change impacts for the State also include a 12-35 % overall decrease in precipitation by mid-century (81). This will reduce surface water volumes and groundwater recharge. In addition, there is an underlying natural variability of decadal-long droughts across the western U.S. that may also be affected by climate change impacts on the Pacific sea surface temperatures (Seager et al. 2005). Although there is no agreement among climate models how the drought cycles will be affected by climate change impacts, there is concern that fewer northerly storms—the source of winter precipitation—will reach the southwest. This underscores the urgency of developing improved strategies for water management strategies that take into account the natural hydrologic complexity and evolving behavior of the climate system.

[1] See USGS seismic risk summary: http://earthquake.usgs.gov/regional/nca/wg02/losses.php

Water Conservation Strategies

To deal with water scarcity, the State initiated in the early 1990s a voluntary urban water conservation program managed by the California Urban Water Conservation Council (CUWCC), which promoted the implementation of Best Management Practices (BMPs) to achieve more efficient water use. In response to the Governor's call for an aggressive urban water conservation plan, in 2009, state agencies with water policy responsibility developed a plan with a target of reducing urban water use through conservation measures by 20% by 2020. This target was incorporated into the 2009 Comprehensive Water Package that was passed by the California legislature in November of 2009. The Water Package (CA Dept. of Water Resources 2009a) included an $11B bond issue that was to be voted upon in the November 2010 ballot,[2] allocating several billion to fix the Delta, and funding for conservation and other water initiatives, including the development of Integrated Water Management Plans. As part of the 2009 state legislation, regional and local water districts will be required and provided incentives to enact conservation and other measures to develop "diverse regional water supply portfolios that will increase water supply reliability and reduce dependence on the Delta" (S.B. X7-7, Sect. 1, Part 2.55, Chapt. 10608 (c)).

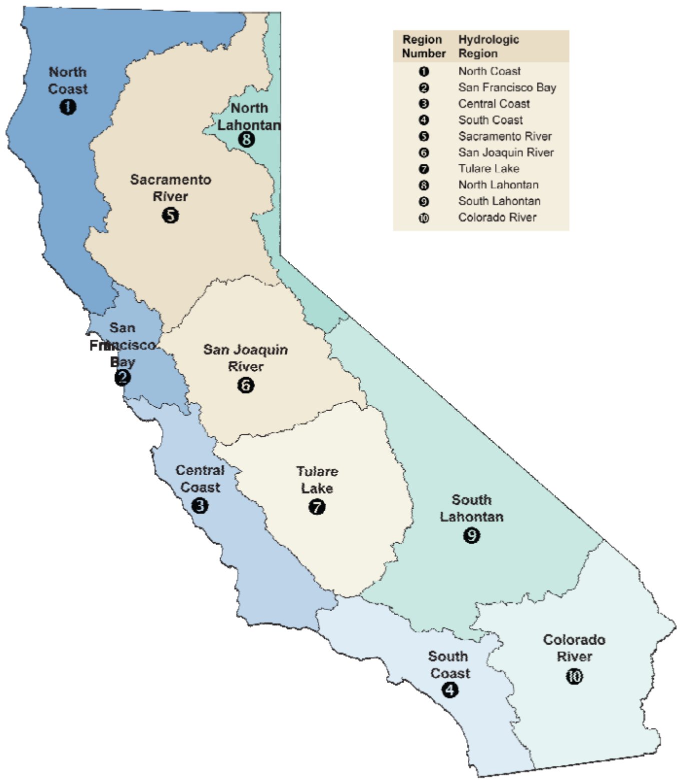
In order to set conservation targets, the 20 x2020 plan established baselines for hydrologic areas in the state. See Figure 1. The Los Angeles metropolitan region falls within the South Coast Hydrologic Region, Region 4. For Region 4, the estimated weighted average per capita per day during the period 1995-2005 was 180 gallons. This is in contrast to 154 gpcd in Region 3, and 346 gpcd in Region 10. The 20 x2020 target for our study region, Region 4, is ***149 gpcd***.[3] This is the overall target for Hydrologic Region 4. According to the legislation and the Plan, water agencies can set their own baselines to determine their specific 20% conservation target by utilizing one of four methodologies that the State identified. The baselines in the methodologies are typically based on a continuous ten or fifteen year timeline ending no later than December 31, 2004 or December 30, 2010. Most of the agencies have used either Method 1 or Method 3 to establish their baselines and associated targets. Method 2 is more complicated, the baseline is calculated based on separate indoor, outdoor, as well as commercial, industrial, and institutional budgets, while the guidelines for Method 4 had not been released by the time the 2010 UWMPs were completed. Method 1 calls for a straight-forward calculation of gross water use with some deductions for recycled, agricultural, and process water divided by the

[2] But the bond issue was removed from the November 2010 ballot, postponed to the November 2012 ballot, but on July 5, 2012 was removed again from the ballot. It is now scheduled to put on the ballot in November of 2014.

[3] This represents 17.2% instead of 20%. The State included some adjustments due to region characteristics. See 20 x 2020 Water Conservation Plan (2010), p. 28.

estimated population. Method 3 is the most straight-forward calculation, 95% of the applicable state hydrologic region target of 149, which amounts to 142 gpcd.

Figure 1.1 California Hydrologic Regions



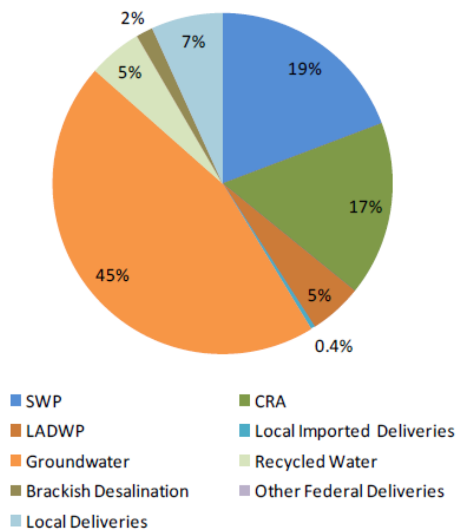
Source: 20 x 2020 Plan, p. ix.

Figure 1.2 provides some basic information on the South Coast Hydrologic Region, including its size, the various sources of supply, its population growth and the extent to which the supply meets an urban or agricultural demand. Note, in particular, the reliance of the region on imported water supplies, 17% from the Colorado River Aqueduct, 19 % from the State Water Project, and 45% from the Region's groundwater.

Figure 1.2 South Coast Hydrologic Region at a Glance

South Coast

Total Water Supply (2010)
5,408 TAF



Size:	10,925 square miles (6.9% of State)
Population Growth (2005-2030):	24%
Water Use:	Urban: 83% Agriculture: 17%
Snapshot: The South Coast Hydrologic Region comprises the southwest portion of the state and is California's most urbanized and populous region. The region has developed a diverse mix of both local and imported water supply sources. Local water resources development since 1995 has included water recycling, groundwater storage and conjunctive use, brackish water desalination, and water transfer and storage. The region imports water through the SWP, the CRA, and the Los Angeles Aqueduct through LADWP. This diverse mix of sources provides flexibility in managing supplies and resources in wet and dry years; but with huge water supply demand and heavy reliance on imports that have declined significantly in recent years due to legal and regulatory issues, the region remains in a tenuous water supply shortage situation.	

Source: GEI Consultants/Navigant Consultants (2010) Vol. 1, p.36.

In its 20 x2020 Plan, the State identifies the best management practices (BMPs) that water agencies can pursue to reduce water consumption to meet State targets. See Table 1.1 for a list of these BMPs. Notice that these BMPs include water-conserving devices such as plumbing retrofits, or water-conserving appliances, and strategies to change behavior, such as water survey programs, audits, school education programs, and retail conservation pricing. The BMPs also play a role in establishing agency baselines for meeting 20 x 2020 conservation targets. Method 4 for establishing agency baselines uses the implementation of specific BMPs to calculate water demand savings. The BMPs included are: retrofits of inefficient indoor residential fixtures, such as toilets, washers, and showers; increased efficiency in the commercial, industrial, and institutional accounts; and conversion of unmetered connections to metered connections.

Table 1.1 List of CUWCC Best Management Practices

BMP	Description
BMP 1	Water survey programs for residential customers
BMP 2	Residential plumbing retrofit
BMP 3	System water audits, leak detection and repair
BMP 4	Metering with commodity rates for all new connections and retrofit of existing unmetered connections
BMP 5	Large landscape conservation programs and incentives
BMP 6	High efficiency clothes-washing machine financial incentive program
BMP 7	Public information programs
BMP 8	School education programs
BMP 9	Conservation programs for commercial, industrial, institutional (CII) accounts
BMP 10	Wholesale agency assistance programs
BMP 11	Retail conservation pricing
BMP 12	Conservation coordinator
BMP 13	Water waste prohibition
BMP 14	Residential ultra-low-flush toilet (ULFT) replacement programs

Source: CA 20 X 2020 Water Conservation Plan (2010)

California arrived at its 20x 2020 targets for the State's hydrologic regions by assessing the extent to which the various BMPs could reduce water consumption in the regions. See Table 1. 2 for the estimated water savings that selected BMPs could provide in Region 4. While the overall reduction target for the South Coast is 36 gpcd, according to the Plan, e.g., efficient clothes washers retrofits could bring down water usage by 4 gpcd.

The State's focus on water conservation strategies makes sense, in that such strategies can reduce the need to invest in new water supply infrastructure, as well as avoid the cost of transporting and purifying water. Many of these strategies are relatively inexpensive and are considered to be the "low-hanging fruit" in water supply. Chapter 7 provides an assessment of the cost-effectiveness of several of these strategies.

Table 1.2 Selected Conservation Strategies and Estimated Savings

Selected Conservation Strategies	South Coast Region Estimated Savings in gpcd by 2020
Overall Target	31 gpcd by 2020
Codes re. to plumbing and appliance efficiency—new development	6
80% of local cost efficient BMPs, e.g., 1,2,3,9	13
Efficient clothes washers retrofits*	2
Large Landscapes (BMP 5)(meters, rate structures, restrictions)	4
Reduction of leaks (non-revenue water)	4
Residential outdoor water controllers	3
Accelerated Coverage goals, e.g., all unmetered urban connections to be converted before 2020	7
Conservation pricing (BMP 11) not estimated, but plans recommends that it be encouraged or mandated	

Source: Adapted from *CA 20 X 2020 Water Conservation Plan* (2010)

Water Supply Initiatives

Given the vulnerability of the Delta, and projected climate change impacts, it is very likely that conservation efforts will not be enough to secure reliable water supplies for Southern California. As indicated, SB X 7-7, the water efficiency act, in its preamble, enjoins water agencies to diversify their water portfolios to increase water supply reliability and reduce dependence on the Delta. Heeding the warnings, many water districts and local governments have already invested in or are actively planning water supply projects such as recycling, ocean and groundwater desalination, storm water capture and groundwater storage to increase their own sources of water supply. A recent Los Angeles Economic Development Corporation study (Freeman et al. 2008) provided estimates of the costs and potential capacity of various water projects to increase supply. Table 1.3 summarizes the results of the study. Notice that urban water conservation strategies are the cheapest strategies with a very high regional potential of saving 1,100 TAF (about 20%) out of the 5,408 TAF that the South Coast Hydrologic Region consumed in 2010. Based on the study estimates, a combination of groundwater storage, storm water capture and recycling could yield over 2,000 TAF per year, about the equivalent of MWD's imported water allocation to the South Coast Hydrologic Region in 2010.

Table 1. 3 Water Supply Initiatives, Comparison of Costs and Characteristics

Features	**Water Supply Initiatives**					
	Urban Water Conservation	Storm water Capture	Recycling	Ocean Desalination	Groundwater Desalination	Groundwater Storage
2025 Potential Regional Capacity	1,100 +TAF	150 +TAF	450 +TAF	150 + TAF	Not determined	1,500 +TAF
Typical Capital Investment	$0	$40-63 M	$480 M	$300 M	$24 M	$68-135 M
Operating Costs	$0.5 M	$1-3.5 M	$30 M	$37 M	$0.7 M	$13 M
30 year cost treated ($ per AF)	$210	$350 +	$1,000	$1,000 +	$750-1,200	$580. (includes pumping costs, treatment, purchase costs—ranging from $0 for captured runoff to $1,000 for recycled water)
Timeframe (years)	0-2	3-5	6-10	6-10	6-10	3-5
Energy Use	Embedded energy in new appliances	For treatment, but avoids energy transportation costs and GHG emissions	More extensive than for storm water treatment	Highest energy intensity of new strategies	Less than for ocean desalination	Less than for ocean desalination

Source: Adapted from Freeman et al. (2008)

Notice the focus on the energy use of the various water supply initiatives in this study. Both energy efficiency and reduction of greenhouse gases are important state objectives established in California's AB 32 Global Warming Solutions Act of 2006. The analysis of energy and emissions intensity of current water supply strategies is the subject of Chapter 9.

Study Objectives

The first objective of this study was to determine the ability of water conservation strategies, which urban water districts in Southern California have been implementing, to meet State targets. In addition, we sought to examine the extent to which innovative strategies can address, if expanded, greater water scarcity under climate change. To assess how these strategies are working, we studied three cases in the LA metropolitan area, the Los Angeles Department of Water and Power, the Cucamonga Valley Water District and its wholesaler, the Inland Empire Utilities Agency, and Huntington Beach and the regional districts on which it relies, the Municipal Water District of Orange County, and the Orange County Water District. These three agencies receive State water imports through the MWD. Although these agencies vary in terms of their own water resources, customer base, and other characteristics, they have implemented many water conservation strategies (California Urban Water Conservation Council 2008). In addition, these agencies have also implemented or are planning a range of strategies to increase water supply, including purifying recycled water to drinking water standards, and desalination plants. The three cases enabled us to study institutional, demographic/economic, land use, natural and infrastructure factors that shape the plans, and to assess the potential of the strategies used to maintain reliable water supplies in the face of growing scarcity.

Secondly, we analyzed the cost-effectiveness of the conservation strategies and their capacity to meet 20 x 2020 targets and beyond. With respect to the new supply strategies, we relied on recent studies to identify their relative costs, and focused on conducting an energy and greenhouse gas emissions analysis of several current water supply strategies and compared these to imported water sources, including those from the State Water Project in Northern California. Water imports require conveyance over long distances, and therefore incur energy costs. As a result, because of the energy sources that power our electricity mix, these imported water sources are an indirect source of greenhouse gas emissions.

The final objective of the study was to identify the strategies that decision makers from the agencies studied judge to be the most robust strategies across multiple future scenarios that incorporate climate change and other major drivers. To accomplish this, we used scenario planning methodology, widely used in strategic planning and future studies. This methodology enabled us to engage decision-makers in a thought process to elicit their expert judgment on conditions in mid-century. The process developed plausible water future scenarios, which were then used to assess the feasibility of a broad range of water supply strategies.

Report Organization

Chapter 2 discusses the complex institutional framework for local water agencies, including the federal, state, and regional context for Southern California. This is followed by the three case studies, Los Angeles Department of Water and Power, the Cucamonga Valley Water District, and Huntington Beach (Chapters 3-5). Chapter 6 provides a comparison of the case studies and identifies several cross-cutting issues that emerged from them.

Chapter 7 analyzes the cost-effectiveness of water conservation strategies that we conducted for LADWP and CVWD using methodology developed by CUWCC. Chapter 8 discusses the saturation rate of selected BMPs in the light of Federal and state standards and statutes to assess the extent to which water agencies can meet their 20 x 2020 targets, and to assess the conservation potential of BMPs beyond 2020. This is followed by Chapter 9 which provides a spatially-explicit life-cycle assessment of LADWP's and IEUA's current urban water supply strategies including both energy-intensity and GHG emissions calculations.

The next three chapters focuses on the scenario planning workshops we conducted. Chapter 10 provides a review of recent research on the impacts of climate change on water resources in California. The review was conducted to guide in the preparation of the scenario planning workshops. Chapter 11 serves as an introduction to scenario planning. Chapter 12 focuses on the Scenario Planning Workshops we conducted in the summer of 2012, summarizing the approach taken, the preparation for the workshops, stakeholder involvement, and the results of the workshop.

A concluding chapter highlights policy issues raised by the study and presents recommendations.

A section on finding concludes each chapter. References and appendixes follow each chapter.

References

Boxall, B. and A. York. 2012. "Gov. Brown pushes $23-billion plan to tunnel under delta*". Los Angeles Times*. July 26, 2012. http://articles.latimes.com/2012/jul/26/local/la-me-water-tunnel-20120726

Climate Action Team 2009a. *Draft Climate Action Assessment Report.* March 2009. http://www.energy.ca.gov/2009publications/CAT-1000-2009-003/CAT-1000-2009-003-D.PDF

Climate Action Team 2009b. Water Sector Summary and Analysis. Subgroup Reports supporting AB 32 Scoping Plan. Updated 3/4/2009. http://www.climatechange.ca.gov/climate_action_team/reports/CAT_subgroup_reports/Water_Sector_Summary_and_Analyses.pdf

California Department of Water Resources. 2009a. 2009 *Comprehensive Water Package. Special Session Policy Bills and Bond Summary.* November 2009.

California Department of Water Resources. 2009b. *California Water Plan Update 2009*. Pre-Final Draft. October 7, 2009. http://www.waterplan.water.ca.gov/cwpu2009/index.cfm

California Department of Water Resources et al. 2010. *20×2020 Water Conservation Plan*. Feb. 2010.

California Urban Water Conservation Council. 2008. A Report on Potential Best Management Practices, Annual Report 2008.

California Water Resources Agency. 2009. *California Climate Adaptation Strategy (CAS).* A Report to the Governor of the State of California in response to Executive Order S-13-2008.

Freeman, G. M. Poghosyan, and M. Lee. (2008) *Where will we get the water?Assessing Southern California's Future Water Strategies.* Los Angeles: Economic Development Corporation.

GEI Consultants/Navigant Consulting, Inc. 2010. Embedded Energy in Water Studies. Study 1: Statewide and Regional Water-Energy Relationship. California Public Utilities Commission, Energy Division. ftp://ftp.cpuc.ca.gov/gopher-data/energy%20efficiency/Water%20Studies%201/Study%201%20-%20FINAL.pdf

Lund, J., E. Hanak, et al. 2007. *Envisioning Futures for the Sacramento-San Joaquin River Delta.* San Francisco: Public Policy Institute of California.

Seager, R., Y. Kushnir, C. Herweijer, et al. 2005. Modeling of tropical forcing of persistent droughts and pluvials over western North America: 1856-2000. *Journal of Climate*. 18(19): 4065-4088.

State of California. 2008. Chapter 728. S.B. 375 Chaptered 9/30/2008. Accessed at the website of Find California Statutes on July 1, 2009: http://www.leginfo.ca.gov/cgi-bin/statquery

State of California. 2009. Senate Bill No. 7, Sect. 1, Part 2.55, Chapt. 10608 (c). Nov. 10, 2009.