



Water Management in Los Angeles

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Water Management in Los Angeles County; a Research Report

Fall 2015

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Water Management in Los Angeles County

A Research Report to the Haynes Foundation

Fall 2015

Introduction

Over the past four years, California has grappled with a deep drought. Snow pack was at its lowest in 300 years. In certain parts of the state, water no longer flows from household taps, while in others, the ground is sinking from overpumping of groundwater reserves. Aging urban water infrastructure is causing important water losses from chronic disrepair and acute pipe failures, even as farmers and urban residents are mandated to cut water use. Across the state, water moves over far distances through highly engineered systems that were designed based on significant snowpack and rainfall from a wetter climate. As water scarcity increases from droughts and population growth, the state is struggling to revamp the complex system of water management to deal with challenges of the 21st century.

California's water management system is highly decentralized and complex, made up of thousands of actors that act in largely uncoordinated ways. The majority of decision-making power for water-related issues lies at the local level. Local water suppliers interface with regional and state agencies to obtain imported water and meet environmental regulations, responding to available rainfall, legislative developments, and prices with policies that aim to maintain reliable water for the customers.

Los Angeles replicates this statewide system at a regional scale. Our research examined gaps, overlaps, inefficiencies and successes in the current water management system of LA County to help the region advance goals of Integrated Regional Water Management. Undertaking a thorough analysis of the region's supply, distribution, groundwater, and water data infrastructure systems establishes the groundwork for a deeper analysis to create a truly integrated, resilient water management system for the region. This research also provides the first comprehensive picture of the current water system in Los Angeles County, comprised of an enormously complex network of institutions and infrastructure that is opaque even to managers. While the analysis is grounded in southern California, water management in the state is equally fragmented and poorly mapped. As concerns emerge, including budget shortfalls, climate change, and population growth, policy measures must promote new technologies, institutional reforms, and collaboration that evolves the current system to meet future challenges.

This report analyzes some of the ways the state of California and local water entities can achieve this goal.

Research Objectives

In 2012, the Haynes Foundation awarded the California Center for Sustainable Communities (CCSC) at UCLA a multi-year grant to research the water management and supply system in Los Angeles County. This research was designed to assess the capacity of the current water system to meet the region's 21st century needs, given climate change, drought and the state's growing population, with a particular focus on informing water agencies, state and city lawmakers, and other stakeholders. Researchers also received concurrent grants from the National Science Foundation Grant in the Water Sustainability and Climate program and the California Resources Legacy Fund (via the California Water Foundation), which further supplemented Haynes funding. This report presents work conducted under the conjoined research grants.

The project established the following research objectives:

- **To understand the complex management of water in the region:**
Over the period of 18 months, researchers assembled the architecture of water management in the County, using multiple data sources ranging from the Los Angeles County Local Agency Formation Commission to the Department of Water Resources, the Public Utilities Commission to the State Water Board. We developed a comprehensive database of the county's water delivery system and its retailing agencies, including shape files of all water delivering entities. The database is supporting development of a dynamic visualization and mapping platform as part of the LA Water Hub (<http://waterhub.ucla.edu>), an online data repository for viewing and finding water-related information in Los Angeles County.
- **To understand the complex governance organization of water management structural obstacles to integrated water management.** Researchers characterized the different types of water delivering entities, including their governance structure, board membership (appointed or elected), popularly elected officials, oversight by Public Utilities Commission, and voting procedures. Further, whether a city is a charter city or general law city also influences management decisions. Each individual utility is now categorized according to these typologies. The analysis quantified the number of entities that exist, with some especially vulnerable small entities that lack capacity to maintain their infrastructure, ensure water quality and respond to the needs of their customers.
- **Groundwater management of the 7 adjudicated groundwater basins in the region and their role in the water supply system.** Researchers investigated how the adjudicated groundwater basins contribute to the region's water supplies and under what conditions. Each basin is separately adjudicated with specific rights holders and management rules. Each depends on imports from the Metropolitan Water District to maintain an 'operating safe yield,' which is the volume of water that can be pumped given both natural (rainfall) and artificial

(spreading basins) recharge. Many basins have capacity for additional infiltration, but in some cases the adjudications prevent the use of this capacity and regulate who has extraction rights. Groundwater basins are a resource that will likely become more central to water resilience in the county, but the governance will need legal and managerial reform to achieve this goal.

- **To propose policy changes to the regional water management system focused on addressing the needs of the 21st century.** The management of water is an artifact of an earlier period of government creation. Today's needs are different. This research aimed to develop a new framework that addresses the needs for greater water reliability and sustainability within a context of limited governmental and budget resources. Our findings will help examine integrated water management agencies and potential avenues for policy reform. From this analysis, researchers will estimate potential costs and the potential for water supply augmentation from alternative kinds of infrastructure on a large scale.

The following four chapters summarize the findings of this research conducted by CCSC and the UCLA Water Resources Group. Research on water management structures is often overshadowed by technical analysis to increase water supply, and as a result, the organizational structure remains poorly understood. This report presents a comprehensive analysis of these structures in order to develop a more complete understanding of the complex water governance regimes in Southern California. The aim of this research is to facilitate the state's efforts in building more integrated water management systems. The four chapters examine: 1) Los Angeles County's potable water supply management system; 2) LA County's groundwater management system; 3) water loss and infrastructure leakage in LA County territory; and 4) LA County water suppliers data infrastructure. The report ends with conclusions and policy recommendations based on our findings.

1) LA County's Potable Water Management Supply and Distribution Systems

Ref: Pincetl, S., Porse E., Cheng D. (2015) "Fragmented Flows: Water Security, Equity, and the Politics of Governance in Los Angeles County". under review

The governance system that oversees the distribution, management and conservation of potable water in Los Angeles County is complex and opaque. Presently, **nearly 100 public and private entities are involved in the management of potable water** supplies in the region—a system born out of a history of fragmented water rights and governance regimes following rapid urban expansion. These suppliers include cities, special districts, Investor Owned Utilities (IOUs), and Municipal Water Districts (MWDs). Each of these has different access to water from different sources, while also having varying roles, regulations, jurisdictions and management structures. Researchers at CCSC developed a typology of water management institutions in Los Angeles County to understand how the system functions, its rules and constraints, its resilience and adaptability to stressors, existing gaps and overlaps in service provisions, and opportunities for improvements.

Findings:

The urban water management system in LA County is divided into **three types of water suppliers**: contractors, which receive annual allocations of imported water from the State Water Project and Colorado River authorities; wholesalers, which purchase and resell water from contractors or other wholesalers; and retailers, which sell water directly to residential, commercial, industrial, and agricultural customers. Researchers at CCSC have developed a comprehensive database of these different suppliers depicting their connections and functions, as well as their scale, role, size and management structures. The basic types of water supply organizations and selected associated descriptive attributes are listed in Table 1 (below). Additionally, Figure 1 below maps the territories of the region's suppliers.

The region's two contractors (Figure 1 top) are the Metropolitan Water District (MWD), which supplies imported water to 26 member agencies across six counties, and the San Gabriel Valley Municipal Water District, which has four member agencies in the area. In most cases, these contractors sell imported water to wholesalers in the region, who then resell this water to retailers. In certain areas, however, contractors may sell water directly to retailers—certain municipalities purchase water directly from the MWD—or water may move through two different wholesalers before reaching a retailer. There is also variation in water sources, as some retailers pump groundwater or use recycled water for non-potable demands.

Figure 2 (below) illustrates the total L.A. water management system linking the LA Aqueduct and MWD's aqueducts to water suppliers.

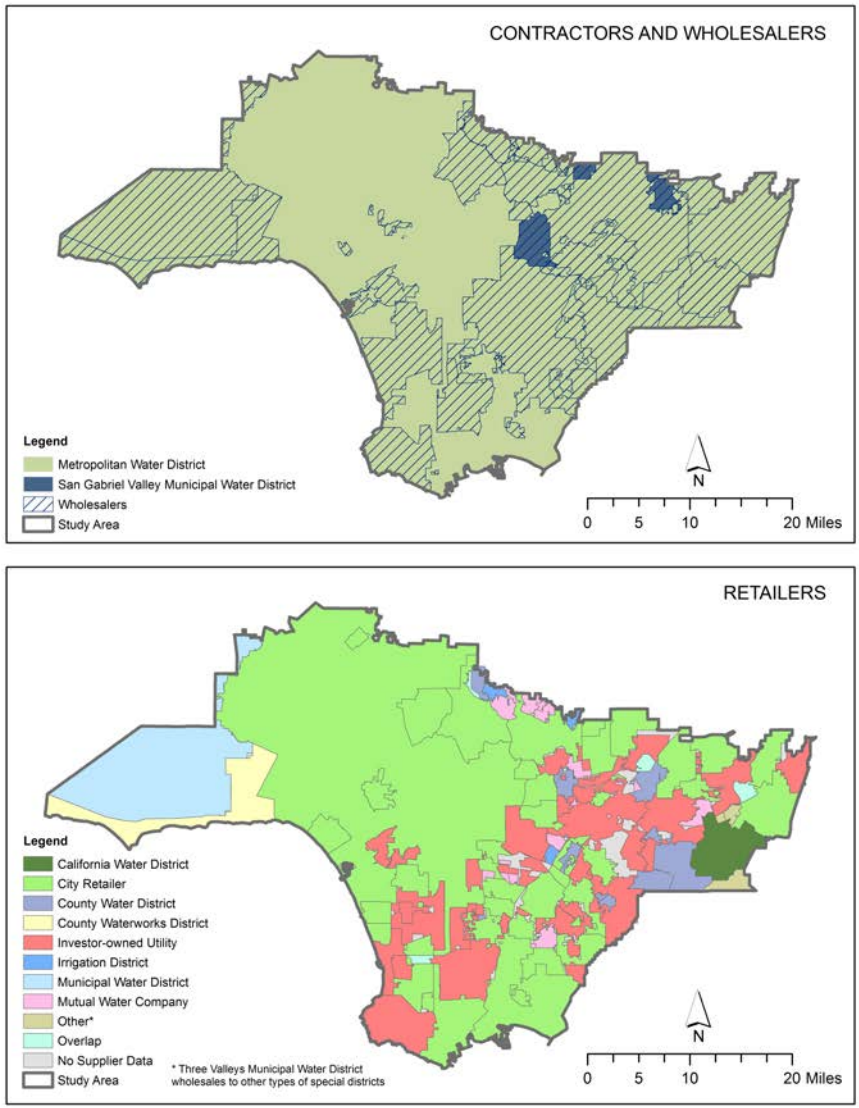


Figure 2. Water contractors, wholesalers, and retailers.

Figure 1: Mapping water contractors and wholesalers (top) and retailers (bottom) in L.A. County

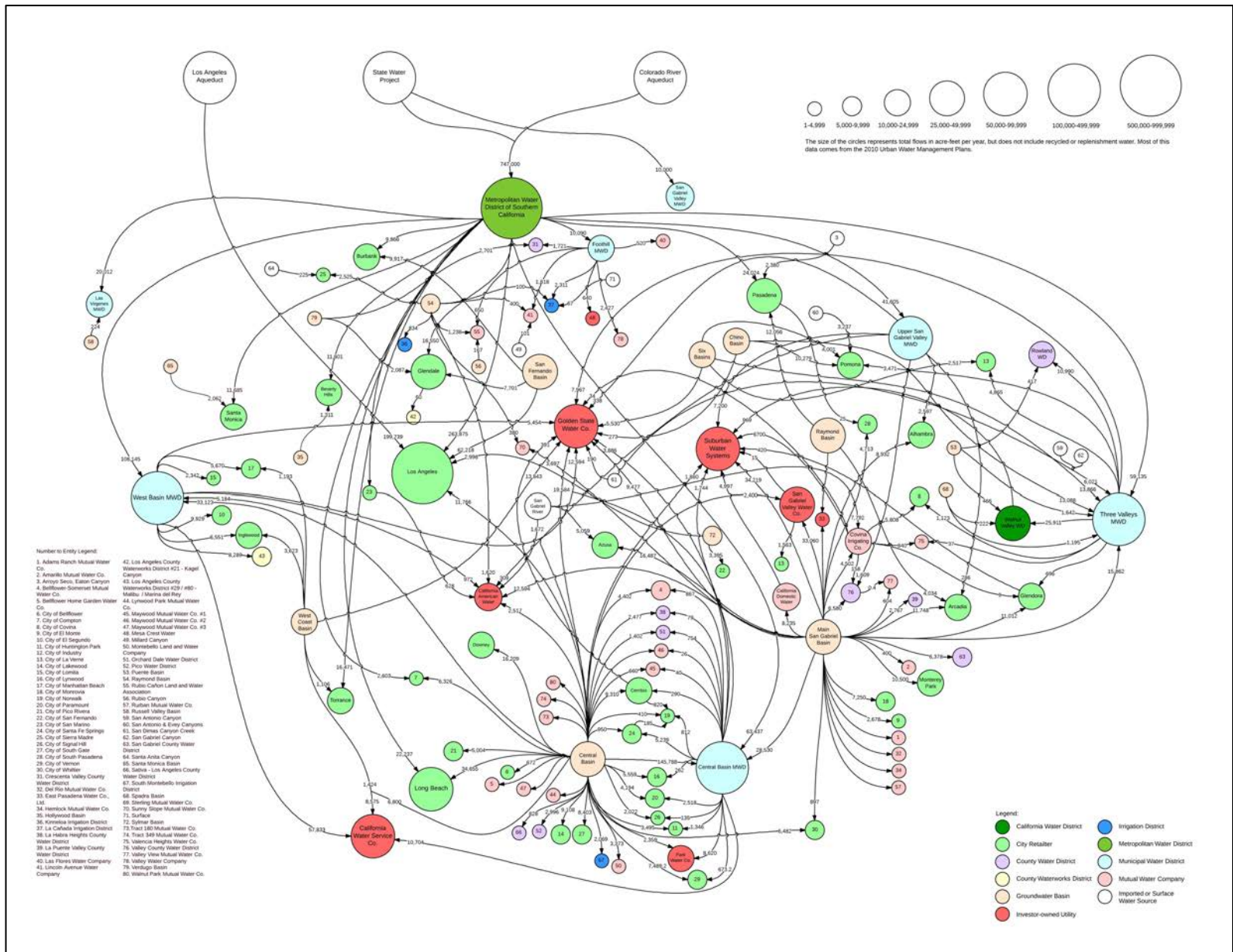


Figure 2: Flowchart of potable water suppliers (contractors, wholesalers, and retailers) in Southern L.A. County

This system is further complicated by unclear service area boundaries for suppliers. Specifically, our research finds that **the boundaries for a number of mutual water companies are unclear**. Their reporting of boundaries involves low-resolution (sometimes hand-drawn) maps that do not allow for detailed understandings of boundaries. We found this to be the case despite efforts such as AB 240 (Rendon), passed in 2013, requiring mutual water companies to report boundary information to a county-level agency, the Local Agency Formation Commission (LAFCO). CCSC researchers found that information for many mutual water companies was insufficient, incomplete or non-existent, and LAFCO lacked the capacity to collect data and enforce rules.

The situation of Mutual Water Companies illustrates one of the fundamental issues within this region's complex water management system: the **lack of standardized, accessible, well-maintained and centralized data** for these many entities. There is no government agency in charge of maintaining this information in a central repository. This is due, in part, to governance rules for specific types of water entities. For instance, private water utilities report to the Public Utilities Commission in San Francisco, which oversees rate setting, safety and infrastructure investment. Mutual Water Companies are private, non-profit companies that register with the Department of Corporations. Elected boards run the MWCs, comprised of property owners from within the MWC's territory. Further, public utilities can be city utilities or special districts, each subject to their chartering laws. Thus, they may have appointed or elected boards. City water utilities may be a department run by a director, or a separate city entity run by an appointed board. Others like County Water Districts may be run by appointed officials. The many types of water utility creates an opaque and impenetrable system in need of a central data base that locates and classifies the different types of entities. Table 1 further details these organizational types.

Tasking an agency (regional or state) with the authority and resources to collect, maintain, and publish this information is an important first step to deciphering the complex governance of water delivery in the region.

Second, documenting the system's management architecture provides a core framework for collecting and tracking standardized records, such as water use over time. At present, few truly comparable data sources are available for key metrics of water consumption, supply, water quality, and sources. A centralized and well-maintained database would provide a platform for comparing across agencies as well as broader systems analysis, both of which can strengthen management options. Chapter 4 of this report will provide a more in-depth analysis on water supplier boundary data in Los Angeles County (Cope and Pincetl 2014).

Additionally, in Los Angeles County, **no agency is tasked with overseeing all of these suppliers**. The system is comprised of many different types of agencies with varying organizational structures and no systematic reporting or regulatory framework. This results in a **lack of supervision, transparency and accountability** in the system, which can lead to uneven and **inadequate understandings of water quality, distribution and service provision** according to our analysis. For example, in order to track current and future water conditions in their service areas, urban water suppliers must submit Urban Water Management Plans (UWMPs) to the Department of Water Resources (DWR) every five years. However, in the past, DWR has not acted to approve plans, instead opting to catalogue them after assuring the presence of requisite

sections. Most UWMPs rely on past assumptions of water deliveries rather than adequately projecting for future risks to supplies such as scarcity. In addition, the plans do not address key information. For instance, plans do not consider changes in water demand from conservation (beyond currently mandated measures), potential in supply sources from water efficiency improvements, or the effects of well-estimated population growth and land expansion on water demand. Meanwhile, smaller suppliers that provide less than 3000 acre-feet of water or serve fewer than 3000 connections are not required to provide these plans at all, creating further gaps in knowledge. Some other counties do provide more support for and oversight of water retailers. For instance, in Santa Barbara County, the county water agency oversees water purveyors (retailers) and administers countywide water planning initiatives, such as modeling efforts.

Results and Recommendations

The CCSC finds two overarching problems in Los Angeles County's present water supply and management system. The first concerns the question of the region's "**water security**" defined by Grey and Sadoff (2007) as "the availability of an acceptable quantity and quality of water for health, livelihoods, ecosystems and production, coupled with an acceptable level of water-related risks to people, environments and economies." **Knowledge gaps, resulting from inadequate data reporting of information across the system, create vulnerabilities.** Until now, the system has proven quite resilient in providing reliable water supplies to a majority of households even during droughts. However, **the lack of coordination and oversight will likely impair cost-effective changes that will be needed if L.A. water supply management is to adapt to growing threats such as climate change and the drought worsen.**

Second, such a fragmented system can lead to **uneven water provision**, as each of the nearly 100 retailers set their own prices and drought-related policies. Our research finds that water rates vary widely among retailers throughout Los Angeles, ranging **from \$20 to \$131 for a single-family home using an average amount of water** (Figure 3). Private water companies (Investor Owned Utilities) tend to charge more than city retailers and mutual water companies, while special district rates vary considerably. However, IOUs are also the only suppliers that are required by the CPUC to maintain lifeline rates for low-income customers.

Questions also arise regarding water restrictions brought on by the drought – and more specifically the people that droughts affect. In a previous study on residential water use in the city of Los Angeles, CCSC found that more affluent households conserve less water than low-income consumers under voluntary and mandatory restrictions (Mini, Hogue, and Pincetl 2014). Thus, across the board water use reductions, mandated by the state, may disproportionately impact those who are less affluent. More consistent analysis of water use and rates by customers and customer classes over time can help water rate and restriction policies that consider equity implications of water conservation. Recent drought reporting of per capita use, which was only standardized in mid-2015, is the only such marker for comparing across large retailers.

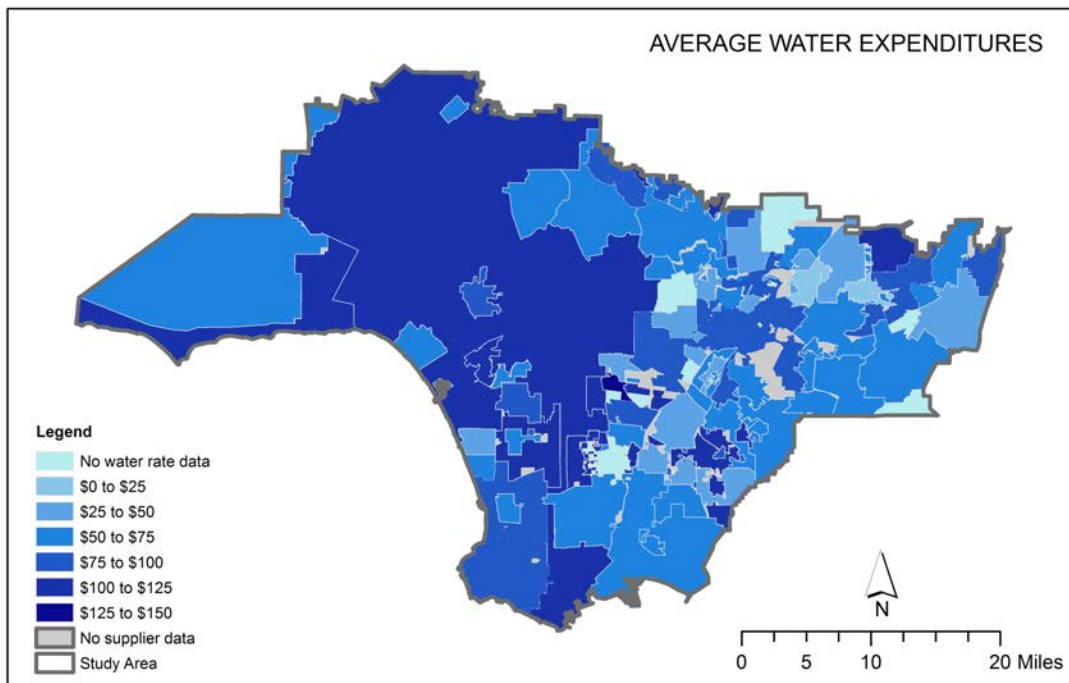


Figure 3: Average water expenditures, based on 2013 rates for a residential consumer having an estimated 3/4-inch pipe diameter.

TOWARDS GREATER INTEGRATED MANAGEMENT

Despite being highly fragmented and complex, the present system is not completely chaotic. In fact, the system has proven flexible and adaptive over time. For instance, following severe droughts in the late 1980's and early 1990's, the Metropolitan Water District built additional surface water storage capacity and negotiated agreements for new water supplies, helping maintain reliable supplies and preventing the early need for conservation measures during the recent multi-year drought. Agencies have also negotiated new agreements for increasing recharge sources for storage in groundwater basins.

Oversight and collaboration have also evolved over time. There are many regional water collaboration practices in place among wholesalers and their member agencies. Yet regional agencies have done little in the way of increasing the region's capacity to better tackle climate change impacts and waning water resources (Bollens 2008). Instead, agencies have met water demands despite intermittent supplies using **informal and formal agreements for water purchasing to transfer available water across jurisdictions**. While LA County region has Integrated Regional Water Management Plans for its watersheds, previous CCSC research demonstrates that **incentives for collaborating across watersheds are weak and large water suppliers are often the most powerful and active entities, supplanting smaller actors** (Hughes and Pincetl 2014).

Our analysis demonstrates that **there are significant structural obstacles for greater water resilience. Water is delivered by a myriad of separate water utilities, each**

with their own territory, governance system, infrastructure and water pricing.

Using more local water, the concept of *local water reliance*, will require reconfiguring the current system of imports and exports to one that increases available recycled water.

Yet, **fiscal barriers exist to expanding direct and indirect potable reuse of water.** In particular, available funding is closely related to demand for recycled water. Sanitation departments or districts primarily provide wastewater for reuse, which is processed in plants managed by themselves or other special districts such as the Water Replenishment District of Southern California, and then sold to water supply agencies.

Linking funding sources for recycled water more directly can help eliminate fiscal challenges for producing more recycled water. As in other parts of the system, fragmentation constrains funding options.

Additionally, transforming the system to use more local water resources and integrating conjunctive management of surface and groundwater will necessitate important organizational changes. **The present system of adjudicated groundwater basins reduces incentives for many agencies to infiltrate and store water in various basins by capping storage rights.** The adjudications also deter new entrants from gaining pumping rights in basins, as entities without groundwater rights in a basin must purchase or lease pumping rights from established entities with rights. Further, the fiscal health of water supply agencies is predicated on the sale of imported water. Water retailers must continue selling water to pay for current and future infrastructure needs. Water supply entities will have to retool their internal management systems in order to compensate for lost revenues as a result of decreased imported water sales. This is especially difficult for public agencies where elected officials face tough popular challenges to proposed rate increases. The recent application of Proposition 218, which requires a strong link between rate increases and cost of water supply, further limits local agency flexibility to invest in diversified water supply sources.

This research makes a meaningful step towards fully interrogating the efficiency of the present water governance and management system. In the following section, we similarly explore the region's groundwater system to begin bridging these largely disconnected water supply systems.

Type of supplier	Scale	Role	Description	Number	Governance structure
Metropolitan water district	Several counties	Contractor	Special district that contracts water from the State Water Project and Colorado River Aqueduct, then sells to member agencies. Established through the Metropolitan Water District Act of 1927.	1	37 directors appointed by member agencies. Each member has at least one representative, with additional representatives based on each agency's assessed valuation.
Municipal water district	Several cities	Contractor, wholesaler, retailer	Special district that typically wholesales water to member agencies. Established through the Municipal Water District Laws of 1911 and 1935.	7	5 to 7 directors elected by registered voters. Each director represents a division.
City retailer	City, portion of city	Wholesaler, retailer	Publicly-owned utility. Serves some or all consumers within city limits (and sometimes beyond).	41	5 to 7 City Council members elected by city residents, or Commissioners appointed by the Mayor and/or the City Council.
Investor-owned utility	City, portion of city	Retailer	Private company that sells water for profit. Some IOUs are part of multinational corporations, and most are publicly-traded. The California Public Utilities Commission regulates operations and rates of return.	8	9 to 11 directors elected by corporate stockholders.
Mutual water company	Portion of city	Wholesaler, retailer	Private, non-profit company. Must submit basic company information to the California Department of Corporations.	25	5 to 7 directors elected by shareholders. Shares are often based on the amount or value of land owned, restricting the vote to property owners.
County water district	City, portion of city	Retailer	Special district. Established through the County Water District Law of 1913.	9	5 directors elected by registered voters.
County waterworks district	City, portion of city	Wholesaler, retailer	Special district. Established through the County Waterworks District Law of 1913 (originally County Irrigation District). Initially served unincorporated areas.	2	5-member County board of supervisors elected by registered voters. The LA County Department of Public Works manages the system.
California water district (or water district)	City, portion of city	Wholesaler, retailer	Special district. Established through the California Water District Law of 1913.	1	5 directors elected by registered voters (originally voting was based on the assessed value of land).
Irrigation district	Portion of city	Retailer	Special district originally formed to serve agricultural land. Established through the Irrigation District Law of 1897.	3	5 directors elected by registered voters.

Table 1: A typology of water suppliers in Los Angeles County (Department of Water Resources 1994; Green 2007). These suppliers also exist throughout California, but roles and governance structures may vary slightly across the state. Retailer jurisdictions may overlap city boundaries and may also include unincorporated area

2) Los Angeles County Groundwater Basins

Ref: Porse E., Glickfeld M., Mertan, K., Pincetl, S. (2015). Pumping for the masses: evolution of groundwater management in metropolitan Los Angeles. GeoJournal. doi: 0.1007/s10708-015-9664-0

Groundwater is an essential water source in Southern California. Many cities in the region use groundwater to meet significant percentages of total demands, sometimes up to nearly 100 percent. Recognizing the threats of depleted basins and sea water intrusion, groundwater pumpers in the several ground water basins organized to regulate pumping and develop long-term resource preservation plans for the aquifers as early as 1949. They codified the details of these plans in court-approved “adjudications.” Imported water from the Metropolitan Water District was essential in helping users agree to curtailed pumping regimes, albeit with pumping levels that still exceeded the natural volume of groundwater recharge.

Today, water scarcity, climate change, and population growth are straining the availability of water imports to supplant or recharge L.A. groundwater basins. This has spurred renewed interest in using groundwater basins as flexible, inexpensive storage zones for new water supplies from recycling or stormwater capture. While already actively managed, many future water use schemes in the region focus on greater conjunctive use of surface water and groundwater, taking surface water when available (winter) and more effectively infiltrating it to groundwater basins and increasing the use of recycled water to enhance supply as well. Reducing impervious surfaces in L.A. through green infrastructure is another strategy being pursued as small scales to help promote more effective recharge.

Groundwater basins can be cost-effective sources for local drinking, agricultural and industrial uses, as well as natural areas for storing water. With the passage of the Sustainable Groundwater Management Act in September 2014, groundwater use in the state of California will be regulated for the first time in its history. The law will provide local and regional agencies with the necessary resources and authority to create sustainable groundwater management plans that reflect local needs and contexts. In this way, the state aims to protect groundwater resources and prevent overdraft, subsidence and contamination and other risks currently threatening California’s aquifers. With many basins already having long-term management plans in place, Southern California has been a leader in the state for groundwater management. Yet, even with these forward-thinking policies, many groundwater basins in the metropolitan area are highly contaminated with plumes of toxic pollutants. Moreover, the system of coastal injection wells that prevent seawater from infiltrating into valuable coastal freshwater basins is threatened by sea level rise from climate change.

The ability of groundwater management institutions to respond to these future challenges is an open question. First, however, we examined the current system to understand its origins, characterize changes over time, and identify vulnerabilities to future challenges. Our research examined the intricate array of public and private organizations involved in groundwater management in the Los Angeles region. The goal of this research is to map the complexity of the system, understand how it has evolved over time, identify trends in the allocation of rights and consider how the current system may function in future water management regimes.

A) Complex, polycentric groundwater management system

Groundwater comprises about 35% of the Los Angeles County's total water supply (as of 2010). This percentage varies from city to city. The number of distinct groundwater basins in the region is not entirely agreed upon—our study focuses on the 23 basins south of the Angeles and San Bernardino National Forests recognized by the LA County Department of Public Works (LADPW). Of these, five judgments cover single adjudicated basins (Central, West Coast, Puente, Main San Gabriel, and Raymond) and two judgments adjudicate multiple basins and sub-basins (ULARA and Six Basins) (see Figure 4). Southern California water basins were the first in the state to develop these legally binding agreements, dividing rights to individual users for pumping water. The adjudicated groundwater basins are managed by groundwater masters that allocate and record extractions.

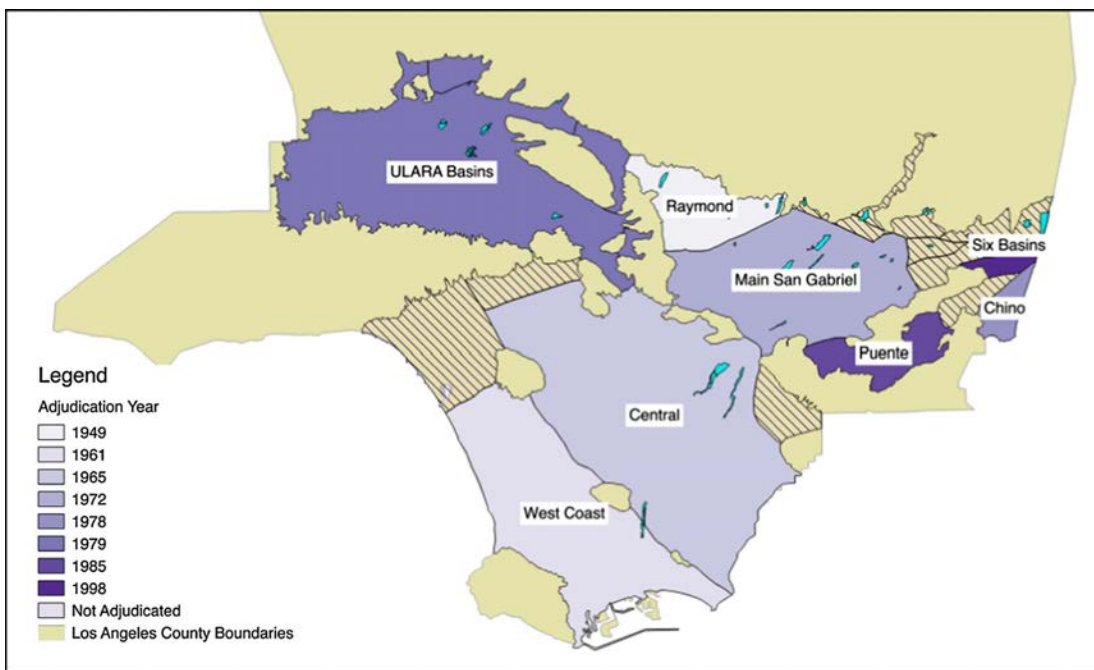


Figure 4: Groundwater basins of Southern Los Angeles County. Lighter colors indicate earlier finalized judgments. Chino Basin, which lies only partially within the county, was not included in the analysis. The map shows physical boundaries of the basins (source: LADPW), which differs from adjudicated boundaries for some basins, such as for the West Coast and Central Basins. LA County maps are based on even more detailed Bulletin 118 data from the California Department of Water Resources

Accumulated adjudications in metropolitan Los Angeles have reinforced a fragmented system of water supply and distribution, where municipalities, investor-owned utilities, non-profit mutual water companies, private water supply companies and many types of special districts and private pumpers all hold groundwater rights. Yet, long-term trends reveal that groundwater rights have also come under greater control of public agencies. The entities function within an elaborate management system and an intricate set of rules and regulations to manage pumping rights, coordinate among basins and conduct water transfers. Figure 5 (below) visually illustrates the number of entities across different types with rights to pump groundwater, while Table 2 below details the number

of pumper in each basin. Figure 5 illustrates that majority of organizations with rights in groundwater basins are cities (in red) of which there are 45 in the region with rights and 22 without pumping rights.

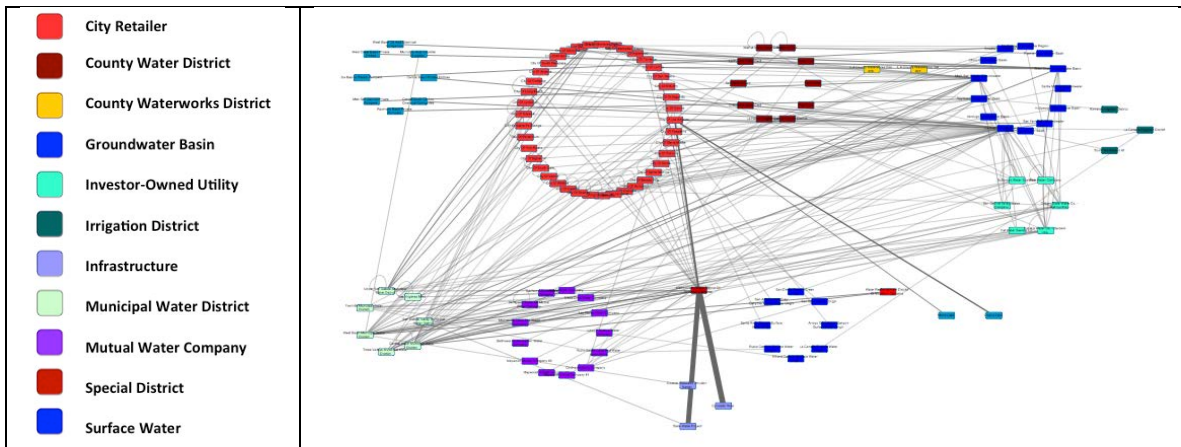


Figure 5: The network of groundwater retailers, basins and infrastructure in the Los Angeles County region (2014)

This management system, developed through successive and overlapping judgments, has created a wide range of access to and reliance on groundwater basins in the region. Figure 6 illustrates the range of access by Southern Los Angeles County retailers to groundwater, ranging from 0% of total supply in Covina and El Segundo, to nearly 100% in El Monte and Monterey Park (Figure 6a). Moreover, per capita groundwater rights (gallons/person/day) also vary widely among cities. The historical allocation of rights, which does not align with population density or environmental water availability, is likely insufficient for future water management.

Our analysis finds that **retailers in the coastal plain often rely more on imported water, while upper basin retailers in the Main San Gabriel and Raymond basins receive significant groundwater supplies** (Figure 6a). For instance, Beverly Hills and Manhattan Beach received 10 and 16 percent of their 2010 water supplies from groundwater, while Alhambra and Azusa received 77 and 76 percent from groundwater. Yet, the trend is not consistent. For instance, Long Beach, which was an early instigator for groundwater adjudications in the region, met 53% of 2010 demands from groundwater resources. Meanwhile, groundwater only represents around 14% (or 76,982 ac-ft/year, not counting rights to incidental recharge) of the overall water supply of the city of Los Angeles, the largest groundwater rights holder in the region (LADWP 2010), due to groundwater contamination. Many of the upper basin groundwater pumpers maintain aquifer levels by importing and infiltrating water from MWD. As a region, groundwater basins are linked. Adjudications had to specify guaranteed sub-surface flows that move from the Upper Basins to the Lower Basins as water drains from the mountains to the sea.

Groundwater rights are critical for future water management schemes that seek to infiltrate stormwater for storage and later use. In L.A. County, **45 of the 67 incorporated cities have pumping rights and, as such, groundwater storage rights**. Of these, **per capita rights ranged from 353 gallons/person/day (gpd) in the City of Commerce to 1.3 gpd in the City of Artesia**. **The majority of these cities (28) have rights of less than 100 gpd, while 12 cities have rights to less than 22 gpd, including the City of**

Los Angeles (15 gpd).

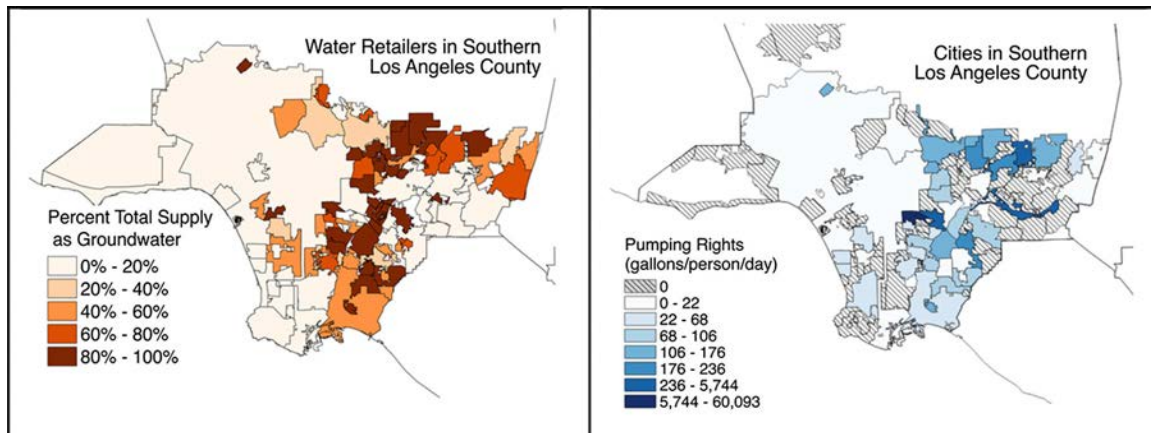


Fig. 6: a) Percent of water supply as groundwater for water retailers in Southern Los Angeles County (left), and b) per capita adjudicated groundwater rights (gallons/person/day) for incorporated cities in Southern Los Angeles County. Note that some cities pump groundwater in non-adjudicated basins, which is not included here

For the one-third of cities with no pumping rights, significant challenges exist. These cities must participate in regional stormwater permits that increasingly seek to use landscape infiltration through green infrastructure. Cities must pay for this infrastructure. Many seek to justify such costs by touting water supply benefits. Yet, cities with no groundwater rights cannot access water they paid to infiltrate through stormwater infrastructure. The long-term implications of this inequity will grow increasingly important if Los Angeles shifts to a regime focused on maximizing use of local water resources.

The diversity of such a landscape is emblematic of the variation that can be found across the state. It is therefore important that groundwater management regulations, such as those currently being developed in the Groundwater Management Act, strike a balance between developing statewide standards while being mindful of local contexts and needs.

B) Historic trends in Los Angeles' groundwater management system

Rights to pump groundwater in the Los Angeles County region have been allocated to many actors over time, based on the social and environmental intricacies of each basin (Ostrom 1965; Blomquist 1992). The system is dynamic. Our analysis of the seven adjudicated basins lying entirely within Southern L.A. County indicates a **trend toward greater control or regulation of groundwater rights by public institutions**, as well as a **consolidation in the amount of rights held by larger parties** (Porse et al. 2015).

Groundwater masters are typically appointed by court order and report to boards of members. In some instances, however, the groundwater master is actually a board of members. For decades, the California Department of Water Resources (DWR) served as the watermaster for the Central and West Coast Basins. In 2014, DWR relinquished duties in the Central Basin to a panel of primarily elected members (pumpers). Table 2 below describes the structure and governance of watermasters in each basin.

BASIN	Adjudication Year	Governance	Recharge Sources
Verdugo	1975	ULARA W.M	Los Angeles County Public Works (LA DPW) spreading grounds, Metropolitan Water District imported water
Eagle Rock	1979	ULARA W.M.	Rainfall, stormwater, and surface water percolation
Sylmar	1984	ULARA W.M.	Rainfall, storm water, and surface water percolation
San Fernando	1955-1979	ULARA W.M.	Rainfall, storm-water and surface water percolation; City of LA, Los Angeles County Public Works do spreading grounds, Metropolitan Water District imports water
Main San Gabriel	1968-1973	9-person board, LA County Court Appointed	Imported water through Upper San Gabriel Valley Municipal Water District, Three Valleys Water District, San Gabriel Valley Municipal Water District supplemental water
Six Basins	1998	Six Basins W.M.	San Gabriel Mountains runoff; Imported water from MWD
Raymond	1944	Raymond Basin Management Board	San Gabriel Mountains runoff; spreading grounds monitored Pasadena, Sierra Madre, LA DPW all do spreading grounds
Puente	1986	3-person W.D.	Rainfall infiltration & mountain runoff percolation; LA County Sanitation Districts do recycled water; Three Valleys Municipal Water District imported water
Central	1965	3-body panel, with 7 members (6 elected)	Natural precipitation & stream-flow; WRD replenishment water; LA County sanitation district spreading grounds
West Coast	1961	DWR (will change pending re-adjudication)	Inflow from Central Basin and percolation; Water Replenishment District imported & recycled water; LA County Department Public Works; Recycled water from LA County Sanitation District.
Chino	1978	9-person court appointed Chino W.M.	Percolation, precipitation & infiltration Santa Ana River; Recharge by San Bernardino County Flood Control District, City of Upland, Inland Empire Utilities Agency, and the Regional Water Quality Control Board

Table 2: Adjudicated groundwater basin characteristics for Los Angeles County

The analysis developed a typology of pumpers for basins (Table 3). We classified rights' holders by type of entity. We also classified pumpers as public, private, publicly-regulated, or non-profit. Public entities include cities, counties, special water districts, municipal water districts, and other government agencies. Private entities include individuals, companies, and a small number of private water supply companies. Publicly-regulated entities include investor-owned utilities subject to oversight from the California Public Utilities Commission. While private companies, we make this distinction because profits are capped for IOUs and the PUC requires them to offer special rate programs for low-income residents. Finally, non-profits include mutual water companies and others such as churches or associations.

Categorization	Public/Private	Examples
City	Public	City of Glendale, City of Los Angeles
County	Public	Los Angeles County Department of Public Works
Investor-Owned Utility	Publicly-Regulated	Golden State Water Company

Irrigation District	Public	La Canada Irrigation District
Special District	Public	MWD of Southern California
Mutual Benefit Corporation	Non-Profit	Rose Hills Memorial Park Association
Mutual Water Company	Non-Profit	West End Consolidated Water Company
Oil and Chemical Company	Private	Chevron, Texaco
Private Entity	Private	Individual pumpers, ranches, companies
Unified School District	Public	Wiseburn School District
Water Investment Company	Private	Aqua Capital Management
Water Replenishment District	Public	Water Replenishment District of Southern California
Municipal Water District	Public	Three Valleys Municipal Water District

Table 3: Pumper categorizations, with the respective public/private classifications and examples. Possible classifications include public, private, publicly-regulated (investor-owned utilities), and non-profits

Table 4 (below) shows the consolidation of pumping rights among larger parties across basins. The volume of pumping rights held by the 5 largest parties in each basin increased significantly. More broadly, Table 5 (below) outlines the distribution and evolution of public, private and non-profit rights in major basins of the study area from time of judgments (finalized between 1949 and 1998) to present (2011-2013). For instance, the percentage of total rights controlled by public entities increased in the West Coast Basin (23% to 37%), Raymond Basin (80% to 82%), Six Basins (37% to 55%), Main San Gabriel Basin (38% to 47%), and Central Basin (41% to 80%). Publicly-regulated rights held by investor-owned utilities also increased significantly in the West Coast Basin (31% to 39%), where the shift was driven by transfers of rights from an oil company to Golden State Water Company, an IOU.

		West Coast	ULARA*	Six Basins	Raymond	Main San Gabriel	Central
Judgment	Private	13,486	0	0			
	Public	0	55,970	6,657	29,140	9,252	35,335
	Publicly-Regulated	15,743	0	6,705	2,299	33,400	46,598
	Non-Profit	0	0	2,972		11,025	
	Total	29,229	55,970	16,334	31,439	53,677	81,933
Current	Private	9,549	0				
	Public	19,495	279,671	12,740	36,397	22,565	86,495
	Publicly-Regulated	35,039	0	6,888		24,613	13,029
	Non-Profit	0	0	5,467		17,747	
	Total	64,083	279,671	25,095	36,397	64,926	99,524

Table 4: Distribution of pumping rights among the top five rights' holders in six basins of the study area. The trend shows a consolidation in pumping rights among large users. (Note: ULARA extraction rights have significantly increased from accumulated storage accounts for the major rights holders (cities of Los Angeles, Burbank, and Glendale), but they are currently not able to extract this entire amount due to overdraft and low groundwater levels).*

These trends are significant in that they indicate a progressive absorption of smaller actors by larger public agencies and investor-owned utilities, rather than further fragmentation of privatized groundwater rights. This consolidation may be an important step forward in advancing the region's local water resilience goals, as fewer, larger public agencies can both generate more resources for infrastructure development and also be more easily regulated than a multitude of small actors. At the same time, the nature of regulation is important for residents of L.A. County. Municipal agencies such as

city water retailers are responsible to popularly elected leaders, while the California Public Utilities Commission oversees investor-owned utilities. Residents likely have more capacity to voice opinions to local leaders than far away government agencies.

Basin	Number of pumpers		Rights' holders classifications as % of total basin rights			
	Judgment	Current	Classification	Judgment	Current	Change
West Coast	103	64	Non-profit	1.5	0.0	Decrease
			Private	44.8	32.1	Decrease
			<i>Public</i>	22.6	23.8	<i>Increase</i>
			<i>Publicly-regulated</i>	31.2	44.1	<i>Increase</i>
Raymond	19	19	<i>Non-profit</i>	10.1	10.4	<i>Increase</i>
			Private	3.6	2.8	Decrease
			Public	79.8	81.6	Increase
			Publicly-regulated	6.5	5.2	Decrease
ULARA	5	5	Non-profit	0.0	0.0	No change
			Private	2.4	0.9	Decrease
			<i>Public</i>	98.5	99.1	<i>Increase</i>
			Publicly-Regulated	0.0	0.0	No change
Six Basins	11	9	Non-profit	22.6	19.8	Decrease
			Private	5.4	0.0	Decrease
			<i>Public</i>	37.3	55.3	<i>Increase</i>
			Publicly-regulated	34.7	24.9	Decrease
Main San Gabriel	119	94	<i>Non-profit</i>	14.4	16.3	<i>Increase</i>
			Private	11.7	4.0	Decrease
			<i>Public</i>	37.5	43.3	<i>Increase</i>
			<i>Publicly-regulated</i>	36.3	36.5	<i>Increase</i>
Central	550	112	Non-profit	8.0	7.3	Decrease
			Private	14.0	1.6	Decrease
			<i>Public</i>	41.7	79.8	<i>Increase</i>
			Publicly-regulated	32.5	10.2	Decrease

Percentage of rights holders are classified as private, public, publicly-regulated (investor-owned utilities), or non-profits (mutual water companies). Italicized values indicate an increase in rights over time

Table 5: Comparison of the distribution of rights over time, from time of judgments (finalized 1949–1998) to current (source: groundwater master reports, with data for 2011–2013)

Despite the fragmented nature of the current groundwater management system however, **this complex and polycentric governance structure has managed to adapt over time.** In this current system, actors of varying sizes and organizational structures negotiate transactions and water transfers, moving water from areas of greater abundance to areas of scarcity. However, the capacity for such a system to continue to adapt is constrained by varying allocation of rights, storage capacity, widely differing institutional capacities, and reduced access to imported water. Some areas may find it harder to achieve local reliance than others under these constraints. **This may necessitate a reallocation of rights and management practices that better reflect current conditions.** Moreover, while citizens often have opportunities to voice opinions to water supply agencies, groundwater masters are appointed by courts, answer to leadership boards comprised of major pumpers in a basin, and have limited public accountability.

C) The future of groundwater use in Southern California

The current groundwater management structure in Los Angeles faces many challenges. Pumping rights were originally facilitated by an abundance of imported water, which ultimately reduced the need for groundwater pumping and supported groundwater use above native safe yields. As imported sources dwindle, tensions will likely arise among groundwater rights holders seeking water supplies for competing end uses. Watermasters will need to develop long-term plans acceptable to their member-driven boards that balance curtailed pumping with new sources of water for recharge. Critically, **basins must reduce reliance on imported water for recharge**. During years with significant rainfall, imported water will likely be available for replenishment, but not consistently. Given continued population growth, management must focus on replenishment through projects that conserve via water demand reductions and capture more local stormwater to store in groundwater. This is particularly important given the MWD no longer sells inexpensive replenishment water. As a result, basin managers have been searching for new recharge sources (WRD 2014) and many regional organizations are examining the possibilities for greater water recycling and stormwater capture (LADWP 2010; LADWP 2014). Interestingly, MWD has just announced it will invest in water recycling, proposing to build the largest water recycling plant ever built in the region. However, broader system changes will most likely still be needed as water rights to the recycled resource will need to be worked out. **It will be important to identify available groundwater basin capacity, where water can be stored and link it with water recycling plants, while also arranging pumping rights.**

The implications of such changes—such as more water reuse—would constitute an overhaul of the current system that links use, reuse, and groundwater as a cycle, rather than the present import and export flows. The current allocation of groundwater rights may impede this process and inhibit the flexibility of the system to adapt to future needs. Such changes will also necessitate a rethinking of conjunctive use of groundwater and surface water.

As imported sources become less reliable for Southern California, periodic conservation actions may become more prominent in some L.A. cities, especially those that rely most on imported water supplies. Our research also examined the total and percentage supplies of supplies that regional water retailers (cities, special districts, IOUs, and mutual water companies) obtain from imported water, surface water, and recycled water sources (Figure 7). Many retailers in the coastal plain rely on imported water for 60% or more of their supplies. L.A. City ranks highly for both volume and percentage of water supply coming from imported sources.

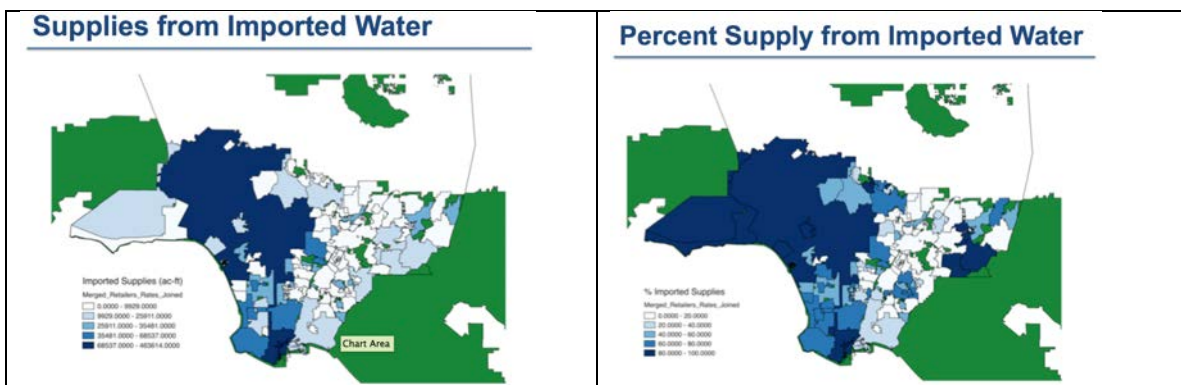


Figure 7: Volume (left) and percent (right) of total water supply from imported water for

water retailers in Southern L.A. County

While little surface water remains in L.A. County, some small retailers, primarily in the upper basin areas, obtain sizeable percentages of water from free-flowing streams (Figure 8). With climate change and reduced snowpack, these stream flow patterns may change.

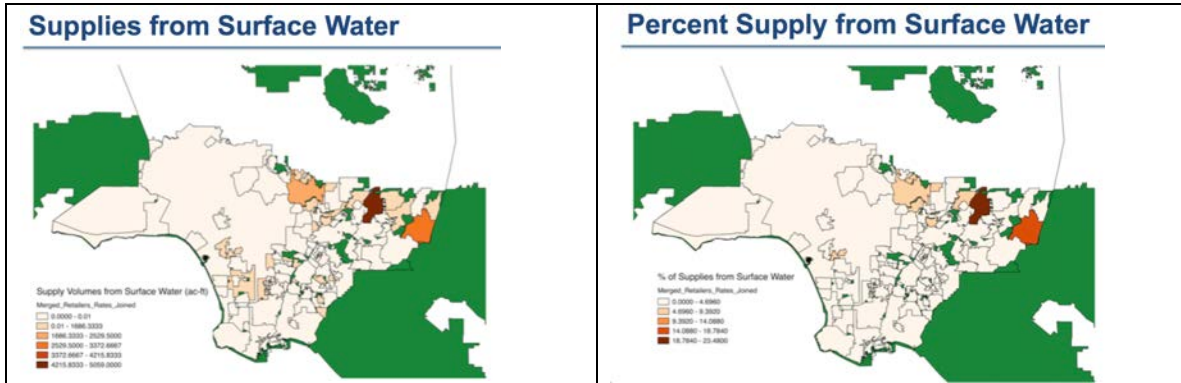


Figure 8: Volume (left) and percent (right) of total water supply from surface water sources for retailers in L.A. County

Finally, while the total percentage of water supplies coming from recycled water is relatively small (~7% in 2010), a few retailers in the coastal plain such as El Segundo and Torrance receive relatively large percentages of water supply from recycling (46% and 26% in 2010). Many retailers that use recycled water are able to easily access recycled water from the WRD's large recycling operations. Figure 9 below shows retailers that receive some percentage of water supplies from recycling.

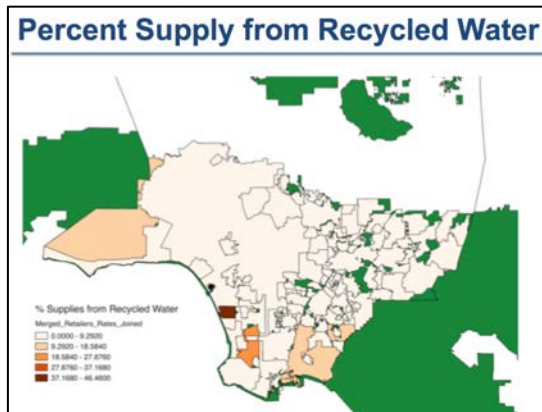


Figure 9: Percent of total water supply from recycled water sources for retailers in L.A. County

3) Water Data Infrastructure in Los Angeles County

Ref: Cope, M., Pincetl, S. (2014). *Confronting Standards and Nomenclature in Spatial Data Infrastructures: A Case Study of Urban Los Angeles County Geospatial Water Management Data*. *International Journal of Spatial Data Infrastructures Research*, 2014, Vol.9, 36-58

The fragmented water governance system described in the previous two sections has led to equally disjointed procedures for reporting water management data. With no central agency in charge of gathering, maintaining, disseminating and overseeing information, water management data in California is often inaccurate or insufficient. This can lead to information gaps on water quality and supply, as well as boundaries and service areas of water retailers. More integrated water management infrastructure requires more unified datasets across water entities and sectors, which are standardized, publicly accessible and regularly maintained and collected. In this way, policymakers and water entities themselves will gain a clearer understanding of water management issues across the state. Indeed, a more holistic understanding of water use and management in the state is difficult when current information is spread across thousands of entities, which operate relatively independently and in an uncoordinated manner. This in turn creates difficulties in developing sustainable water management plans. Data—and thus information and knowledge—is a key tool of sustainable water planning.

Our analysis found **highly uneven geospatial water management data across entities and service areas, with no coordination among entities**. Therefore, **spatial water management data would be greatly improved with the introduction of geospatial data and mandates for a more robust water management spatial data infrastructure (SDI)**.

Findings:

Overall, 3 of the 5 criteria used to assess spatial data quality in the US Spatial Data Transfer Standard (Montalvo 2003) are missing in urban Los Angeles SDI (Cope and Pincetl 2014):

- First, **the nomenclature for attribute data is inconsistent across entities' geospatial data sets**. At a basic level, if the same spatial feature has different names, then organizations and the public fail to share the same understanding about that water management feature.
- Second, **agencies do not apply universal numeric identifiers that persist with data updates**. This negates the analysis of data over time and subsequently the lineage of spatial data.
- Lastly, **positional accuracy may differ between water management data sets**. Although less of a problem for geo-visualization purposes, positional accuracy is what makes geospatial data unique: that features on the earth's surface are tied to a particular coordinate or reference point as precisely as possible.

Taken together, these problems affect the quality of spatial data in the region, and limit the understanding of where water is managed and by whom.

Collecting spatial data on water retailer jurisdictions faced two key challenges: **identifying all potable water suppliers and locating geospatial boundary data**. In 2000, the state of California began developing a spatial data infrastructure (SDI), which has led to the current California Geoportal, an online resource that enables data sharing and management options across public and private entities and at different governmental scales. While this system has enabled important gains in geospatial data access and interoperability, the lack of mandatory updates, standardization and greater

oversight of geospatial data still leaves gaps in knowledge.

Concluding thoughts and findings (Cope and Pincetl 2014):

- 1) Although a statewide spatial data infrastructure exists for water data, **most water management entities in LA County continue to maintain their own data collection processes, standards, and data sharing protocols. Agencies coordinate data sharing only through voluntary participation** rather than required procedures. This leads to redundancy in spatial data production and limits the accuracy of publicly available information. Even the naming conventions used to save and manage of data sets differ between agencies.
- 2) Comparative analysis among water management agencies is inhibited by **a lack of standard numeric ID system to identify potable water suppliers** independent of spatial and non-spatial data sets and databases.
- 3) **Data sharing within and between organizations remains limited.**
- 4) The **nomenclature for attribute data in unique data sets was inconsistent.** While not a panacea to resolving institutional problems of isolated water management, unique identifiers for water suppliers is a necessary requirement to trace water use and boundary information over time and between regulatory agencies.

As a first step to building further integrated water management spatial data infrastructure, **we recommend creating a universal ID system that assigns standardized numeric identifiers to water entities in California.** Federal Information Processing Standard (FIPS) code equivalents should be mandatory for all state water management agencies. These codes would create a unique spatial identifier that would be linked to U.S. census designated geographies. The FIPS code field would allow for different data, in different formats or platforms, to be linked, and could be used to “join” or “relate” spatial and non-spatial water use data information. This information could also be transferrable into other databases that use FIPS codes, and their fixed IDs would be traceable across platforms.

This would be an important first step in standardizing data and helping to build appropriate links between water entities (public and private) and across governmental scales. This infrastructure can facilitate greater integrated water resource management, as well as more sustainable, resilient water systems in the state.

4) LA County water loss and infrastructure leakage

Ref: Naik, K., Glickfeld, M. (2015). "Water Distribution System Efficiency: An Essential or Neglected Part of the Water Conservation Strategy for Los Angeles County Water Retailers?" UCLA Water Resources Group. Institute of the Environment and Sustainability. UCLA.

Water leaks from old and failing infrastructure present a particular problem for sustainable water management. Yet, such issues have not been prominent in water policy discussions in California. Only suppliers of potable water systems with more than 3,000 connections are mandated to report system losses via Urban Water Management Plans submitted every five years. Importantly, loss estimates are not considered separately from other non-revenue uses of water.

To understand the importance of system-wide water losses and leakage monitoring practices in the LA County region, researchers surveyed 10 of the nearly 100 retailers in LA County. Each of these represented different types of retailers, sizes and geographies (Figure 10). Researchers developed a questionnaire on leakage volumes, water loss estimation methods, infrastructure monitoring and replacement, and per capita water consumption.

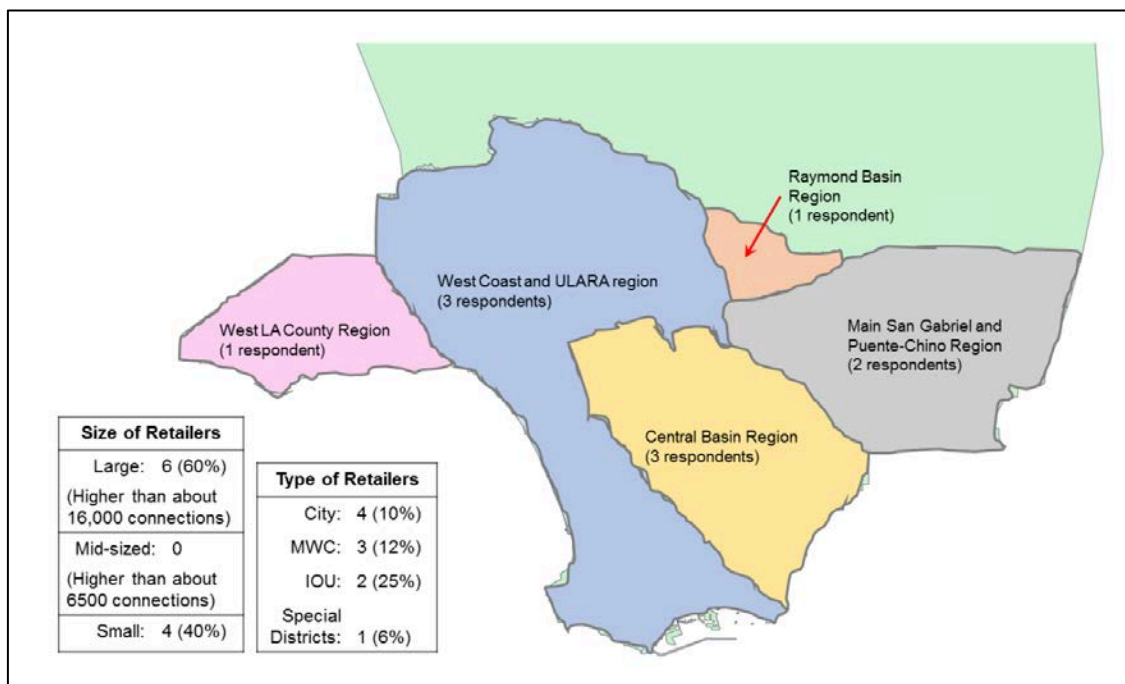


Figure 10: Geographic distribution of survey respondents on water leakage

Best practices were also allocated performance indices and were evaluated based on the following criteria (Table 6):

The results of the survey address information shortfalls in water loss reporting, including:

- The **percentage of water loss due to breaks and leaks is still a widely used metric to measure water losses.**
- **Sixty percent of the agencies sampled still monitor only ‘unaccounted for**

water’ and not ‘real losses’.

- **Retailers that do measure real losses reported them to be between 3-4% of total water supplied, which is an improbably low figure compared to international estimates.**

Best Management Practices	Indices allotted
Monitor GPCD	1
Awareness and regularity of usage of AWWA Water Audit Methodology	3
Existing or future programs for smart meters	1
Preventive maintenance (exercising of valves and flow testing of meters)	2
Infrastructure replacement (for pipe, valves and meters)	3
Monitoring of annual number and location of pipe breaks and implementation of leak detection programs	2
Monitoring of age and material usage on GIS	1

Table 6: Performance indices allotted for Best Management Practices for water distribution

Sample Retailer	Real Losses (%)	Unaccounted for water (%)	Verification
Large City C	Not measured	2.8 %	No
Large City B	3.4 %	4.5 %	Yes
Large City A	4.1 %	Measures real loss	Yes
Small MWC A	Not measured	3 %	No
Small MWC B	Not measured	11.35 %	No
Large SD	4 %	Measures real loss	Yes
Large IOU A	No response	1 %	No
Small City B	No response	6.5 %	No
Large IOU B	4.02 %	Measures real loss	Yes
Small MWC C	No Response	No Response	No
Responders	7 out of 10	9 out of 10	4 out of 10

Table 7: Estimates for water losses by sample water retailers

Through survey results, we found that **larger retailers use more best management practices to maintain storage and distribution systems, but many small retailers did not report prioritizing best management practices to minimize water loss.** However, few systems fully implement state of the art water audits and even fewer are making use of new water technology to aid in locating pipe leakages in the system as well as on customer property.

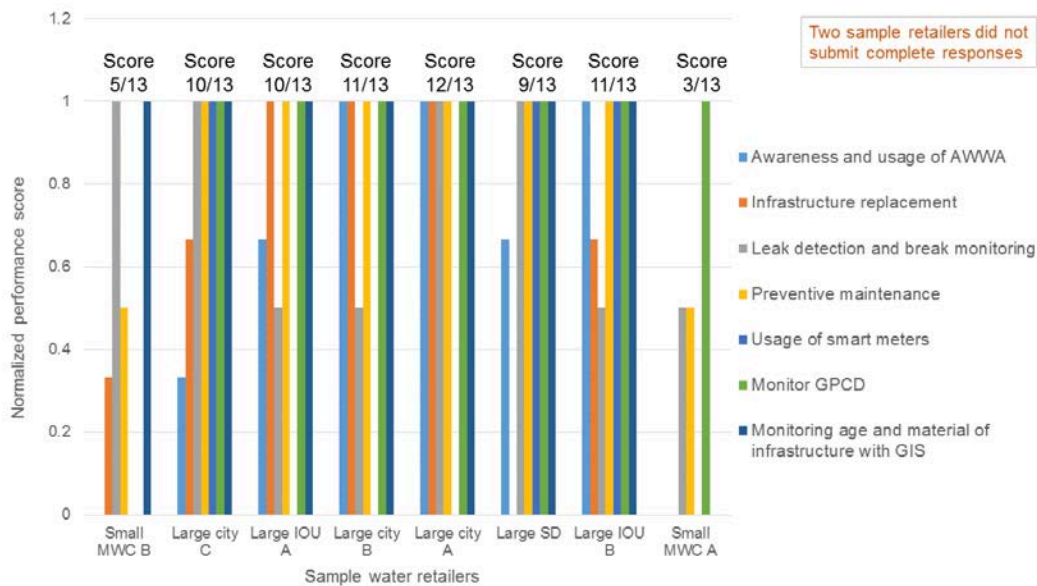


Figure 11: Scoring of participating retailer with respect to best management practices followed

Recommendations:

To better estimate real water losses, **water retailers must estimate non-revenue water**. As a first step, water entities could install meters to measure non-revenue or unbilled water uses, such as well and pump cleaning, firefighting, and municipal and water retailer uses. This would also necessitate maintaining meter accuracy to ensure reporting is accurate and being correctly reported.

Additionally, auditing water losses across the distribution system is not enough to plan for pipe breaks and water leakage. **Water entities should develop capital improvement plans with annual targets of replacing pipes, valves, and other infrastructure, based on empirical data.** Importantly, utilities should emphasize physical and IT infrastructure that helps limit losses when failures do occur.

To obtain returns, **leak detection must be an ongoing process that strengthens the water auditing process**, to obtain accurate loss estimates. The State should assist small retailers in obtaining reliable water technology to assist in audits. Smaller retailers could pool their resources in order to better detect, monitor and reduce distribution water losses.

Further, **basic methods for reporting water losses, such as the AWWA Water Audit tool, must be improved** to better address water efficiency. At the moment, this tool relies heavily on self-reported data, which is subject to non-standardized data collection, especially for non-revenue water volumes. **Prescribing standards for retailers, as well as developing a compendium of the best management practices, would be a critical first step in helping to reduce water losses.** In such a way, retailers can be evaluated based on these standards and practices that would be supported by verifiable data.

Finally, there are currently over 46,000 connections in LA County served by retailers with less than 3,000 connections. These retailers are exempt from reporting on water losses caused by breaks and leakage. State regulatory agencies must identify policy mechanisms and funding to **assist smaller retailers in performing water audits and using best management practices, to replace old pipe, clean and repair inaccurate meters, and monitor breaks and leaks.**

In summary, California water regulations should aim at recommending crucial best management practices, ensuring accurate and verifiable water loss monitoring and prescribing an effective water loss metric and maximum acceptable standard as a roadmap for water retailers. The recent passage of SB555 (Wolk) requiring annual water audits for larger water retailers is a first step in tackling water losses and helping the state to conserve the water it already uses.

5) PRELIMINARY CONCLUSIONS AND POLICY RECOMMENDATIONS

Most water policy prescriptions in California focus on regulations (quantity and quality) and funding. Many water supply agencies face severe fiscal challenges to renew old infrastructure, build new infrastructure, and maintain services even as conservation reduces revenues. New public funding sources for water infrastructure are limited by imposed constraints such as the recent California Supreme Court ruling that applied Proposition 218 to water rate pricing (*California Taxpayers Association v. City of San Juan Capistrano 2015*). The Prop 218 referendum, which passed by voter approval in 1996, mandates that localities only raise fees in proportion to the direct cost of service. For water utilities, it restricts tiered water rate structures, requiring agencies to tie the higher costs of services to pricing of top tiers. To comply, localities will need to better document operational costs to tie it to needed fees and revenue generation. More broadly, funding integrative programs such as Integrated Watershed Management and ecosystem restoration is difficult within the current dispersed water management network of the state, requiring cooperation among agencies (Hanak et al. 2014).

Yet, as policy development necessarily focuses on funding, we must also evolve current siloed management practices to facilitate improved 21st century water systems in California. In particular, we must update the historic methods of managing groundwater in Los Angeles County, which are codified in both legal documents and practices, to meet future needs. The historic allocations of groundwater rights do not support a regime of future local reliance, where groundwater basins will provide critical short- and long-term storage. Some water suppliers with limited or no groundwater rights will find it difficult to reduce imported water needs. Moreover, while the City of Los Angeles has the greatest volume of groundwater rights of any entity in the county, it has limited per capita groundwater rights (~15-20 gallons per capita per day, or gpcd). Smaller cities, especially lower-income cities such as Hawthorne (~20 gpcd) or El Monte (~22 gpcd), may find it even more difficult to identify sources to make up for the shortfall between total use and rights to available groundwater. Finally, while environmental uses of water (stream habitats) are considered in managing surface water, no such considerations go into managing groundwater, even as surface water and groundwater resources are intimately connected.

Future decades will increasingly emphasize collaboration and coordinated use of data. Collecting, analyzing, and distributing comparable data across agencies is especially

critical for this task. This need became critically evident following the California Governor's mandated 25% conservation target for water suppliers in 2014. The State Water Resources Control Board had to develop and institute procedures for standardizing residential per capita water use, including procedures to estimate water consumption and service area population, before data could compare agencies across the state. Agencies revised calculations and resubmitted numbers for a year, which lost valuable data as drought effects worsened.

We describe below key policy recommendations to improve institutional capacity for **data management, performance metrics, and agency collaboration**, with the goal of achieving more transparent and resilient water management systems capable of meeting climate change challenges.

1. Determine an institutional home for a database of existing water utility management— where data for operations and infrastructure is collected, standardized, maintained and updated.
 - a. Centralize data management of Southern California water, including comparable descriptions of utility classifications, locations, sizes, service area populations, and capacities, housed within an existing or new agency.
 - b. Create a publicly available data repository that includes multiple platforms for mapping and downloading water data.
 - c. Establish standardized numerical identifiers for each utility and its service area, which will enable consistent reporting over time and can be ported across analysis platforms, including GIS and statistical programs.
 - d. Require up-to-date geospatial data from retailers for service areas and make shape files publicly available.

2. Develop new guidelines to assess water utility performance capacity.
 - a. Retain current emergency water use reporting requirements for standardized reporting of per capita water use across retailers throughout the state.
 - b. Develop standardized metrics for commercial, industrial, and institutional water consumption aligned with future water management goals. For instance, utilities should begin to measure and report water deliveries to commercial and industrial end-users by water grade- i.e. the quality of imported and reused water. This can help match end-uses with water supplies of appropriate quality. Industrial and commercial water consumers require water for many diverse uses, from highly treated indoor consumption to non-potable water for cooling. Such monitoring can uncover new markets for recycled water and reduce needs to treat all water supplies to high levels.
 - c. Expand monthly water use reporting by utilities to include sectors- commercial, industrial, residential (single and multi-family) and institutional- using a standardized methodology as described above that can be tracked over time.
 - d. Establish minimum performance thresholds for water utilities to report data, including:
 - i. Fiscal performance measures that assess sufficient capital for maintenance and upgrades.
 - ii. Leakage assessment, monitoring, and repairs.

- iii. *Water conservation and efficiency* programs, including incentives.
 - iv. *Monthly water use by sector-* commercial, industrial, residential (single- and multi-family) and institutional- that can be tracked over time.
 - v. *Standardized data reporting* developed by the State Water Resources Control Board.
- 3. Promote institutional reforms to ensure future water reliability.
 - a. *Build technical capacity in non-compliant utilities* to meet data standardization and reporting requirements.
 - b. *Establish procedures for consolidation* of utilities that consistently fail to comply with water data management standards, focusing especially on utilities that perform poorly across multiple performance metrics such as data reporting and reliability of water supply deliveries.
- 4. Monitor implementation of SB 555 at the state level to require annual water audits with quantified measures of system leakage.
 - a. *Ensure accurate and comparable data on efficiency and leakage* for retailers
 - b. *Examine incentives and funding sources to reduce water losses* through infrastructure replacement
 - c. *Assist small retailers to pool resources* and implement water system audits
- 5. Examine institutional barriers to achieving 'one water' policies.
 - a. *Promote revenue sharing agreements* to enable separate city agencies, such as sanitation departments and water utilities, to develop jointly funded projects for water reclamation and groundwater recharge, or alternatively develop interdepartmental and interagency agreements that expedite jointly funded projects.
 - b. *Develop credible ways to measure the volume of water captured* by different projects in different places so that the value of the water becomes a way to finance a part of the project.
 - c. *Identify opportunities to increase groundwater recharge* by working with groundwater masters and groundwater basin boards in adjudicated areas in to allow replenishment and storage by non-pumpers. This is currently an impediment for many agencies that would benefit from capturing and infiltrating stormwater but lack groundwater pumping rights. Updating adjudications in a groundwater basin requires unanimous approval from all pumpers with rights and must then be approved by the court overseeing the adjudication.
- 6. Enhance institutional capacity for integrated water management.
 - a. *Develop collaborative conjunctive water use programs* that transcend individual water delivering utilities and adjudicated groundwater basins.
 - b. *Develop cross-platform tools* that combine water quality and quantity data from different sources (geospatial, water supply and demands by agency, groundwater quality and recharge, stormwater capture basins, and more) to assess broader water quality questions facing the region.
 - c. *Determine realistic estimates of local water supply reliance* by combining water data across sectors (stormwater, groundwater, water supply,

recycling) and using developed cross-platform tools to determine current agencies that are well-positioned to improve local reliance based on water supply sources. This assessment can also determine utilities that will face significant challenges in increasing local water use, which can identify candidates for technical or fiscal assistance.

- d. *Integrate water quality into groundwater basin management* through new policies and changes to adjudications. Importantly, a central repository for currently contaminated groundwater basin areas, which can inform future pump-and-treat operations.

6) Products (Papers and Presentations)

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Pincetl, S. Cheng D, Porse E. (2015) "Fragmented Flows: Water Security, Equity, and the Politics of Governance in Los Angeles County". Under review

Porse, Erik C. (April 22, 2015). *Managing Water Scarcity in Future Cities: What Makes Sense to Sense?* Center for Information Technology in the Interest of Society (CITRIS). Special seminar series on Resilience. University of California, Berkeley.

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Naik, K., Glickfeld, M. and Porse, E. (2015). "Water Distribution System Efficiency: An Essential or Neglected Part of the Water Conservation Strategy for Los Angeles County Water Retailers?" Presentation to the California Water Foundation. Sacramento, CA.

7) Connections to Other Work

In addition to our proposal, we leveraged our Haynes Foundation funding, in order to come to greater policy implications. In particular, funding from the Resources Legacy Fund via the California Water Foundation (Grant #2014-0139) supported work to assess leakage and inventory recycled water infrastructure, which is being used along with the institutional and groundwater data to develop a systems analysis of water management in L.A.

Additional Sources

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