

Digital Commons
@ LMU and LLS

Cities and the Environment (CATE)

Volume 10

Issue 2 *Climate Change Adaptation in Mediterranean
Cities*

Article 5

11-16-2017

Transferring Water and Climate Resilience Lessons from Australia's Millennium Drought to Southern California

Deborah Weinstein Bloome
TreePeople, dbloome@treepeople.org

Edith de Guzman
TreePeople, edeguzman@treepeople.org

Recommended Citation

Weinstein Bloome, Deborah and de Guzman, Edith (2017) "Transferring Water and Climate Resilience Lessons from Australia's Millennium Drought to Southern California," *Cities and the Environment (CATE)*: Vol. 10: Iss. 2, Article 5.
Available at: <http://digitalcommons.lmu.edu/cate/vol10/iss2/5>

This Practitioner Notes is brought to you for free and open access by the Biology at Digital Commons @ Loyola Marymount University and Loyola Law School. It has been accepted for inclusion in Cities and the Environment (CATE) by an authorized administrator of Digital Commons at Loyola Marymount University and Loyola Law School. For more information, please contact digitalcommons@lmu.edu.

Transferring Water and Climate Resilience Lessons from Australia's Millennium Drought to Southern California

Southern California and Southern Australia are two regions of the world which share many climatic, socioeconomic and demographic characteristics that lend themselves to meaningful exchanges of knowledge and innovations. With the benefit of Australia's documented experiences, California can learn what solutions worked and did not work in Australia, potentially avoiding major pitfalls. While some changes in California are already underway, many opportunities – and challenges – still remain. California's policymakers and residents can adopt and adapt the most fitting solutions from Australia's experience. California, and especially Southern California, can use these to appropriately and effectively respond to the extremes of our long-term water and climate crises. In doing so, we will put California on a better path towards resilience as we navigate the challenges of drought, flood and extreme heat forecast to increase in our future.

In October 2014, TreePeople and The Energy Coalition co-organized and co-led a delegation of policymakers and elected officials from throughout California to the Australian cities of Melbourne and Adelaide. These cities implemented innovative water management solutions during the Millennium Drought that helped to drought-proof their water supplies and increase resilience in anticipation of a changing climate. The goals of this delegation were to show California water leaders first-hand the drought and climate response initiatives that Adelaide and Melbourne employed and to focus on transferring and implementing viable approaches in California.

This article highlights the key lessons learned from this research and provides recommendations for how Southern California can best approach transferring these lessons.

Keywords

water and climate resilience, water supply, rainwater capture, protection from extreme heat, green infrastructure, collaborative governance, urban canopy, multiple benefits, public health, urban water

Acknowledgements

This paper was co-authored by Deborah Weinstein Bloome and Edith de Guzman, with contributions by David Jaeckel, Yale University and Daniel Berger, TreePeople.

INTRODUCTION

From 1997 to 2010, Australia experienced its longest stretch of rainfall deficit on record: a devastating period dubbed the “Millennium Drought.” Four years in, the Millennium Drought looked very similar to Southern California’s current water crisis, wreaking havoc on both the environment and the economy. Australia’s response was varied and far-reaching, implementing significant structural changes to its water governance framework along with a host of water-management solutions, ranging from comprehensive water conservation programs to desalination facilities. Some of these approaches proved effective, helping Australia to make efficient use of dwindling water supplies; others proved problematic, beset by ballooning costs and lengthy construction times that severely undercut their utility. This article highlights key lessons from TreePeople’s research of Australia’s response to drought and climate change, providing recommendations for the optimal transfer of relevant lessons to advance a climate- and water-secure future for Southern California.

ABOUT TREEPEOPLE

TreePeople is a Los Angeles-based non-profit organization. Founded in 1973, TreePeople has a long history demonstrating and advocating for systemic change to the water management of Southern California’s cities and watersheds. With over 20 years’ experience proving the effectiveness and efficiency of collaborative multi-agency, multi-benefit urban water infrastructure, TreePeople specializes in bringing agencies and communities together to plan, fund and implement projects in partnership. TreePeople works with partners to showcase the benefits of green infrastructure on individual parcels, school campuses, public parks, streets and sidewalks, and at the neighborhood and watershed levels.¹

THE VALUE OF CITY-TO-CITY COLLABORATION

The need for swift action to secure a water- and climate-resilient future is indisputable as the impacts of climate change and extreme weather are felt more palpably around the globe. While overarching reforms are called for at the national and international levels, innovative, nimble solutions are critical and often best suited to the sub-national level -- and particularly the regional or municipal level. For the first time in history, the majority of the world’s population lives in urban settings. As demographic and economic hubs, cities are epicenters of both climate-changing activities and experiencing the impacts of a changing climate. City governments therefore have the dual imperative to implement swift, innovative approaches that both *mitigate* contributions to climate change and *adapt* to the realities of an altered climate. These twin objectives can be significantly furthered through partnership, with cities collaborating to exchange innovations and quickly refine increasingly effective approaches through joint iterative processes.

¹ Green infrastructure incorporates a set of practices that mimic natural systems in infrastructure projects, such as those in parkways, roadways and buildings. Outcomes from green infrastructure often include: improved stormwater management, air quality, water quality and soil health; increased sustainable energy production, biodiversity, food production and recreational opportunity; and reduced heat stress; and other climate adaptation benefits.

Various factors must, of course, be evaluated to determine the applicability of innovative approaches between cities. Population size, geographic characteristics, political structures, demographics and climate are but some of the relevant filters through which to assess the transferability of approaches. As detailed below, Australia's and Southern California's cities share many such characteristics, making for an apt comparison and fruitful exchange of approaches between the regions.

AUSTRALIA: A CASE STUDY FOR SOUTHERN CALIFORNIA'S RESILIENCE PLANNING

Australia is the world's driest inhabited continent and is heavily urbanized, with approximately 89 percent of the country's 21 million inhabitants living in urban areas. Ensuring that residents of Australian cities have access to water resources is an ongoing challenge to which the country has dedicated an immense amount of resources.

Australia shares several similarities with Southern California that make for an ideal case study to analyze drought and climate change response strategies. Both Australia and California:

- 1) Enjoy a high standard of living and support similar lifestyles for residents;
- 2) Have Mediterranean climate zones that are subject to alternately wet and dry seasons and long periods of drought;
- 3) Project increases in population for major metropolitan areas; and
- 4) Have sufficiently similar governance systems to accommodate comparable reform models.

However, while both Australia and Southern California have populations of around 21 million, a notable difference between the two regions is their geographic scale. Australia is 2.97 million sq mi (4.88 million sq km), approximately the size of the entire United States.



Figure 1: Relative sizes of Australia and the United States.

TreePeople's research and policy exchange targeted the Australian cities of Melbourne and Adelaide, which share notable similarities with Southern California's cities and provide ample and extensive examples of innovative solutions from which to draw. Melbourne and Adelaide offer robust models for two of urban Southern California's most pressing climate threats: extreme urban heat and a vulnerable, unsustainable water supply system.

Melbourne is located in the state of Victoria, in southeastern Australia, and has a moderate oceanic climate with average annual rainfall totaling approximately 25 in (635 mm) (Figures 1 and 2). Adelaide is located in the state of South Australia and has a Mediterranean climate similar to much of Southern California, with hot, dry summers and cool, wet winters (Figure 2). Historic average annual rainfall is approximately 17 in (432 mm) in Adelaide. Of Australia's capital cities, Adelaide has a climate pattern and average annual precipitation that approximates Los Angeles, with Los Angeles receiving an annual rainfall average of 15 in (381 mm) (Figure 2).



Figure 2: Average monthly precipitation for Los Angeles, Adelaide and Melbourne. Australia is in the Southern Hemisphere and thus experiences seasons opposite to Los Angeles. Adelaide and Los Angeles are in Mediterranean climate zones and thus experience the wettest months in winter (June, July and August in Adelaide; December, January and February in Los Angeles). Adapted from data provided by the Australian Bureau of Meteorology. (Australian Government, Bureau of Meteorology. Climate Statistics for Australian Locations: Monthly Climate Statistics. 4 February 2016.)

TREEPEOPLE’S RESEARCH AND POLICY EXCHANGE WITH AUSTRALIA

In 2012, TreePeople embarked upon a research and policy exchange program between government, academic and community organizations in Australia and Southern California that continues to this day. The exchange has included study tours to both countries and opportunities for governmental, academic, business and non-governmental representatives to meet with their counterparts from other cities, regions and countries. The program is aimed at sharing innovations, best practices and experiences related to community, commercial and government engagement in urban water management and climate adaptation. A particular focus is to identify successes, challenges and lessons learned from Australia's devastating Millennium Drought, which was accompanied by extreme heat events.

Research is a major element of the exchange program. TreePeople staff conducted two research expeditions to Australia in 2012, meeting with water management and planning entities in Australia’s five largest cities. Lessons from these trips were compiled in a study tour report,

[*Lessons from the Land of Oz for the American Southwest: Australia's Response to its Millennium Drought.*](#) The report highlights innovations and experiences related to urban water conservation, rainwater harvesting and other drought response strategies.

In October 2014, TreePeople and The Energy Coalition partnered to organize and lead a delegation of policymakers and elected officials from throughout California -- including representatives from federal, state, regional and local levels -- to experience and evaluate a range of urban water- and climate-resilience solutions underway in Australia.²

The delegation sought to identify viable approaches to address California's immediate drought emergency as well as the state's long-term water crisis and increasingly altered climate. The range of drought-response strategies at work in Melbourne and Adelaide, coupled with the cities' underlying similarities to Southern California's cities, made an ideal focus for the delegation.

LESSONS LEARNED & RECOMMENDATIONS

Several key lessons emerge from the water and climate crisis response strategies employed in Adelaide and Melbourne, resulting in a range of actionable recommendations to address Southern California's current challenges.

Lesson #1: Drought urgency represents a unique opportunity to reshape water management strategies and requires swift, smart actions.

Melbourne acted quickly and aggressively to pursue water conservation during Australia's 12-year drought. Had the city not done so, storage reservoirs would have run dry by July 1, 2009 (Figure 3). At that time, the City's stream flows plummeted, and, for the first time in its history, did not rebound with expected precipitation (Figure 3).

² The Energy Coalition is a social change organization dedicated to partnering with communities, public agencies, private companies, educators and policymakers to design, implement and evaluate energy and water-energy nexus strategies.

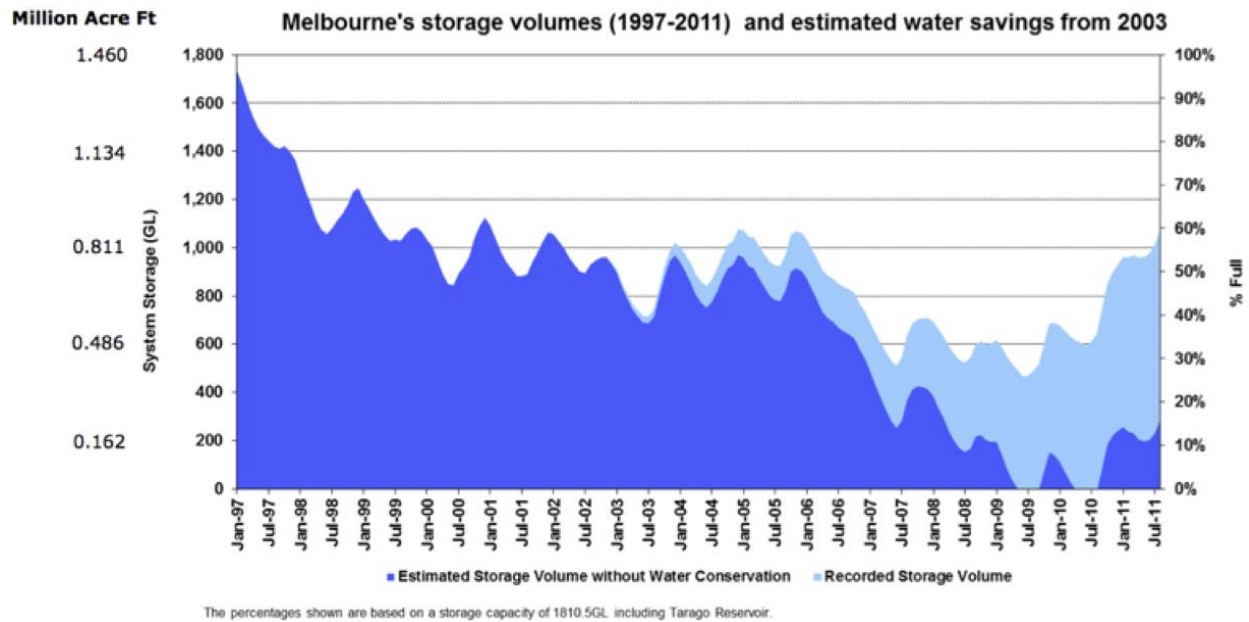


Figure 3: Melbourne's water supply with and without water conservation measures

This cautionary tale stresses the need to:

- Implement drought-response strategies early in a drought; and
- Not rely on historical records to predict the severity of future water scarcity.

Further, the Millennium Drought showed that water managers and policymakers can successfully harness public and political sentiment to institute ambitious reforms during periods of water scarcity. Melbourne and Adelaide leveraged the drought to implement significant supply- and demand-side reforms that would have proven difficult, if not impossible, given historically normal precipitation patterns.

In one example, images of Melbourne's scorched storage reservoirs, part of a broad public outreach campaign, galvanized the public to embrace water conservation and augmentation measures, allowing the Victorian government to implement a suite of reforms, including:

- Rebates on water saving fixtures and appliances;
- Tiered pricing structures that more accurately reflect the value of water;
- Water restriction plans to limit wasteful use;
- Ambitious per-capita water consumption targets;
- Wastewater reuse and stormwater capture projects at scale; and
- A desalination facility and interbasin transfer pipeline.

In its fifth year of drought, some parts of California experienced near-average historical precipitation through the first half of 2016. Yet one season of mean precipitation sparingly scattered cannot cure the historic drought conditions afflicting the state; water scarcity is here to

stay, and California must not squander the current opportunity to implement necessary, far-reaching reforms.

Lesson #2: The whole-of-water-cycle approach created a more efficient and effective water management system.

During and after the Millennium Drought, both Adelaide and Melbourne restructured water management frameworks multiple times, adopting the whole-of-water-cycle approach to increase coordination among urban planning, public health, transportation and natural resource management entities. Whole-of-water-cycle planning is a multidisciplinary, fully collaborative structure by agreement of all entities with a role in the water cycle. It harnesses synergies to realize efficiencies and multi-benefit solutions through coordinated planning and implementation of policies, programs and infrastructure projects. An example is the establishment of the progressive Living Melbourne, Living Victoria initiative in 2011 by the State of Victoria. This initiative (which has since been absorbed by the Department of Environment, Land, Water and Planning) is transforming the way urban water is managed in Victoria. It provides critical funding for whole-of-water-cycle projects and decentralized infrastructure, and a process for increased agency integration and community engagement to identify and prioritize supply- and demand-side water management options. And though the drought ended, whole-of-water-cycle remains: the State of Victoria continues to institute collaborative governance processes and involve the public to develop and implement projects that maximize cost savings and shared benefits.

Absent a whole-of-water-cycle approach committed to collaborative, multi-benefit solutions, the long-term viability of projects and programs may be compromised. In an era of increased scrutiny of public investments, single-benefit infrastructure -- prone to inefficiency and obsolescence, but often the default when agencies plan in isolation -- will be hard-pressed to garner popular and political support. Desalination of ocean water, for example, is an energy-intensive, single-benefit process that is significantly more expensive than traditional water sources -- with costs both to the economy and the environment. In 2010, with the return of heavy rains, dam levels throughout much of Australia rose dramatically, and with them, the water supply. Loss of demand for more expensive desalinated water quickly followed, and the desalination plants expedited for drought-response in both Melbourne and Sydney went effectively idle. Ratepayers are nevertheless left to foot the sizable bills for these mothballed behemoths.

Lesson #3: Water scarcity issues are fundamentally tied to public health, safety and quality of life.

In the midst of the drought crisis, Australia focused almost exclusively on water supply, with significant negative repercussions for quality of life issues. Hindsight revealed this was an error. Extreme heat brought urban temperatures above 115°F (46°C) and heat waves lasting several days. At the same time, in order to save water, vegetation in public open spaces has been allowed to turn brown and dry, and trees began to die en masse, resulting in the loss of cherished recreation, shade and ecosystem services. Public health and quality of life were severely

impacted, as precious shade and recreational opportunities vanished in parks and fields that turned to dust.

Without the ecosystem services provided through the shade and evaporative cooling of leafy tree canopies, the urban heat island intensified and, at times, became lethal.³ In 2009, Melbourne experienced a 62 percent increase in heat-related mortality, prompting the City to rethink the impact of drought restrictions on public green space (Norton et al. 2015). Researchers determined an effective way to protect lives in times of extreme heat is to maximize tree canopy (Norton et al. 2015). While drought restrictions were imperative on a citywide scale, Melbourne learned a critical lesson: Special attention must be paid to keep public spaces green, even during severe drought. The City had to reassess its one-size-fits-all approach to drought-induced restrictions.

After the drought ended, Melbourne created a climate adaptation plan, which included a goal to double its tree canopy to 40 percent to reduce peak temperatures by approximately 7°F (4°C). The plan also calls for keeping soil moisture at adequate levels to reduce urban temperatures through evaporative cooling, and for all new green spaces to be irrigated with non-potable, fit-for-purpose water from recycled water and stormwater harvesting projects.⁴

Lesson #4: Public behavior programs focused on water conservation were tremendously effective.

The Millennium Drought correlated with dramatic shifts to the water consumption behaviors of Adelaide and Melbourne residents. Through a mixture of water use restrictions, water pricing mechanisms, public education, target-setting and efficiency rebates, per capita water use was reduced substantially by residents of both Adelaide and Melbourne. In Melbourne, the Millennium Drought saw per capita demand decrease from 121 gal (458 L) to 65 gal (246 L) per day for all land uses (Grant et al. 2013). For residential properties, Melbourne's per capita use dropped to about 40 gal (150 L) per day during the drought.

³ The term "urban heat island" describes developed areas that are hotter than nearby less developed areas due to heat-retaining surfaces such as streets, buildings and parking lots. Heat islands can affect communities by increasing peak energy demand, air conditioning costs, air pollution, greenhouse gas emissions, and heat-related illness and mortality.

⁴ Fit-for-purpose water is treated only to the level needed for its intended end use.

MELBOURNE'S PER CAPITA WATER USE

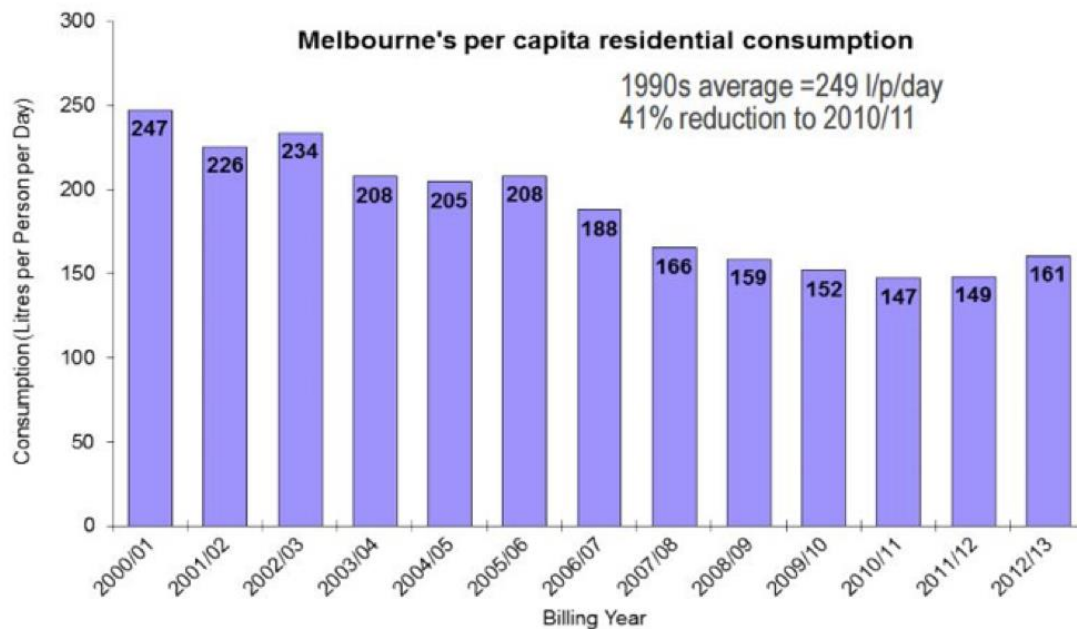


Figure 4: Melbourne's per capita water use between 2000 and 2013 (Yarra Valley Water 2014).

In 2003, Adelaideans used 87 gal (330 L) of water per person per day. In 2009, toward the end of the drought, water demand averaged 60 gal (227 L) per person per day (Maier et al. 2013). In comparison, in 2015-16 Los Angeles averaged demand of 107 gal (405 L) per person per day for all land uses, according to the Los Angeles Department of Water and Power, as of January 2016. While trailing Australian figures, this is lower than historical averages and represents the progress of recent conservation efforts.

Melbourne and Adelaide utilized the following strategies to facilitate behavior change around water conservation:

- *Coordinated Mass Media and Public Education*
Melbourne implemented a large-scale, mass media advertising campaign via television, radio, print, billboards and public events that saturated the market and dramatically increased awareness of the drought. The campaign's messaging was clear and concise, motivating residents to pull together and providing information on continued water restrictions and current reservoir levels. Enormously successful, the campaign's efficacy was continually gauged through sampling surveys and phone interviews with ratepayers. The total cost of advertising was estimated at AU\$8 million, with Melbourne Water contributing approximately AU\$6 million, and City West Water and Yarra Valley Water, retailers serving the greater Melbourne area, contributing AU\$1 million each. Importantly, these agencies

pooled resources toward an integrated campaign, rather than risk a diluted impact from individual campaigns, as is often the case in Southern California and throughout the state.

- *Ambitious Water Consumption Targeting*

Implemented based on a task force finding advocating ambitious residential water consumption targets, Melbourne’s “Target 155” initiative encouraged limiting use to 155 L (40 gal) or less per person per day. The voluntary initiative was extremely effective in changing consumers’ attitudes and behaviors toward water conservation (see Figure 5). Target compliance became a badge of honor for the public, and new social norms developed around water consumption. The media delivered weekly reports comparing Melbourne’s water use to the Target 155 goal, and its achievement was intensively covered by print, television and radio outlets. Melbourne has since revised these standards to Target 130 liters in the winter and Target 190 liters in the summer to account for seasonal variations in water demand.



Figure 5: Target 155 campaign advertisements (Thwaites 2014).

- *Smart Water Bill*

Yarra Valley Water redesigned its traditional water bill to a new “Smart Water Bill” – an informative, easy-to-read document that includes comparisons to water consumption of both average and water-efficient households. The bill employs both descriptive and injunctive

norms to adjust perceptions of “normal” water use and encourage further conservation.⁵ Research conducted by Yarra Valley Water indicates that the Smart Water Bill was tremendously effective, changing behavior toward water by clarifying use patterns and connecting these patterns to societal norms. In many instances, this simple feedback mechanism created large changes in consumer behavior. The Smart Water Bill also contains water efficiency tips and rebates, and shows progress toward water conservation targets.

- *Water Restrictions*

Water use was heavily restricted in both Melbourne and Adelaide, which had a tremendous impact on public behavior. Further, deputized inspectors and meter readers wearing patrol vests were common and helped remind the public that water restrictions were in place. Fines for non-compliance were typically AU\$100 to \$500 and not issued until the second or third offense (Heberger 2012). However, as most restrictions were difficult or impossible to enforce, the high compliance with water restrictions should be attributed to the willing cooperation and goodwill of the public. Australians generally adopted a “we’re all in this together” attitude and were highly supportive of the water restrictions (Heberger 2012).

- *“Right Water” Campaign*

In 2014, Victoria launched the “Right Water” campaign to encourage households to make greater use of alternative water sources. The campaign, which continues today, educates the public to use fit-for-purpose water, pairing water type with water need and conserving potable water for appropriate uses, unlike toilet flushing and landscape irrigation. “Right Water” incentivizes installation of rainwater harvesting tanks and rain gardens by showing expected water bill decreases that would result from associated reductions to potable water use.⁶ For example, it is estimated that every year Melbourne households have approximately AU\$200-400 worth of rainwater fall on each roof on average (Government of Victoria 2014). (Figure 6).

⁵ Injunctive norms are perceptions of what behaviors are approved or disapproved of by others. Descriptive norms are perceptions of how people actually behave.

⁶ Rain gardens are slight land depressions that are landscaped and designed to capture and infiltrate rainwater.



Figure 6: An example of a “Right Water” campaign kiosk educating passersby in a high-visibility area in Melbourne.

- Water Pricing*

Among the many reforms passed during the Millennium Drought, the National Water Initiative, in part, established a set of principles for pricing urban water nationwide. The principles require utilities to put water rates on a rational footing, removing pressure to underprice water as a means to win political favor (Heberger 2012). Both Melbourne and Adelaide were forced to raise water rates during the drought, with the dual objectives of signaling water scarcity and supporting major investments in water supply infrastructure. In Melbourne, a 5 percent environmental levy was added to water bills in addition to a modification of the block tariff structure from two to three tiers (Grant et al. 2013). In Adelaide, block prices were nearly doubled in comparison with pre-drought levels (Maier et al. 2013).
- Water Conservation Rebates and Appliance Retrofits*

Beginning in 2003, water conservation rebates were provided by the Victorian government for a range of water-saving products and services, such as rainwater tanks, greywater systems, dual-flush toilets, water conservation audits and efficiency showerheads, dishwashers and washing machines. Rebates were allocated in four-year cycles based on drought severity and forecast demand, and generally focused on residential water use, initially targeting single-flush toilets. Dual-flush toilets are now mandatory for all households. Reuse was another central focus, and, through mid-2015, the State of Victoria offered rebates up to AU\$1,500 for rainwater tanks when connected to toilets or laundry systems.

Lesson #5: Decentralized water sources can increase water system resilience.

During and after the drought, Adelaide and Melbourne employed a mix of decentralized strategies, including wastewater recycling, managed aquifer recharge, rainwater harvesting and stormwater capture. These short- and longer-term strategies augmented and accelerated the development of alternate water supplies, providing a diverse mix that reduced dependence on any single source. Diversified supplies allowed public green spaces to be irrigated with non-potable, fit-for-purpose water, reducing costs and strain on potable water supplies. In many cases, decentralized water sources can be brought online faster than larger, centralized projects, providing rapid response to emergency drought conditions.

One of the aforementioned strategies, rainwater harvesting, proved particularly popular. Most Australian cities have a culture of rainwater harvesting, partly owing to the country's outback heritage, where rainwater was and often remains the only water supply available. The drought reawakened interest in rainwater harvesting, igniting its application in Adelaide, Melbourne and elsewhere. Water agencies found the concept exceedingly popular with ratepayers, in part because water restrictions banned the use of potable water for residential landscape irrigation. As a result, public pressure mounted for rainwater harvesting incentives, and agencies responded accordingly, rolling out rebate programs to meet exploding demand. Nationwide, the number of households with rainwater tanks grew from 24 percent in 2007 to 34 percent in 2013 (Australian Bureau of Statistics 2013). Uptake was particularly pronounced in Australia's cities (Figure 7). In Melbourne, for example, residential rain tank adoption increased from 11.6 percent to 31.1 percent, and in Brisbane, adoption rose from 18.4 percent to 47 percent.

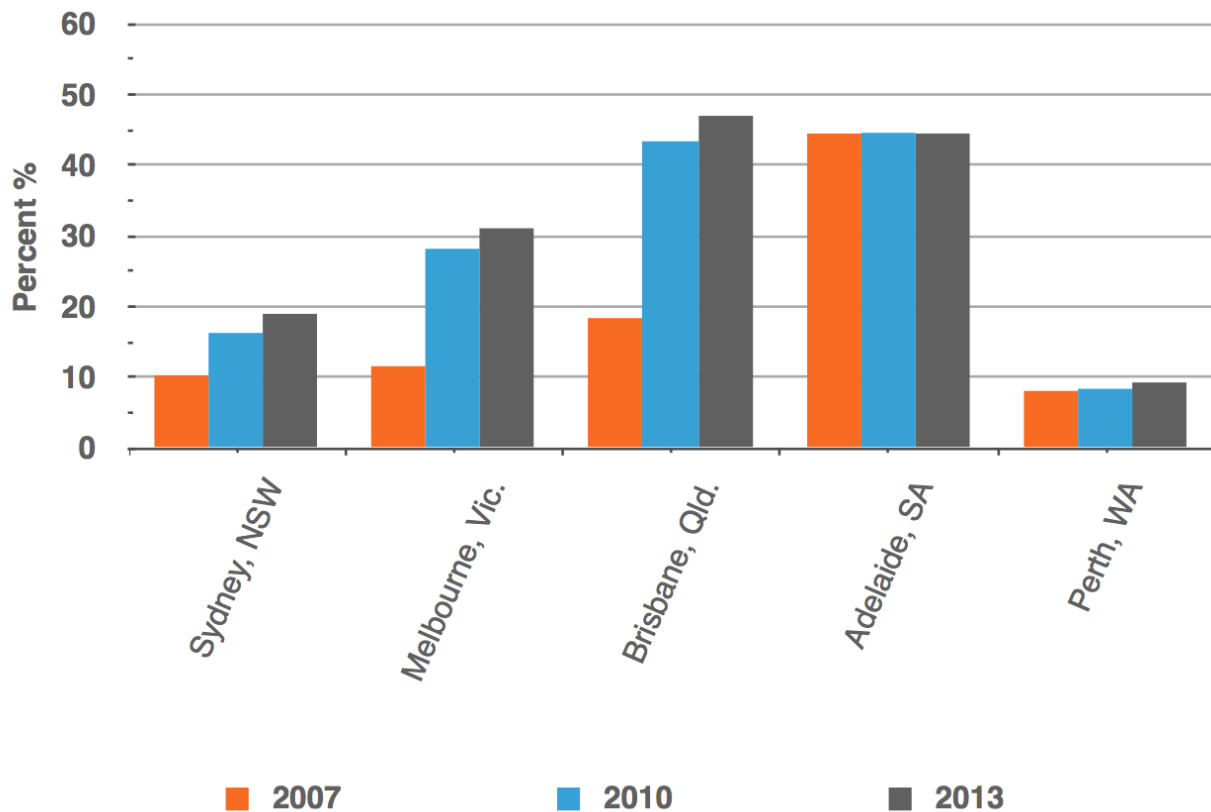


Figure 7: Households with rainwater tanks installed in Australia’s capital cities. (Adapted from Australian Bureau of Statistics 2013).

SUCCESSSES SINCE THE DELEGATION

In addition to facilitating research and spearheading a policy delegation to Australia, TreePeople has pursued numerous activities to support the expedient and effective transfer of lessons from Australia to Southern California. Tangible outcomes from these efforts include:

- Legalizing and streamlining use of alternate water sources for indoor and outdoor non-potable uses in Los Angeles County:*
 In February 2016, the Los Angeles County Department of Public Health released the “[Guidelines for Alternate Water Sources: Indoor and Outdoor Non-Potable Uses](#),” which updates regulations for outdoor uses of non-potable water and, for the first time, expands regulations to include indoor uses. Inspired in part by Australia’s “fit-for-purpose” approach to water use, TreePeople worked with local government, partner organizations and the Los Angeles County Department of Public Health to create a regulatory framework for using rainwater, stormwater, greywater, recycled water and air conditioning condensate both indoors and outdoors, including for toilet flushing, laundry and irrigation. More information about this effort is available at [TreePeople’s website](#).

- *Formation of the Los Angeles City Committee on Cooling and Urban Heat Impacts:* Los Angeles City Councilmember Felipe Fuentes was among the policymakers who participated in the 2014 delegation to Australia co-led by TreePeople and The Energy Coalition. Based on this experience, Councilmember Fuentes authored a motion, with support from TreePeople, to create a Committee on Cooling and Urban Impacts for Los Angeles, charged with establishing a cooling target for the City and developing strategies to counter extreme heat, particularly in disadvantaged communities. The City Council passed the motion unanimously in May 2016, and, as of this writing, the City is taking steps toward implementation ([related Council files here](#)). More information is available at [TreePeople's website](#).

CONCLUSION

Southern California's cities can greatly benefit from water- and climate-resilience lessons learned during and since Australia's Millennium Drought. TreePeople's research and policy exchange with Australia highlights key elements for cities to both adopt directly and adapt to particular circumstances. While all of the lessons outlined above are important, some elements, such as instituting collaborative governance structures and developing comprehensive alternate water supply solutions, may require more time to fully realize. However, there is no question that cities can also implement myriad reforms in the short-term to place them on a more climate-resilient path, including:

- Diversifying local water supplies, such as through rainwater harvesting, to advance fit-for-purpose uses;
- Ensuring water restrictions do not overly compromise public spaces necessary for recreation, shade and beauty;
- Implementing policies and programs to protect public health from extreme heat, such as pursuing and maintaining a robust tree canopy; and
- Instituting a variety of public behavior campaigns to reduce water consumption, including use restrictions, pricing mechanisms, public education, target-setting and efficiency rebates.

Southern California's municipal and regional policymakers should leverage protracted drought conditions to harness public and political will for necessary reforms. With a new climate reality facing the region, the continued drought offers a critical window of opportunity to educate the public and institute programs and policies imperative to climate-resilience.

About the authors:

Deborah Weinstein Bloome is the Senior Director of Policy and Research at TreePeople. She has worked on environmental policy issues for over twenty years at international, federal, state and local levels. In her current role, she creates policies, laws and incentives to support climate-resilient cities. She holds a BA in Business/Economics from the University of California, Santa Barbara and a Master's in Public Policy from the University of California, Los Angeles.

Edith de Guzman is Director of Research at TreePeople, where she manages research into best practices for the sustainable transformation of the Greater Los Angeles area and develops and maintains strategic partnerships with policymakers, agencies, and community partners around urban ecosystem management. In her tenure with TreePeople, Edith has been a lead or team member on groundbreaking research, demonstration projects and public planning in areas of urban forestry, urban watershed management and climate adaptation. Edith earned a Master's in Urban Planning from UCLA, and a BA in History/Art History, also from UCLA.

LITERATURE CITED

Australian Bureau of Statistics. March 2013. Rainwater Tanks. Environmental Issues: Water Use and Conservation.

Heberger, M. 2012. Australia's Millennium Drought: Impacts and Responses, pp. 97-125. In Gleick, P. H. (Ed.). *The World's Water Volume 7: The Biennial Report on Freshwater Resources*. Island Press, Washington, D.C.

Government of Victoria. February 20, 2014. Victorians Urged to Use the Right Water. Melbourne.

Grant, S.B., Fletcher, T.D., Feldman, D., Saphores, J.D., Cook, P.L.M., Stewardson, M., Low, K., Burry, K., and A.J. Hamilton. 2013. Adapting urban water systems to a changing climate: Lessons from the Millennium Drought in Southeast Australia. *Environmental Science and Technology*: 10727-10734.

Maier H.R., Paton, F.L., Dandy, G.C. and Conner, J.D. 2013. Impact of Drought on Adelaide's Water Supply System: Past, Present, and Future, pp. 41-62. In Schwabe, K., Albiac-Murillo, J., Connor, J.D., Hassan, R., Meza González, L. (Eds.) *Drought in Arid and Semi-Arid Regions: A Multi-Disciplinary and Cross-Country Perspective*. Springer Science+Business Media, Dordrecht.

Norton, B.A., Coutts, A.M., Livesleya, S.J., Harris, R.J., Hunter, A.M., and N.S.G. Williams. 2015. Planning for cooler cities: A framework to prioritise green infrastructure to mitigate high temperatures in urban landscapes. *Landscape and Urban Planning* 134:127-138.

Thwaites, J. 2014. Water and Behaviour Change: Lessons from the Front Line: Presentation. Monash Sustainability Institute, Climateworks Australia.

Yarra Valley Water. Oct. 23, 2014. Water Conservation Residential Programs: Presentation.