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Evaluating the effects of turf-replacement programs in Los Angeles

Stephanie Pincetl [a], Thomas W. Gillespie [b], Diane E. Pataki [c], Erik Porse [a d], Shenyue Jia [b], Erika Kidera [a], Nick Nobles [b], Janet Rodriguez [b], Dong-ah Choi [e]

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Highlights

- Half of urban water consumption is used for outdoor irrigation, dominated by lawns.
- Turf replacement incentive programs have a high potential for transforming urban landscapes.
- In 2014, a Los Angeles regional turf replacement led to 165 million square feet of turf removal.
- Participation in turf replacement incentives in Los Angeles County correlated with income.
- Alternative landscapes in front yards showed a high diversity of typologies.

Abstract

Water utilities incentivize turf replacement to promote water conservation, but the effects of such programs have received limited evaluations. In 2014, the Metropolitan Water District of Southern California (MWD) undertook an unprecedented investment to incentive turf replacement throughout Southern California in response to a serious Statewide drought. MWD devoted $350 million to the program, resulting in more than 46,000 rebate payments (25,000 in Los Angeles County) to remove 15.3 million square meters of turf. The program implementation provided a unique opportunity to address research gaps on turf replacement implementation. We analyzed socioeconomic and spatial trends of program participants and assessed landscape changes from turf replacement using a random sample of properties (4% of LA County participants in 2014–16). Specifically, we used a novel and cost-effective approach *Google Earth Street View* to characterize landscapes in front yards and created a typology of land cover types. Results showed: post-replacement landscapes had a diversity of land cover types – diverse yards with several land cover types, as well as more homogenous yards with a single land cover such as woodchips, bare soil, gravel, and artificial turf. Analysis also indicated some evidence of "neighborhood adoption" effects. We describe the need for longitudinal studies to understand long-term effects of turf replacement and associated water use, and suggest that water utilities should also evaluate results in backyards, which requires site visits. This study provides a novel contribution that can be replicated over space and time to further knowledge of turf replacement program implementations and evaluation.

Introduction

Lawns are dominant landscapes in many North American neighborhoods, even in drier western states with limited and seasonal precipitation (Robbins, 2007). Maintaining green lawns in such areas with grass species that are better acclimated to wetter climates requires significant irrigation and may not be sustainable. Population growth and increasing competition for water between agriculture and urban areas, as well as among cities, are straining available water resources in Western North America, raising questions about the availability of water for lawns relative to other uses (MacDonald, 2007, McDonald et al., 2011). Cities such as Mesa, AZ, Las Vegas, NV, Austin, TX, Albuquerque, NM, along with several regions in California, have funded turf replacement as a way to achieve long-term reductions in water demand (Addink, 2005, Agthe et al., 1986, Hollis, 2014, Sovocool et al., 2006). Even without fully removing lawns, changing the varieties of planted species and associated social expectations of yard appearances, reducing excess irrigation, and promoting tree canopy cover to reduce turf water losses can potentially yield more drought-tolerant and amenable landscapes in arid western U.S. climates (Johnson et al., 2013, Kjelgren et al., 2000, Litvak et al., 2013).

Despite investments by some water utilities in turf replacement, however, evaluative studies of the effects of turf replacement programs are limited (DeOreo and Mayer, 2012, Mayer et al., 2015). In general, retrospective evaluations can examine: (1) effects of turf removal on water use and conservation savings (Hollis, 2014, Sovocool and Rosales, 2004, Sovocool et al., 2006), (2) changes in

land cover and the composition of plant species after replacing turf (Agthe et al., 1986, Sovocool and Morgan, 2005), (3) socio-demographic trends in program participation, (4) social preferences of implemented (and presumably water conserving) landscapes on the part of both residents and professional landscapers (Hooper et al., 2008, Kilgren et al., 2010, McCammon et al., 2009), and (5) cost-effectiveness of such programs for water savings and associated cost drivers (Addink, 2005, Agthe et al., 1986, Baker, 2017, Helfand et al., 2006, Jessup and DeShazo, 2016, Sovocool and Rosales, 2004, Testa and Newton, 1993). Here, we address two of the above topics by presenting an analysis of land cover composition and structure that results from turf replacement, as well as socio-demographic trends in program participation. We evaluate landscape changes to front yards of properties participating in a large-scale turf replacement program in the service territory of the Metropolitan Water District of Southern California (MWD). The analysis examined observed changes in landscapes directly resulting from turf replacement based on analysis of properties before and after implementation. Systematic studies of program participation and effects, in this program and similar ones in other areas, are typically not conducted or not available in research. We undertake the task of evaluating landscape effects by combining imagery data with knowledge of rebate implementation. Our study did not survey residents, nor examine back yard landscape change due to access limitations and funding constraints. Yet, despite these limitations, our research methods provided a unique opportunity to study unaddressed aspects of turf replacement effects, which can improve knowledge for implementation and evaluation.

Previous studies of turf replacement have especially focused on water savings and the associated cost-effectiveness of replacing turf in relation to other water supply and demand management options (Baker, 2017, Baum-Haley, 2013, Farag et al., 2011, Hollis, 2014, Mini et al., 2014, Mini et al., 2014, Tull et al., 2016). Early studies tended to use small data sets of participating properties, yielding mixed conclusions on effectiveness (Addink, 2005, Agthe et al., 1986, City of Austin, 1993, Testa and Newton, 1993). The size of contemporary turf rebate programs, along with available data, has grown to support more comprehensive evaluations. Larger studies with more participants have, to date, generally (but not consistently) identified water savings from turf replacement, though a host of factors influence the effectiveness of programs, especially properly-installed irrigation systems (Hollis, 2014, Sovocool et al., 2006). Controlling for those factors requires significant data collection, including detailed account-level data, well-designed experiments, advanced statistical procedures and large datasets to control for confounding factors, and imagery (Hollis, 2014, Sovocool and Rosales, 2004, Sovocool et al., 2006, Tull et al., 2016). Tailored tools and metrics, including methods to compute excess irrigation of landscapes, assist in understanding human influences on resultant water use and conservation (Glenn, Endter-Wada, Kjelgren, & Neale, 2015). Irrigation systems can help institutionalize water use savings from converting landscapes (DeOreo et al., 2011). But the existing studies of turf replacement and resident preferences have not focused on the composition of landscapes that are installed following turf removal. Those that have generally used broad landscape categorizations such as traditional yards with turf, xeric (low-water), and combinations thereof (Hurd, 2006). A gap exists in understanding not only the water savings effects that water utilities might find most interesting, but also the ecological effects of

plant diversity and landscape change that could yield a broader, multi-benefit view of turf removal in arid- and semi-arid-climate cities.

Turf replacement initiatives are one type of resource conservation program that relies on voluntary participation. Determinants of participation in conservation programs vary, driven by both social attitudes and economic incentives. Voluntary conservation actions may not have sufficient public support, especially when program goals conflict with social expectations or the need for change is uncertain. Weak correlations often exist between behavioral intentions for management or conservation actions, and a wide range of beliefs and attitudes (Cook et al., 2011, Field et al., 2017, Larson et al., 2010). In some cases, rebate programs may have subsidized so-called free-riders, or residents who were likely to replace lawns anyway (Addink, 2005). Even philanthropic supporters of conservation can be slow to change behavior (Field et al., 2017). Conservation and environmentalist practices, including landscape choices, are not consistent with personal values or preferences (Larson et al., 2010, Yabiku et al., 2008). Much more work needs to be done systematically to understand landscape change and conservation choices among many programs and across many sociodemographic groups. Our study provides observational data to help inform understanding of drivers of participation actions, along with plant and landscape decisions, in southern California, a Mediterranean climate, given conventional offerings in local plant nurseries (Pincetl, Prabhu, Gillespie, Jenerette, & Pataki, 2013).

Like many places, lawns are dominant landscapes in California neighborhoods (Robbins, 2007). Preserving such landscapes in summer requires significant seasonal irrigation in almost all parts of the state. California urban areas use approximately 20% of the state's developed water supply, but in many areas, over half of urban water consumption in the residential sector is used for outdoor irrigation (Hanak & Davis, 2006). Some cities in California have supported turf replacement for a decade or more, but offerings are sporadic and unevenly distributed (Baum-Haley, 2013). During recent drought (2011–2016), water utilities incentivized and promoted outdoor water conservation to reduce consumption (Mitchell et al., 2017). As part of this effort, in 2014, MWD, Southern California's water importer serving a 13,468 square kilometer region and nearly 19 million people in the coastal and Inland Empire regions, implemented the largest single investment by a water utility to date in turf replacement. It revamped its existing regional turf replacement program, which had funded $100 million annually of incentives, and increased available funds across its service territory to $350 million. Residents received $2.00 of incentives per square foot ($0.09 per square meter) of lawn removed, which was subject to payment upon providing documented evidence of turf replacement (MWD, 2015). This was potentially boosted by additional local incentives, such as in the cities of Los Angeles and Long Beach. MWD received over 85,000 applications for the 2014 program.

By mid-2015, program funds were exhausted, paying out 46,000 rebates to replace more than 165 million square feet (15.3 million m^2) of turf (M. Hollis, personal communication, December 10, 2016). Such programs aimed to change landscapes and resident behavior, achieving long-term water savings rather than just short-term reductions (Office of the Governor of California, 2016).

Turf removal incentives in California have been provided at local, regional, or state levels, but for Southern California, the availability of monetary incentives has not been consistent throughout service areas, nor year to year.

The habits of water use, including outdoor water, are subject to many factors. For instance, water demands across all end-uses in the city of Los Angeles were extensively analyzed by Mini et al., 2014, Mini et al., 2014 in longitudinal studies, including under a period of drought. Higher water prices and mandatory irrigation restrictions contributed to water conservation behavior, but was not directly related to landscape change as there were no turf replacement incentives in place. Further, lower income neighborhoods curbed water use more than wealthier neighborhoods. Recent post-drought data has shown that throughout California, sizable gains in outdoor water conservation achieved during periods of drought often reverse, though not always fully (Gonzales and Ajami, 2017, Hanak and Lund, 2011, Mitchell et al., 2017). Water use levels have tended to regress to amounts that are higher than during peak conservation, but often not as high as at the beginning of drought (SWRCB, 2018). Technological innovations, new fixtures, and converted landscapes help promote long-term savings, but for lawns that remain, irrigation habits tend to revert to prior practices, as evidenced by urban water use trends after past droughts (Mitchell et al., 2017).

Prior to recent drought, many southern California cities had been slow to transition to low-water landscapes, due in part to the region's access to multiple sources of imported water. The boost in program funding from MWD created a unique environment among turf replacement initiatives. Freedom to choose new landscapes resulted in a diversity of post-replacement landscapes based on participant preferences regarding design, composition, drought-adapted plants, and non-turf land cover types. A comprehensive evaluation of turf replacement habits can help summarize and understand landscape choices, including important questions such as whether all participants converted turf to drought resistant landscapes. To date, no comprehensive analysis of participants exists and there is no data on the floristic composition, species richness, or structure of these new landscapes.
Our research sought to answer three key research questions regarding turf replacement program outcomes:

(1) What were the socio-demographic, economic, and geographic characteristics of turf replacement program participants?

(2) What plants and landscape types were installed?

(3) Is there evidence of neighborhood adoption effects, whereby a resident who participates in a program spurs additional nearby neighbors to also replace their turf?

The results can provide critical information about the results of large-scale turf removal programs for landscape and land cover change as California is increasing broad planning efforts to address long-term water management and climate change adaptation challenges.

Section snippets

Study area

The program evaluation focused on Los Angeles County (LA County). LA County has over 10 million residents and more than 100 water agencies (Census, 2013, Pincetl et al., 2016). The climate is Mediterranean, characterized by dry summers and wet winters, with an average temperature of 16 °C and 562 mm of rainfall annually. MWD, the Los Angeles Department of Water and Power (LADWP), and the San Gabriel Valley Water District all import water to the region, with MWD and LADWP being the dominant …

Program participation factors

Program participation was not evenly dispersed throughout Los Angeles County. Properties lying within the service territory of a water retailer that offered supplemental rebate amounts in addition to MWD comprised the vast majority of participants. One retailer, LADWP, dominated the turf replacement applications with more than 20,000 of the 24,921 records used in the analysis (Appendix 2). This likely results from LADWP's significant additional rebate amount. Results from statistical analysis …

Participation

The highest participation rates were clustered in the San Fernando Valley region of the City of Los Angeles. While likely related to the higher rebate amount offered through the combined MWD and LADWP programs, the trend also has implications for program effectiveness. The San Fernando Valley is significantly hotter than coastal areas of Los Angeles and more suburban, with generally lower population density, diverse populations, and more yard space. Replacing turf in these areas with other land …

Conclusions

MWD's 2014 turf replacement program was an unprecedented investment in future urban landscapes that can help reduce long-term urban water demands in California. The significant boost in funding and new program requirements in 2014 offered a prime opportunity to test the effects of such programs on landscapes and behavior using new imagery techniques and integrated large-scale data sources. We found strong correlations between rebate program participation and home ownership, income, and …

Acknowledgements

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Recommended articles

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Reduced urban green cover and daytime cooling capacity during the 2012–2016 California drought

2021, Urban Climate

> *Citation Excerpt :*
>
> …3) The Metropolitan Water District of Southern California incentivized turf replacement programs during the drought. These programs were more successful in inland areas, particularly in the San Fernando Valley (Pincetl et al., 2019). These results suggest that drought may have lasting impacts on the urban environment not only from direct drought induced losses of GV cover, but also from policy and individual decisions in response to drought.…

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