Potential Outdoor Water Savings of Los Angeles

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Section A02

Abstract

In Southern California, water is in short supply and in high demand. This is sharply contrasted with Northern California, where water is well supplied and water demand is lower. To adjust for this imbalance of water use, Southern California receives diverted water from systems like the Colorado River and Northern California reservoirs, and all cities seek new water conservation solutions to reduce overall demand. Most Northern California cities, notably San Francisco, report significantly lower water total water demand in comparison to Southern California cities where demand is so high it borders abuse. As a baseline scenario, we adjusted the water use per capita of Los Angeles based on the growing population to estimate water use per capita and potential water savings. In order to determine how much of an impact certain mitigation measures can take, our group decided to calculate the net benefits of xeriscaping all of Los Angeles' backyard and front lawns currently with grass. Through this approach, we hoped to demonstrate the scale of such a radical conservation policy and approximate associated implementation costs.

By projecting the water use per capita (now and future) in Los Angeles, we can quantify the impact of implementing water efficiency or water reduction policies for individual households and the city at large. We developed hypothetical scenarios to estimate potential water savings by looking at census and LA water monitoring data. Our research estimated water demand and supply, the net economic benefits of xeriscaping for individual households, and a citywide implementation cost. By expanding education on money saving practices and environmental benefits of water conservation, we can inform the dense population of Los Angeles to increase awareness and concern for our current water situation. This may have significant impacts on reducing total water consumption on county and statewide scales. By developing water conservation policy targeted at California cities with the highest water use per capita, we reduce overall California water-use and increase the effectiveness of taxpayer dollars.

Introduction

Population, geographic location, and the percentage of water use in a community by residents and industries determine urban Water use. Different cities in California have different strategies and infrastructures that help maintain their water supply. Some are more efficient at water conservation than others. Water allocation is very important because it has to be done in a manner that achieves economic efficiency, social equity and environmental sustainability. These cities get their water from groundwater, watersheds, aquifers, reservoirs, etc. There is not an endless supply of water and there seems to be many shortages, so decisions have to be made on how we are going to divide it up amongst the different users.

Urban water use has two main components indoor and outdoor water uses. Indoor water use comes from daily activities like showering, flushing the toilet, washing dishes, clothes washer and inside leaks. Outdoor water sources are watering the lawn and plants. In our analysis we only considered outdoor water uses in Los Angeles.

Water scarcity in Southern California has increased dramatically, more specifically Los Angeles. Data from USGS has shown that the county of Los Angeles withdraws about 598.36 million gallons of groundwater per day. On the other hand San Francisco withdraws only 1.50

million gallons of groundwater per day (USGS 2010). Both cities are highly populated and urbanized, so what components makes these two cities so different?

Landscaping, which accounts for 50 percent of a typical residential water bill, is only one of the many driving factors (LACWD 2015). Los Angeles homes have lush green lawns and bushes surrounding it. San Francisco has more buildings and apartment like structured homes that have little lawns or no lawns at all. Each city has their own water conservation plan, but S.F seems to be much more efficient than L.A. Water demand is rising due to increasing populations. A great way to sustain Los Angeles' water demand is to implement xeriscaping strategies. Xeriscaping is landscaping and gardening that reduces the need of supplemental water from irrigation. Xeriscaping would take less water to help keep lawns and plants alive.

Objectives

Our main objectives will be divided across our four team members. Our main objectives include:

1) Gathering population data and water use per capita data for the LA and SF.
2) Estimate the population growth and water use per capita specifically in outdoor water use via lawns in LA, projecting current consumption trend.
3) Developing a conservation scenario adjusting water use per capita of LA through the implementation of xeriscaping. This will provide us with any potential water savings in LA.
4) Estimating the implementation costs associated with this conservation scenario and assessing its feasibility.

Hypothesis

We predict Los Angeles is capable of saving significant quantities of water through xeriscaping strategies. Independent of population size, the water use per capita of Los Angeles is surprisingly close to that of San Francisco. Because Los Angeles has such a large population that engages in more outdoor water use than San Francisco residents, the potential water savings is magnified, and through conservation strategies like xeriscaping landscapes, it is possible. We also expect it to be feasible given that this solution has a "Cash for Grass" rebate program courtesy of the Los Angeles County Waterworks District (LAWCD) rebate program.

Data Sources

1. USGS (2010). Estimated Use of Water in the United States County-Level Data for 2010. USGS Circular 1405. Online.
2. LA County Waterworks District
    a. LACWD. (2015). "Water Conservation." Retrieved June 3, 2015, 2015, from http://dpw.lacounty.gov/wwd/web/Conservation/WaterConservation.aspx.
    b. LACWD. (2015). "Water Rates." Retrieved June 3, 2015, 2015, from http://dpw.lacounty.gov/wwd/web/CustomerService/WaterRate.aspx.
    c. LACWD. (2015). "Cash for Grass Rebate Program." Retrieved June 3, 2015, 2015, from http://dpw.lacounty.gov/wwd/web/Conservation/CashForGrass.aspx.
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    a. Census, U. S. (2015). State and County QuickFacts. U. S. C. Bureau. Online.
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Methods and Assumptions

Our team gathered data from a variety of research papers, LA city websites, and federal agencies. From these sources, we modeled population growth and calculated estimates for urban outdoor water use from now until 2030. In this section, we assumed that the average household water use per capita was unchanging from now until 2030. In calculating the number of lawns in the city, we overestimated that the number of households equates to the number of lawns in the city. As population grew, we also assumed that the number of households grew at the same rate. To estimate potential citywide water savings as a result of xeriscaping residences, we calculated a baseline and conservation scenarios for LA.

Our next step was to estimate the costs and benefits of implementing a xeriscaped lawn. To calculate this, we averaged the size of several household lawns in LA, and used a representative lawn size of 2,000 square feet. For a given 2,000 square-foot lawn, we calculated the benefits by adding the rebate received from the LACWD to the present value of the annualized water savings after 15 years (assuming a constant LACWD pricing plan and an inflation rate of 7%).

To estimate the cost, we factored in the average installation cost of xeriscaping the lawns, both by retrofitting an existing lawn, and developing a new property. Using the estimated costs and benefits, we calculated the estimated net benefits per individual LA household of converting to a xeriscaped lawn. By multiplying the individual costs by LA households in 2015, we approximated the city-wide implementation cost, and possibly the potential amount to be awarded to participating households of the LACWD "Cash for Grass" Rebate Program.

Calculation/Results

Part A: Estimating Citywide Water Savings in Gallons Per Year

Population data from the City of Los Angeles was attained from the US Census Bureau for the years of 1990-2013 (Census 2015)**.** By using the population for those years, a power trend line and a linear trend line were added to the data.

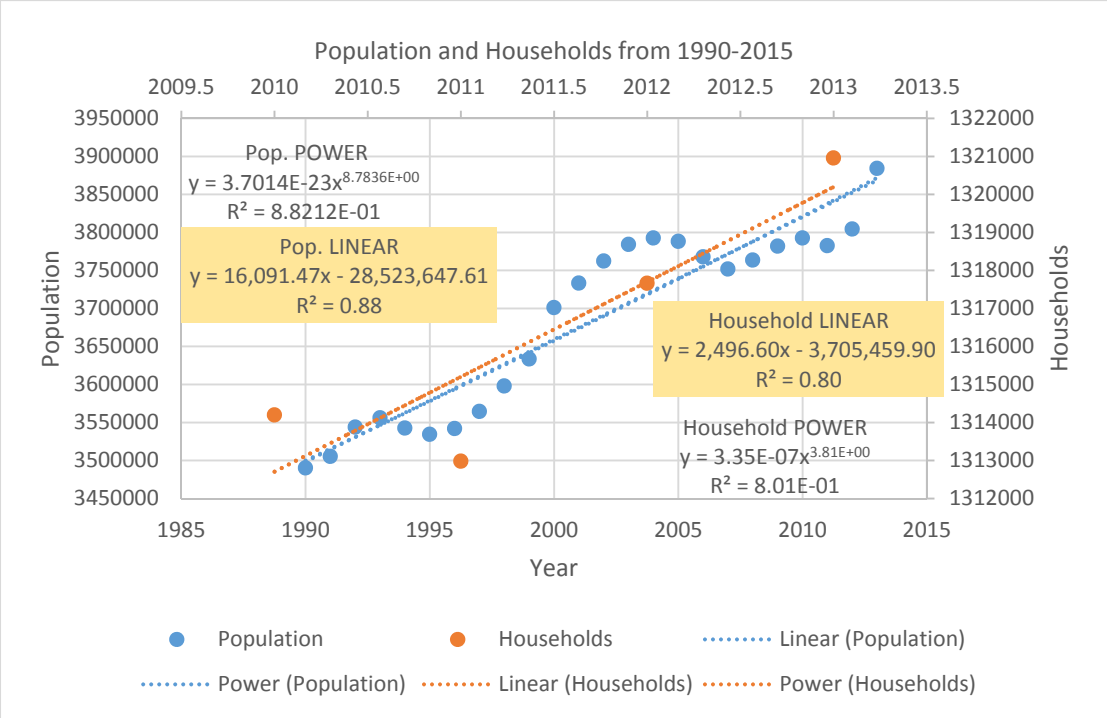

Figure 1- Los Angeles Population data from 1990-2013 used to find trend line. Household data from 2010-2013 used to find household trend lines. Linear trend lines used to project population and households from 2014-2030 in Table 1.

Both had very similar R^2 values of .88, so the linear trend line was used to project future Los Angeles population up until 2030. Household data was more difficult to find and was only found for the years 2010-2013. Using the population projection and the data points, linear and power trend lines were added to the household data. The linear line was also chosen to best represent the household data, although both linear and power also had similar R^2 values of .80. The equations used to project population and households from 2013-2030 are highlighted in yellow in figure 1 and are below.

Population projection trend line
y = 16,091.47x - 28,523,647.61
R^2 = 0.88
Household projection trend line
y = 2,496.60x - 3,705,459.90
R^2 = 0.80

Year	Households	GPD for LA (households x 500 GPD)	GPD without Xeriscaping (70% of total use)	GPD with Xeriscaping (50% reduction)	Water saved with xeriscaping
2010	1314198	657099000	459969300	229984650	229984650
2011	1312983	656491500	459544050	229772025	229772025
2012	1317663	658831500	461182050	230591025	230591025
2013	1320960	660480000	462336000	231168000	231168000
2014	1322693	661346250	462942375	231471187.5	231471188
2015	1325189	662594550	463816185	231908092.5	231908093
2016	1327686	663842850	464689995	232344997.5	232344998
2017	1330182	665091150	465563805	232781902.5	232781903
2018	1332679	666339450	466437615	233218807.5	233218808
2019	1335176	667587750	467311425	233655712.5	233655713
2020	1337672	668836050	468185235	234092617.5	234092618
2021	1340169	670084350	469059045	234529522.5	234529523
2022	1342665	671332650	469932855	234966427.5	234966428
2023	1345162	672580950	470806665	235403332.5	235403333
2024	1347659	673829250	471680475	235840237.5	235840238
2025	1350155	675077550	472554285	236277142.5	236277143
2026	1352652	676325850	473428095	236714047.5	236714048
2027	1355148	677574150	474301905	237150952.5	237150953
2028	1357645	678822450	475175715	237587857.5	237587858
2029	1360142	680070750	476049525	238024762.5	238024763
2030	1362638	681319050	476923335	238461667.5	238461668
				Total saved	4915944968

Table 1- Estimated water use in Gallons per Day. There is an assumption that 70% of all water use is used for the outdoors. There is an assumption that when xeriscaping the land, 50% of the outdoor water use will be saved.

There are several assumptions made in the data attained from sources. For each household, 500 gallons per day were used. Of the total amount of water used daily, 70% if for outdoor use. When switching to a xeriscape landscape, 50% of the amount used outdoors could be saved (Census 2015).

Example for the year 2010:

Total amount of households for the year: 1314198
Each household uses 500 GPD
1314198 x 500 = 657099000 GPD for all households
70% of the water used daily is for the outdoors
657099000 x .70 = 459969300 GPD
Xeriscaping can reduce the amount by 50%.
459969300 x .50 = 229984650 GPD

The final amount of water saved with xeriscaping in totality is 4,915,944,968 GPD in 30 years.

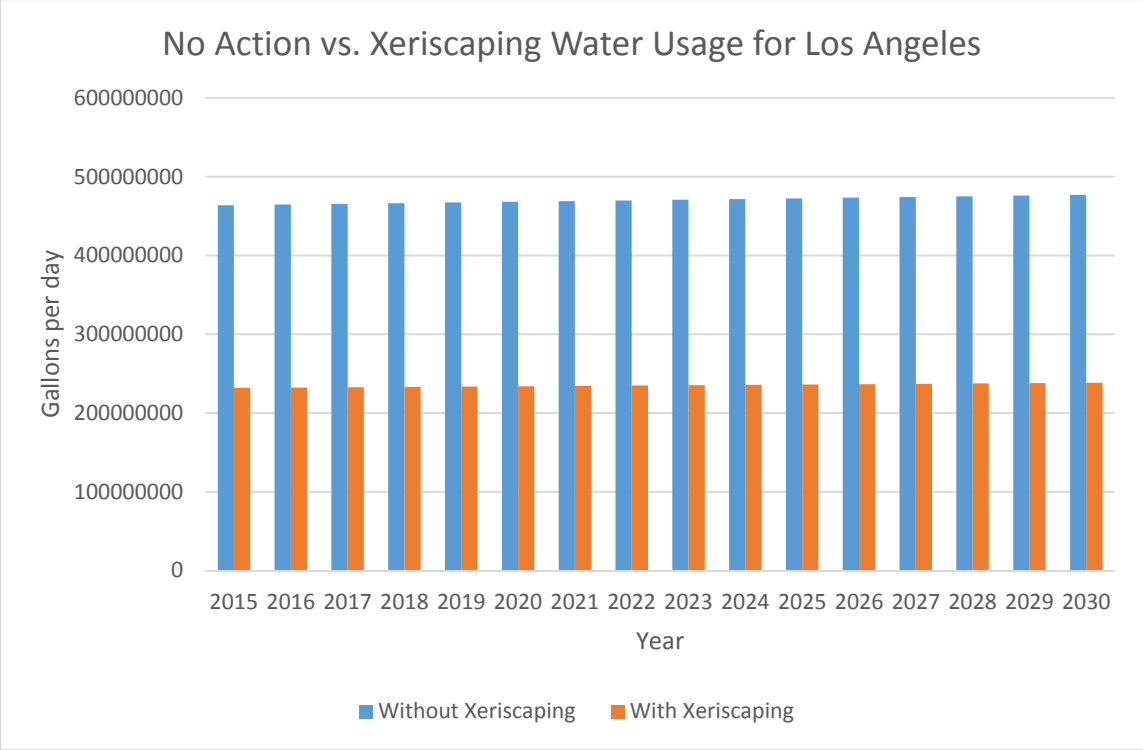

Figure 2- Xeriscaping water use and No action water use as displayed in Table 2.

Part B: Estimating Net Benefits of Xeriscaping for an Individual Household in LA

Tables 2, 3, and 4: A breakdown of values (Table 2) used in our calculations (Table 3) to determine the net benefits (Table 4) of xeriscaping for an individual household in LA.

Relevant Figures Base Information			
WUPC (LACWD 2015)	500 gpd	Inflation Rate	7%
Outdoor WUPC (LACWD 2015)	350 gpd	Years of Xeriscaping	15 (2015 - 2030)
Indoor	150 gpd	LA Water Rate (LACWD)	$1.467 / 748 gpd
Avg. Household Lawn Size (Cohen 2009)	2000 sq. ft	Cash For Grass Program Rebate (LACWD 2015)	$1.50 / sq. ft.

Table 2

Xeriscaping Total Benefits	Outdoor WUPC (GPD)	Water Cost (Dollars/Day)	Water Cost (Dollars / Year)	Annualized Benefits (Dollars / Year)	Present Value after 15 years (Dollars)	Cash For Grass (Dollars)	Total Benefits
Do Nothing	350	$0.69	$250.55	$0.00	$0.00	$0.00	***$0.00***
Xeriscaped	175	$0.34	$125.27	$125.27	$1,140.98	$3,000.00	***$4,140.98***

Table 3

Xeriscaping Total Cost & Net Benefits	Total Cost (Installation & Labor)	Net Benefits (Dollars)
Retrofitting Lawn	$1,432	***$2,709***
New Start Lawn	$768	***$3,373***

Table 4

The values in the initial base table were calculated from data sources cited earlier. The xeriscaped scenario was compared against a "do nothing" scenario as calculated from the information in Table 2. The final value of net benefits were found to be ***$2,709 for retrofitting an existing lawn, and $3,373 for developing a new property (Medina 2004).***

Part C: Estimating Implementation Costs for Xeriscaping Citywide

Xeriscaping Citywide Implementation Costs	Total Cost to Xeriscape All of LA (Installation & Labor)
Retrofitting Lawn	$1,897,670,791
New Start Lawn	$1,017,745,229

Table 3. Data reflecting the calculation of the total cost (Table 4) multiplied by the number of LA households in 2015.

By multiplying the number of households in 2015 against the total cost of xeriscaping per individual household (Table 3), we estimated the ***total cost of implementation to be $1,017,745,229 - $1,897,670,791.***

Conclusion

Based on our research and calculations, we are confident that relying on xeriscaping, as a water conservation strategy to reduce outdoor urban water use in Los Angeles would be extremely beneficial to the economy as well as to the environment.

Substituting drought tolerant plants and shrubs for grass lawns would significantly decrease water use, conserving 238,461,667.5 gallons in 2015 alone. Individual water bill rates would decrease, allowing residents with xeriscaped lawns to enjoy $2,709 - $3,373 in savings over 15 years – depending on whether or not they retrofit an existing lawn, or develop a new property. To fully implement xeriscaped lawns and provide rebates for all participating households, it would cost the city of LA between $1,017,745,229 and $1,897,670,791 in 2015.

Although expensive, it would allow water savings to be allocated toward other demands such as agriculture or urban indoor use.

Implementing xeriscaping into the yards and front lawns of Los Angeles residents will significantly reduce the city's demands on their water supply. Demonstrating that a xeriscaped city is possible would alter conservative mindsets, highlighting the severe water crisis we'll continue to face in the coming years.

Recommendation/Limitations

In the beginning, our project was comparing San Francisco water use per capita against Los Angeles water use per capita and determining what factor caused the largest discrepancy between the two. Initially we put our attention on indoor water use and attempted to veer towards the idea of indoor water efficiency differences. However, water efficiency data for the city, let alone the county, was next to impossible to find. Due to this minor setback, we set our sight on outdoor water use, specifically converting lawns to xeriscapes.

A limitation in this aspect was the lack of data on total lawns in Los Angeles. We had to assume that a household by default had a lawn that had not yet been xeriscaped. In addition, the amount of households in Los Angeles data only went back to the year 2010. Prior to 2010, only county household data was estimated. We needed to use known population data to help project household data to 2030. Without ever having a clear idea of how socioeconomic factors in Los Angeles will grow or shrink the population, rough projected estimates were our best guess by using trend lines on population data

Another limitation was finding a representative number of gallons used per household; they differed from site to site. We settled on 500 gallons per day per household. Within that same limitation, the numbers given as to how much of the total water per household was used for outdoors was 70%. There was no known amount for lawns specifically, so we had to assume that all of the 70% was going towards the lawns. As for the xeriscaping reduction, we based the data on the idea that every household in Los Angeles switched to xeriscaping within that year, which is an impossible estimate. In regards to net benefits of xeriscapes, we had to come up with an average cost for retrofitting a lawn to a xeriscape and assumed that no contractors were hired. In order to better project the net benefit, perhaps contractors should have been estimated as well. In addition to the cost, we estimated the water savings in dollars and added the cash for grass rebate program provided by the LACWD. There is no exact known inflation amount for the future value of water, so that also had to be estimated.

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Cohen, Y. (2009). Graywater - A Potential Source of Water. Southern California Environmental Report Card. Online, UCLA Institute of the Environment and Sustainability. Fall 2009.

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