Comparing Indoor Water Saving Methods and Implications

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Abstract

California currently is suffering through one of its most severe droughts in history. As this drought persists, we need to evaluate where conservation needs to be applied to most. Our project evaluates efforts to reduce household indoor water usage by comparing costs and benefits of efficient toilets, shower heads, laundry machines, and faucets in California. This analysis will help to decide which device is the most cost effective. Some challenges include estimating the amount of devices per household, average life span of each device, and water cost. Many variables had to be researched to conduct the appropriate analysis.

Objective methods for Cost Benefit Analysis**:** Data for how much water is saved**,** Cost of installation**,** Cost of water, Lifespan of device**,** and Rebates.

Results from the cost benefit analysis show that shower heads save the most water and have the highest net benefit. From the full results it can be concluded that indoor water conservation through efficient technology is not as effective as it was years ago, and has perhaps reached the peak of its potential efficiency. This implies that efforts for water conservation should be focused upon outdoor water usage instead. But the main conclusion from the calculations is that water is too cheap. Water efficient technology, while it does save water, does not save enough money for people to truly care. However, this project did not take into account future values and interest rates of water and devices, estimation of lifespan, and maintenance cost as these variables may fluctuate.

Introduction

Previously, California has not had a plan for dealing with how we will conserve water in a drought. We decided to look at household indoor water usage conservation methods in order to compare what would be the most cost effective method for households to help in our time of drought. We discuss further our

methods of approaching this problem later in this paper, but found some challenges in either the lack of data or too much data to choose from for several sections of our calculations.

As members of the California community, we were motivated to look closer into this topic because we want to help do our best to alleviate the problem of the drought. By comparing household indoor methods of water conservation, we felt that this would be the most applicable way to decide for ourselves what we could realistically do to do our part in saving water. In the process, we also hoped to help others make an informed choice about what they could and should do to save water. Indoor water conservation is heavily promoted by the media, but we wanted to know if this is really the most effective way of saving water.

Objective

The main objective of this project is to estimate the costs and benefits from indoor water efficient devices and determine which is the most cost efficient for Californians. This project involves much research, so all group members have to be involved in each step so that information could be quickly found. Additionally, errors are easily made in calculation projects so all group members needed to be present so that minimal errors were made. In order to calculate the cost benefit analysis, past data had to be found on the gal/household/year and compared more current data. Then the average cost per gallon in California had to be found and applied to annual gallons used per household. After calculations of cost benefit analysis, net benefits had to be determined. Lastly, conclusions about the project had to be drawn based upon the results calculated.

Data Sources

California Urban Water Conservation Council (CUWCC). (2015). <https://www.cuwcc.org/Resources/Conservation-at-Home-and-Work/Smart-Rebates-Program> (May 25, 2015).

Circle of Blue. (2014). "Circle of Blue's 2014 Water Pricing Survey." <http://www.circleofblue.org/waternews/wp-content/uploads/2014/05/WaterPricing2014TableInteractive.pdf> (May 20, 2015).

Home Depot. (2000-2015). "Water Conservation – Toilets." <http://www.ecooptions.homedepot.com/water-conservation/toilets/> (May 21, 2015).

Methods and Assumption

- First, we collected our data and research by visiting several websites included above and wanted to do a different research project but found that there was not enough data for us to continue. We decided to do further research, met up, and then decided to work on this project of comparing four methods of indoor water conservation and seeing which would be most cost effective.
- We estimated the average household water cost per gallon in California by taking the average of four cities' (SF, LA, SJ, and SD) average monthly water bill for a family of four using 100 gallons per person, per day (Circle of Blue 2015).
- We estimated the average cost of water per person per day by taking the average monthly bills of the four cities and divided that number by the product of 30 days and 400 gallons of water each day, giving us $0.0065.
- Next we found the total benefits from the water saved for 2009 Water Usage for each method (measured in gallons/household/year) and the 2013 Water Usage for each method (measured in gallons/household/year), including replacing the following with more water efficient appliances: shower heads, faucets, toilets, and washing machines.
- We did this by finding the Total Water Saved (measured in gallons/household/year) per method of saving water (including shower heads, faucets, toilets, and washers), comparing 2009 and 2013 annual indoor water demand and multiplying the cost of $0.0065 per gallon per household of four by 15 years.

- The Total Cost was done by multiplying installation cost for the next 15 years of three low-flow shower heads, three faucets, three toilets, and one washing machine with consideration of their lifespan and rebate fees.
- After calculating the benefit and cost of each method, we found the net benefit from the difference.
- We found that replacing shower heads and faucets are the most cost effective way to conserve water because they have the highest positive net benefits compared to the washer and toilet replacements.

Assumptions:

- We chose the years 2009 and 2013 – we could have chosen other years but decided to look at these two.
- We could have chosen different websites for our data which might change the calculations, conclusions and implications of our project.
- We also could have chosen different quality of appliances, different prices for those appliances depending on the store, location, installation costs, etc.
- We also chose the four biggest cities in California in order to calculate the average water cost per person per household of four in California, but we could have chosen another method to calculate this cost. We also could have chosen a different method of estimating water cost per person, such as not doing water use per household of four.
- We also did not include many other costs that could be included, for example, the environmental costs of using water, future values, interest rates of water, estimated life span for appliances, and maintenance costs.

Calculation/Results

We calculated *the average household water cost per gallon in California* by taking the average of four cities' average monthly bill for family of four using 100 gallons per person per day (Circle of Blue's 2014 Water Pricing Survey).The four major cities we used were San Francisco, Los Angeles, San Jose, and San Diego. We took the average monthly bills of the four cities, and divided that number by the product of 30 days and 400 gallons each day. This gives us *$0.0065*.

City	Average Monthlly Bill for Family of 4 using 100 gallons/person/day	Avergae monthly	$78.57/(4people *100gallons/day *30day)=$/gallon
San francisco	92.5	78.57	0.0065
Los Angeles	75.98		
San Jose	56.43		
San Diego	89.37		
Average	78.57		

The total benefit of each method is calculated from the amount of water saved comparing 2009 and 2013 annual indoor water demand and multiplied by the cost of 0.0065 per gallon per household of four and times 15 years.

Example for the total benefit of washer-head:

(23,360-29,200 annual)*$0.0065/gallon*15 years =*$569.4*

Methods	2009 water usage (gal/household/year)	2013 water usage (gal/household/year)	Total Water Saved (gal/household/year)	Annual gallon saving ($) **water saved multiply by 0.0065 **	Total benefit for 15 years
Shower Heads (average lifespan is 10 years)	29,200	23,360	5,840	37.96	569.4
Faucets(average lifespan is 15)	15,257	12,155	3,102	20.163	302.445
Toilets (average lifespan is 20)	7008	5606	1402	9.113	136.695
Washer (average lifespan is 15 years)	7,650	5,400	2,250	14.625	219.375

The *total cost* comes from installation cost for the next 15 years of three low-flow shower heads, three faucets, three toilets and one washer machine with consideration of their average lifespan, and rebate fees ($150 for washer and $100 for each toilet).

Example for the total cost of three toilets:

($250 each for one replacement - $100 rebate fee for each toilet) x 3 units = *$450*.

Facilties	Average lifespan (Years)	Quantity	Cost of installation ($) in 15 years
Shower Heads	10	3	50*3*2=300$
Faucets	15	3	50*3=150
Toilets	20	1	(250-100)*3=450
Washer	15	1	724-150=624

After we calculated all the benefit and cost of each method, we found the *net benefit* from the difference of benefit minus cost. As a result, we found that replacing both shower heads and faucets are the most cost effective way for water conservation because they have more positive net benefits compared to washers and toilets.

Cost of installation ($) in 15 years	Total benefit in 15 years	Net benefits	
50*3*2=300$	569.4	269.4	Shower heads
50*3=150	302.45	152.45	Faucets
(250-100)*3=450	136.7	-313.3	Toilets
724-150=624	219.38	-404.62	Washer

Conclusions

After conducting a cost-benefit analysis of the different water-saving appliances in a household, we found that showerheads were most cost-effective, followed by faucets, washer, and finally toilets. In other

words, out of the four methods, installing showerheads in a model home requires the least cost and acquires the most benefit in terms of how much water it saves.

However, looking at the entirety of the analysis, many future implications about water conservation methods can also be made. First of all, although technology has become a lot of efficient in its water use since 1975 when restrictions on water flow became popular on home water devices, comparing the efficiency of 2009 to 2013, we see that efficiency does not change as much as it did before. This means that even with more efficient technology, not much more water can be saved. For instance, toilets in 1975 were made to have 5.0 gallons per flush (gpf) compared to ones in 2013 that have 1.28gpf. However, by 2009, toilets were already only using 1.6gpf, which is only 0.4 gallons away from the 2013 efficiency standard. This could imply that reducing indoor water use through more efficient devices may not yield as much result as trying to conserve water through other means in other areas, such as in agriculture and industry. Perhaps money resources and efforts should be put into constructing better irrigation systems and other methods to make saving water more beneficial.

Another important implication, as observed from the low net benefits seen in the analysis, is that the cost of water at its current value is too low. For example, if the estimated cost of water were a lot higher, more specifically if it were raised to a value greater than $0.0215, then the installation of all four water-saving methods appliances would yield a positive benefit.

$0.0215 was calculated using the method with the lowest benefits, which were toilets

1402gal/household/year saved * cost of water * 15 years > 0; cost of water > $0.0215.

This could suggest that one reason why some people are still passive about saving water even during one of California's longest drought is that there is little or no economic incentive to do so since water is so cheap.

On the other hand, in recent years, the perpetuated water crisis has become more and more common knowledge among regular citizens as California's lakes are drying and water supply from reservoirs are

quickly disappearing. Many homes have already installed efficient water-use devices, and many laws have set flow standards for these devices. It seems people are finally beginning to realize the true value of water, of its importance to the environment, ecosystems, and quality of life, and will continue to take more drastic measures to conserve water as limited supply drives up the value of water. Water conservation is not simply a responsibility for the state or government entities; it should be a responsibility of all residents living in California to develop a water-saving mindset and lifestyle.

Recommendation/Limitations

One limitation encountered during this analysis was the unavailability of a set discount rate for 15 years following 2013. In calculating the total benefit and cost of each method, we did not take into account an interest rate that would either drive the benefit or cost higher or lower in the future depending on how the value of money increases or decreases (the inflation rate). The reason why we chose not to incorporate a discount rate was because we considered all the variables that would render the effect of a discount rate to zero, and decided that it would not make a difference to our results. For example, the cost of water, the interest rate, new efficient technology and standards, and many other variables could affect the costs and benefits of each water-saving method, and so the concern over a discount rate would be unnecessary. Some other limitations in our analysis included the maintenance cost of each device, which was neglected in the calculations, the number of cities' water bills we used to find the average cost of water, and the estimated life span of each device.

References

California Urban Water Conservation Council (CUWCC). (2015). <https://www.cuwcc.org/Resources/Conservation-at-Home-and-Work/Smart-Rebates-Program> (May 25, 2015).

Circle of Blue. (2014). "Circle of Blue's 2014 Water Pricing Survey." <http://www.circleofblue.org/waternews/wp-content/uploads/2014/05/WaterPricing2014TableInteractive.pdf> (May 20, 2015).

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