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Water Conservation in San Antonio, TX: The Economics of Water Pricing and the Effectiveness of the WaterSaver Landscape Rebate

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WATER CONSERVATION IN SAN ANTONIO, TX

THE ECONOMICS OF WATER PRICING AND THE EFFECTIVENESS OF THE WATERSAVER LANDSCAPE REBATE

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Table of Contents

Abstract

We address the effort to decrease residential water use in San Antonio, Texas, because recent droughts have made water conservation a high priority there. Since the city's water utility—the San Antonio Water System (SAWS)—maintains water prices below economically efficient levels, demand is outstripping supply. To address this problem, we apply microeconomic analysis to the utility's residential water pricing structure and the drought restrictions it imposes. We make recommendations for incentivizing water conservation in high-volume consumers by increasing the progressivity of SAWS pricing policies. SAWS also offers water conservation rebates, such as the WaterSaver Landscape Rebate, whose effectiveness we analyze herein. The criteria for the rebate are examined, and the SAWS-approved plant list is scrutinized. We then make recommendations for improving the efficiency of the rebate program, the plant list, and the public's awareness of the rebate. Lastly, we apply our landscaping findings to the Trinity University campus to help conserve water and further ecological integrity on campus.

Introduction

Recent droughts have made water management a high priority in Texas, and interest in water conservation has grown among the citizens of San Antonio. We review the economics of water conservation through using progressive water prices both year round and during times of drought. The economic analysis is based on previous academic studies focusing on using water prices to incentivize water conservation and the theoretical knowledge of the field of water demand management. We apply this knowledge to the San Antonio Water System's (SAWS) current tiered residential water pricing system and its drought restrictions. We then discuss the residential water consumption data recently provided by SAWS and the most promising methods of analyzing that data. From this theoretical and empirical economic evidence, we then make policy recommendations for making these policies more efficient—saving money and water—and thereby increasing social welfare.

Since the current SAWS prices are lower than what is economically efficient, water demand exceeds supply. So, to encourage conservation, SAWS offers rebates, such as the WaterSaver Landscape Rebate, to customers who upgrade their water fixtures and redesign their landscapes with water-efficient plants to reduce water consumption. We then analyze the effectiveness of this rebate and give recommendations on improving the list of plants it requires and the general public's awareness and use of this rebate. These rebate structures have been successful to varying degrees around the country. Their success is largely contingent on the public's awareness of the existence of the rebate, the public's perspective on water conservation and the price of water. Finally, we make recommendations on how our research could be integrated into Trinity University's landscaping policy as well, with the goal of furthering the University's conservation efforts.

The Economics of Water Pricing

SAWS Residential Water Rate Structure

Let us begin with a description of the SAWS rate structure. This section is the basis for the following discussion of the mostly untapped potential for price to be used to incentivize water conservation in San Antonio. The SAWS rate structure is an inverted block-pricing scheme (also known as an inclining or increasing rate structure). Inverted block pricing means that the price per unit of water consumed rises as the amount consumed rises (Fig. 1). This type of structure incentivizes water conservation because consumers face an increasing marginal cost of consuming additional water. However, consumers only face increased costs if they use enough water to be pushed up into the next of the four SAWS water consumption categories, which are differentiated by volume (Fig. 2). For instance, users who consume up to the first 5,596 gallons of water per month are charged at $0.0948 per 100 gallons.

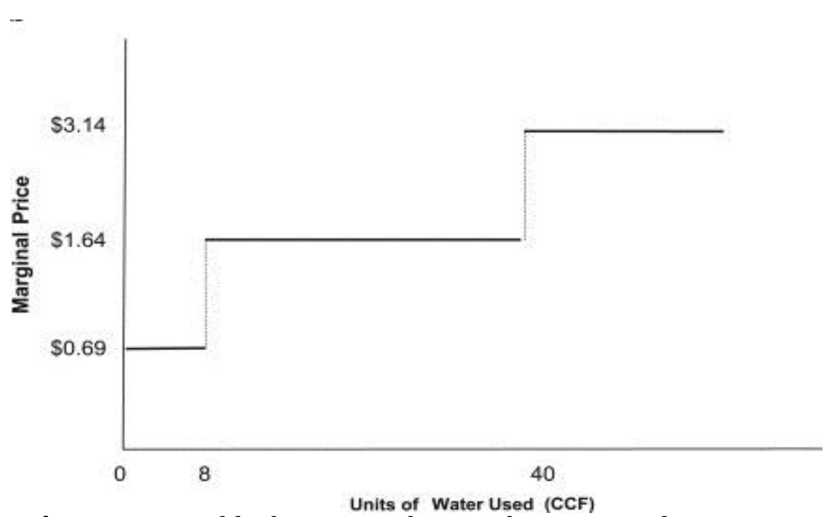

Figure 1: Example of an increasing-block pricing scheme, where marginal price increases in blocks at various levels of consumption by volume. From Shanthi Nataraj and Michael Hanemann; 2011

2012 MONTHLY VOLUME CHARGE	INSIDE CITY LIMITS	
	RATE PER 100 GALLONS	
Step in gallons	**Standard**	**Seasonal**
First 5,985	$0.0948	$0.0948
Next 6,732	0.1372	0.1492
Next 4,488	0.1935	0.2219
Over 17,205	0.3388	0.4597

Figure. 2: Residential water rates; San Antonio Water System (SAWS); 2013; 2 Mar. 2013.

With the goal of projecting how future water rate increases will affect the quantity of water demanded, it is necessary to know the price elasticity of water demand for this segment of the San Antonio population. The price elasticity of water demand will tell us how consumers will respond to increases in price. Nevertheless, it is important to remember that calculations of price elasticity of demand assume that all independent variables affecting demand remain unchanged (the *ceteris paribus*, “all else being equal,” assumption). Price elasticity of demand is therefore meant to be understood as a correlative measurement, not a purely causative statistic.

Elasticity varies with indoor versus outdoor usage. A considerable amount of indoor usage is for subsistence and bathing, so it is quite inelastic. Outdoor usage is primarily irrigation and therefore is more elastic; consumers will first forego irrigation when water rates increase (Turner 2013). Since households doing greater amounts of irrigation will be in the higher-volume blocks of consumption, these higher blocks have more elastic demand (Sarafidis 2011). This prediction—that higher-volume blocks are more price elastic—is at the heart of our analysis, and our initial goal was to see if this prediction holds with the data from SAWS. If the prediction is true in San Antonio, then increasing the progressivity of the current pricing structure can be used further to incentivize water conservation.

Data Analysis and Interpretation

For us to calculate the price elasticity of residential water demand, SAWS provided us with residential water consumption data from its customers inside and outside the San Antonio City limits in gallons per month, displayed as aggregate totals for each of the four blocks of consumption (distinguished by volume consumed; Fig. 2). The data cover the period from January 2001 to December 2012 and include the number of consumers in each block for each month.

There are statistical caveats that must be considered with this set of data. With aggregate data instead of individual household consumption data, we could not account for differences in preference across consumers. Consumers may shift in and out of a given block each month depending on their use. A large problem we faced is the multivariate nature of the data; weather, seasonality, drought stages, and economic conditions also affect water usage in different ways. That is to say, the quantity of water demanded is a function of price as well as of many other things, and the *ceteris paribus* assumption is broken if these other potential independent variables are not held constant. On top of the difficulty of distinguishing between independent and dependent variables, it is possible too that some of the independent variables have lagged effects on the dependent variables (i.e., March's weather may have an effect on June water usage) (Turner 2013).

Literature Review: Price Elasticity of Residential Water Demand

Considering the many potentially hidden problems contained in the data provided, our calculations of price elasticity are insufficient for drawing any accurate conclusions. A more accurate way of projecting future water demand is to import elasticity estimates from legitimate academic studies. A frequently cited paper from 2003 by Dalhuisen *et al*. is the most exhaustive data set on the price elasticity of residential water demand (Griffin 2006). It derives 314 price elasticity estimates from 64 different studies from around the world. The authors conduct a "meta-analysis" to identify important determinants explaining the variations in price elasticities of residential water demand. The authors find that residential water demand is relatively price-elastic and that increasing block rate structures make water demand more price-elastic (Dalhuisen et al. 2003). To narrow down the conclusions from the Dalhuisen *et al.* collection of price elasticities, Griffin omitted the outliers in their data set and found that modern price elasticities lie in the -0.35 to -0.45 range, meaning that a 10 percent increase in the marginal price of water will decrease water demand by 3.5 – 4.5 percent in the short run (Griffin 2006). Consumers are more responsive to price changes (more elastic demand) in the long run because they can adapt their water usage (i.e. through installing more efficient irrigation). Furthermore, the data in the academic literature for the United States points to price elasticities of residential water demand that are between -0.3 and -0.4 (Olmstead and Stavins 2009).

Year-Round Water Pricing Recommendations

In short, these data point to the recommendation that increased progressivity in the SAWS increasing block rate structure (i.e., a higher jump in price between blocks as volume increases) is an efficient way to decrease the quantity demanded in the high-consumption blocks. Increasing the progressivity of the current rate structure means increasing the rate differentials, or price jumps, between the four blocks (Fig. 1). The goal here is to match the rate differential from one block to the next to the increase in the price elasticity of demand between those two blocks. This structure would send the correct price signal to the higher-volume consumers, making their discretionary water use (luxury irrigation, pool filling, etc.) more expensive. The reason this increased progressivity in the rate structure would promote water conservation is that high-volume, discretionary water use has a higher price elasticity than more necessary indoor water uses like eating, drinking, and bathing. Notably, a related benefit of this policy is that it promotes water conservation by rewarding consumers in the first two blocks by giving them lower rates for using less water.

Here enters the normative side of the issue, as the setting of water rates in San Antonio is not exempt from political pressure, and there is not much pressure from any side for higher water rates. In 2009, the SAWS Conservation Department identified a conservation goal of 126 gallons per day per capita (GPCD) usage by 2016 by targeting discretionary water use. Also in 2009, however, the San Antonio Rates Advisory Committee (RAC)—a group of citizens representing low-consumption, high-consumption, business, and neighborhood interests—recommended that the rate differentials be changed in a way that decreased the progressivity of the inclining block structure. These are the differentials currently in place (Fig. 3).

	Consumption Cutoff (gallons)	Pre-2009 Rate Differentials	Current Rate Differentials
Block 1	7,481 (now 5,985)	1.00	1.00
Block 2	12,717	1.44	1.45
Block 3	17,205	2.27	2.04
Block 4	>17,205	3.63	3.57

Figure 3: Adapted from San Antonio Water System's *2012 Water Management Plan*

The result is that high-volume consumers in the third and fourth blocks are not penalized as much for their discretionary water consumption. The 2009 change in rate differentials thus made it less likely that San Antonio will achieve its water conservation goal. Ironically, it is exactly discretionary water use (blocks three and four) that received relative price decreases from the newly established 2009 RAC recommendation. So, to incentivize water conservation year round, SAWS should reconsider its elasticity estimates of residential water demand and return the rate differentials between consumption blocks to the more progressive pre-2009 levels.

Drought Restrictions versus Drought Pricing

Scarcity rent is the cost of "using up" a finite resource because benefits of the extracted resource are unavailable to future resource users (Moncur and Pollock, 1988). The San Antonio water market is inefficient because it does not recognize the full cost of using the resource during droughts. With artificially low prices, the current resource extractors consider only their own immediate costs, not the costs to others of increased scarcity, and as a consequence deplete the water resource too quickly. This dynamic is especially applicable to San Antonio when SAWS approaches its legal entitlements (pumping rights) to a given water source (i.e., the Edwards Aquifer). Imposing quantity rationing regulations like drought restrictions is one way to prevent resource depletion, but these regulations do so inefficiently since they are inflexible, not letting water use be substituted across households or directed toward its most highly-valued uses (Olmstead and Mansur 2012).

SAWS does, however, use “seasonal pricing” for the three highest-volume blocks by charging slightly higher rates for these blocks in the summer months from May through September when water usage is relatively high. The second block’s seasonal rate is 8.75% higher than its standard rate; the third block’s seasonal increase is 14.68%; and the fourth block’s seasonal increase is 35.68%. This seasonal mechanism is a form of drought pricing that incentivizes water conservation during the summer months, thereby using a market-based policy to supplement the regulatory drought restrictions on water use in San Antonio. It is important to note, though, that, if SAWS were to use serious drought pricing instead of drought restrictions, people would ration the water by themselves and there would be a gain in economic efficiency.

There are studies that remove us from the theoretical world by examining the current welfare gains that can be realized when drought pricing is implemented instead of drought restrictions. Using data from 11 different urban areas and 16 different water utilities in the United States and Canada, Olmstead and Mansur found that welfare gains from drought pricing are approximately $92 per household during a summer drought, about 28 percent of average annual household expenditures on water (Olmstead and Mansur, 2012). Brennan et al. (2007) arrived at a similar conclusion of potential welfare gains of $100 per family in Perth, Australia.

Drought Pricing Recommendations

There are two factors that contribute to the savings from market-based water conservation. The first is the ability of households facing higher prices rather than quantity restrictions to decide which uses to reduce according to their own preferences; the second is allowing heterogeneous responses to the regulation across households, resulting in substitution of scarce water from those households who value it less, to those who value it more (Olmstead and Mansur 2012). These welfare gains are complemented by potential savings from forgoing the enforcement costs that are necessary under drought restrictions, where the public has to be monitored for compliance. Lastly, in the long run, drought pricing provides the incentive for innovation in water-saving technologies and landscapes. With this incentive—where water prices accurately reflect the resource's marginal cost and scarcity rent—it would not be necessary for utilities to spend time and money implementing water-conservation rebate programs.

So, considering the substantial theoretical and empirical evidence, the benefits of drought restrictions do not exceed the costs imposed through the regulatory inefficiency stemming from heterogeneous water demand. Hence, there are significant welfare gains to be had from replacing drought restrictions with a market-clearing drought price. All readily available evidence points to the conclusion that such a drought price would realize welfare gains in San Antonio. The current "seasonal pricing" scheme used by SAWS is insufficient because it still needs to reflect the full scarcity rents during periods of drought-induced excess demand. A policy of increased water prices during drought periods could be easily implemented through the current SAWS "seasonal pricing" mechanism. The aforementioned seasonal percentage increase in each of the top three blocks could be further increased to achieve the SAWS Conservation Department's desired conservation goals.

SAWS WaterSaver Landscape Rebate

Overview of the WaterSaver Landscape Rebate

We are focusing on the WaterSaver Landscape Rebate since lawn irrigation is the largest non-essential residential water use (Vaughan 2012). Consumers receiving the rebate can earn up to $400 from reducing their water usage while still maintaining a colorful and appealing landscape ("WaterSaver Landscape Rebate"). The WaterSaver Landscape rebate is an excellent opportunity for homeowners to decrease their water bill and for the City of San Antonio to reduce its overall water consumption. The requirements to receive the landscape are these:

1) The entire landscape must meet the requirements.

2) No more than 50 percent of the landscape may be planted in turf. Turf can be Bermuda, Buffalo, or Zoysia varieties only (no St. Augustine).

3) A minimum of 4 inches of soil must be present under turf.

4) Shrubs and flowers must be selected from an extensive plant list approved by SAWS.

5) If a permanent irrigation system is installed, it must pass a free irrigation check-up performed by SAWS to receive a rebate.

6) A minimum of one shade tree selected from an approved tree list for lots less than 6,000 sq. ft. and two shade trees in larger lots are required.

7) No more than 5 percent of the landscape may be planted in annuals or unapproved plants ("WaterSaver Landscape Rebate").

Unfortunately, only 227 San Antonio residents have received the rebate since 2009. This is due to several reasons: the high cost of refurbishing your lawn, a lack of awareness and proper promotion, and poor website design. Even though the benefits in the long run will outweigh the initial costs, homeowners are hesitant to make any water-saving improvements to their landscape. Currently, the rebate mainly attracts homeowners who can afford new plants and a redesigned irrigation system, not necessarily families who need the $400 rebate, but those who care about conserving water. Says Ellen Clegg, a Terrell Hills resident, “I'm not doing it to save money, I'm doing it to conserve resources." Clegg's water bills averages around $25 per month, but the $4,700 invested in refurbishing her irrigation system and yard is not going to pay for itself anytime soon. She stresses the real payoff is about paying it forward (René 2012). This is consistent with findings in other cities, in North Marin of California, 50% of those who received a landscape rebate said that they were planning on removing their turf regardless (Addink 2008). If SAWS wants to attract more people to their rebate programs, they will need to offer incentives that will reduce the initial cost of xeriscaping or updating their yard to meet the strict requirements.

Unfortunately, not enough citizens are aware of the SAWS rebates. There is very little promotion for the WaterSaver rebate, and there seems to be a general misunderstanding of what the rebate requires. Our culture has grown up with the image of the “All-American” lawn with St. Augustine grass from the sidewalk to the front door, so when many San Antonio residents hear about xeriscaping, they picture a yard filled with rocks and gravel. Many people don’t know how beautiful these lawns can be, and they don’t see the benefit of them. A xeriscape is a native plant landscape that needs little extra water or other assistance to look its best (Guz 2005). People will be more willing to apply for the rebate if they knew what their lawn would look like, how much water they would conserve, and how much money they would save in the long run. For example, one household, the Roemers, have seen their water bill go down by transforming their landscape into a water-saving landscape. The Roemers used approximately 3,700 gallons of water in August of 2012, while the average water usage in their neighborhood is almost 9000 gallons (Vaughan 2012). If more citizens were aware of the benefits of having a xeriscape lawn, more people would apply for the rebate.

Since there is insufficient advertisement and awareness, the main way people find out about the rebate is through the SAWS website. The WaterSaver Landscape rebate site has a lot of great information, but it is unorganized, inconsistent, and hard to navigate. There are very few pictures and hardly any comprehensive instructions on how to transform your lawn or apply for a rebate. The application process is through the mail and takes a very long time. If anything, the website is discouraging people from considering the rebate, but with a few easy improvements, the website will draw in more people who will sign up for the rebate.

New Voucher Policy

On 2 April 2013, the SAWS board told the staff to start negotiations with local nurseries to set up a program that would offer instant rebates to customers who replace part of their lawns with plants that require little or no water (McDonald 2013). According to Karen Guz, customers who are interested in participating would first fill out a form and pledge to remove either 150 or 250 square feet of grass. Once approved, customers would receive a voucher to redeem at a local nursery that would cover at least half the cost of plants and mulch from an approved list (Guz 2013). Of course, SAWS staff members would have to do periodic checks to make sure the yards meet the requirements of the rebate. This new voucher system could remedy the main deterrent against the rebate: the high initial cost of re-designing one's landscape. This new system offers people money for the initial investment and will hopefully attract more people to the rebate program to help reduce water consumption in San Antonio.

Rebate Effectiveness Data Analysis

Using the water consumption data from January of 2007 to January of 2012, we estimated the effect of the landscape rebate on residential water consumption. Out of those data sets, we excluded the statistics of all those households which did not receive the rebate by using a VLOOKUP function in Microsoft Excel. Then, we averaged each of the individual households across the different months to control for seasonal differences and the differences in household consumption. Each household had two averages, the first was from before the rebate and the second was after they received the rebate. The final step was in averaging each of the households' averages, resulting in a city-wide average before and after the rebate.

The data set was less than ideal. Out of 227 total households that received the rebate, we could only use 84. Some data was excluded because we did not have consumption data with the correct dates to compare their water consumption from before and after the rebate. If we had less than 5 months of data from before or after the rebate, then we ignored it.

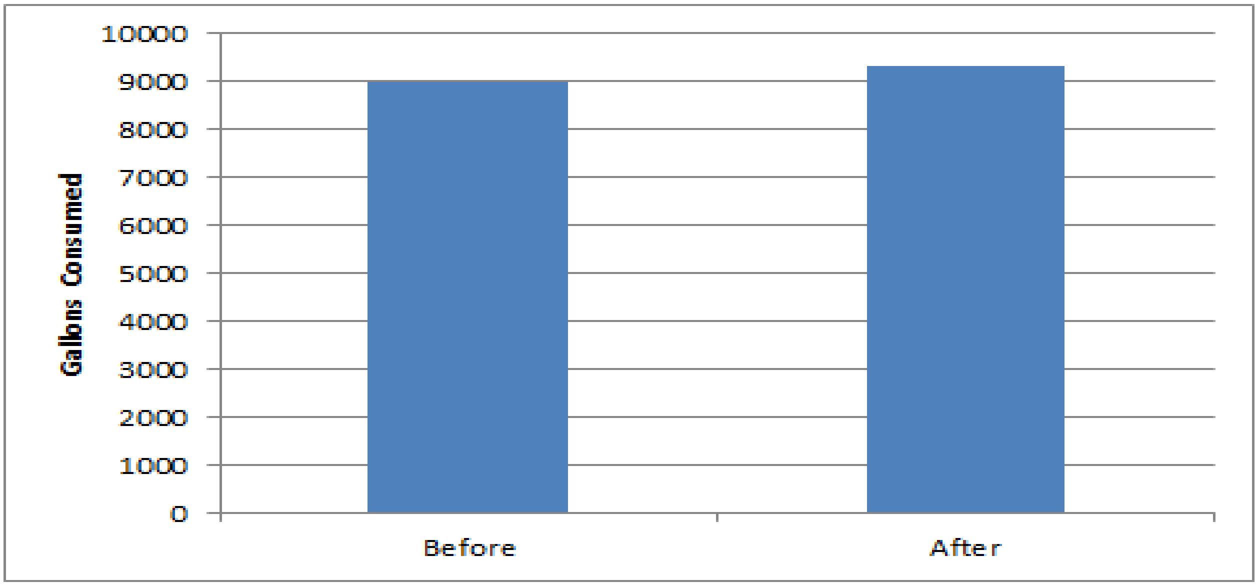

Figure 4: Comparison of household water consumption before and after SAWS WaterSaver Landscape Rebate. Sample size was 84 and standard deviation of the difference was 2560.9

Many households also had many months where water consumption was either listed as N/A or 0 because of the rounding strategy that SAWS employs. Elliot Fry, conservation data analyst from SAWS, confirmed that SAWS rounds down to zero if less than 750 gallons of water are consumed in a month. Early in the data analysis stage there was confusion over the prevalence of repeated numbers, but this can be explained by the disparity in how SAWS measures water use and how SAWS records water use. They measure water by the cubic yard while they record and convey water prices in gallons. This is to minimize confusion for the consumer while maximizing the optimal measurement type. There is a large range of potential gallon measurements between each cubic yard of water, which causes the rounding of individual gallon measurements. We also excluded the months where the rebate was given to clearly distinguish months where there was and was not compliance with the rules.

One extra complication with the data was that for the 12 months leading up to the award of the rebate, actions are supposed to be undertaken to improve the drought-tolerance of the lawns. Our initial estimates didn't account for the 12 month buffer before the rebate, which could skew the average of consumption rates. When we re-evaluated the data by excluding the 12 prior to the rebate, the relationship between the before and after consumption rates did not change. Water consumption after the rebate stayed higher than before, though just barely.

Counter-intuitively, our findings indicate that water consumption rose after receiving the landscape rebate. After reviewing with the SAWS conservation staff, they were not entirely surprised by these findings. The average monthly use was considered normal, and the increase in water consumption was actually consistent with the data that they collected in regards to the previous landscaping rebate, which used a pay per square foot model. Still, conservation director Karen Guz cautioned us against pessimism because she argued that although there was not a substantial improvement in water use efficiency, part of the rebate is to deter households from substantially increasing their landscape water consumption, which is more difficult to measure. Still, the intended effect of the rebate seems to be to decrease consumption thereby increasing conservation. There are several good explanations for why that decrease in consumption didn't take place.

A study in North Marin, California, concluded that about 50% of participants in a landscape rebate planned to replace their turf regardless of the existence of a rebate, but took advantage of the program to support an action they were already taking (Addink 2008). Many San Antonio residents are likely to have followed this same line of behavior. This is especially true because SAWS has not advertised this rebate except on their website, so those that find the information online are likely to already have been conducting online searches for water-conservative plants or replacements for their lawns. Similar programs in New Mexico, nicknamed "Cash for Grass," also didn't cause a substantial drop in water consumption (Addink 2008). Still, the rebate program has a great deal of potential to incentivize a transition to lower use of irrigation because of landscape changes. Some of those changes should affect the recommended planting list and some of those changes should affect the demographic that is being targeted to receive the rebate.

Recommendations for Improving the WaterSaver Landscape Rebate

Reconsidering the Grass Requirements

One of our goals is to restructure the plant list to make it easier for customers to use the rebate and conserve more water. We investigated the grasses that SAWS recommends for use as turf. Of the 50% of landscape that is allowed as turf, SAWS only considers Bermuda, Buffalo, and Zoysia species as viable selections. The rebate recipient can use other grasses to fill in the remaining requirement, however, including Curly Mesquite and Prairie mix, likely because of their drought tolerance.

Although St. Augustine grass has been a popular turf option for many years, it requires a lot of management, for "[m]owing, fertilization and supplemental watering are required to maintain a dense, green, weed-free turf of St. Augustine grass" (Duble 2013). Since San Antonio is an area where we cannot depend on rainfall, St. Augustine requires regular irrigation to maintain. It consumes 40-50 inches of water each year (Maekles 2013). There is some confusion on the website as it exists now, the rebate page specifies that St. Augustine is prohibited, but it is still listed under the Approved Plant List. SAWS should ensure that St. Augustine is stripped from the approved list.

Bermuda, a grass approved by the list, should not be an option because it is an invasive species that is difficult to eradicate once it is established, and it requires much water ("SAWS Approved Plant List"). On the other hand, Buffalo, Prairie Mix, and Curly Mesquite are good options because not only are they native species but because they are also drought tolerant. Native species are good plants to use because they also support wildlife throughout the year, are often more adaptable to natural environments, and can have greater resistance to droughts ("PA Trees.org").

Categorizing Species within the Approved Planting List

The plant list on the SAWS website puts the plants into 14 categories for a total of 461 species. The list is separated into annuals, cacti and succulents, grasses and turf, groundcover, herbs, ornamental grasses, palms, perennials, roses, shrubs (ranging from small, medium, and large), trees, and vines.

Dr. Kelly Lyons, a Trinity University professor of plant biology and ecology with a concentration in Texas grasses, guided us on how to amend the plant list. We looked at each plant to determine if it is native or not. Being a Texas native is important because they generally use less water, require less mowing and maintenance, and use fewer fertilizers, soil amendments, and pesticides (Maekle 2013). After researching various plant databases, we determined the water use for each plant and ranked them on a number system. We categorized the plants according to their water use in an excel document. If the plant is drought tolerant or uses very little water, it has a ranking of 1. A plant that needs a medium amount of water was given a 2. Lastly, a plant that requires a lot of water, such as needing watering almost every day, was given a ranking of 3. We had a total of 14 sheets for each category of plants. Then we listed the common name, scientific name, origin, and water use for each plant. Finally, we utilized the sort function to rank everything to show which would be the best plants to use to conserve water.

Recommendations for Removing Plants

After ranking the plants, we concluded that any plant with a ranking of 3 should be taken off the list whether it was native or not. If the purpose of the rebate is to use water-conserving plants, these rank-3 plants are counterproductive. We also recommend removing plants that are not native with a ranking of 2, which means that the plant required a medium amount of water. These rank-2 plants are St. Augustine grass (*Stenotaphrum secundatum),* Bermuda grass *(Cynodon dactylon*), Coleus species, Vinca 'Cora' (*Catharanthus roseus 'Cora'*), Gulf Muhly (*Muhlenbergia capillaris*), Eastern Gamagrass (*Tripsacum dactyloides*), Clover Fern (*Marsilea macropoda*), Mexican Petunia (*Ruellia brittoniana*), Ruellia "Blue Shade" (*Ruellia suarrosa*), Monarda (*Monarda fistulosa*), Hoja Santa (*Piper auritum*), Pineapple Sage (*Salvia elegans*), and Cecile Brunner Rose (*Rosa x 'Cecile Brunner'*) (Duble 2013; Russ and Polomski 1999; “SAWS Approved Plant List”; “USDA Plants”).

The new plant list that we have formulated for SAWS has a high chance of being considered in the adjustments SAWS will soon make to its approved plant list. At the conclusion of the meeting that we had with the Conservation Department of SAWS, we were told by the director of outdoor conservation programs that it was unlikely that they would take our recommendation of eliminating the bottom-ranked plants in terms of water conservation. Karen Guz told us, however, that they would likely remove the species that we flagged as invasive rather than simply non-native (SAWS 2013). The difference is in the danger of these plants outcompeting native plants and therefore negatively affecting the overall ecology, usually because of physiological factors such as leaf-area allocation, shoot allocation, growth rate, size, and fitness (Van Kleunen, Weber, and Fischer 2010). Not only did we consult our research to come up with the revised list, but Dr. Lyons gave us a list of plants that she already knew from prior knowledge that should be taken off the list: Muhly Bamboo (*Muhlenbergia dumosa*), Maidenhair Grass (*Miscanthus sinensis*), Purple Fountain Grass (*Pennisetum setaceum 'Rubrum'*), Dwarf Fountain Grass (*Pennisetum alopecuroides*), Mexican Feathergrass (*Nassella tenuissima*), Pampas Grass (*Cortaderia selloana*), and Purple Fountain Grass (*Pennisetum setaceum 'Rubrum'*) (Lyons 2013).

<u>Promotion and Marketing Recommendations</u>

After these plants are taken off the list, the different categories of the plants should be presented on the SAWS website. As we have stated, the WaterSaver Landscape rebate is an excellent tool to incentivize San Antonio citizens to conserve water, but changes need to be made in order to make it a success. The first hurdle is the website. From our meeting with SAWS, they are well aware of the website's flaws, and they intend to redesign it. The new site should be informative, interactive, and easy to use. There should be pictures of example xeriscape lawns with lists of plants used and how to properly care for them, and there should be step-by-step instructions on how to redesign your lawn.

Customers need to know not just want plants are acceptable to use in order to get the rebate but also how to use the plants. The website could rank the plants in different categories for the customers such as listing whether the plant is native or not, water use, sun or shade preference, and ease of maintenance alongside a photo of the plant. These categories will allow customers to have more flexibility and creativity with their landscaping projects. Although the priority is to use drought tolerant or plants that require less water, customers are also going to be interested in how difficult it will be to maintain their plants and the attractiveness of the plant. Customers may choose to use more vines than roses, and they would then be able to see the difference in the two categories of plants.

There should be an online registration form for the rebate; this step has helped catalyze the public's awareness and application for other SAWS water conservation rebates. In addition, there needs to be a calendar of events that clearly displays when and where water conservation workshops and events are taking place.

Customers also need more guidance of how to use the plant list to receive the rebate. Although customers may change their landscape by taking out their turf and replacing it with drought tolerant plants, they may not see a decrease in their water bill. The reason may be that they have a water system that needs to be updated. This rule is stressed as part of the requirements for rebate, but customers need to make sure that their plants are zoned appropriately around or even away from the sprinklers. Customers also need to make sure that they zone plants appropriately according to sun and shade preference. On the other hand, the plants that happen to require more water should stay near the sprinklers and the ones that are drought tolerant should be further away so they do not receive any more water than necessary. If a sprinkler system is already in place, the customer should schedule the sprinklers to run less and possibly cap some of the sprinkler heads.

Another important way to get San Antonio interested in conserving water is through community outreach. SAWS can host family events and volunteer opportunities where people work together to create a xeriscape in a public place, like a park. This would be a fun way to educate people about lawns that conserve water and also inform people about the WaterSaver rebate opportunity. Promotions can be targeted specifically to the demographic of citizens who might utilize the rebate: those who can afford to pay the initial cost to redo their lawn. Holding events at places like farmers markets or nurseries can directly reach people who are most likely to sign up for the rebate.

Trinity University Landscaping

While our goal for the biological portion of this study was to review SAWS' current plant list for the landscaping rebate, our intention was to make all of this research usable for Trinity's landscaping policy as well. While completing a comprehensive analysis of the existing Trinity landscaping policy was beyond the scope of this research project, many plants that would be unacceptable according to our water conservation guidelines surely reside on Trinity's campus. The campus features lots of open space because of turf-centered landscaping choices. Two factors prevent this turf from being overly problematic and therefore largely excluded from the criticism of this paper. First, Trinity's turf is well-established and on top of deep soil that is effective at retaining moisture, contrasted from the thin soil and recent seeding of many San Antonio lawns. The SAWS staff conveyed this (SAWS 2013) and it is consistent with findings examining the relationship between water retention rates and soil depth in Iowa (Mohanty and Mousli 2000). Second, Trinity utilizes recycled water rather than potable water, reducing the impact of overuse. Turf is not the only maintained plant on campus, however.

Many of the annual flowers and ornamental grasses are water-intensive and non-native. Flowers lining the walkways are planted as seedlings in the spring and die off during the winter only to be replaced again the following year. Establishing these seedlings and maintaining them in a region that they are not native to requires quite a bit of water (Evans 2000). Unlike turf, annual flowers have fairly obvious native perennial substitutes that would substantially diminish the amount of water used. Similarly, the ornamental grasses require a lot of extra irrigation according to our analysis from USDA Plants. They are perennials and therefore require much less water to establish because of fewer plantings, but their physiology requires high water use. They have the added characteristic of often being invasive rather than simply being non-native. For example, the courtyard in front of Storch on east campus features maidenhair grass, also known as miscanthus, which expands rapidly in the Southwest United States (Lyons 2013).

Trinity's landscaping is a source of great pride for the University, boasting one of the best student-to-gardener ratios in the country (College Prowler 2012). The campus is also a meeting point for existing arborist conventions and master gardeners, who should be exposed to a sustainable native and drought tolerance landscaping policy. Trinity's landscaping should be reflective of the thoughtful and environmental goals that the University administration and student body espouses. A student organization, Students Organized for Sustainability, is gathering signatures on an amendment to the existing landscape policy in the form of a petition which will be submitted in the fall of 2013. The petition includes recommendations for substitutes rather than just a list of unacceptable plants. The maidenhair grass near Storch, for example, could be easily integrated into the successful and growing Trinity University Community Garden. Annual flowers can be replaced by native and perennial chrysanthemums or firespikes. Invasive ornamental grasses can be replaced by little bluestem or eastern gamagrass.

Summary and Conclusions

For incentivizing year round water conservation, water pricing is an unexploited policy tool relative to its potential. If the political will can be summoned, SAWS should recalculate its price elasticity estimates of residential water demand and return the rate differentials between consumption blocks to the more progressive pre-2009 levels. This policy would put make high-volume users pay a higher price for their luxury irrigation, forcing water to be rationed by the market to its more essential uses. Drought pricing can increase the size of the economic pie through increasing welfare gains and cutting enforcement costs. However, since water prices are also set by other, more political factors, rebates for water conservation measures can be a helpful step in the right direction. Political considerations are important here, as in any policy context. Just as the elimination of any subsidy is politically difficult, so too would be the raising of water prices. Nevertheless, for those politicians who can demonstrate the cost-effectiveness advantage and welfare gains of the price-based approach, there may be some political capital to be earned.

Since the WaterSaver Landscape rebate is currently under used, increasing its visibility in society was a major focus in this study. For the rebate to be more appealing to customers, it would help if there is a change in the aesthetic outlook on the traditional landscape. People need to understand that having the traditional, lush, green lawn is not always ideal. Lawns can be just as appealing with ornamental grasses, cacti, and shrubs. Xeriscaping is does not simply consist of rocks and gravel, but it aims at eliminating grass and turf as the main means of landscaping—and significant water and monetary savings result. Our amendments to the plant list used for the rebate would further help conserve water in San Antonio and benefit the area's ecology. Notably, though, we end with the reminder that demand-management policies like this rebate would not be necessary if the political barriers to efficient water pricing could be broken. Water prices should be set by considering the true cost of supplying the resource and how price elasticity of demand differs between consumption blocks. Such a policy would make consumers ration water to its highest-valued uses by themselves through weighing the newly higher price of water against the color of their lawn. For the goal of water conservation, high-volume uses like luxury irrigation should be progressively more expensive whereas low-volume uses such as drinking and bathing should be easily affordable.

References

Addink, S. 2008. ‘Cash for grass’—A cost effective method to conserve landscape water? Web. 11 February 2008.

Brennan, D., S.et al. “The welfare costs of urban outdoor water restrictions.” *Australian Journal of Agriculture and Resource Economics.* Vol 51 (2007): 243-261.

College Prowler. Trinity University. 2012. Online Book. 1 May 2013.

Duble, Richard L. "St. Augustine Grass." St. Augustine Grass. Texas A&M Agrilife Extension, Web. 03 Apr. 2013.

Evans, Erv. “Annual Flowers: Maintenance.” NC State University College of Agriculture & Life Sciences. Web. 03 Apr. 2013.

Griffin, Ronald. Water Resource Economics: the Analysis of Scarcity, Policies, and Projects. Cambridge: MIT Press, 2006. Print.

Guz, Karen. “What is a Xeriscape?” San Antonio Landscape Care Guide. San Antonio Water System. 2005.

Lyons, Kelly. Collaborative meeting. April 20, 2013.

Maekle, Monika. "As SAWS Pushes Native Plants, Texas Legislature Considers Native Plant Bills." *The Rivard Report*. The Rivard Report, 18 Apr. 2013. Web. 29 Apr. 2013.

McDonald, Colin. “SAWS Promotes Lawn Alternatives.” *San Antonio Express News*. 2 April 2013. Web. 2 April 2013.

Mohanty, B.P. Mousli, Z. “Saturated hydraulic conductivity and soil water retention properties across a soil-slope transition.” *Water Resources Research* (2000). Vol 26 no. 11: 3311-3324. Scopus.

Moncur, James and Richard Pollock. “Scarcity Rents for Water: A Valuation and Pricing.” Land Economics. Vol. 64, no. 1 (1988): 62-72.

Nataraj, Shanthi and Michael Hanemann. “Does marginal price matter? A regression discontinuity approach to estimating water demand.” Journal of Environmental Economics and Management. Vol. 61, No. 2 (2011):198-212. 28 Feb. 2013.

Olmstead, Shelia and Erin Mansur. “The value of scarce water: Measuring the inefficiency of municipal regulations.” Journal of Urban Economics. Vol 71, No 3 (2012): 332-346

"PA Trees.org | The Tree Resource Guide." *PA Trees.org*. PA Trees, n.d. Web. 09 Apr. 2013.

"PLANTS Profile for Catharanthus (periwinkle) | USDA PLANTS." *PLANTS Profile for Catharanthus (periwinkle) | USDA PLANTS*. Natural Resources Conservation Services, n.d. Web. 03 May 2013.

René, Guzman A. “Greener Homes Take Lots of Green.” *San Antonio Express News*. 22 April 2012. Web. 1 April 2013.

Russ, Karen, and Bob Polomski. "Coleus." *HGIC 1162: Extension: Clemson University: South Carolina*. Clemson University, June 1999. Web. 03 May 2013.

Sarafidis, Vasilis and the Sydney Water Utility. “The residential price elasticity of demand for water.” Sydney: University of Sydney (2011). Web. 3 Feb 2013.

“SAWS Approved Plant List.” San Antonio Water System. 2013. Web. 28 Feb 2013.

San Antonio Water System. Collaborative meeting. May 1 2013.

“SAWS Comprehensive Cost of Service and Rate Design Study.” San Antonio Water System (SAWS). December 2009. Web. 27 March 2013.

“SAWS 2012 Water Management Plan.” San Antonio Water System (SAWS). 2012. Web. 28 Feb 2013.

Stavins, Robert and Sheila Olmstead. “Comparing price and nonprice approaches to urban water conservation.” Water Resources Research Vol. 45, W04301. (2009): 1-10. Web. 3 Feb 2013.

Vaughan, Vicki. "Landscaping: Water misers have low bills." 2012. *San Antonio Express-News.*

Van Kleunen, M, Weber, E, and Fischer, M. “A meta-analysis of trait differences between invasive and non-invasive plant species.” Ecology Letters (2010). Vol. 13 no. 2: 235-245. Scopus.

"Water and Sewer Rates." San Antonio Water System (SAWS). 2013. Web. 2 March 2013.

"WaterSaver Landscape Rebate." San Antonio Water System (SAWS). 2013. Web. 28 Feb 2013.