Abstract

Throughout the past decade, the city of San Angelo, Texas and surrounding areas have experienced extreme drought levels and consequent water shortages that have caused homeowners and businesses to go to great lengths in order to conserve water. This project used cost-effectiveness analysis to compare the economic efficiency of a water conservation method called xeriscaping to the efficiency of traditional turf landscaping. It compares the initial fixed costs, such as materials and installation costs, to variable reoccurring costs, such as maintenance and lawn care expenses. The uniform comparison provides a user-friendly reference guide to aide consumers in the decision making process when comparing various landscaping plans. It was concluded that one hundred percent xeric yards are the most cost efficient, but any of the alternatives presented that involve a portion of xeriscaped area, no matter how small, proved to be more efficient than one hundred percent turf.

Introduction

Drought has been a consistent issue on the minds of Texans for many years, but in the last decade those mere concerns have transformed in to grave realities. In the past ten years, the city of San Angelo, Texas and surrounding areas have experienced devastating levels of drought. According to the United States Drought Monitor provided by the National Weather Service Forecast Office, approximately 94.28 percent of the Southern region of the United States, which is largely comprised of the state of Texas and includes the city of San Angelo, falls under the drought intensity levels of severe, extreme, or exceptional (National Weather Service Weather Forecast Office, 2013). These drastic drought levels and consequent water shortages have become an increased threat to people in both rural and urban areas, causing widespread conservation efforts to present themselves, particularly in the last three to four years.

During the summer of 2012 the city of San Angelo, Texas, for example, increased levels of restriction on water consumption from drought level one to drought level two, remained there for a significant period of time, and eventually increased restrictions to drought level three, which represents dangerously low water levels. With each increase in drought level, there was an increase in the cost of water for residents and business owners (The City of San Angelo, 2013).

As listed on the City of San Angelo website, drought level one is to be implemented when the city has less than twenty-four months of water supply left in the lakes, rivers, and reservoirs. Restricted hours of watering for lawns and landscapes are from noon to six o'clock p.m., and residents can only water two days per week. Later into drought level one, but before drought level two would be implemented, the

number of times citizens were allowed to water was reduced to once every fourteen days. Drought level two is to be implemented when the city has only eighteen months of water supply left, and the restricted watering hours from noon to six o'clock p.m. from drought level one would be maintained. If conditions continue to worsen in drought level two, further changes in watering restrictions would come into effect. The most drastic of those would be hand watering one day per week, meaning that a sprinkler couldn't be left unattended. Someone must be present in the landscaped area during watering. Drought level three is to be implemented when there is less than twelve months of water supply left. The restrictions placed under this drought level would be very extensive. Watering of lawns, gardens, landscaped areas, trees, golf courses (including greens), shrubs, or other plants being grown outdoors would be absolutely prohibited. In addition to landscape restrictions, the filling of swimming pools and fountains would be prohibited. Washing of automobiles, trucks, trailers, boats, or other types of vehicles or mobile equipment would also be prohibited unless the health, safety, and welfare of the public is contingent upon vehicle cleaning, as determined by the director of city health services (City of San Angelo, 2013).

With each additional drought level, consumption caps would be implemented with monetary fees being charged for each usage violation. These fees could range anywhere from two dollar to eight dollar charges for each 1,000 gallons used over the maximum allotted amount. The usage brackets for each different fee amount would vary according to what drought level has been declared (City of San Angelo, 2013).

The restrictions listed above that correlate with each successional drought level might seem harsh to people from different parts of the United States, or even from different parts of Texas. However, the city of San Angelo chose to implement and enforce strict regulatory measures due to the massive amount of water used each day in the area. San Angelo is located in a very rural area of Texas. It is surrounded by land operated by farmers and livestock producers. The economy of San Angelo greatly reflects the success of its rural neighbors, so it was important in 2012 that the city's legislature supported the people living within the city limits, as well as those individuals from small surrounding communities that so greatly impact San Angelo's economy each year. In order for San Angelo businesses and merchants to maintain inflows from the farmers and ranchers surrounding the Concho Valley, agriculturalists must be able to continue a profitable business. Water is an absolutely essential product for the survival of plants, animals, and humans alike, so it will continue to be crucial for people to conserve as much of this asset as possible to maintain their way of life.

As the various drought level restrictions have been enforced, more homeowners and citizens of San Angelo have started to realize what a severe shortage of water the

city of San Angelo and the surrounding area is encountering, making it a very precious commodity. These realizations led many home owners to consider xeriscaping their yards in replacement of turf yards in order to conserve water (Begnaud, J., 2013). The purpose of this research project was to determine and compare the economic costs of xeriscaping lawns to help homeowners determine which landscaping method best suits them.

Objectives

The overall objective of this study was to provide a uniform comparison of the economic efficiency of xeric yards in contrast with turf yards through a cost-effectiveness analysis. This project was designed to provide a user-friendly comparison aide for homeowners trying to decide which type of landscaping best suits their needs.

Methodology

Cost-effectiveness analyses are particularly useful in situations where there is wide agreement on an objective, but uncertainty in how to reach it. This type of analysis would be used to aide researchers in deciding which alternative presented would be the most economically efficient in order to achieve the final objective. For this project, cost-effectiveness analysis was used to identify the effects of several proposed landscaping projects, and to quantify those effects in terms of dollar amounts (Sewell, M. and M. Marczak, 1997; FAO Corporate Document Repository, 2013). This project inspected the variation in costs of fully turfed yards, fully xeric yards, and several combinations of the two. The assumed area to be landscaped for the project is based on average yard size, as well as water and utility prices in San Angelo, Texas. Using the cost-effectiveness analysis, homeowners will be able to decide if a landscaping project that involves xeriscaping will benefit them in terms of monetary savings. While this cost-effectiveness analysis might not be the only factor in a homeowner's decision it should aide their decision by providing a simple, consistent model.

Some of the factors included in this analysis were water usage levels per household, material, labor, freight expenses, and maintenance costs. Other factors to potentially be considered by homeowners but could not be included in this analysis due to time constraints include the economic utility provided to homeowners through the various levels of aesthetic value of lawns that are completely xeric, completely turf, or a combination of the two. There are significant initial costs when xeriscaping a lawn,

including materials, labor, freight, and contracting or planning (Olive's Nursery, 2013). These costs are offset in the long-run by savings on watering expenses in addition to potential increases in aesthetic value and future value within the real estate market. Some other factors homeowners would need to consider that are not included in this project would be potential increases in household energy costs due to the reflection of sunlight on xeric surfaces compared to turf surfaces, as well as potential foundation damage or cracking due to lack of ground water if xeric lawns are not properly maintained (Begnaud, J., 2013). Finally, homeowners would need to consider possible restrictions or laws in place within their city or homeowners' association.

There were some assumptions made in this project in order to provide a constant example for costs and expenses to revolve around. In San Angelo, Texas, the average lot size is about 5,000 square feet. It was assumed that about 2,000 square feet will be taken up by a house or other structures, so the average amount of land to be landscaped would be approximately 3,000 square feet. This project assumed that there was no established turf or gravel in the area to be landscaped. Estimates were obtained from local nurseries for freight costs, and the average price was used for the calculations. Labor costs are also based on local nurseries' protocols, amounting to seventy-five percent of the cost of materials to be installed (Olive's Nursery, 2013; Scherz Landscape Co., 2013).

As each homeowner's preference varies, so does their choice in turf. For the purpose of this project, prices were collected for Common Bermuda grass and Raleigh St. Augustine grass. These two grasses are both very common in the area surrounding San Angelo due to their proven hardiness in persistently droughty areas (Begnaud, J., 2013). It was assumed that the newly installed turf of choice would be fertilized twice a year and conditioned with straight nitrogen once a year. Pre-emergent would also be applied twice a year. An external lawn-care service would be hired to mow the lawn every two weeks throughout the year. Water usage levels for this project were based on the assumption that turf would be watered one half inch of water daily during the time period lasting from installation to a period of establishment. This time frame usually lasts around two weeks, after which the lawn would be watered one inch of water two times per week, assuming the city's water restrictions allow that much water usage for each household (Olive's Nursery, 2013; Scherz Landscape Co., 2013).

Just as consumer preference varies in turf selection, preferences are widespread when selecting which kind of gravel to landscape with. This project assumed the chosen gravel was a small to medium sized River Rock. It is very cost efficient and has a steadfast color that, unlike many other types of gravel containing dyes for color uniformity, is somewhat resistant to fading in the harsh direct sunlight common in San

Angelo. This small to medium sized River Rock would be installed at a depth of two inches in the area to be xeriscaped. A vital piece of xeriscaping that is occasionally overlooked is a liner between the soil and the xeric gravel. Although tarps or heavy-duty plastic can be used, they do not last long and are not as effective in preventing weed growth within the xeric area as a nylon liner. This project assumed a high quality, long lasting nylon liner would be used. It has a "fuzzy" texture on the bottom side that clings to the bare ground, making it last for up to five years (Olive's Nursery, 2013; Scherz Landscape Co., 2013). Weed killer would be used throughout the year on xeric areas to control any unwanted growth surrounding the gravel. It is assumed that one bottle of herbicide (weed killer) would be applied as needed throughout the year to solve any unwanted growth issues (Lowe's Home Improvement, 2013). This project assumed the only xeriscaping materials to be considered in the cost-effectiveness analysis were River Rock and herbicide. Additional drought-tolerant plants, boulders, and other gravel variations were not taken into cost consideration due to the wide range of consumers' personal preferences.

Results

Table 1. Initial Fixed Cost and Yearly Variable Cost Estimates for Turf and Xeric Landscaping Combinations

Costs	100% Turf	100% Xeric	75% Turf, 25% Xeric	50% Turf, 50% Xeric	25% Turf, 75% Xeric
Variable (Reoccurring) Costs					
Water *	2188.32	0.00	1641.24	1094.16	547.08
Lawn Service †	345.00	0.00	258.75	172.50	86.25
Fertilizer	41.98	0.00	31.49	20.99	10.50
Conditioner	29.99	0.00	22.49	15.00	7.50
Pre-Emergent	31.98	0.00	23.99	15.99	8.00
Herbicide (Weed Killer)	0.00	18.00	4.50	9.00	13.50
Total Variable (Reoccurring) Costs	2637.27	18.00	1982.46	1327.64	672.83
Fixed (Initial) Costs- First Year Only					
Sod Pallets	1160.58	0.00	870.44	580.29	290.15
Gravel	0.00	1283.40	320.85	641.70	962.55
Liner	0.00	600.00	150.00	300.00	450.00
Labor ‡	870.44	1412.55	1005.97	1141.49	1277.03
Equipment Fee	100.00	100.00	100.00	100.00	100.00
Freight	111.60	111.60	111.60	111.60	111.60
Total Fixed (Initial) Costs	2242.62	3507.55	2558.86	2875.08	3191.33
Total Costs	4879.89	3525.55	4541.32	4202.72	3864.16

* Assuming a watering of 1 inch twice per week after establishment period (about two weeks) in which grass is watered 0.5 inches daily.

† Assuming the resident hires external source to mow lawn once every two weeks for 6 months out of the year.

‡ Assuming the resident hires external source to install landscaping materials and is charged 75% of material costs for labor.

The data from this project showed that based on fixed (initial) costs, a one hundred percent turf yard is the most economically efficient to install, costing only $2,242.62. The second most cost efficient alternative for initial installment is a lawn comprised of seventy-five percent turf and twenty-five percent xeric material, costing $2,558.86. These combinations are followed by a fifty percent turf; fifty percent xeric yard, a twenty-five percent turf; seventy-five percent xeric yard, and a one hundred percent xeric yard, costing $2,875.08, $3,191.33, and $3,507.55, respectively.

However, based on total costs that include installation and maintenance, the results are perfectly inversely related. A one hundred percent xeric yard is the most economically efficient to install, costing only $3,525.55. The second most cost efficient alternative overall is seventy-five percent xeric; twenty-five percent turf, costing $3,864.16. These combinations are followed by a fifty percent turf; fifty percent xeric yard, a seventy-five percent turf; twenty-five percent xeric yard, and a one hundred percent turf yard, costing $4,202.75, $4,541.32, and $4,879.89, respectively.

Conclusion

After using a cost-effectiveness analysis to form a uniform comparison, the data showed that, based on fixed (initial) costs, a one hundred percent turf yard in San Angelo, Texas costs approximately $1,265 less than any alternative that utilized xeriscaping. However, once variable (reoccurring) costs were evaluated, the maintenance costs, predominantly water expenses, overshadow the low installation price of turf landscaping. In fact, based on total costs for the first year, the most expensive yards to install and maintain are one hundred percent turf. One hundred percent xeric yards are the most cost efficient, but any alternative that involves xeriscaping proved to be cheaper than one hundred percent turf. This project utilized a break-even analysis to find how quickly savings on maintenance costs for a xeric yard would surpass the expense of a turf yard (Fields, B., 2013). Savings in maintenance costs for each alternative that utilized xeriscaping would surpass the price of the one hundred percent turf yard in less than one year. Additionally, if a homeowner in San Angelo were to replace previously established turf with any level of xeric material, it would take approximately twenty-one months' worth of water savings to recover the installation expenses. Finally, the water usage costs for turf yards were based on the recommendations of local experts who advised that turf would be watered twice a week. However, if the city of San Angelo has level one water usage restrictions in effect, watering could be limited to once a week or less. While the cost of watering would decrease, those savings would, in turn, be offset by a decrease in aesthetic appeal due to

unhealthy turf and a possible decline in value within real estate market (City of San Angelo, 2013).

Discussion

Certain qualitative factors that could also sway homeowners' decisions toward xeriscaping would not be quantifiable without conducting a contingent valuation survey to determine the exact value residents would place on the various qualitative factors, and therefore were not included in this project. The largest of these factors would be the personal utility gained from conserving water through xeriscaping, particularly in a town such as San Angelo that has experienced such extreme water shortages. Increased aesthetic value could also provide personal utility and potentially be reflected by increased future value in the real estate market. Finally, if homeowners were to install landscaping in which the majority of materials immediately next to a house or other structure were xeric, they would need to take proper maintenance precautions in order to prevent damage or cracking of the house's foundation due to a lack of groundwater (Begnaud, J., 2013).

Homeowners' decisions could be directed toward a turf yard by factors that can result from a xeriscaped yard, including potential increases in electricity prices due to the reflection of sunlight off of a xeriscaped yard onto the walls of a house or other structure. The monetary consequences of this factor could not be quantified without performing a separate experiment designed to document and evaluate electricity costs. One way to potentially offset the effects of reflection is strategic placement of shade trees around the house in order to provide shade coverage and decrease the temperate of air immediately above xeric landscapes. Again, this factor could not be quantified without performing an experiment designed specifically to measure electricity savings resulting from shade trees and cooler ground temperatures (Fields, B., 2013).

Due to such a wide variation in personal preference and insignificantly small cost estimates from vendors in San Angelo, the scope of this project also did not include additional xeriscaping costs that result from installing drought-tolerant plants, shrubs, or other xeric materials. It is acknowledged that drought-tolerant plants and trees would need water, and if added to a xeric landscape these elements would further increase costs, but it is believed that the increases would remain small enough for xeriscaping to continually prove to be the most economically efficient alternative.

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