The Residential Urban Landscape as a Frontier for Water Conservation

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In the United States, growing populations in every community will face different water supply and demand issues. And the urban residential landscape might be the frontier where water conservation issues collide. Irrigation is the largest user of freshwater in the United States (Hutson et al. 2004). Irrigation used for agricultural and horticultural practices averages 2.48 acre-feet per acre (Hutson) and accounts for 81 percent of the consumptive use of water (Solley et al. 1998) in the United States. Traditionally, this consumptive use estimate includes freshwater irrigation on crops, parks, golf courses, and other recreational areas. But, increasing urbanization could mean the water used to irrigate the urban landscape will become an increasingly important factor in consumptive water use estimates. Urban landscape irrigation may not necessarily cause an increase in fresh water withdrawals from existing sources, but the consumptive water of the urban landscape as a proportion of the total consumptive use may increase. For example, in Arizona, agricultural water use is projected to decline, whilst municipal use (eg. residential water use) will double over the next 50 years (Unruh and Liverman 2008).

On average, yearly residential water use ranged from a low of 55 gallons per day per person in the temperate mesic state of Wisconsin to a high of 207 gallons per day per person in the arid state of Nevada (Emrath 2000). This difference in water use indicates that climate-related differences in outdoor water utilization contribute significantly to the high water use in arid western states (Emrath, 2000). However, landscape irrigation can average 40 to 70 percent of residential water use in the United States (Ferguson 1987), making it clear the urban landscape commands a significant portion of residential water use.

Although total fresh water withdrawals have flatlined since 1950 and remained at about 80 percent surface water and 20 percent ground water (Hutson et al. 2004), the drivers that are tending to shift consumptive water use to the urban landscape are increasing. Urban and suburban population growth has dramatically altered the balance between consumptive water demand and available supply. This is evident in portions of the arid and semiarid regions of the western United States where rapid expansion of urban areas and increases in population have occurred during the last few decades. Between 2000 and 2008, the western states of Nevada, Arizona, and Utah experienced percentage population increases of 30, 27, and 22 percent, respectively. Although California's population growth ranked eighteenth among the states, it is the most populous state (US Census Bureau 2008). This population growth demands creative strategies to satisfy the increased demand for landscape irrigation from existing sources. Some of those existing water sources are already fully allocated or are rapidly becoming fully alloted. For example, two decades ago the entire 7.5 million acre-foot of water of the lower Colorado River basin (Arizona, California, and Nevada) became fully allotted for the first time (Unruh and Liverman 2008).

That the urban landscape might be a frontier for water conservation is clearly illustrated with the case of Nevada. In addition to Nevada having the highest population growth in the United States, the Las Vegas Valley in Nevada is one of the fastest growing metropolitan areas in the United States (Sovocool et al. 2006). Together with population growth, the increasing number of people who visit Las Vegas because of its tourism and gaming industries has mandated a serious commitment to managing the regions water supply to ensure adequate future supplies (Sovocool 2006).

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Landscape irrigation contributes to most of southern Nevada's consumptive water use (Sovocool et al. 2006) which prompted the Southern Nevada Water Authority (SNWA), a regional collaborative of seven public water and waste water agencies, to craft strategies aimed at conserving water in the residential landscape.

The SNWA showed single family residencies with xeric landscapes use 76 percent less water than those with turf-dominated landscapes. Xeric landscapes were composed of desert-adapted shrubs, trees, ornamental grasses, and crushed rock mulch (Sovocool et al. 2006). Total water use of households with xeric landscapes averaged 96,000 gallons less than homes with turf-type landscapes. Using xeric landscapes might be one way to conserve water in the urban environment.

While xeric landscapes are likely to flourish in Nevada because of their documented water conservation benefits, the use of xeric landscapes as a water conservation measure could influence urban landscaping in other regions of the United States. For example, the increasing frequency of summer droughts in parts of the United States, such as the Northeast, that are unaccustomed to droughts (Wolfe et al. 2008), will place increasing demand for landscape irrigation and landscapes that conserve water. Additionally, expected increases in the earth's average temperature will increase evapotranspiration which could exacerbate drought conditions (NDRC 2008). Higher temperatures will increase evaporation from outdoor water features and elevate evapotranspiration from plants. Both of those occurrences will augment the demand for water in urban landscapes

Before xeric landscapes can be widely adopted, barriers to their adoption must be conquered. One of the highest rated barriers to installing xeric landscapes is concern about their aesthetics (Hurd et al. 2006). Consumers may select xeric landscapes as a way to conserve water if those landscapes can offer similar functions as traditional landscapes (Spinti et al., 2004). So, landscape designers and planners must incorporate the same design elements found in traditional landscapes into xeric landscapes to ensure that xeric landscapes are appealing.

As a frontier for water conservation, perhaps the greatest gain in water conservation in the urban environment will be made by improving the efficiency of landscape irrigation delivery systems. In the broadest sense, landscape irrigation is the application of water to land areas that supply the water needs of ornamental and landscape plants (St. Hilaire et al. 2008). Because landscape irrigation involves an engineered physical system that requires user input, skilled installation, and periodic maintenance, the risk of inefficiency is high. A breakdown in any one of these items or activities causes reduced irrigation efficiency. So, improving irrigation efficiency must be at the heart of any strategy that seeks to guarantee the most efficient use of water in the urban landscape.

Significant gains in urban landscape irrigation efficiency will be made if landscape water budgets are developed, irrigations are scheduled correctly, and user-friendly technology is infused into the landscape irrigation process. An urban landscape water budget, also known as its maximum applied water allowance, can be calculated to provide a quantitative estimate of an urban landscape's water budget (St. Hilaire et al. 2008). Residential urban landscapes are heterogenous mixes of turfgrass, woody, and herbaceous plant species that are valued for their aesthetics, not their production. So, crop water budgets, steeped in the concept of optimum growth and yield, are not relevant to the urban landscape (Shaw and Pittenger 2004). Rather than rely on water budgets calculations that have been developed for crops, urban landscape professionals must develop water budgeting tools that are unique to the urban landscape. Some urban residential landscapes can thrive with less water than is indicated from a calculated water budget. This fact alone offers a unique opportunity for water conservation in the urban landscape.

User-friendly technology, such as smart controllers and soil moisture sensors can remove the decision to irrigate from the hands of the homeowner. Because most conventional in-ground irrigation systems are operated by a controller that mandates operator (homeowner) intervention to adjust the daily or seasonal irrigation run times, most homeowners set the schedule and do not seasonally adjust their irrigation schedules. This results in an over-irrigated residential landscape during periods of reduced plant water demand, such as the fall to winter period (Davis et al. 2007).

Some smart controllers will automatically adjust irrigation schedules based on weather conditions. Soil moisture sensors can detect levels in soils and terminate irrigation events when soil moisture reaches set levels. Smart controllers have been reported to reduce summertime applied water by up to 42 gallons per day for residential landscapes and up to 545 gallons per day for commercial landscapes (Irvine Ranch Water District 2008a). The widespread adoption of smart controller technology or the use of soil moisture sensors has the potential to realize significant water savings.

Saving water will become a significant piece of future water management programs for rapidly growing populations (California Office of Water Use Efficiency 2006) and has implications for how water is used in the residential landscape. Environmental laws, crafted to limit ecosystem degradation, are constraining the development of new sources of water for the urban environment (Dickinson 2008). Thus, utilization of reuse water in the urban landscape is one strategy communities can use to offset the lack of new water sources. Potential sources of reuse water include effluent, storm water runoff, and nursery runoff. Reuse water is more likely to be used to irrigate golf courses, parks, and roadway medians where public acceptance is highest and human contact is perceived to be low (Devitt et al. 2004). While irrigating the residential urban landscape with reuse water is a perfect way to extend existing water supplies, greater management skills are needed to minimize soil salinization, plant damage, health-related problems, and loss in aesthetic appearance of water features (St. Hilaire et al. 2008).

Travails are likely to occur at a frontier and water conservation in the residential landscape is no exception. A substantial body of scientific knowledge on the most effective ways to conserve water in the urban landscape is lacking. So, it is hard to predict the outcome of those travails. For example, in 1981, a court ordered the Denver Water Department to promote water conservation in outdoor landscapes. This action led to the development of xeriscapes as water conserving landscapes (Hagan 1988). In contrast, on September 17, 2007, a severe drought prompted the state of Georgia to ban outdoor watering (Brown and Pharr 2007). This decision had a financial impact of $3.5 billion on Georgia's urban agriculture sector. These two historical events are likely to be repeated in some way. The urban sector could be the maelstrom for water conservation efforts as more water is diverted from agricultural to residential use and more constituents converge toward an increasingly scarce resource.

More research on effective water conservation measures for the residential landscape would ensure sustainable water conservation methods are developed. There should be greater public investment in this area of research. Possible research areas include understanding the relationships between residential landscape types and the potential for water conservation. Ways to divert excess precipitation into the residential landscape must be perfected. One economic incentive program, often called Cash for Grass, offered rebates for conversion of turf to xeriscapes. An economic analysis of this program, led Addink (2008) to conclude that Cash for Grass programs are an expensive way to save water. So, a research question that needs to be answered for every proposed economic incentive is whether this incentive is cost effective in promoting water conservation in the urban landscape. Finally, the block rate pricing model that many municipalities used to price water may not be fully capturing the real price of water (Dalhuisen et al. 2003). For that reason, newer water pricing models, such as the Irvine Ranch Water District's (IRWD) tiered-rate structure that reflect a water budget, should be developed and tested. The IRWD water pricing model decreased water consumption without jeopardizing the urban landscape function (Irvine Ranch Water District 2008b).

Population growth, increased economic activity, and urbanization will increase the demand for water in the United States. In fact, the demand for water is already exceeding the supply (Dickinson 2008), so conservation of the existing water supply is quintessential for both the United States and urban areas. The lack of water has the potential to jeopardize our food supply, disrupt fragile ecosystems, alter alliances among constituents, and threaten our way of life. The heterogeneity of the urban landscape and the plethora of existing urban water conservation strategies have limited a cohesive strategy for urban water conservation. Sensible water conservation standards, such as national standards for plumbing fixtures have contributed to improvement in efficiency of use of the in-house water supply. Perhaps the same could be considered for the urban landscape. This could be one step that could be used to secure our future water supplies.

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