The Inherent Drought Response Flexibility in Irrigated Landscapes

by

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ABSTRACT

Many western U.S. landscapes can be typified by irrigated areas in turf grasses, shrub beds, trees in turf grasses, and vegetable gardens. The irrigation systems can be typified as sprinkler irrigation systems, or often combination drip and sprinkler systems, with sprinklers used in appropriate turf areas and drip irrigation used in shrub beds. Generally, if these irrigation systems are properly designed, then there is clear distinction with individual laterals irrigating either turf grass or shrub beds.

The water for irrigation is often potable but it can be raw water that is continued to be used for its decreed purpose, namely irrigation. In many parts of the country, the demands of landscape irrigation can be nearly 50 percent of the total annual potable water demand. Because landscape demand is seasonal, the peak season water treatment needs are in effect driven by the landscape irrigation.

Under drought circumstances, supplies are limited and reductions must be made. Typical drought responses include odd-even day irrigation, a proscribed number of irrigation days per week, or some other, blanket curtailment. Alternatively, many water purveyors increase unit cost and reduce demand in a punitive way. None of these methods take advantage of the drought-resilience or economic value of landscape elements in their "one-size-fits-all" approach to drought response.

Landscapes offer tremendous flexibility to adapt water applications to the severity of the drought and drought response plans can be formulated at various levels that are tied directly to the drought severity. For example, under a moderate drought it may be suitable to simply reduce applications to turf grass. Increasing levels of drought severity result in expansion of the drought response to other areas of the landscape, from turf to shrubs to trees.

Introduction

In various regions of the United States, water availability and seasonal water quantity issues are receiving unprecedented discussion, scrutiny, and attention from many perspectives. Landscapes and landscape irrigation are an important part of the

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discussion and often enough, the target of the discussion. Irrigation is often 45% to 55% of annual potable water deliveries based on numerous studies.

A short list of intertwined landscape issues includes:

- Amount of landscaped area, including the proportion of the turf grass area.
- Approach to landscape irrigation system -- the products, the control system, and water use efficiency.
- Sources of water and including the poignant question “should be irrigated with potable water?”
- Overall sustainability of the landscape.
- Adequacy of water supplies to include safe yield, quality, and losses in an aging infrastructure.
- Metering of water for irrigation.

In the past, and in the author’s view, the topic of outdoor water and the approach to landscapes has periodically seen elevated discussion, press coverage, and public attention. Those discussions have often been rather short lived. An example is the promotion of xeriscaping and xeriscape landscapes in the Denver area during the late 1970s. There was good public acceptance of the approach, and to saving water outdoors generally, but the duration of the discussion and active promotion of xeriscape was less than 10 years. As with xeriscaping, outdoor water savings and efficiency tend to ebb and flow much like the discussions of floods and droughts, respectively. Public attention is garnered and held most often when there is a crisis.

At present, we are seeing a national debate and base-level questions considering the amount of landscape and the amount of water that can be used for landscape irrigation. This paper attempts to frame an argument for some adjustment in our collective thinking about landscapes and landscape irrigation without dramatic impact on our valuable and much appreciated landscapes. This might be a good time for a paradigm shift to occur and settle in for the long term. Use of sound science and public education are part of a sustainable solution.

Landscape Water Requirements and Irrigation Scheduling

A great deal has been written about landscape water requirements and scheduling irrigations to effectively meet but not exceed the plant needs. The homeowner tenancy has long been, and still is, to over-irrigate landscapes because water is relatively cheap and the water bill still does not get much attention from homeowners.

The evapotranspiration rate is published daily in some areas and if the homeowner has that information at hand, and can relate it to the application rates of their system, then improved irrigation scheduling can be attained. The results vary widely and reports of successes are often tied to very in-depth communications and training with customers. Often enough, qualified irrigation contractor oversight becomes important in keeping home owners on a suitable track of scheduling irrigations to need.

A key factor in making landscapes more flexible is to have a complete understanding of the water requirements, the manner of water applications, and an understanding of where adjustments can be made for purpose. *This is the management component.*

The Landscape Irrigation System

The irrigation system is just that -- a system. The collective system consists of the myriad of valves, wire, pipes, controllers, and water emission devices (sprinklers, drip emitters, etc.). The system, if properly designed and installed, is assumed to be capable of irrigating the landscape to meet peak season water requirements using laterals that are tied, in a practical way, to "hydrozones" within the landscape. Assume for the purposes of this paper, that the landscape irrigation system is properly designed for the landscape, well maintained, and operationally flexible.

Auditing of landscape irrigation systems to understand the built system along with application rates and application efficiencies is now more accepted than ever before. In some areas, initial and periodic auditing of the system is required. The Irrigation Association has certified approximately 1,200 individuals as Certified Landscape Irrigation Auditors (often abbreviatated as "CLIA). Most of these individuals have also become WaterSense Partners within the EPA's WaterSense program.

Control systems that underpin high efficiency irrigation include full-featured, multiple program, controllers having features such as "cycle and soak" that allow run times that are compatible with soil intake rates. The newer "smart" or climate-based controllers provide adaptation to changing water requirements. Sprinkler and emitters are preferred to be of the pressure compensating types.

The distribution uniformity (DU) is a sprinkler performance metric that has gained wide acceptance in the industry as a means of truly comparing sprinkler / pressure / nozzle alternatives at the design stage. Almost more importantly, DU can be field evaluated via an audit and using catch can data to ensure desired as-built performance.

It would appear that a system performance bar is being raised for landscape irrigation which will ultimately play out to the benefit of the homeowner, the water purveyor, and the irrigation industry. Water use efficiency is getting unprecedented attention and rightly so.

Relative to the topic of this paper, it is important that the irrigation design incorporate a suitable amount of operational flexibility to adapt to a drought response plan. What this may mean, is strict design and definition of hydrozones and possibly increased numbers of laterals if plant material water applications are to be tied ever so much closer to water availability.

This is the system component.

The Landscape

It certainly is not my intent to espouse on the merits of various plant materials or landscape design in this paper. That is not my area of expertise. However, there are characteristics that, especially when married up with the landscape irrigation system, provide the desirable flexibility for drought response.

These general characteristics include groupings of trees and shrubs, drought tolerant grasses, and manicured and irrigated turf grasses. The intent of the landscape design is very important and that intent simply needs to be balanced with a water budget to provide the desired flexibility. The landscape and the irrigation system, taken together, provide options and flexibility. Likely, the future holds a more thoughtful and water budgeted design to achieve needed flexibility.

The landscape and the irrigation system, taken together and functioning together, provide the flexibility. An example is shown in Figure 1 showing drip irrigated trees in otherwise unirrigated areas, drip irrigated trees and shrubs in a mulched shrub bed, and sprinkler irrigated turf grass (in this case bluegrass) for human activity.

This is the landscape component.

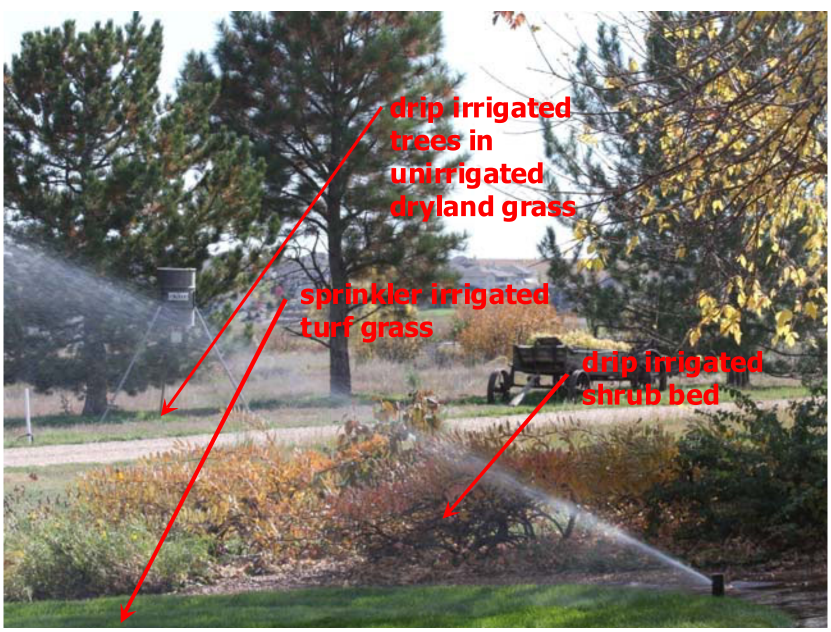

Figure 1. An example of desirable flexibility in an irrigated landscape.

Water Supply, Drought, and Drought Response

Water supply for municipal use is generally evaluated on the basis of “safe yield” which is a term that helps understand a water purveyors risk as associated with the variables in the supply. Fifty years is often the hydrologic period of record that is used. A community needs a projected annual supply to meet all the needs of the community and that would include projections of population change – population growth in most of the western U.S.

Drought does not have a single definition. It has been noted that we do not know when droughts start or end until you look back at the event. The threshold data could be precipitation or it could be stream flows. Stream flow is most often an indicator or drought in those areas having snow pack from which water supplies are derived.

An example is shown in Figure 2 for the Poudre River in northeastern Colorado.

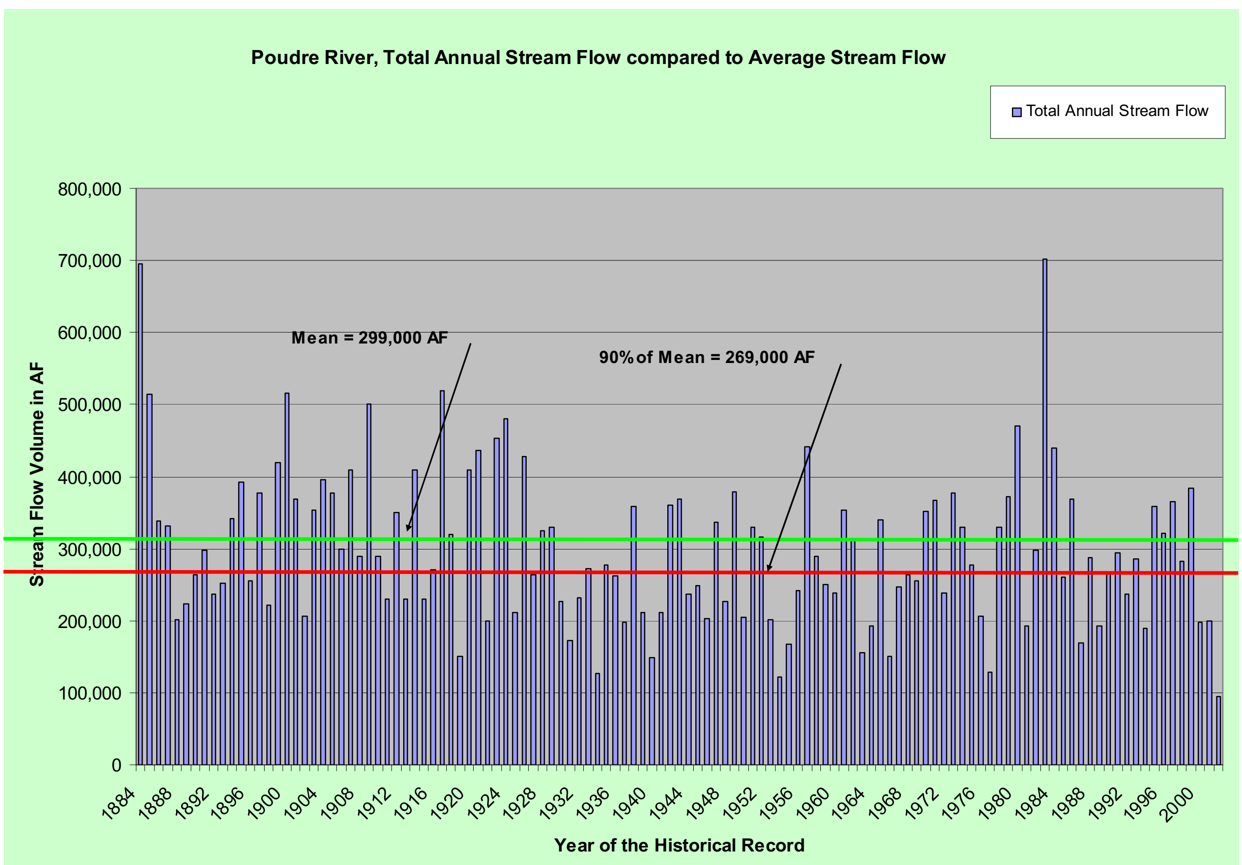

Figure 2. The variability in stream flow over a long period and indicative of the wet and dry periods of record. Reservoirs help capture excess flows in wet years for delivery in dry years and thereby provide needed flexibility to the potable water purveyor.

Clearly, the historic record for the Poudre River and many rivers is highly variable as shown in Figure 2. The droughts of the past tend to be those droughts that we plan for in the future. If reservoirs are a part of the water supply system, then reservoirs capture water in the wetter years to be delivered in the dryer years, thereby creating needed flexibility in the upstream delivery system.

This is the drought response and water supply delivery system component.

Responsible and Sustainable Landscape and Irrigation Operations

The overall premise here is that landscapes provide operational flexibility that we do not take full advantage of. Sure, if we are short of water due to drought or other supply concerns, our water purveyors, and we as customers, will decrease water applications. This can be driven by water purveyor mandates and “water cops” or it can be driven by punitive unit rates, including escalating water rate structures. Most generally, outdoor water use becomes the obvious target for reductions because of the large volume and because landscapes, stating the obvious, are clearly less important than human health and safety. Indoor culinary water, wash water, and sanitary water are a more important use of potable water than outdoor irrigation.

There is potential to dramatically decrease outdoor water applications and thereby chop the top off of the typical annual potable water delivery curve as shown in Figure 3.

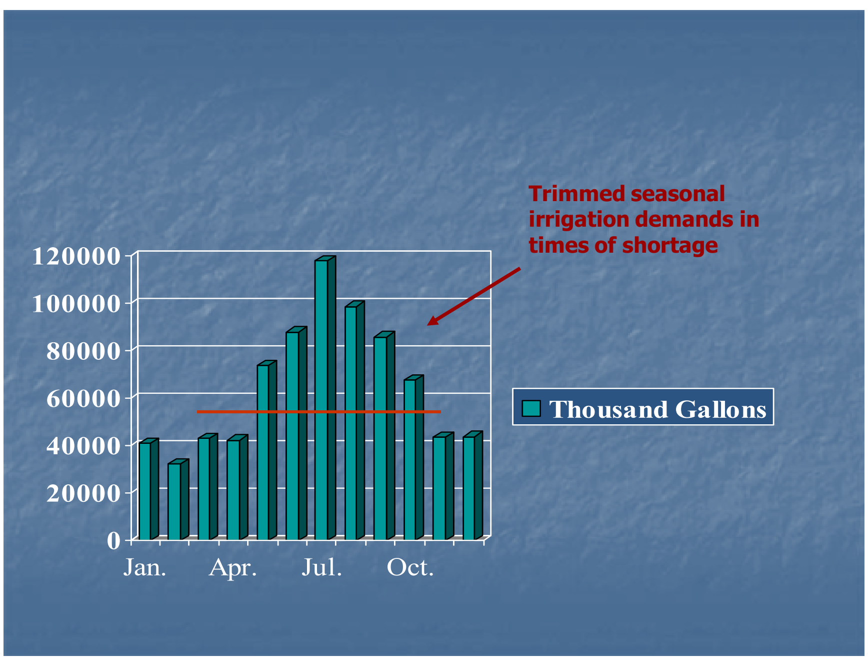

Figure 3. Many potable water purveyors see annual deliveries as shown with dramatically higher deliveries during the irrigation season. Reducing landscape water deliveries in times of drought will reduce the total annual delivery while also reducing the peak season water treatment requirements.

Figure 4 is a representation of two different but equally important aspects of managing water delivery systems in a flexible and sustainable way. On the upstream side of the delivery system, water storage is key to capturing water in wetter hydrologic years for delivery in dryer years. Likewise, on the downstream side of the distribution system, landscapes can be provided with less water than optimal for decreasing deliveries and saving reservoir storage. The overall delivery system can be managed for seasonally varying water availability circumstances.

Thresholds for action levels should be defined in a planning process and a drought response plan created that utilizes the flexibility in the landscape. An example of such a drought response plan is shown in Figure 5.

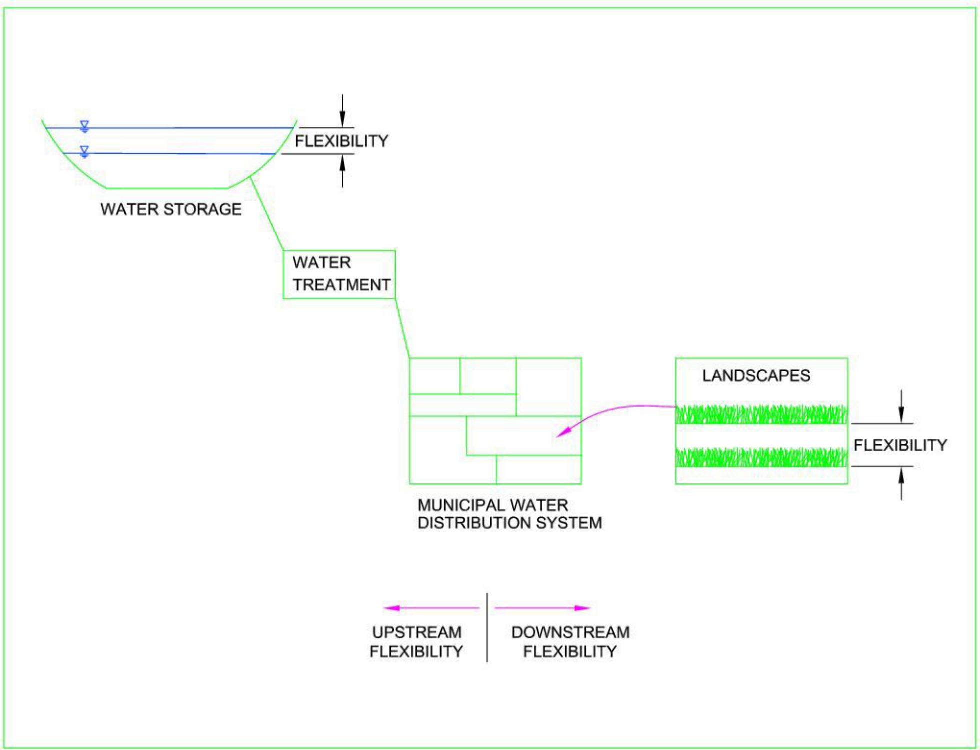

Figure 4. The potential to treat landscapes and water for landscapes as a flexible delivery in consideration of drought or other water short circumstance is diagrammatically shown. Just as a reservoir provides flexibility on the upstream delivery, landscapes can provide flexibility on the downstream delivery.

Drought Triggers and Response by Threshold

Storage at July 1st	Drought Stage	Water Savings Target	Restriction	Probable Restriction	Notes / Staff Action
100%	0	Unrestricted, normal use	No restriction	none	Customer mailings advise of policy matters and service area happenings.
90%	1	5% reduction from normal use	Voluntary restrictions	Customers asked to conserve.	Drought education mailings are initiated. Staff contacts blatant policy violators.
80%	2	10% reduction from normal use	Voluntary restrictions	Customers asked to carefully monitor irrigation and avoid waste.	Educational mailings concerning irrigation scheduling and sprinkler application rates.
70%	3	20% reduction from normal use	Mandatory restrictions	Residential customers limited to 3 days per week by house number. Parks irrigation decreased on low public use areas. Golf course roughs are not irrigated.	Additional staff assigned to monitor and contact violators.
60%	4	30% reduction from normal use	Mandatory restrictions	Residential irrigation limited to 2 days per week by house number. Parks irrigation limited to high use areas and sports fields. Golf course fairways are deficit irrigated.	Fines imposed for water wastage or irrigation outside of imposed restrictions.

Figure 5. An example of drought response triggers and varying thresholds that indicate corollary response actions is shown. This type of drought response plan is best accomplished as a relaxed planning exercise and should not wait until a time of crisis.

Summary

We all hear the word “sustainable” and “sustainability” a lot. One definition of sustainability is “the capacity to endure.” Irrigated landscapes can have the capacity to endure and survive short term drought events without long term repercussions. The primary elements that allow for this adaptation and successful operational flexibility are:

1) Landscapes: well designed landscapes that are characterized by plant materials selected with purpose and grouped appropriately so hydrozones can be defined. This is simply sound landscape and irrigation design.

2) Irrigation systems: well designed irrigation systems that utilize efficient equipment (pressure compensating devices and high distribution uniformity), smaller and adaptable laterals, appropriate hydrozones, and sound control and irrigation scheduling practices.

3) Deficit irrigation: understanding of the effects of deficit irrigating plants in the landscape and which plants, or plant groups, offer the most potential for reduced water applications in times of drought or other water shortage.

References

Smith, S.W. 1997. Landscape Irrigation: Design and Management. John Wiley & Sons, Inc., New York.