GLOBALIZATION AND WATER RESOURCES MANAGEMENT:
THE CHANGING VALUE OF WATER

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WATER CONSERVATION USING SATELLITE TECHNOLOGY FOR IRRIGATION SCHEDULING

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ABSTRACT: Northern Nevada faced a severe drought from 1987-1994. $6M dollars of emergency conservation programs were implemented. Savings were temporary and per capita outdoor water consumption is now higher than prior to the water shortage. When water supplies have been fully allocated, conservation is the only avenue for an extended supply. Residents intuitively apply 2-10 times more water than is needed for turf production. We have initiated a study evaluating the use of satellite technology as an effective means of water conservation. The study consists of 4 treatments: intuitive irrigation, manually ET scheduled irrigation, manually ET scheduled irrigation with management training, and ET satellite controlled irrigation. Residential and commercial cooperators are included. Cost/benefits for each treatment will be compared using the current fixed cost of water in the Truckee Meadows. Preliminary results indicate a potential of 15-30% water savings using satellite technology. A 15% savings would equate to 12.5 AF/Y in our area.
KEY TERMS: domestic water supply, water use efficiency, satellite-controlled turf irrigation.

INTRODUCTION

The State of Nevada averages 9 inches of annual precipitation and is one of, if not the driest state in the nation. Of this amount only 10% accounts for stream runoff and groundwater recharge (Division of Water Planning, 1992). Specific to northern Nevada, most of this precipitation occurs as winter snowfall and during periods of non-irrigation when outdoor turf is dormant. Conversely, during summer when plant water requirements and outdoor use are high, peak demands occur when water supplies are lowest. Compounding this situation is the periodic cycling of prolonged drought events; 1928-1937 (9 years), 1959-1962 (3 years), 1976-1977 (1 year), and 1987-1994 (7 years) being the most recent (State of Nevada Division of Water Planning, 1992)Now in 2001 it appears we are entering another drought cycle.

Washoe County, which includes the City of Reno, City of Sparks, and adjacent areas of the Truckee Meadows (Figure 1), is second only to the Las Vegas area in population growth. The historic (since 1960) and projected increase in population over the next 15 years for Washoe County is presented in Figure 2 (State of Nevada, 1992). Corresponding and projected water withdrawal for 1990, 2000, 2010, and 2020 in AF/yr are 75,000, 103,000, 121,000, and 141,000, respectively (Department of Water Resources, 1992). Indeed, projected demand is rapidly approaching water right availability (Figure 3). As the population increases in drought plagued areas where water supplies have been fully allocated and no new sources are available, conservation is the only avenue toward sharing a limited supply of water (Guitjens, 1982). During the drought years from 1987-1994, northern Nevada faced severe water shortages. Losses to agricultural entities in 1991 were an estimated $22 M. Emergency conservation programs were implemented at a cost to taxpayers of an additional $6 M (Division of Water Planning, 1992).

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Figure 1. Map of Truckee Meadows and adjacent Washoe County.

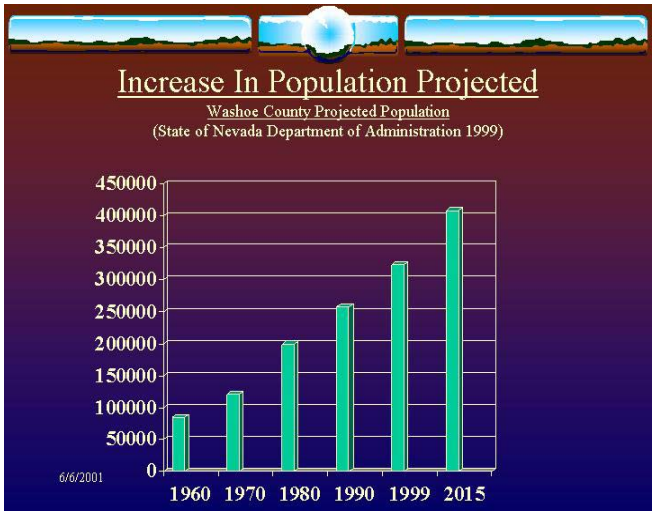

Figure 2. Projected increase in population for areas showing City of Reno, City of Sparks and portions of Washoe County.

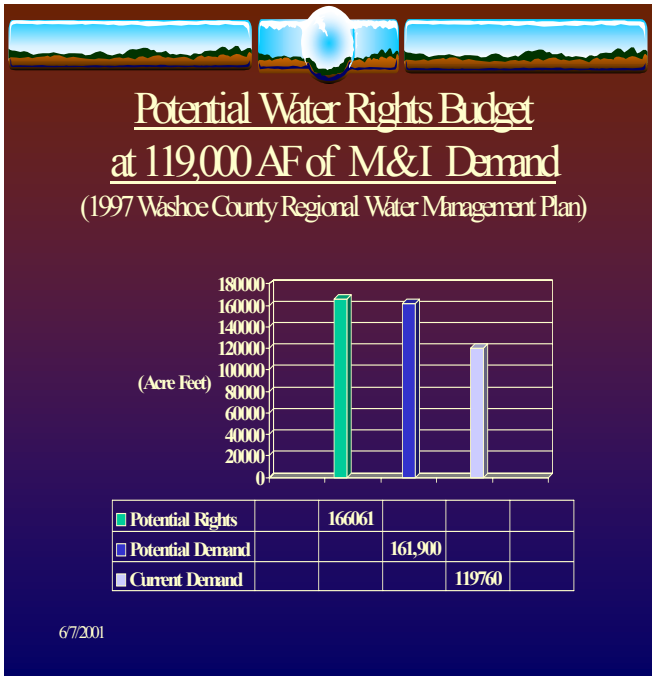

Figure 3. Existing water right availability relative to demand. SPCo is Sierra Pacific Power Co., Ag is Agriculture, Rvr is Truckee River rights, respectively.

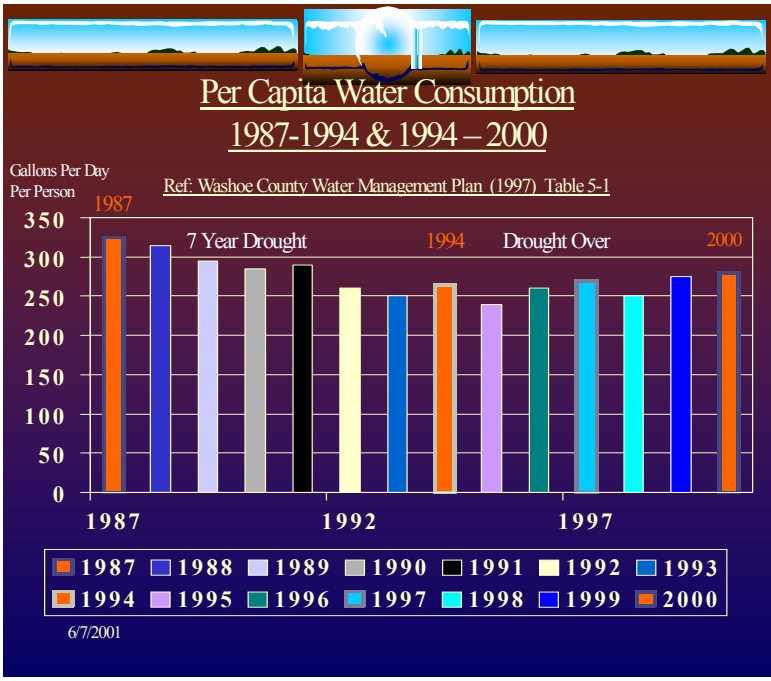

Figure 4. Per capita water consumption during and following the drought years 1987-1994.

Among other actions, mandatory two day per week water restrictions for lawn irrigation were implemented in the Truckee Meadows (City of Reno, City of Sparks, portions of Washoe County), with no outdoor watering allowed between the hours of 1:00 and 5:00 pm. Domestic water consumption was reduced by 25%. However, although outdoor watering restrictions remained in place following the drought, water use immediately escalated from a low of 64,000 AF in 1995 to 70,000 AF in 1996 and 1997, to a high of 82,000 AF in 2000 (unpublished data, Sierra Pacific Power Co., Reno, NV 2001). Indeed, the American Water Works Association (1998) has shown the use of water restrictions to be only a short-term solution because volunteer cooperation with the conservation program ends when the emergency is over and per capita consumption quickly reaches levels comparable to those prior to the water shortage. Northern Nevada is no exception (Figure 4).

This study is a contribution of the Nevada Cooperative Extension and Nevada Agricultural Experiment Station. The purpose is to investigate the use of satellite technology as a means of water conservation and to determine its cost/effectiveness relative to typical volunteer outdoor water conservation programs and conventional irrigation scheduling. While the goal is water conservation, our objective is to do so without sacrificing turf quality or at excessive cost to the consumer.

STUDY APPROACH

The State of Nevada Department of Water Resources (1992) defines conservation as activities designed to reduce water demand, improve efficiency in water use to reduce loss and waste, and/or to improve land management practices to conserve water. A primary target currently identified in the Washoe County Department of Water Resourses 20 year conservation action plan (1997) for potential water savings in the Truckee Meadows is landscape conservation and irrigation efficiency. Sierra Pacific (now Truckee Meadows Water Authority) is the largest residential water purveyor in the Truckee Meadows and serves approximately 80% of the residents. It has been estimated that 50% to 70% of the total water supply is used for outdoor irrigation during the summer months and their unpublished data suggests that in non-drought years residents typically apply anywhere from 2 to 10 times more water for landscape irrigation than is actually needed (personal communication, Gary Kah, Aqua Metrics 1999); most of which occurs during spring and fall when evapotranspiration demands are lower relative to irrigation application rates. Figures 5 and 6 present the monthly ET_o for three locations and illustrate the potential water savings assuming excessive consumer use of 2 and 10 times the actual ET_o, respectively. The potential for substantial water conservation clearly exists.

Current Technology

The Washoe County Regional Water Planning Commission and the offices of the Nevada Cooperative Extension currently maintain several Campbell Scientific weather stations throughout the Truckee Meadows and adjacent areas. During the irrigation season reference evapotranspiration (ET_o) is determined using the Penman-Montieth method and posted daily on their web site (www.washoeet.dri.edu). Consumers, by choice, may use this information to determine how much water to apply during their twice-weekly irrigations. One simply views the suggested run times or sums the ET_o for each day of non-irrigation plus that on the actual day of irrigation. This is a volunteer program however, and no independent data exist as to its success in water conservation. Moreover, even those using the service seldom know or understand the application rates and/or distribution efficiency of their irrigation systems.

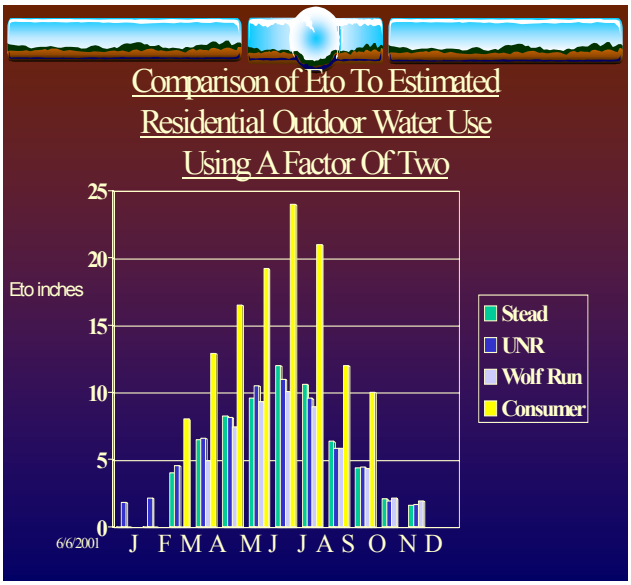

Figure 5. Comparison of ET_o to estimated residential Outdoor water use using and excessive use factor of 2.

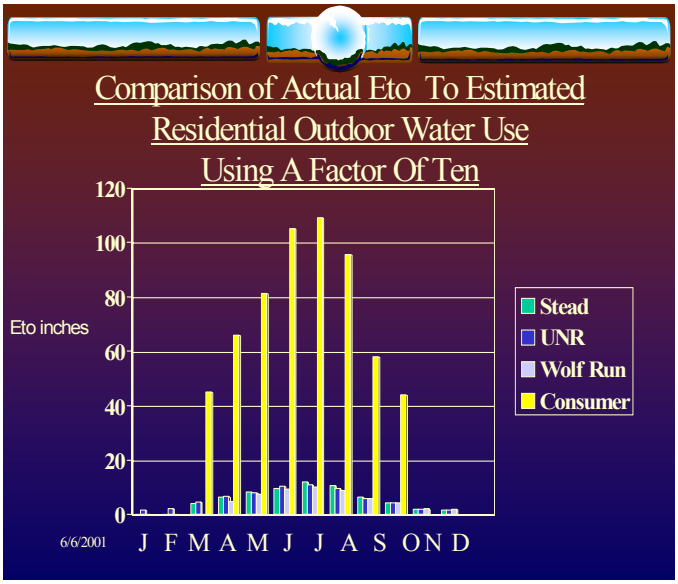

Figure 6. Comparison of ET_o to estimated residential outdoor water use using and excessive use factor of 10.

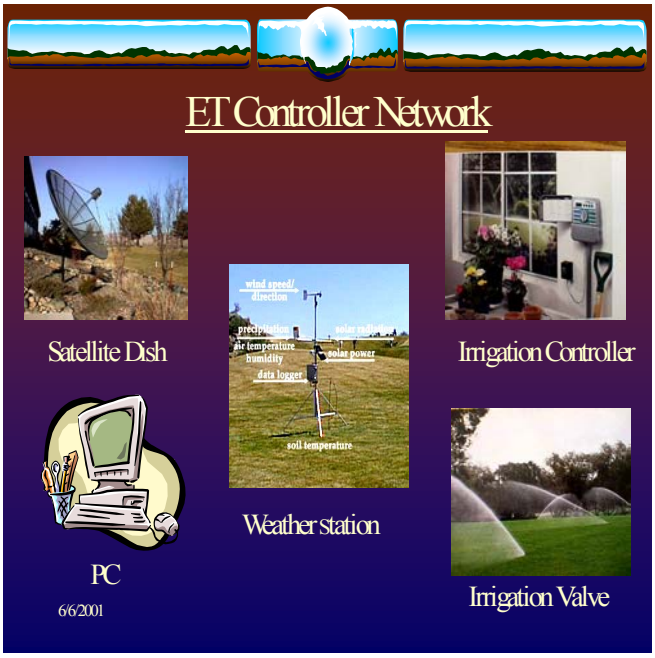

Figure 7. Schematic of ET Controller network.

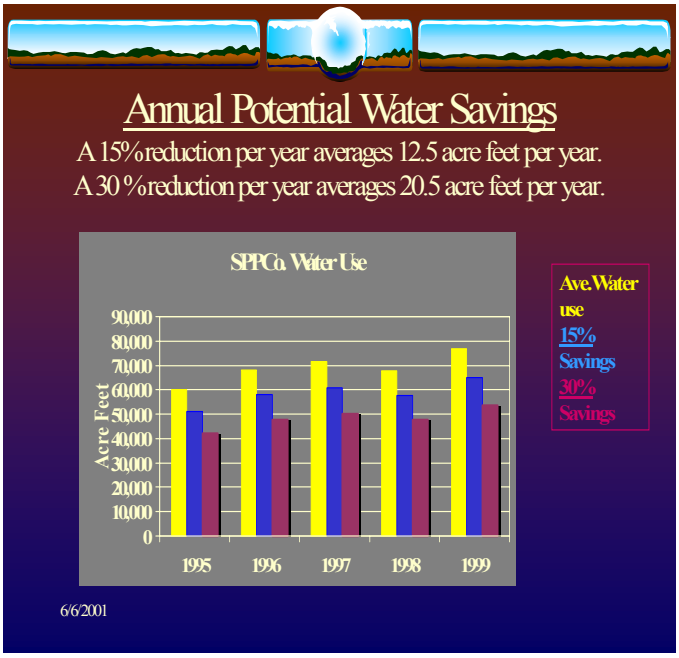

Figure 8. Impact of a potential 15% to 30% reduction in outdoor water use as a result of controlled irrigation.

New Technology

An emerging technology utilizes localized data generated from weather stations to control the duration and frequency of outdoor irrigation. Weather station data are sent to a PC unit cellularly where ET_o is computed then sent via satellite dish to an orbiting satellite. The satellite then beams the signal down to an irrigation controller individually located at the consumer's place of residence on a weekly basis. The controller opens the irrigation valve and automatically sets the duration and frequency of irrigation based on a pre-assessed application rate and distribution efficiency of the irrigation system (Figure 7).

Methods

This study consists of four treatments (intuitive irrigation, volunteered manually ET scheduled irrigation, manually ET scheduled irrigation with management training for volunteers, and ET satellite controlled irrigation), on two management landscapes (commercial vs. residential), with 3 replications per treatment. Five response variables are considered: total applied water (each application and seasonal), plant stress index, soil moisture penetration, turf quality, and cost recovery. To test the four treatment effects and two managed landscapes on the five response variables a 4 x 2 factorial experiment with 3 replications in a completely randomized design will be used. Each experimental unit consists of similar turf variety and uniform cultural and management practices will be maintained. The GLM procedure in the SAS systems will be used to analyze this factorial ANOVA, treatment comparison, and checking for any violations of statistical assumptions. Cost/benefit analysis will be compared for each treatment to determine cost effectiveness and cost recovery of the specific management practice.

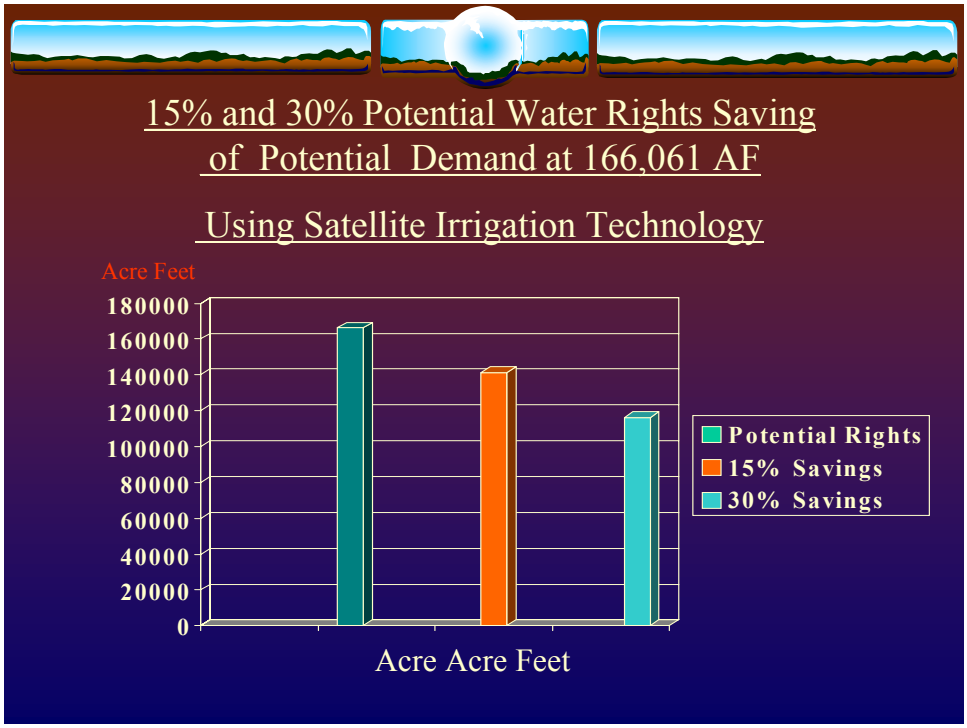

Figure 9. Water right availability relative to projected demand given a 15% to 30% savings.

PRELIMINARY FINDINGS AND EXPECTED OUTCOME

Time is past when water supply needs can simply be met by building more water storage and delivery systems. The challenge facing water suppliers in today's political, environmental, and economic climate is to fully integrate such findings on demand management into long-range water supply planning (Nevada State Division of Water Planning, 1992). Preliminary results (International Truf Producers Foundation, 2001) indicate a potential 15% to 30% savings in residential landscape irrigation in areas where outdoor water conservation practices already exist. If valid for our area, a 15% to 30% reduction in water use would equate to about 12.5 to 20.5 AF/yr (Figure 8), a substantive savings. This study will validate the conservation potential specific to the Truckee Meadows location in that local climatologic conditions will be used. This will allow us to develop greater local expertise and outreach information on the effectiveness and cost of various adaptive management strategies for water conservation. Given a potential for 15% to 30% savings, projected demand should remain below the limit of available water rights beyond 2020 (Figure 9).

ACKNOWLEDGMENTS

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