Using Water Wisely

Southwest Data Shows the Promise of Efficiency

ENVIRONMENT AMERICA
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Timothy Telleen-Lawton
Frontier Group

John Rumpler
Environment America Research & Policy Center

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Executive Summary

Water is a precious commodity in the Southwest, yet the rate of water consumption outstrips natural supply. Rapid population growth, excessive water consumption, water pollution, and years of drought have depleted the Southwest's natural water reserves and put the region at greater risk of a water crisis.

Without a dramatic change from business as usual, the Southwest's water scarcity problem will only get worse. The population in Arizona, Colorado, Nevada, New Mexico, Texas, and Utah grew by 2.3 percent between 2006 and 2007. At that rate, there would be twice as many people in the region by 2040. Scientists predict that global warming will decrease rainfall and increase temperatures in the Southwest, further exacerbating the problem.

By using existing water efficiency technologies and adopting effective programs to conserve water region-wide, six states in the Southwest could save as much as 5.7 million acre-feet of water per year.

Figure S-1. Water Efficiency Could Save up to 5.7 Million Acre-Feet of Water Each Year in the Southwest.

State	Potential Water Savings (millions of acre-ft. per year)
Arizona	0.8
Colorado	1.3
Nevada	0.4
New Mexico	0.4
Texas	2.4
Utah	0.5
Southwest Total	**5.7**

Agriculture: Agriculture is responsible for about 71 percent of all water consumption in six Southwestern states (Arizona, Colorado, Nevada, New Mexico, Texas and Utah). Better water efficiency in agriculture could save up to 2.9 million acre-feet of water for the region every year.

- The irrigation techniques used most frequently in the Southwest waste significant amounts of water. For example, the vast majority of all farmland in the Southwest is irrigated with either sprinklers or surface irrigation, which partially floods fields. Both of these common techniques lose significant amounts of water to evaporation, whereas microirrigation, in which water is applied directly to the plants, dramatically reduces evaporation losses.

- Switching fields to microirrigation could reduce water consumption by as much as 0.4 million acre-feet each year in Arizona, 0.9 million acre-feet in Colorado, 0.2 million acre-feet in Nevada, 0.2 million acre-feet in New Mexico, 0.8 million acre-feet in Texas, and 0.3 million acre-feet in Utah.

- Microirrigation has been around for decades and is especially popular in dry areas around the globe, such as Israel, where it is used on 70 percent of all irrigated lands.

Homes: Homes are responsible for about 15 percent of all water consumption in the Southwest. In the residential sector, large water savings can come from cutting down unnecessary water use outdoors. Xeriscape – landscaping designed and maintained in ways that use water efficiently – is generally easier to maintain than a typical yard and is compatible with a wide diversity of flowers, grasses and shrubs.

- Southwestern homeowners consume more water for outdoor use than for all indoor uses combined.

- A five-year study by the Southern Nevada Water Authority found that Xeriscaping reduced total home water consumption by a third.

- Encouraging homeowners to implement Xeriscaping could save 2.7 million acre-feet of water a year. If all new homes built in the Southwest were designed to implement Xeriscaping techniques, it could save another 0.4 million acre-feet of water every year by 2020.

Electricity: Electricity generation is responsible for about 2 percent of all water consumption in the six Southwestern states. Reducing electricity generation from traditional fossil fuel power plants by just 20 percent through greater use of energy efficiency and renewable energy could cut water withdrawals by 140,000 acre-feet every year.

- Typical 'once through' power plants withdraw about 448,000 acre-feet of water a year, depending on the size of the plant. After being used for cooling, the water in such systems is returned to the source along with contaminants and heat from the plant.

- Developing energy efficiency and renewable electricity sources, such as solar and wind power, would reduce the need for water in power plants.

Business: Businesses are responsible for about 3 percent of all water consumption in the Southwest. Some cities have already found that financial incentives can spur businesses to find new ways to save water. Reducing water consumption in industry by another 2 percent would save the Southwest 25,000 acre-feet every year.

- A program run by Denver Water is expected to save an average of 4,650 acre-feet of water annually by paying businesses to adopt water-saving technologies. This type of broad incentive can encourage innovation in water efficient technologies.

- Several Southwestern cities, including Denver, also give rebates to businesses that install water-efficient versions of common devices, such as high efficiency toilets and urinals.

Southwestern states should use appropriate public policy tools to promote more efficient use of water resources and alleviate the region's water scarcity problems. Specifically:

- Any new development or heavy water user should have to demonstrate that they have acquired a sustainable water supply, as is the case in Arizona. Farmers should be allowed to sell or lease water saved through efficiency improvements to others, increasing the use of microirrigation and other water-saving techniques.

- States should decrease the amount of electricity generated by coal, natural gas and nuclear power plants, which use large amounts of water. States should meet more of their electricity needs with ultra-low water use generation – primarily energy efficiency and renewable energy sources such as wind and solar power.

- States should cap the water use of new houses to ensure water responsibility and encourage Xeriscape in early stages of development. Additionally, all homeowners should receive incentives for increasing water efficiency and pay higher prices for water use beyond a certain threshold.

- States should develop commercial incentive programs like Denver Water's program to encourage better use of water-saving technologies and programs in businesses.

Introduction

It has been more than three decades since Marc Reisner's book, *Cadillac Desert: The American West and its Disappearing Water*, focused national attention on the mounting problems of water scarcity in the Southwest. Since that time, population and water use have grown, while the region has experienced one of the worst droughts on record. Little progress has been made in matching our water consumption with our water resources.

Water shortages in the Southwest can have serious and widespread consequences. Dams and water diversions disrupt river ecosystems, and falling water tables cause land subsidence and leave less water to dilute pollution and other contaminants. And because every part of society relies on water, bankrupting the Southwest's water reserves would force hard choices about the economy and lifestyle of the region.

While the Southwest's water deficit is already alarming, the region's population continues to grow, placing additional strain on water supplies. The population of the Southwest is growing faster than that of the United States as a whole, with a 2.3 percent increase between 2006 and 2007 in the six states considered in this report: Arizona, Colorado, Nevada, New Mexico, Texas, and Utah.[1] At that rate, if water consumption per person did not grow, we would use twice as much water by 2040 as we use today. Unfortunately, per capita consumption has been growing, meaning total water consumption will double even sooner if left unchecked.[2]

Added strain on the region's water supply is expected to come from global warming. According to the Intergovernmental Panel on Climate Change, the Southwest's drought is expected to worsen over the next century, making it necessary to stretch water resources even farther.[3]

Improving the efficiency with which we use water in the Southwest can alleviate our water scarcity problems. From watering lawns at home to watering crops in the field, significant opportunities to save water exist throughout the Southwest. A comprehensive set of water-efficiency policies is the single best step Southwestern states can take to ensure adequate water for ourselves and our environment.

Water Scarcity in the Southwest

The availability of water has been the defining factor in the history and development of the Southwest. Less than 100 years ago, most of the region was far too dry to support large populations. But as new engineering techniques – combined with massive infusions of taxpayer dollars – allowed water diversion projects of unprecedented magnitude, the Southwest began to grow in earnest. With the advent of the United States Bureau of Reclamation in 1902, large desert tracts were converted to cropland, and dirt streets became tree-lined boulevards. During the 20th century, exploitation of water resources allowed the region's population to swell from 4.2 milion to 36.3 million.[4]

But now that pattern of growth is challenged by the lack of adequate water supplies. And between decreased supply and increased consumption, the Southwest's major sources of water are being stretched to the breaking point. The Colorado River, now dammed in half a dozen places, is so overused that it often dries up before reaching the ocean. Aquifers, once viewed as a limitless water source, are relied on so heavily that natural replenishment cannot keep up with water withdrawals. The Ogallala aquifer, which reaches eight states including Colorado, New Mexico, and Texas, has already lost 9 percent of its water.[5] As a result, farmers have to dig deeper and pump harder for water, lowering property values and even forcing some into bankruptcy.[6] And subsidence – ground settling into the gaps left by retreating water – shrinks the capacity of the aquifers forever.

The Southwest cannot maintain its current population and economy indefinitely, much less grow, unless we get much smarter about how we consume our precious water supplies. Thankfully, there are many technologies and practices available to us that would enable the region to reduce its use of water. Improving the efficiency with which the Southwest uses water can alleviate our current water scarcity challenges and bring the region a step closer to sustainable water usage.

Saving Water in Agriculture through Microirrigation

The single biggest user of water in the Southwest is agriculture, at 71 percent of consumption across Arizona, Colorado, Nevada, New Mexico, Texas, and Utah.[7] On average, farms in the Southwest apply 11 percent more water to their crops per acre than the United States as a whole, despite the lack of abundant water supplies.[8] Some of that water finds its way back to rivers and aquifers, and is therefore able to be used again in the Southwest. However, much of that water evaporates into the air, where it is lost to the Southwest. [See Text Box on "Quantifying Water Use"]

Modern Irrigation Technologies

By taking advantage of existing irrigation technologies, the Southwest could use water for agriculture more efficiently, saving millions of acre-feet of water each year. Currently, Southwestern crops are watered with surface irrigation, sprinkler irrigation, and to a lesser extent, microirrigation. These technologies differ dramatically in the efficiency with which they deliver water to crops.

Surface Irrigation

Surface irrigation is the most water-intensive form of irrigation. It is also the most commonly used form of irrigation in the Southwest. In surface irrigation, large amounts of water are periodically released from an irrigation channel at one end of the fields. Enough water is released to spread out across the entire field where it seeps into the soil and is absorbed by the plants through their roots.

Sprinkler Irrigation

Sprinkler irrigation uses pipes and sprinkler heads to spray water onto crops. Sprinkler systems can be stationary or roll through cropland on wheels, such as the common "center pivot" system that is used on circular crop fields. Various types of sprinkler heads change how water can be distributed to the crops. "Guns" use high water pressure to shoot water over a larger range, while smaller sprinkler heads can hang close to the ground and use lower water pressure to spray over a smaller range.

Quantifying Water Use

Water use is measured by either withdrawal, which is the amount of water taken out of a river or other water source, or by consumption, which is the amount of water that is used or lost to evaporation and does not return to a water source.

For example, if a person takes 20 gallons of well water to water their garden, that represents a withdrawal from the groundwater source. If 5 gallons ends up evaporating, 5 gallons is absorbed by the plants in the garden, and the other 10 gallons seeps into the ground, then the total consumption is only 10 gallons (from evaporation and plant usage) since the other 10 gallons eventually returns to a water source.

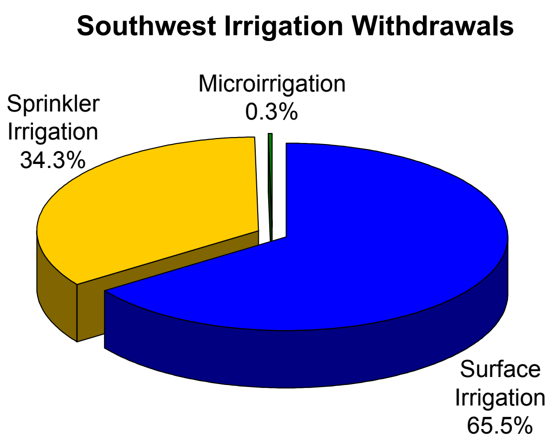
This report deals primarily with water consumption, since it is a better measure of the Southwest's total water balance. Water withdrawals, however, should also be reduced when possible because water that is withdrawn and subsequently returned to rivers and aquifers is often contaminated with pollution and other solutes. Since any water consumed must be part of total withdrawals, the consumption savings discussed in this report also result in withdrawal savings at least as large. The potential water savings discussed in the agriculture sector, for example, are 2.9 million acre-feet of consumption, but 8.0 million acre-feet of withdrawals every year.[9]

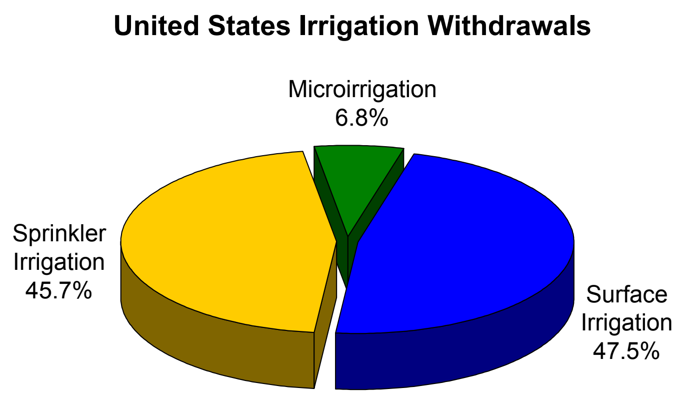
Sprinkler irrigation is about as common as surface irrigation in the United States.

Microirrigation

Microirrigation applies water directly to the individual plants or root systems using narrow plastic tubing laid throughout the planted area. The tubing systems can either be laid on the surface of the soil or be buried, and water comes out at a much lower water pressure than sprinkler systems. Some types of microirrigation

Figure 1. and 2. Irrigation Water in the Southwest Is Used Less Efficiently Than in the United States as a Whole





are called drip irrigation because water comes out drop by drop. Some systems are disassembled at the end of a growing season while others are permanent fixtures in a field. Microirrigation is especially popular where the availability of water is low, such as in Israel, which irrigates 70 percent of its crops that way.[10] In the United States, 7 percent of all crops are watered using microirrigation, though in the Southwest the figure is closer to 1 percent.

How Water Is Lost in Agriculture

The method of irrigation used on a particular field affects how much of the water is absorbed by the crop and how much becomes recharge, runoff or evaporation.

Recharge

"Recharge" refers to any irrigation water that seeps into the soil and percolates down to an aquifer instead of being absorbed by the crop. Recharge only happens with enough saturation of the surface soil, and sometimes rock layers underground block water from reaching any aquifer, preventing recharge altogether. Unfortunately, recharge from agriculture can carry fertilizers, pesticides and other chemicals used on the fields, which in turn contaminate the aquifers. Thus recharge helps refill depleted aquifers, but can bring unwanted pollution in the process.

Surface irrigation, in which fields are partially flooded, typically causes the most recharge, while virtually no recharge comes from all but the heaviest applications of microirrigation.

Water that is recharged to the aquifer below can be withdrawn in the future by anyone with access to that aquifer, so the water is not lost to the region. Since water recharged in this way can carry pollution, it is generally better for the availability of usable water and for local environments to leave water in a river or aquifer than to take it out, contaminate it, and return it.

Runoff

Unused irrigation water can also run off of farm fields into rivers or lakes. Runoff is often more polluted than recharge, because in addition to carrying fertilizer and pesticides it may also transport sediment. Over time, runoff can carry enough soil away from cropland to hurt its productivity. When the sediment is deposited in rivers and lakes it can damage water quality, navigability and the natural ecosystem. Runoff water is not lost to the region unless it evaporates or flows out of the area before it is used.

As with recharge, surface irrigation typically causes the most runoff, followed by sprinkler irrigation.

Evaporation

Both recharge and runoff result in excess water returning to the Southwest's water supplies. Water that evaporates during irrigation, however, is permanently lost to the region.

Evaporation is the process by which water molecules escape into the air as vapor. Evaporation can make a big difference in the amount of water needed for irrigation, and becomes faster with warmer and drier air, both of which are common in the Southwest. Evaporation also increases with the amount of water that is exposed to the air, which is why sprinkler systems, which shoot water directly into the air, have particularly large amounts of evaporation. Fields being watered with sprinklers will often become veiled with mist because the air is saturated with water. Microirrigation, on the other hand, has the least amount of evaporation because water is not long exposed to air before being absorbed by the soil and crops. In cases where the irrigation system is completely buried, known as subsurface drip irrigation (SDI), water is released directly to the soil and doesn't come in contact with the air at all.

Benefits of Microirrigation

Microirrigation leads to the lowest evaporation rates, and therefore requires less water consumption than the other forms of irrigation. Only about 1 percent of the water applied by microirrigation is lost to evaporation, although the figure varies. For surface irrigation, closer to 4 percent of applied water evaporates, while crops watered by sprinkler irrigation lose up to 11 percent or more of the total water applied to the fields.[11] Thus, switching from a surface or sprinkler irrigation system to microirrigation reduces the amount of water consumed significantly.

Microirrigation can be used on the vast majority of crops grown in the Southwest. According to Dr. Freddie Lamm at Kansas State University, about 90 percent of all American crops may eventually be appropriate for microirrigation technology, which is constantly being tested and applied to new situations.[12]

Based on the amount of cropland that is currently watered with each type of irrigation, and the expected savings from switching to microirrigation, it is possible to estimate the water-saving potential of the technology.

Figure 3. Potential Water Savings from Microirrigation (millions of acre-feet per year.

State	Potential Savings (millions of acre-ft. per year)
Arizona	0.4
Colorado	0.9
Nevada	0.2
New Mexico	0.2
Texas	0.8
Utah	0.3
Southwest Total	**2.9**

If 90 percent of all cropland in the Southwest used microirrigation, the region could cut its agricultural water consumption by just under 10 percent, saving 2.9 million acre-feet each year. Arizona would save about 0.4 million acre-feet, Colorado would save 0.9 million acre-feet, Nevada and New Mexico would each save 0.2 million acre-feet, Texas would save 0.8 million acre-feet, and Utah would save 0.3 million acre-feet every year.[13] These figures include only avoided losses to evaporation. Implementing microirrigation on a broad scale would also significantly reduce water withdrawals.

The potential water savings of microirrigation are impressive, but microirrigation also delivers other benefits. Because water is applied directly to the plant in need, crops are better able to absorb water when they need it, reducing risk of water stress and resulting in higher quality produce.[14] Fertilizers can also be added to irrigation water, which allows a more precise application, reduces the cost of fertilizer, and reduces chemical runoff. Finally, microirrigation does not prevent field work during water application, unlike the other methods which leave the fields muddy.

A few factors have prevented farmers from taking advantage of microirrigation more broadly. Since the price that farmers pay for water is heavily subsidized, they have little incentive to save water. Additionally, microirrigation has not been in use for as long as surface and sprinkler irrigation, and widespread adoption is slowed by the time and money required to learn and implement the new system. Finally, the advantages of microirrigation are more pronounced with certain crops, while for others it has yet to be tried on a large scale. Altogether, the costs of investing in microirrigation are outweighed by the potential for saving precious water in the Southwest, but farmers need appropriate incentives to make the switch.

Incentives for Saving Water Encourage Microirrigation

Policy makers have several tools available to them to increase the use of microirrigation. These policies enable states in the Southwest to prevent further depletion of the Southwest's water resources.

Offer Tax Credits

Giving tax credits for installing microirrigation would lower the upfront cost of the systems, increasing their usage across the Southwest. The cost of buying and installing the systems has dissuaded some farmers from using microirrigation despite projected savings in the long term.

The number of farmers who would switch to microirrigation depends on the size of the tax credits. Larger credits would be a greater cost to government, but could also help reduce costs through the resulting water efficiency. With more farmers switching to microirrigation and saving water, less government money would be needed for subsidized irrigation projects. Greater use of microirrigation would increase awareness and technical knowledge, further increasing its usage, but there would be no guarantees for how many would ultimately switch.

Remove Harmful Subsidies

Currently, the Bureau of Land Reclamation subsidizes water to agriculture, which encourages farmers to use more than they need. Removing these subsidies would save taxpayer money in addition to encouraging microirrigation and reducing the consumption of water.

Removing perverse incentives has a similar effect as tax credits by making microirrigation more financially attractive. Instead of giving farmers taxpayer money, however, such transfers of public funds that already exist are taken away. Removal of harmful subsidies should be combined with positive incentives such as tax credits or other mechanisms to assure that farmers are not driven to sell their farms outright to developers.

Allow the Leasing of Saved Water

Allowing or encouraging the lease of agricultural water rights that are made available through water efficiency savings can create appropriate incentives for water-saving techniques on farmlands while also helping farmers overcome upfront investment costs in water-saving technologies like microirrigation. Farmers should not be forced to sell their water outright in order to consider leasing saved water to eager users.

Implement Efficiency Standards

Southwestern states could implement water efficiency standards to eliminate excessive water usage. The standards would work similarly to existing energy efficiency standards for appliances. A state body would determine the maximum amount of water, including rainfall, that would reasonably be necessary to produce a certain amount of harvest and would set the weather-adjusted standard for that crop.

The advantage of an efficiency standard is that it ensures that all crops are grown in a responsible way. Additionally, efficiency standards would require funding only to set up the standards and conduct spot-checks of compliance. Combined with removing perverse subsidies, these policies could provide net savings for taxpayers. And, of course, any water saved by farmers should be available to them for their own use or lease.

Saving Water in Homes through Xeriscaping

Outdoor Watering Is Majority of Residential Use

Water use at home accounts for about 15 percent of all water consumption in the Southwest. Most residential water use in the Southwest goes towards outdoor uses such as watering gardens and lawns. The water ends up being absorbed by plants, trees and grasses, evaporating into the air or becoming recharge and runoff, as with agriculture. Southwestern homeowners can save large amounts of water through Xeriscaping.

Xeriscaping Can Reduce Water Use

Xeriscaping is the art of creating and maintaining a landscape that reflects the natural vegetation and climate of the region. Use of succulent plants, for example, which have evolved to survive in arid climates by storing moisture within the plant organism, reduces the watering requirement in gardens. Kentucky Bluegrass, which is one of the most common types of lawn grass, on the other hand, cannot survive in the arid Southwest without copious amounts of water. Besides just choosing appropriate plant life for gardens, Xeriscaping techniques include landscape design and the use of microirrigation, soil changes, mulches and landscape maintenance to further reduce watering needs.

The first step in Xeriscaping is planning out a yard in a way that reduces water consumption. Turf grass such as Kentucky Blue grass is common in Southwestern yards despite its large water requirements. Reducing non-native grass areas or removing them completely can save a significant amount of water over the course of a year. Similarly, plants native to arid areas have evolved to survive on less water. Many bring vibrant colors and a more natural aesthetic.

Another Xeriscaping technique that saves a large amount of water is preventing over-watering. Homeowners often water their plants excessively, so using the appropriate amounts of water with existing plants can save water without any negative impact. On average, residents of southern Nevada water their grass 40 percent more than is necessary.[15]

Additionally, as with croplands, microirrigation saves water by preventing unnecessary runoff, recharge and evaporation. Homeowners can also use special soil types and mulches to further reduce water loss and fully capitalize on Xeriscaping techniques.

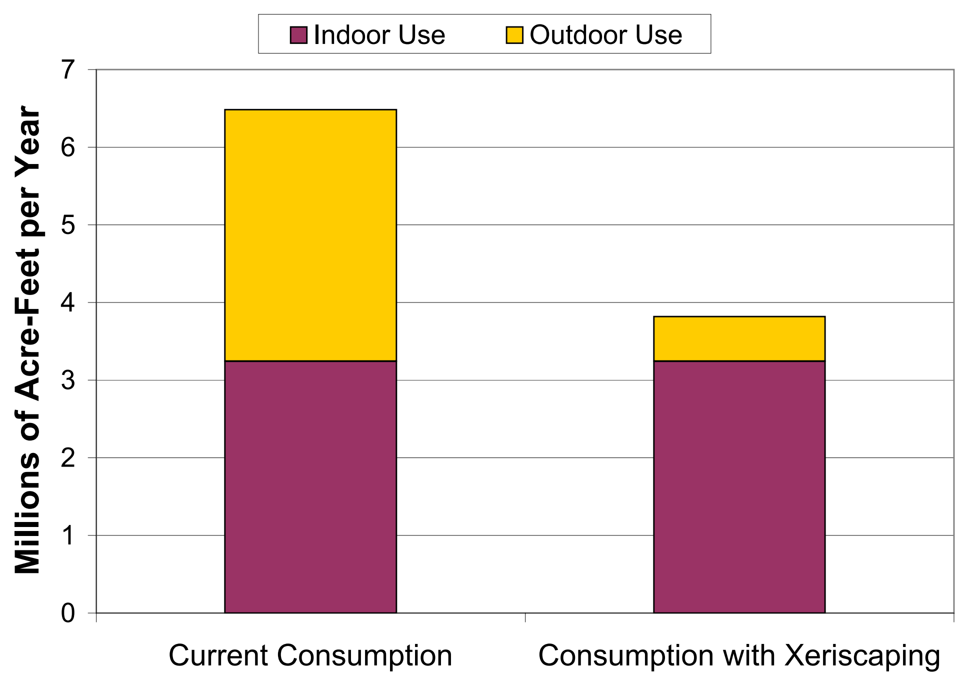
The Southern Nevada Water Authority (SNWA) completed a five-year study in which it looked at the water savings of lawns and gardens converted to Xeriscapes. The authority found that homeowners cut down total domestic water usage by 33 percent, and saved over 80 percent of the labor and financial cost of home irrigation.[16]

Additional incentives for water savings could enable the Southwest to take advantage of these potential water savings at home. Assuming savings similar to the households studied in the SNWA study, the six Southwestern states could save up to 2.7 million acre-feet of water every year by using Xeriscaping techniques in all households.

Public Policies To Encourage Xeriscaping

Policy makers have several tools available to them to increase the use of Xeriscaping. These policies enable states in the Southwest to prevent further depletion of the Southwest's water resources.

Figure 4. Southwest Residential Water Consumption and Savings Potential[17]



Allow Xeriscaping

Some local homeowners' associations have prevented the use of Xeriscaping by requiring homeowners to install grass or other water-intensive flora. These restrictions mandate water consumption and make water shortages in the region more intense. Forcing homeowners to grow grass when they prefer a Xeriscape or want to conserve water goes against the long-term interests of the region and puts a ceiling on the potential to save water at home. Cities and states should pass laws preventing homeowners associations from enforcing anti-Xeriscaping measures to allow individuals and communities to protect their water resources.

Reward Xeriscape Conversion

Providing financial incentives to homeowners who switch from a typical yard to a Xeriscape reduces upfront costs and will reduce water usage in the community. While Xeriscaping saves time and money in the long run, the initial investment can deter individuals who would otherwise prefer a Xeriscape. Las Vegas, where water savings are particularly valuable, pays homeowners $1.50 per square foot of turf converted to Xeriscape, which provides significant water savings for the city.[18]

Use Block Pricing

By pricing public water higher for households that consume excessive amounts, known as block pricing, cities can encourage Xeriscaping and all other home water-saving techniques. Many cities in the Southwest already use some form of block pricing, but a steeper block schedule, with lower prices for small, necessary amounts of water and even higher prices for large, voluntary amounts of water consumption will further encourage water efficiency and could generate revenue to support other water conservation efforts.

Establish New Development Efficiency Standards

In order to help stop the growth in water consumption, states could adopt water efficiency requirements that new developments would have to meet. New households would be limited to an amount of water consistent with water-efficient landscaping and household use. Violations would incur penalties. If all new homes built in the Southwest were designed to implement Xeriscaping techniques, it could save 0.4 million acre-feet of water every year by 2020.

One advantage of focusing on new homes is that many efficiency improvements, both for landscaping and indoor water use, are cheaper and easier to make during original planning and construction. The clear weakness in this policy is that it doesn't address existing homes, which, in the aggregate, will continue to be the biggest residential water users for many years. Combining this policy with some of the aforementioned options would make it significantly stronger.

Require Developers to Cover New Demand By Investing in Efficiency

With existing water sources already failing to sustainably meet demand, new developments should be required to make up for their new water demand by using efficiency to decrease demand elsewhere. For example, a developer could pay for enough Xeriscape conversions in a nearby neighborhood to free up the water needed for a new development. Designing water efficiency techniques into the new development itself would also reduce the need to invest in efficiency elsewhere. Thus instead of further exacerbating the water scarcity problem, new developments would increase investments in water efficiency technologies.

Saving Water in Electricity Production

Power plants are responsible for 2 percent of all water consumption in the six Southwestern states.[19] States can save water by increasing energy efficiency and using more renewable electricity sources.

Water Consumption in Power Plants

Power plants that use traditional steam-driven turbines, such as nuclear reactors and coal-fired power plants, use water as a cooling mechanism to increase their efficiency. After water heated into steam passes through the turbine, it is exposed to cool water, where it condenses. The change from gas to liquid shrinks the volume of the steam, pulling more steam from the turbine behind it, thereby driving the turbine faster.

Power plants use two different methods to cool steam with water. One way is a "once through" system in which large quantities of water are brought in from a river, lake or ocean. After absorbing heat from the steam, the water is returned to the original body of water at a higher temperature and with contaminants from the plant.[20] A typical system withdraws about 448,000 acre-feet of water a year, depending on the size of the plant, some of which evaporates after finishing the cycle. Among the states considered in this report, Texas has by far the most power plants with a once-through cooling system.[21]

More common in Arizona, Colorado, Nevada, New Mexico and Utah are "re-circulating" systems, which withdraw a much smaller amount of water, about 9,000 acre-feet a year, but cycle it through several times, with a chance to cool off and evaporate on each cycle.[22] More water is lost to evaporation in these systems, and the remaining water is periodically discharged into a nearby water body. Since the water is reused several times before being discharged, it contains even more contaminants than discharge from once-through systems.

Additionally, a few plants, including one near Las Vegas, use "air cooling" systems, which require significantly less water than the previous two systems. The systems, which use about 220 acre-feet a year, are similar to re-circulating systems except that instead of exposing the hot water directly to the air, metal pipes or barriers keep the water from evaporating while transferring heat to the outside.[23] The drawback of using air cooling when water is not expensive is that it costs more than the other two systems and is not as efficient for energy production, especially if outside air temperatures are high.

Across the six Southwestern states of this report, 0.7 million acre-feet of water are consumed each year for electricity production.[24]

Energy Efficiency and Renewable Electricity Use Little Water

Southwestern states can cut down on the 0.7 million acre-feet of water used for electricity production each year by using energy efficiency and renewable sources of electricity. Both alternatives provide huge water savings and other benefits.

Most renewable forms of electricity, such as wind and solar photovoltaic power, do not rely on heating water into steam and do not require an ongoing water supply. Similarly, energy efficiency reduces demand for power from lighting, appliance operation, and all the other uses of electricity reducing the need for water usage at traditional power plants.

Energy efficiency and renewable energy sources provide significant benefits for the Southwest beyond saving water. Because they do not rely on the combustion of fossil fuels like coal or natural gas, energy efficiency and renewable electricity cause little if any global warming pollution. Global warming is expected to create severe environmental problems in the next century and beyond, including exacerbating the Southwest's drought.[25] Taking a leadership role in promoting renewable electricity sources, therefore, would also help the Southwest both reduce water consumption directly and avoid more severe water scarcity problems in the future by reducing emissions of pollutants that cause global warming.

Incentives for Energy Efficiency and Renewable Energy Could Save Water

Southwestern states have begun to demonstrate leadership in promoting the use of renewable energy technologies. Southwestern states should develop the following policies to decrease the water needed for electricity production:

Renewable Electricity Standards: A renewable electricity standard requires a state to obtain a certain amount of its electricity from renewable sources like wind and solar power. New Mexico and Colorado, for example, have committed to getting 20 percent of their electricity produced by investor-owned utilities from renewable sources by 2020. Nevada mandates that utilities get 20 percent of the energy they produce from renewable sources or achieve an equivalent reduction in electricity demand from energy efficiency improvements by 2015. Arizona's program requires 15 percent renewable electricity by 2025. Texas doesn't require a specific percentage, but mandates that 5880 MW of renewable electricity capacity be created by 2015, which is about 5% of current production These states should consider strengthening and extending their requirements, while Utah should implement a renewable electricity standard of its own. If the entire Southwest replaced 20 percent of its fossil fuel electricity plants with renewable energy sources that do not require an ongoing water supply, the region could save up to 140,000 acre-feet every year.

Distributed Generation: States should initiate or strengthen programs that encourage homeowners and businesses to install small renewable generators such as solar panels by paying home and business owners for excess electricity put back on the grid. Electricity generated on site generally uses less water and also avoids transmission losses, replacing the need for traditional water-intensive forms of electricity generation even further.

Solar Assistance: Southwestern states should make sure they take full advantage of the sunshine in their states by providing financial incentives such as tax rebates for solar panel installations on homes and businesses.

Energy Efficiency Policies and Incentives: Several policy options exist for improving energy efficiency, including updating and strengthening building energy codes, providing tax rebates to homeowners who undertake certain efficiency improvements, creating utility programs to encourage energy efficiency, and providing rebates or other incentives for energy efficient appliances. Each of these policies is already being implemented in at least one Southwestern state. Throughout the region states should make sure they are taking full advantage of their efficiency potential, adding programs and continuously strengthening existing ones.

Saving Water in Businesses

Businesses are responsible for about 3 percent of water consumption in the six Southwestern states and can play an important role in saving water.[26] Businesses respond particularly well to financial incentives, providing an excellent opportunity for public programs to encourage water savings. By rewarding businesses that successfully reduce their water usage, municipalities and states can reduce water demand at minimal cost, and inspire creativity in the commercial sector. A model program in Denver shows how financial incentives can achieve large water savings through improvements in efficiency.

Denver Water's Rebate Program

One of the simplest ways to encourage businesses to save water is by offering rebates for pre-approved equipment that is known to result in large water savings. For example, Denver Water gives $125 to commercial organizations that install high efficiency toilets that use no more than 1.28 gallons per flush. The rebate is increased to $200 for restaurant bathrooms because their high usage ensures that replacements bring large water savings. Denver Water also has set commercial and industrial rebates for water-saving urinals, cooling equipment, food steamers and hose nozzles for car washes.

Denver Water's Incentive Program

In addition to preset rebates, Denver Water encourages larger scale savings with its Commercial, Industrial, & Institutional Incentive Program. In an average year, Denver Water is expected to save about 4,650 acre-feet of water from its incentive program by encouraging businesses and organizations to invest in water efficiency improvements that will last for at least 20 years.[27] Participants are audited before and after the improvements are made, and are awarded $4,500 for each acre-foot of verified savings, up to $40,000.[28]

The program's stated goal is to shorten the payback period of large water efficiency improvements with broadly applicable incentives. This approach allows businesses to be creative in designing their own ideal methods for saving water, provided the water-saving benefits can be measured. Projects in the past have included: reusing or eliminating the need for water in cooling equipment, industrial laundry equipment upgrades, and improved cleaning processes.[29]

Commercial Incentive Programs Could Be Useful Throughout the Southwest

By using programs similar to those implemented by Denver Water, cities and states across the Southwest could save water at low cost. While some cities have already implemented water-saving programs for commercial users, there is still much room for improvement. If cities across the region implemented new and improved water efficiency programs to cut business usage by 2 percent, the Southwest could save 25,000 acre-feet of water a year.

Additionally, as with developments in the residential sector, new commercial buildings could be required to meet their water demand through efficiency investments. The program would automatically inspire commercial developers to use water-saving elements, as well as increase investments in water efficiently across the sector.

Conclusion

The Southwest faces serious water shortage problems, and those problems will likely get worse if we do not become much smarter about how we use water in the region. Taking advantage of existing opportunities to save water is an excellent way to alleviate these problems. States should use incentives to encourage greater water efficiency.

- **Agriculture:** To encourage microirrigation and other water-efficient techniques in agriculture, policy makers should consider a range of options, including: providing tax credits for microirrigation systems, removing perverse incentives to use more water, instituting water efficiency standards for crops, and requiring microirrigation where applicable.

- **Energy Sector:** In order to decrease the amount of water used to produce electricity, states should decrease the amount of electricity generated by coal, natural gas, and nuclear power plants. Energy efficiency programs and standards can reduce demand for electricity, reducing the need to consume water in power plants. Encouraging the use of renewable energy sources like wind and solar power will further decrease the Southwest's reliance on fossil fuel fired power plants.

- **Residential**: To encourage Xeriscaping and other water-saving options at home, policy makers should consider a range of options, including: outlawing anti-Xeriscaping contracts, providing incentives for converting lawns to Xeriscapes, implementing water efficiency standards for new houses, and requiring that new developments cover their new water demand by investing in efficiency improvements of existing water users.

- **Commercial/Industrial:** States should develop incentive programs, along the lines of Denver Water, to encourage better use of water-saving technologies and programs in businesses.

Together, these water-saving policies could save up to 5.7 million acre-feet of water consumption every year.

Acting now to encourage more responsible water usage will help create a sustainable water future for the Southwest.

Figure 5. Water Efficiency Could Save up to 5.7 Million Acre-Feet of Water Each Year in the Southwest.

State	**Potential Water Savings** (millions of acre-ft. per year)
Arizona	0.8
Colorado	1.3
Nevada	0.4
New Mexico	0.4
Texas	2.4
Utah	0.5
Southwest Total	**5.7**

Methodology and Assumptions

In order to estimate potential water consumption savings, data from the United States Geological Survey (USGS) and the Energy Information Administration (EIA) was used wherever possible. Estimates for other data were made based on existing literature and conversations with Dr. Freddie Lamm of the Kansas State University Northwest Research-Extension Center.

Withdrawal numbers in each state are directly from USGS's*Estimated Use of Water in the United States in 2000*, and estimates for the residential and commercial sector are based on their proportional share of public supply in *Estimated Use of Water in the United States in 1995*.

Consumption numbers were based on estimates of the proportion of withdrawals that is consumed. Residential and commercial water withdrawals are assumed to be completely consumed. Estimates for electricity proportions were obtained from EIA data on withdrawal and consumption rates of power plants of at least 10 megawatts.[30] Southwest plants that reported water withdrawal and discharge numbers were broken down by state and by cooling system (once-through and re-circulating). Total withdrawals and consumption was totaled for each category and the proportions were applied to the USGS withdrawal numbers to account for non-reporting power plants in the region.

Estimates for agricultural consumption proportions were based on a review of existing literature and conversations with Dr. Lamm on irrigation types and its effect on evaporation, runoff, recharge and plant absorption. Irrigation withdrawals were divided into surface irrigation, sprinkler irrigation and microirrigation by state based on USGS acreage numbers and estimated application efficiency of each irrigation type. Application efficiency was assumed to be 69 percent for surface irrigation, 89 percent for sprinkler irrigation, and 99 percent for microirrigation. These figures assume that on average, 28 percent of surface irrigation water and 4 percent of sprinkler irrigation water leaves the field as runoff or recharge, and that 7 percent of surface irrigation water and 11 percent of sprinkler irrigation water evaporates without getting absorbed by crops. The figures also include a discount factor to account for greater water absorption by microirrigated crops, as discussed in this paper.

Commercial consumption estimates were derived from USGS's *Estimated Water Use in the United States*. Most commercial water comes from the public supply. Our estimate for the commercial industry's portion of public supply was based off of total public supply consumption in 2000 and the commercial industry's consumption relative to public supply in 1995, the last date for which specific commercial data is available. Assuming the ratio of commercial consumption to public supply remained constant between 1995 and 2000 for the six states considered in this report, commercial consumption in 2000 was 1.1 million acre-feet for the region.

Notes

1. United States Census Bureau, *Population Estimates*, downloaded from www.census.gov/popest/states, 31 August 2007.

2. Consumption per person in 1995: United States Geological Survey, *Estimated Use of Water in the United States in 1995*, 1998. Consumption per person in 2000: United States Geological Survey, *Estimated Use of Water in the United States in 2000*, 2004.

3. M.L. Parry et al., Intergovernmental Panel on Climate Change, Summary for Policymakers, *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 2007.*

4. The 760 percent increase was in the six states studied in this report: Frank Hobbs and Nicole Stoops, United States Census Bureau, *Demographic Trends in the 20th Century*, November 2002.

5. "Total water in storage in 2005 was about 2,925 million acre-feet, which was a decline of about 253 million acre-feet (or 9 percent) since predevelopment." United States Geological Survey, *Changes in Water Levels and Storage in the High Plains Aquifer, Predevelopment to 2005*, downloaded from pubs.usgs.gov/fs/2007/3029/pdf/FS20073029.pdf, 6 October 2007.

6. Nancy Cole, Arkansas Democrat Gazette, *Shrinking Aquifer Looms as Big Problem for Farms*, downloaded from www.nwanews.com/adg/Business/167660/, 6 October 2007.

7. United States Geological Survey, *Estimated Use of Water in the United States in 2000*, 2004.

8. Southwest average: 2.76 feet of water on irrigated land each year; national average: 2.48 feet. Calculated from: United States Geological Survey, *Estimated Use of Water in the United States in 2000*, 2004.

9. 8.0 million acre-feet is calculated from: United States Geological Survey, *Estimated Use of Water in the United States in 2000*, 2004, downloaded from pubs.usgs.gov, 6 October 2007. See Methodology and Assumptions.

10. Kansas State University, Research and Extension, *Sprinkler and Microirrigated Areas in Some Participating Members of ICID*, downloaded

from www.oznet.ksu.edu/sdi/News/s&mi.htm, December 2006.

11. These figures, known as "application efficiencies," vary widely based on several factors including method of irrigation. Application efficiencies decrease with excessive or poorly timed watering, environmental effects that increase evaporation, and other factors: F.R. Lamm, Personal Communication, 1 November 2006 and 22 October 2007. See also F.R. Lamm and T.P. Trooien, "Subsurface Drip Irrigation for Corn Production: A Review of 10 Years of Research in Kansas," *Irrigation Science* 22: 195-200, 2003.

12. Freddie Lamm, Research Agricultural Engineer, Kansas State University Northwest Research-Extension Center, Personal Communication, 22 October 2007.

13. 90 percent represents a rough estimate of the existing Southwestern crops for which microirrigation could be used: F.R Lamm, Personal Communication, 22 October 2007.The current acres of cropland irrigated with each method was used to estimate the portions of all irrigation water that was used by each method, and the savings that would result from switching 90 percent of all cropland to microirrigation. Acreage and total irrigation water usage numbers from: U.S. Geological Survey, *Estimated Use of Water in the United States in 2000*, 2004; Estimates of application efficiencies for each irrigation method from: F.R. Lamm, Personal Communication, 22 October 2007. See also F.R. Lamm and T.P. Trooien, "Subsurface Drip Irrigation for Corn Production: A Review of 10 Years of Research in Kansas," *Irrigation Science* 22: 195-200, 2003.

14. F.R. Lamm and T.P. Trooien, "Subsurface Drip Irrigation for Corn Production: A Review of 10 Years of Research in Kansas," *Irrigation Science* 22: 195-200, 2003.

15. Sylvan Addink, *Cash for Grass: A Cost Effective Method to Conserve Landscape Water?* downloaded from ucrturf.ucr.edu/topics/Cash-for-Grass.pdf, 15 November 2006.

16. Kent A. Sovocool and Janet Roseles, *A Five Year Investigation into the Potential Water and Monetary Savings of Residential Xeriscape in the Mojave Desert*, Southern Nevada Water Authority, 2000.

17. Numbers in figure estimated from: United States Geological Survey, *Estimated Use of Water in the United States in 2000*, 2004.

18. Southern Nevada Water Authority, *Water Smart Landscapes Rebate*, downloaded from www.snwa.com/html/cons_wsl.html, 6 June 2008.

19. Calculated from: United States Geological Survey, *Estimated Use of Water in the United States in 2000*, *Table 13*, 2004.

20. Riverkeeper, *Biodiversity: The Facts*, downloaded from riverkeeper.org/campaign.php/biodiversity/the_facts/179, 15 November 2006.

21. See note 7.

22. See note 20.

23. Ibid.

24. See note 7.

25. See note 3.

26. See note 7.

27. David G. Groves, James Griffin, and Sara Hajiamiri, *Estimating the Value of Water-Use Efficiency in the Intermountain West*, RAND, 2008.

28. Denver Water, *Commercial & Industrial Incentive Program*, downloaded from www.denverwater.org/cons_xeriscape/conservation/pdfs/CIBrochure.pdf, 6 June 2008.

29. Ibid.

30. Energy Information Administration, *Annual Steam-Electric Plant Operation and Design Data 2005*, 2006.