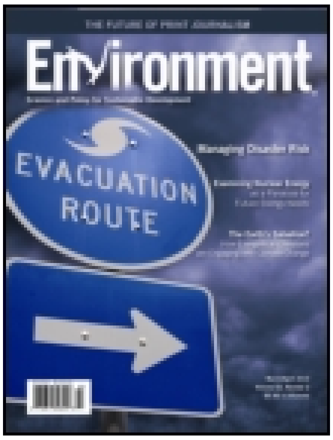

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The Water Short List: The Most Effective Actions U.S. Households Can Take to Curb Water Use

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THE WATER SHORT LIST:

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Texas creek bed in drought.

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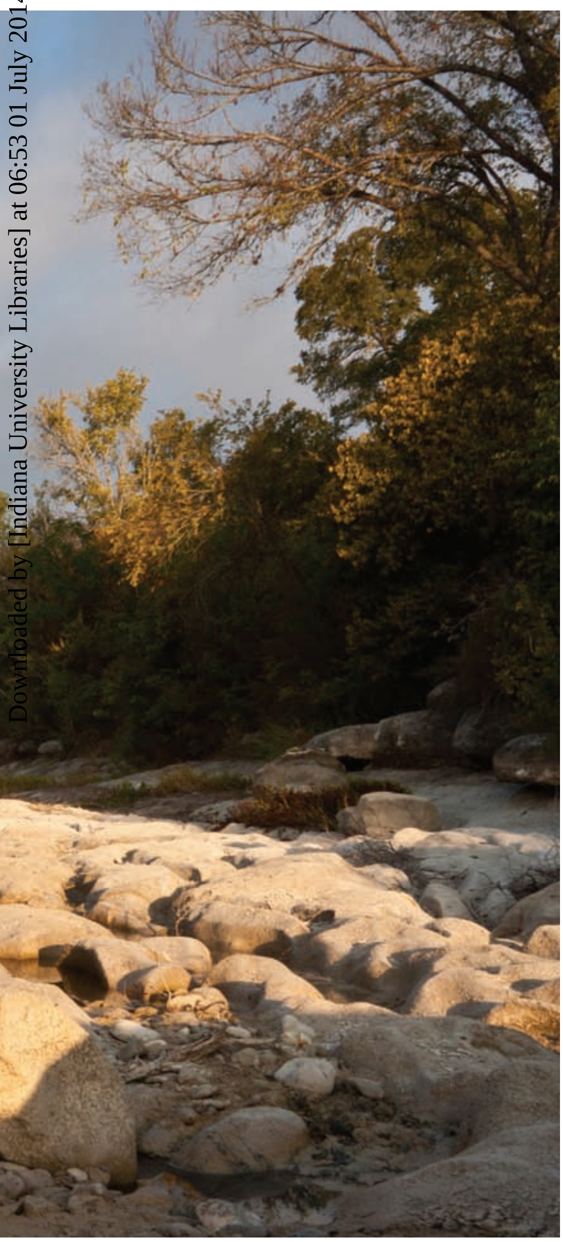
The long-term sustainability of many urban water supply systems in the United States is under assault from a confluence of forces. Climate change, an aging and increasingly obsolete water infrastructure, an expanding population in water-scarce regions, and economic growth are several of the formidable challenges to meeting present and future freshwater demands.[1] Water conservation (broadly defined as reducing water use) offers a cost-effective and environmentally benign way to address these challenges in comparison to capturing, transporting, and treating new supplies.[2] American households, a key end user of publicly supplied water, can play a vital role by curbing their own water use through installing water-efficient appliances (e.g., clothes washing machines) and fixtures (e.g., faucets) and adopting conserving habits. Determining the extent to which overall water use can be curbed can demonstrate the potential broader role that households can play in contributing to more sustainable water systems. Furthermore, identifying the most effective actions can help individuals and households with limited time, attention, and resources prioritize actions with larger savings.



Many municipal utilities and other public water suppliers, who supply 86% of Americans, are expected to face water availability problems in the 21st century.[3] Before the recent economic recession, which shifted attention to business factors and infrastructure concerns, water managers consistently ranked source water availability as the first or second most important long-term concern, ahead of macro factors (e.g., population growth, climate change, etc.), security, regulation, infrastructure, water treatment, and work force.[4] A recent analysis of the water availability in the 225 largest cities in the United States confirms that availability is a widespread issue, finding that more than half of the population (54%) lives in cities that have vulnerable water supplies.[5]

Water supplies are expected to come under further strain in the coming decades for several reasons. Demand for publicly supplied water has grown consistently in the past 60 years, and a growing population and an expanding economy are expected to keep demand high in the United States for the foreseeable future.[6] As human-induced climate change nudges average temperatures higher, evapotranspiration rates will increase, leading to increased demand for agricultural irrigation, landscape irrigation, and thermoelectric power generation to meet space cooling needs.[7] In addition, climate change is expected to deteriorate water quality; alter the amount, timing, and geographic distribution of precipitation; and increase the frequency and intensity of both droughts and floods, resulting in increased variability of water quality and quantity.[8] The aging and increasingly obsolete water and wastewater infrastructure will further exacerbate the difficulty of matching a fluctuating supply with rising demand.[9]

These trends are harbingers of an impending water crisis and highlight the critical importance of household water conservation today.[10] Although improvements in appliance and fixture efficiency along with declining household size have already partially tempered average household water use, substantial reductions remain achievable.[11] In the United States, we currently withdraw 98 gallons per capita per day (gpcd) for domestic uses, considerably more water than citizens of most other countries and in excess of the roughly 13.2 gallons actually needed to meet daily basic human needs by a factor of 7.4.[12]

Water Conservation Strategies and Tips

A primary reason for such high levels of household water use in the United States is a lack of meaningful financial incentives for households to conserve, as publicly supplied water is almost universally priced well below its economically efficient cost.[13] Even though utility bills are generally modest, households may want to reduce water usage to save money on water bills, minimize their environmental footprint, or do their part in contributing to larger community conservation goals during times of shortages. Many households may therefore be motivated to conserve, but lack the knowledge, time, or resources necessary to take meaningful action to curb use. As shown by Attari, Americans also have severe misperceptions about which activities are the most effective to conserve water in their lives, where 43% of the survey respondents listed shorter showers and very few respondents listed any actions related to toilets.[14] For a

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Elephant Butte Lake water levels are dropping in New Mexico.

sample of 17 activities, respondents to the online survey tended to underestimate residential water use by a factor of 2 on average, with large underestimates for high water use activities. [14] Thus, determining whether substantial savings are readily available and easily achievable is likely difficult for the average household, given the existence of severe misperceptions of which actions are most effective and the general underestimation of how much water a variety of household activities actually use.

While copious water-saving tips are promoted by government agencies at the local, state, and federal level, as well as by water conservation organizations, the actual effectiveness of the diverse recommendations offered remains unclear.[15] No resource to date provides comprehensive, quantitative estimates about the water savings available to the typical U.S. household from both improving appliance and fixture efficiency and changing daily habits indoors, and even less is known about the effectiveness of actions designed to reduce outdoor use. Water-saving tips are typically presented in long lists that fail to prioritize or quantify the reductions associated with specific actions.[16] When quantitative estimates of the water savings available have been provided, they are generally limited to indoor efficiency improvements or are optimistic upper bounds rather than average savings available to the typical American household.[17] In comparison, the potential savings available from adopting simple changes in daily habits indoors or conserving water outdoors are less certain.[18]

More troubling, some of the so-called water-saving tips offered appear to save little, if any, water, and some egregious examples appear to actually *increase* water use. For example, tip #103 offered on the website of the "Water—Use It Wisely" water conservation campaign suggests "washing your face or brushing your teeth while in the shower," which would appear to use substantially more water than doing these activities at the sink, since the maximum showerhead flow rate (2.5 gallons per minute) exceeds the maximum bathroom faucet flow rate (2.2 gpm), and it is easier to shut off the faucet than the shower to conserve water during these activities.[19] An example of a recommendation that appears to save only a negligible amount of water is using dropped or leftover ice cubes to water plants (tips #102 and #108).

Households looking to reduce their water use are therefore left to guess the best method to achieve significant savings or to rely on incomplete information about the range and effectiveness of available options. We fill this gap by estimating the savings associated with a variety of water-conserving actions.

Residential End Uses of Water

The most comprehensive study measuring how American households use water is the Water Research Foundation's *Residential End Uses of Water* study (REUWS).[20] In the REUWS, the end uses of water were measured in 1,188 households from 14 North American cities, providing a useful snapshot of household water use. We estimate water savings available to the typical American household by comparing average water use in the REUWS households to a calculated theoretical water use of a household implementing a given water-conserving action.[21]

While indoor water use tends to be relatively stable across regions, outdoor water use varies substantially depending on climate, with 22–38% of total household water use going to outdoor uses in cool, wet regions compared to as much as 59–67% in hot climates.[22] While the REUWS estimates of indoor water end uses provide a suitable baseline of water used in the typical American home, estimates of outdoor water use cannot be used here because the REUWS used a nonrandom sample of cities from which to select households for study, skewing the distribution of represented climates.

To address this challenge, we use the same approach as Vickers, who used multiple sources from varying years to estimate average outdoor household water use nationwide.[23] According to the U.S. Geological Survey's (USGS) most recent quinquennial *Estimated Water Use in the United States* report, which provides estimates of water use by sector, each American was responsible for 98 total gallons of water withdrawn per day for indoor and outdoor domestic uses in 2005.[24] Assuming the REUWS estimates of indoor water use hold for the nation as a whole, indoor water use accounts for an average of 59.8 gpcd, and indoor and outdoor leaks accounts for an average of 9.5 gpcd, leaving a balance of approximately 28.7 gpcd ((98 gpcd) – (69.3 gpcd)) for outdoor uses.[25] Household water use can be approximated by multiplying per-capita use by 2.6 capita per household (cph).[26]

Figure 1 combines average indoor and leak end use values from the REUWS with the outdoor end use value calculated earlier to show where the average U.S. household uses water. While separating indoor and outdoor uses serves a clear purpose, leaks are separated primarily because the technology used to measure end uses employed in the REUWS did not allow for distinguishing between indoor and outdoor leaks, preventing an accurate delineation of the two here.

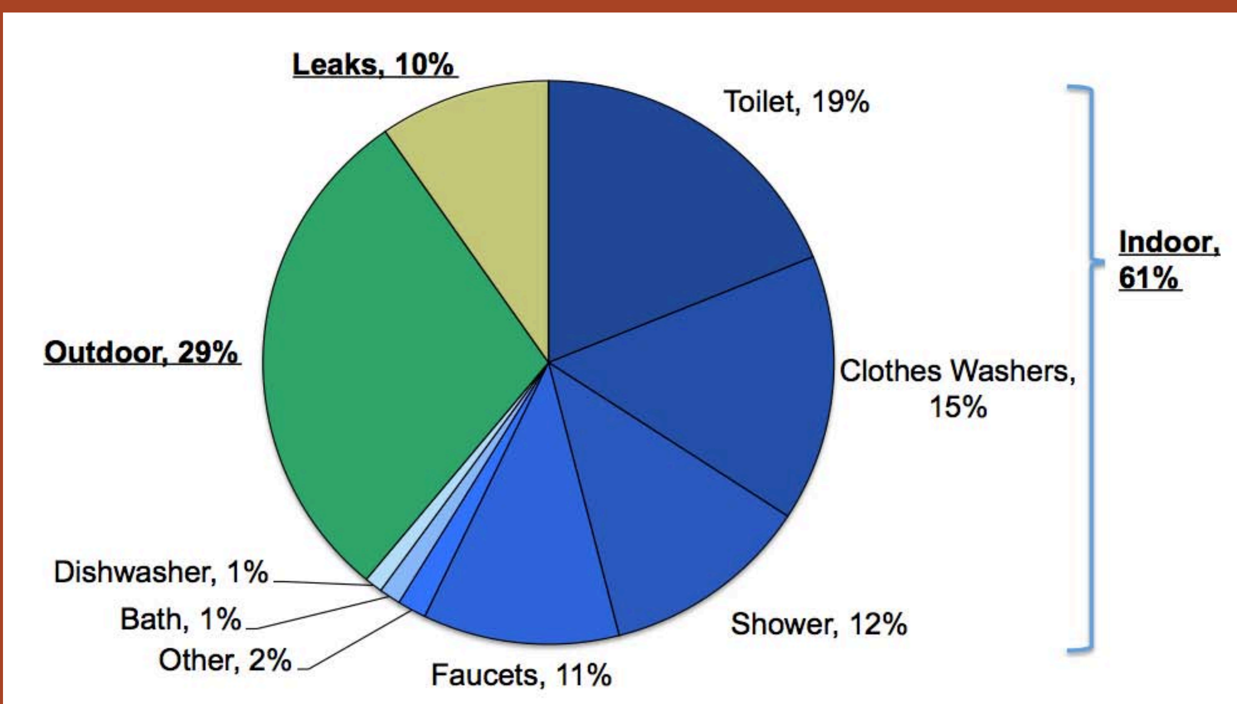
On average, U.S. households use roughly 255 gallons per household per day (gphd) ((98 gpcd) × (2.6 cph)), of which 100 gphd is used outdoors or lost to leaks, categories that generally reflect nonessential uses.[27] Since up to 90% of outdoor water use is attributed to watering lawns, plants, and gardens, we make a simplifying assumption for the purposes of this article that all outdoor water use is for irrigation purposes.[28] Under this assumption, irrigation (29%) is the single largest water end use, but toilets (18%), clothes washers (15%), showers (12%), faucets (11%), and leaks (10%) all use substantial quantities.[29]

Figure 1 shows the end uses of water for the average U.S. household, but the exact breakdown varies geographically both between and within geographic regions. For instance, Nevada's per-capita domestic withdrawals exceed Maine's by a factor of 3.5, and Las Vegas, NV, exceeds Mesa, AZ, in per-capita outdoor water use by a factor of 4.2.[30]

The Most Effective Actions to Reduce Household Water Use

To help households lower their carbon footprint, Gardner and Stern created the original "short list," ranking

Figure 1. End uses of water for the average U.S. household (total = 255 gallons per household per day). Indoor and leak end use values are based on data from the REUWS, and the outdoor end use is calculated by subtracting total indoor end use from total daily water use given by the USGS.



Source: Benjamin D. Inskeep and Shahzeen Z. Attari

Table 1. The Water Short List: Estimated percentage of U.S. household indoor water use that can be saved by implementing efficiency and curtailment actions, by activity

Activity	Efficiency action	Indoor water saved	Curtailment action	Indoor water saved
Flushing	Replace standard toilets with WaterSense-labeled toilets	18.6%	Reduce daily toilet flushes by 25% (3.3 fewer flushes per household per day)	7.3%
	Install toilet tank water-saving insert	5.9%		
Clothes Washing	Replace clothes washer with an ENERGY STAR-labeled washer	16.7%	Only wash a full load of clothes (or adjust water level in washer to match load size)	7.9%
Showering	Replace standard showerheads with WaterSense-labeled showerheads	1.9%	Take shorter showers (5 minutes instead of 8.2 minutes)	8.2%
Faucet use	Install WaterSense-labeled faucets (or equivalent flow-reducing aerator)	5.4%	Reduce the amount of time the faucet is left running by 2 minutes per person per day	4.4%
			Stop using food disposer (compost or trash food scraps instead)	1.7%
Dishwashing	Wash dirty dishes in an Energy Star-labeled dishwasher instead of hand-washing	2.1%	Do not pre-rinse dishes before putting in the dishwasher	0.4%
	Replace standard dishwasher with energy-labeled dishwasher	0.4%		
Bathing			When taking a bath, fill tub only half full	0.3%
Total	**Efficiency**	**45.1%***	**Curtailment**	**30.2%**

*Excludes savings from "Install toilet tank water-saving insert," which is a less effective alternative to "Replace standard toilets with WaterSense-labeled toilets."

Source: Benjamin D. Inskeep and Shahzeen Z. Attari

technology upgrades and behavioral changes on their effectiveness at reducing household energy use.[31] Similarly, we quantify a *water short list* to inform households on the average potential reductions in water use available from implementing a variety of technology upgrades and behavioral changes. It is worth emphasizing that our list is based on population averages and as such is a very general estimation based on a theoretical 2.6-person household. The list should therefore be interpreted as a guide, not a hard-and-fast rule, to choosing among water conservation actions. Households can apply this guide within the context of the specific characteristics of their household by prioritizing the implementation of higher ranked actions that they have not already implemented.

The water short list uses the results of the REUWS to determine baseline water use for each indoor appliance and fixture. The effectiveness of water-conserving actions is estimated using secondary sources that provide information on the average water use of existing and new appliances and fixtures (see the Supplemental Information for calculation methods, assumptions, and sources).

As Gardner and Stern did for energy-saving behaviors, water conservation actions are divided here into efficiency and curtailment actions.[32] Efficiency-improving actions involve one-time technology upgrades or modifications to water-using appliances and fixtures. Curtailment actions involve adjusting daily habits so that appliances and fixtures are used less frequently or for shorter durations. Both categories of conservation actions have unique challenges: Efficiency actions require incurring a potentially large upfront cost, and curtailment actions require that the action be continuously repeated.

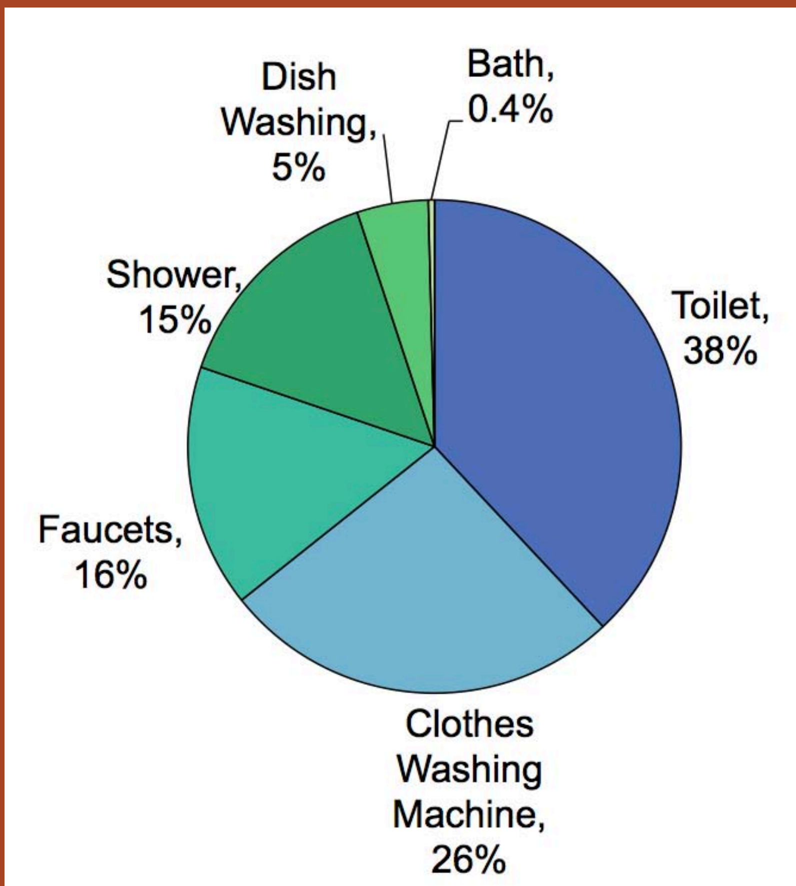
Indoor Actions

Indoor efficiency actions involve replacing standard appliances and fixtures with less water-intensive counterparts. We use labeling criteria for Energy Star and WaterSense products provided by the U.S. Environmental Protection Agency (EPA) (as well as the Department of Energy in the case of the former) to estimate the water used by efficient appliances and fixtures, respectively.

Curtailment actions are more difficult to precisely quantify because they involve a degree of variation in behavioral adoption. Additionally, what may seem a reasonable level of reduction to some may be more difficult for others due to situational limitations. The uncertainty associated with these assumptions should not eliminate the usefulness of the estimation. Individuals can see how our underlying assumptions apply to their own context to identify their achievable reductions through curtailment. Savings resulting from curtailment actions were estimated from secondary sources and by making informed assumptions for our estimations; we assumed that all the proposed actions were implemented with a 100% adoption rate.

Table 1 presents the water short list for indoor actions. Installing water-efficient toilets, clothes washing machines, dishwashers, showerheads, and faucets is estimated to reduce indoor household water use by 45.1%, or 70 gphd. Households can reduce indoor water use by 30.2% (47 gphd) by implementing seven

Figure 2. Proportion of total indoor savings available from combining efficiency and curtailment actions, by end use.



Source: Benjamin D. Inskeep and Shahzeen Z. Attari

curtailment actions, such as reducing toilet flushes by 25% (reducing 3.3 flushes per household per day (fphd)), only washing full loads of clothes in the clothes washing machine, and taking shorter showers (5 minutes instead of 8.2 minutes per shower).

Households can combine efficient technologies with curtailing habits to generate larger reductions than would be available from implementing either in isolation, but the two categories cannot simply be added together because that would double count some savings. Once more efficient appliances and fixtures are installed, subsequently implementing curtailment actions will save less additional water than had they been implemented in the absence of more efficient appliances and fixtures (and vice versa). Therefore, to estimate savings from combining efficiency and curtailment actions, we calculate household water use by end use after efficient appliances and fixtures are installed, from which additional savings accruing from curtailment actions can be estimated. When six efficiency actions are implemented simultaneously with seven curtailment actions, the average household can reduce indoor water use by 60.5% (94 gphd).[33] As shown in Figure 2, combining more efficient toilets with reducing toilet flushes by 25% (3.3 fphd) represents 38% of the 99 gphd in total possible savings available from indoor conservation actions.

The five most effective actions to save water indoors (excluding leaks) are (1) installing low-flush toilets (19%), (2) using a water-efficient clothes washing machine (17%), (3) reducing shower time to an average of 5 minutes (8%), (4) washing full loads of clothes (8%), and (5) reducing toilet flushes by 25% (7%).

Outdoor Actions

While fewer than one in five households surveyed in the REUWS over-irrigated their lawn, and 38% of U.S. households say they never water their lawn, irrigation still uses more water on average than any other residential end

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Watering a lawn.

Table 2. Savings from Outdoor Efficiency and Curtailment Actions

Action	Percent Reduction in outdoor water use	Efficiency = E, Curtailment = C
Do not water lawn (e.g., let it go dormant in the summer)	Up to 100%	C
Water plants and turfgrass with water collected from a rain-harvesting system	Up to 100%	N/A
Replace most outdoor turf and plants with water-wise landscaping (e.g., use native plants) and irrigate only as much as is needed	20-100%	E
Replace cool-season turfgrass with a warm season, native, or low-water-use species of turfgrass	20-100%	E
Install a soil moisture sensor	11-92%	E
Install a drip irrigation system for non-turfgrass plants	25-75%*	E
Install a rain sensor	19-53%	E
Water all plants in the morning	Up to 40%	C
Manually water turfgrass with a hose	33%	C
Program automatic irrigation system by historic evapotranspiration	30%	E

*Percent reduction for water used on non-turfgrass plants only, not total irrigation.

Source: Benjamin D. Inskeep and Shahzeen Z. Attari

use (see Figure 1).[34] Turfgrass remains the single largest irrigated crop in the United States, with an estimated 5–10 million hectares (68.3% of the total) around private residences.[35]

While it is not possible to definitively rank outdoor actions because their effectiveness depends on where and how actions are implemented, Table 2 provides a useful starting place. Estimating the savings available to the average household from actions aimed at curbing water used on irrigation is difficult because of variation in the water needs of different plant species, which further varies by climate. We strongly recommend that households looking for more detailed estimates and recommendations use the Alliance for Water Efficiency's Home Water Works Water Calculator (http://www.home-water-works.org/calculator) or the U.S. EPA's WaterSense Water Budget Tool (http://www.epa.gov/watersense/water_budget). These interactive tools allow the user to estimate outdoor water use specific to his or her household's geographic location, size of irrigated area, and method of irrigation, among other factors.

Since all outdoor water use (with the exception of watering gardens used to grow food) goes to nonvital purposes, the theoretical maximum reduction in outdoor use is 100% for most households. Given the benefits many enjoy from keeping maintained outdoor landscapes, eliminating all outdoor water use may seem optimistic.[36] Four actions—water-wise landscaping, not watering turfgrass, replacing turfgrass with a regionally appropriate turfgrass species (e.g., using a "warm season" species in the Southeast), and watering only with collected rain or reused water—appear to come the closest to achieving this ideal. Less restrictive efficiency and curtailment actions, such as using a rain sensor or only watering turfgrass one to two times per week, respectively, can also lead to substantial reductions without the need for major landscape alterations. By implementing one or more of the actions described in Table 2, the average U.S. household should be able to meet the U.S. EPA WaterSense labeling requirements for a water-efficient landscape, which must be designed to use 30% less water than would be theoretically required to maintain a landscape completely covered with cool-season turfgrass.[37]

Leaks

Leaks may appear to be the end use best suited for immediate reductions because no benefits are derived from the water wasted. However, in the context of making recommendations for the typical U.S. household, three concerns arise. First, a small minority of households are responsible for the vast majority of leaked water; although the average household leakage in the REUWS was 21.9 gphd, the median household leakage was only 4.2 gphd, with two-thirds of households leaking less than 10 gphd.[38] Second, some leaks are very difficult to detect (e.g., underground pipes). Third, implementing other conservation actions not explicitly related to leaks may have the serendipitous outcome of eliminating some common sources of leaks. For example, leakage related to a faulty toilet flapper valve would be eliminated by upgrading to a low-flush toilet.

The prevalence and average volume associated with different household leaks have not been well established. While toilets, especially faulty flapper valves, are suspected of being the largest contributor, no study was found that disaggregated household leaks by appliance or fixture or even where the leak occurred (indoors or outdoors).[39] Previous attempts at estimating possible reductions associated with leaks have relied on many assumptions, such as the total leakage in a water-conserving household or the total percentage reduction in leaks stemming from implementing efficiency and curtailment actions.[40] For these reasons, we are unable to quantify savings to the typical household from fixing leaks here.

Leak detection remains a critical conservation action and may allow households to easily reduce water use. Conducting a visual inspection inside and outside the house of all appliances and fixtures and looking for signs of water damage is the best way to quickly detect most leaks. Faulty flapper valves on toilets can be identified by dropping a few drops of food coloring in the toilet tank and seeing whether the color leaks into the toilet bowl. Leaks can also be detected by shutting off all water-using appliances and fixtures and seeing whether the water meter changes over time. Similarly, jumps in water usage on a utility bill can indicate the presence of a large new leak.[41]

Uncertainties and Limitations of Available Data

While estimates in the water short list can help households prioritize actions to decrease water use, several caveats should be noted. Our baseline household water use relies on data approximately 15 years old. Since declining household size coupled with the proliferation of water-efficient appliances and fixtures has led to declines in indoor household water use over the past several decades, the choice of this baseline may result in overestimating the potential reductions of indoor actions.[42] Furthermore, the REUWS estimates of household end uses of water relied on a convenience sample of 12 U.S. and two Canadian cities, so baseline estimates may overestimate (or underestimate) savings if the sample had lower (or higher) than average water use for the nation as a whole.

Our estimates may also overstate actual water savings because of the associated *rebound effect,* or the tendency to use a device more often as its efficiency improves because it has become cheaper to use on a per-use or per-time basis, and in the case of some water-using appliances and fixtures, because the service quality decreases. For example, installing low-flow showerheads may lead individuals to take longer showers, and installing low-flush toilets may result in an increase in flushes if the toilets are less effective at removing waste. The rebound effect has been extensively studied in the domain of energy efficiency, with the size of the direct effect typically estimated at below 30%.[43] The rebound effects in the domain of water have been studied much less. Measured rebound effects have been small, with one study finding that more efficient clothes washers were used 5.6% more frequently than standard clothes washers, and another finding that high-efficiency toilets were not flushed more frequently than standard toilets.[44] Although the REUWS found individuals in households with exclusively low-flow showerheads took

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Rain barrel for rainwater harvesting.

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Aerial view of flooded houses.

showers that were 25% (1 minute and 48 seconds) longer than individuals in households without low-flow showerheads, individuals in households using low-flow showerheads still used 4.5 gpcd less water on showers.[45] More research is needed to confirm these results and determine the extent to which rebound effects impact other end uses.

Barriers to Implementation

The water short list demonstrates that the average U.S. household can substantially reduce water use indoors and outdoors through both efficiency and curtailment actions. Many households could feasibly eliminate most irrigation, the single largest end use, by implementing water-wise landscaping, letting lawns go dormant, relying on harvested rainwater to meet their outdoor watering needs, or using regionally appropriate species of turfgrass. The biggest indoor savings come from improving toilet and clothes washing machine efficiency, corroborated by these being the two largest indoor water end uses. Similarly, the biggest reductions in household energy use on the original short list stemmed from efficiency improvements, not curtailing actions.[46]

Curtailment can still offer substantial and immediate savings to households. Washing full loads of clothes, taking 5-minute showers, and reducing toilet flushes by 25% (3.3 fphd) can reduce indoor water use by 7–8% each, making them the third through fifth most effective indoor actions, respectively. Until now, residential water curtailment actions have received little attention as a method of significantly reducing urban water demand. Behavior change typically has been viewed as a feasible method of achieving reductions over the short term only, such as in response to temporary droughts.[47] Our findings challenge the assumption that behavior changes do not have an important role to play in household water conservation.[48]

The tremendous potential to reduce water use through both efficiency and curtailment actions begs the question of why water use remains so high in the United States. While the answer is likely nuanced and specific to the household and the type of end use in question, economic, psychological, sociocultural, and informational barriers all likely play a part in explaining general patterns in household water use.

Households in many cities lack a strong financial incentive to curb use because publicly supplied water is typically inexpensive.[49] Paying an up-front financial cost to implement efficiency actions therefore may be financially unattractive to households and dissuade or delay implementation. For example, one field study funded by the U.S. EPA found that it costs the typical household $1,584 to upgrade to water-efficient appliances and fixtures, with a payback time of six years from savings accruing from water and energy reductions.[50]

Although curtailment actions do not involve a financial cost, they take effort to implement and must be repeated on a daily basis to generate water savings.

The initial inertia or status quo bias that works against changing habits and routines is one example of a possible psychological barrier specific to curtailment actions.[51] Limited time and attention to devote to water conservation more generally could also lead to a tendency to commit the single action bias.[52] Applied to household water conservation, the single action bias suggests that when individuals are prompted to reduce water use, they may be likely to implement only one or two actions that readily come to mind, even if substantial savings are achievable through additional actions.


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A low-flow showerhead.

Sociocultural factors could also work to shape the degree to which water-using and water-conserving actions will be sanctioned by society, influencing which, if any, actions households are willing to implement to curb use. Certain water uses are needed to maintain status symbols, like lush, green lawns, clean cars, and decorative fountains. Curtailment actions may also be seen as asking for an unacceptably high level of personal sacrifice (e.g., taking short showers), or deviation from social norms (e.g., not flushing the toilet after each use or not showering daily). Sociocultural barriers can also be formalized into rules, policies, and laws, like homeowner associations that restrict the types of turfgrass or landscaping allowed or statewide restrictions on rain collection.

Households may simply lack awareness about their water use or information on effective ways to conserve, an issue we seek to directly address with the water short list. For example, utility bills provided to customers are often devoid of even the most basic usage information, like the actual number of gallons of water used or even the marginal price of purchased water.[53] The lack of information obfuscates both patterns of usage and potential dollar savings resulting from incremental reductions in use, which could otherwise inform and motivate households to conserve water.

Implications for Policy

Local water use restrictions and national water-efficient plumbing standards have thus far been the preferred policy mechanisms to curbing residential demand.[54] For instance, mandatory water use restrictions were in place for 661 of 4,664 community water systems in drought-plagued Texas in July 2013.[55] One benefit of these types of policies is that they can overcome psychological biases or sociocultural barriers by limiting the options available to households by preventing certain water uses or limiting choices to more efficient appliances and fixtures are options. While these "command-and-control" policy tools can be effective, they are arguably open to the criticism that they are paternalistic government intrusions on personal liberty.[56] For this reason, people may prefer voluntary and market-based policies aimed at reducing resource use over command-and-control policies.[57] Therefore, in addition to command and control policies, we can use market-based incentives, remove legal barriers that hinder conservation, and provide information to overcome psychological and sociocultural barriers.

Pricing water closer to its long-run marginal cost of supply, which encompasses all of the economic costs, including transmitting, treating, distributing, and storing water, as well as its opportunity cost (e.g., the value of leaving the water in the stream to provide habitat to endangered aquatic species), is often recommended as an efficient policy tool for generating reductions in household use.[58] Other market-based policies, such as offering rebates on water-efficient appliances and fixtures or even providing them for free to households, could produce similar outcomes. Of course, removing legal barriers to household water conservation, like allowing households to replace turfgrass with water-wise landscaping without facing sanctions from homeowner associations, is a necessary condition to realizing all the potential benefits of these policies.[59]

Informational deficits can be corrected for in several ways. Providing

Pepper plant in garden with drip irrigation.

households with useful guides on how to effectively conserve water, such as the water short list, can help them prioritize actions to implement. Government labeling schemes, like Energy Star and WaterSense, promote awareness of a product's relative efficiency and simplify identification of efficient appliance and fixture models. Providing free water audits to residential accounts in the top tier of water users may be an effective intervention to reduce leaks.[60] Educating the general public on local water availability issues through water conservation campaigns and other forms of outreach can also help raise awareness and build a conservation ethic.

The water short list highlights the differences in average potential effectiveness across a host of household actions, illustrating the crucial role that information provision can play as a policy tool. Clear and accurate communication of the potential savings associated with specific actions can draw the attention of households to actions that are relatively easy for them to implement and effective at curbing water use. As water availability is expected to become an increasingly urgent issue in the coming decades, it is heartening to find that substantial reductions in household water use are readily available to U.S. households.

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Supplemental data for this article can be accessed on the publisher's website.

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16. For example, Water—Use It Wisely (2013), note 14.

17. Both the Alliance for Water Efficiency (2013), note 14, and A. Vickers, *Handbook of Water Use and Conservation: Homes, Landscapes, Businesses, Industries, Farms* (Amherst, MA: Waterflow Press, 2001), provide some quantitative estimates of available water savings.

18. The Home Water Works Calculator (http://www.home-water-works.org/calculator) is an exception in that it estimates the user's outdoor use and compares it to average and water-wise landscapes. To meet U.S. EPA labeling requirements for a WaterSense, a "water-efficient" landscape is one that is designed to use 70% of the water that would be required of an otherwise identical landscape composed of 100% cool-season turfgrass (U.S. Environmental Protection Agency, *WaterSense Water Budget Approach*, (2009), 2).

19. Water - Use It Wisely (2013), note 14; U.S. Environmental Protection Agency. *Showerheads*, http://www.epa.gov/WaterSense/products/showerheads.html. (accessed 11 July 2013); U.S. Environmental Protection Agency, *Bathroom Sink Faucets and Accessories*, http://www.epa.gov/WaterSense/products/bathroom_sink_faucets.html. (accessed 11 July 2013).

20. P. W. Mayer et al., *Residential End Uses of Water* (Denver, CO: AWWA Research Foundation, 1999), 1–310.

21. An updated REUWS is due to be completed toward the end of 2014. W. DeOreo and P. Mayer, "Resential End Uses of Water: Progress Report and Interim Results," *Drinking Water Research*, July–September (2012): 14–22.

22. Mayer et al. (1999), note 19, page 167.

23. Vickers (2001), note 16, pages 15–16.

24. Kenny et al. (2009), note 3, page 19.

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26. U.S. Census Bureau, "State & Country Quickfacts," http://quickfacts.census.gov/qfd/states/00000.html (accessed 9 July 2013).

27. In comparison, the U.S. EPA estimates that the typical U.S. household uses 260 gphd (*Conserving Water*, http://www.epa.gov/greenhomes/ConserveWater.htm; accessed 23 August 2013) to 320 gphd ("Outdoor water use in the United States," http://www.epa.gov/WaterSense/pubs/outdoor.html; accessed 23 August 2013). Irrigation used to grow food consumed by the household would be an example of outdoor water use that served an essential (as opposed to discretionary) purpose.

28. Vickers (2001), note 16, page 141.

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