

Variability in Consumption and End Uses of Water for Residential Users

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Audiences:
citizens
city engineers
city planners

Key Points

- Studies of single-family residential water end-use can help individuals and water managers improve water efficiency
- Indoor water conservation techniques include replacing or adjusting household toilets to be more efficient and shortening showers
- Outdoor water conservation techniques include replacing turf with drought-sustainable plants and turning off automatic sprinklers during weeks when rain provides enough moisture for the yard

Research Objective/Summary: In most large urban water systems in the US, the residential sector consumes the majority of total supplied fresh water. In a world plagued with increasing water scarcity and climate change stresses, understanding individual home water end-uses is vital to water management and conservation. We studied the end uses of water in residential homes, both indoor and outdoor to find patterns and variations in consumption over time. Results indicate a need for more efficient water fixtures, particularly toilets, and provide an opportunity to promote conservation behavior.

Why this research?

Residential water use metering is widespread in the US, but most meters often don't record data frequently enough to show how and when water is used. Without more frequent data, it is difficult to draw conclusions about water management, conservation, and efficiency in residential homes.

Additionally, past studies analyzing residential water end-use have not examined variations in indoor and outdoor water use practices over long periods of time, making generalization across households difficult.

What we did

We gathered and analyzed indoor (toilets, faucets, showers, bathtubs, clothes washers) and outdoor (irrigation via hose or sprinklers) water use data at 31 single family homes in Logan and Providence, Utah, to understand how water use varied between homes and to identify opportunities for water conservation related to user consumption and water fixture performance.

Households were ranked as low, medium, or high water consumers based on their average

daily indoor water consumption. Toilet, shower, and faucet events were labeled as efficient, compliant, or inefficient to assess fixture performance and identify opportunities for improvement.

We developed an innovative water meter datalogger and an open-source, semisupervised water end-use disaggregation and classification tool to process the data collected. The datalogger, which is mounted on a home's water meter, collects high resolution water use data that can then be processed by the disaggregation and classification tool into individual end-use events, such as a shower or a load of laundry.

What we found

Indoor water use—For indoor water use, frequency of events had the largest influence on water consumption, while the distribution of uses was fairly consistent regardless of the household's level of water use.

Showers were the largest consumer, averaging 30.9% of daily water consumption, while toilets averaged 22.1%. Faucets were the highest performing category, which may be explained by their being most likely to be

Read More: *Bastidas Pacheco, C.J, Horsburgh, J.S, Attallah, N.A, (2023). Variability in Consumption and End Uses of Water for Residential Users in Logan and Providence, Utah, USA. ASCE Journal of Water Resources Planning and Management, [https://doi.10.1061/\(ASCE\)WR.1943-5452.0001633](https://doi.10.1061/(ASCE)WR.1943-5452.0001633)*

frequently replaced. Accordingly, our results indicate an opportunity to conserve water by replacing or adjusting toilets and showerheads to be more efficient. Another impactful strategy is shortening showers.

Patterns in water use timing showed that low consumption households had a larger increase in weekend verses weekday water use, which suggests that individuals in those households are at home for shorter periods of time on weekdays. All households consumed more water on weekends than weekdays. Hourly distribution showed that water use was generally larger in the morning than the afternoon, though the differing schedules of occupants affected hourly patterns.

Outdoor water use—Approximately 84% of all water use was outdoors. Irrigation area size and method (hose verses sprinkler system) determined differences between households. Automated sprinkler systems showed a strong correlation with higher water use.

During six weeks of the study, irrigation was unnecessary because rainfall supplied all the water needed by the landscape. One opportunity for conservation is reducing



Use of automated sprinkler systems is correlated with higher water use than manual irrigation using a hose.

irrigation during such rainy weeks, though homeowners would need additional information to anticipate and respond to these events.

We found that households with automated sprinkler systems generally irrigated in the early morning or late evening, which are the recommended times for reducing evaporation loss.

In general, hose irrigators consumed less water than those using automated sprinklers, and those with larger landscaped areas consumed more water than those with smaller landscapes. However, we also found that during most weeks, residents applied irrigation at or near their landscape's water needs, which means that achieving greater outdoor water conservation will require reducing irrigated landscape size. City planners have the opportunity to make water-conscious landscaping choices in future infrastructure plans.

Why it matters

The data analyzed in this paper provides multiple opportunities for water conservation at the single-family household level. Further study is needed to characterize the why behind the observed water use behavior, which would help with the efficiency of conservation campaigns.

Patterns and differences in water use varied over time, and this key information can help water utilities and decision makers in Utah and other similar areas better understand how and when water is being used. If we have better information, we can make better decisions regarding water efficiency and conservation in households across the state. By putting the results in the hands of residents, we provide them opportunities to make informed changes to their water use behavior and aid in conservation efforts in their communities.

“ This type of specific information can motivate conservation behavior. ”

Other Info

For more information on the water end-use tool, see <https://doi.org/10.26077/7cc4-8e5b> or the full paper cited above.