Down the drain: Here's why we should use rainwater to flush toilets

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Many urban areas are encouraging the use of rain barrels as part of their stormwater management plans.

If you live in one of four major U.S. cities chances are you're letting the benefits of a ubiquitous natural resource go right down the drain—when

it could be used to cut down your water bill. Research by a team of Drexel University environmental engineers indicates that it rains enough in Philadelphia, New York, Seattle and Chicago that if homeowners had a way to collect and store even just the rain falling on their roofs, they could flush their toilets often without having to use a drop of municipal water.

Toilet flushing is the biggest use of water in households in the United States and the United Kingdom, accounting for nearly one-third of potable water use. But there is no reason that clean, treated, municipal water needs to be used to flush a toilet—rainwater could do the job just as well.

"People have been catching and using rain water for ages, but it's only been in the last 20-30 years that we have realized that this is something that could be done systematically in certain urban areas to ease all different kinds of stresses on watersheds; potable water treatment and distribution systems; and urban drainage infrastructure," said Franco Montalto, P.E., PhD, an associate professor in Drexel's College of Engineering, and director of its Sustainable Water Resource Engineering Lab, who led the research effort. "The study looks at four of the largest metropolitan areas in the country to see if it rains enough to make implementation feasible and, if everyone did it, what effect it would have on domestic water demand and stormwater runoff generation in those cities."

The process of collecting and using roof runoff, which researchers call rainwater harvesting, has been working its way into vogue among urban planners and water managers over the last couple decades and has been implemented widely in California in the wake of its water crisis. This study, which started as the graduate thesis of Drexel alumnus Nathan Rostad, was recently published in the journal *Resources, Conservation and Recycling*, and is one of the first to crunch the numbers and sort out

just how feasible, and beneficial, it would be as a way of offsetting potable water use for non-potable purposes while at the same time reducing generation of undesirable urban stormwater runoff.

Environmental engineers at Drexel estimate that with large enough storage tanks, the average rainfall in four major U.S. cities would be enough to offset a household's water requirement for flushing toilets.

"When the natural landscape is replaced by a building, rain can no longer infiltrate into the ground," Montalto said. "It runs off, is captured in drains, where it can cause downstream flooding, carry pollutants that settle out of the air into local water bodies or—in the case of a city like Philadelphia or New York—cause the sewer to overflow, which leads to

a discharge of untreated wastewater into local streams and rivers. So capturing rainwater can help to reduce the demands on the water treatment system and ensure that it will still function properly even during heavy rainfall events."

Taking into consideration the cities' annual rainfall patterns, residential population and roof areas, the team calculated that, with enough water storage capacity—a little more than a standard 1,000-gallon home storage tank—a three person family in a home with the city's average roof size would have enough water to cover over 80 percent of its flushes throughout the year simply by diverting their downspouts to collect stormwater.

This would reduce overall household potable water demand by approximately 25 percent, which could mean slashing the municipal water bill for an average-sized home by as much as one-fourth. But even without installing a storage tank capable of holding a year's worth of flushing water, a scaled-back version would still help chip away at the water bill.

"In general, greater potable water savings are estimated in cities with either larger roof areas or lower population density. However, such savings would be accompanied by smaller reductions in runoff," the authors write. "Philadelphia and Seattle are the two cities where percent water savings would be greatest if residential neighborhoods were all equipped with rainwater harvesting systems."

From a stormwater management perspective, an average residence with a 1,000-gallon rainwater harvesting system could reduce runoff by over 40 percent, according to the study. Obviously this would vary by residence—with the size of the water storage container and the water demand for toilet flushing—but as a whole, cities could see a significant reduction in the amount of stormwater their infrastructure would have to

handle during each storm.

Among the cities studied, Philadelphia would see the largest percentage of runoff reduction if rainwater-harvesting systems were installed in residences citywide. This is because the average roof size in Philadelphia is the smallest of the cities surveyed, so there is less runoff to manage from a single roof. The researchers found that larger percentages in runoff reduction from a rainwater harvesting system can be the result of either small roof sizes or high population densities. But managing stormwater is a concern for all urban areas.

"Think of it this way. Before the building was on the site, the rain was intercepted by vegetation canopies, and/or infiltrated into natural soils. Either way, the rain ended up replenishing soil moisture, allowing the plants to grow, and recharging the local groundwater aquifer," Montalto said. "The more buildings that go up, the more we need to consider how to manage the water that would have landed in the drainage area they're displacing."

Provided by Drexel University