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Conservation:

Solving the World's Water Crisis on the Demand Side

By Graham Symmonds

Symmonds

According to A Global Innovation Outlook Report from IBM in 2009, "As a species, we have survived knowing very little about our water systems. We have always known where to find it and how to use it, but we never gained an intimate understanding of how to preserve or sustain these systems. We have never learned how to efficiently manage water. But we will not have the luxury of this ignorance in the future."

The statistics remain alarming:

- By 2025, 1.8 billion of the world's projected 8.9 billion people will be living in countries or regions that are experiencing "absolute water scarcity," and two-thirds of the world population could be under conditions of water stress.
- By 2020, the capital infrastructure funding gap for water and wastewater will be $84 billion (and $144 billion by 2040).
- U.S. water systems experience 240,000 water main breaks annually resulting in the loss of 1.7 trillion gallons of water every year.
- The cost of non-revenue water (NRW) in the United States is estimated to be $2.6 billion per year.

But the statistics don't provide an understanding of the cause, nor do they provide a solution. The fact is we do not have a water crisis. The world's water has, for all intents and purposes, remained constant for billions of years. Our problem is that we have never lived within our means when it comes to water. The engineering feats of the Mayans, the Hohokum, the Egyptians, the Romans and others served a singular purpose: to decouple everyday life from the volatility of water supply. We continue that today with supply-side thinking.

Supply-Side Water Management

The developed world has been forged on the supply-side. In the past, we've assumed that we could engineer our way out of trouble. However, "when we build big, we build wrong." This is because we typically build within a narrow band of expected conditions. Those assumptions, spurred by the relative passivity of the Holocene epoch, are being proven to be invalid for the future.

In the southwest United States, peak spring runoff from the Colorado River basin occurs an average of three weeks earlier due to a five-fold increase in dust events on snowpack. This earlier snowmelt increases transpiration of water, and strains the engineered collection systems which are designed for a slower release of the stored water over a longer period.

Globally, changes in atmospheric temperature are driving an increase in the volatility of the water cycle, and the frequency of extreme events. Leading climate scientists recently noted "widespread annual droughts, once a rare calamity, have become more frequent and are set to become the new normal."

Trying to adapt to this increasing volatility through engineered solutions alone is difficult. Large-scale damming activities, floating bags of water down coastlines, pumping water across the continental divide and hauling glaciers from the Arctic and Antarctic are not going to be economically or environmentally feasible.

A recent National Resources Defense Council report notes that there are inherent dangers in relying on the supply-side solution. In fact serious questions remain about the reliability of surface and groundwater sources for proposed pipeline projects.

Most importantly, these supply-side projects take years to complete, at tremendous environmental and fiscal cost. Worse, they can result in mixed messages for consumers. Recent wet weather in Australia has reduced the need for the supply-side systems constructed over the last decade. However, to pay for these facilities, officials like South Australia Water Minister Paul Caica are now encouraging water use: "What we want ... more than anything else, we want people to use water but we want people to save water, we want people to use it wisely."

Fortunately, the world has been presented with a unique opportunity: much of the first generation water and wastewater systems are at end-of-life, and in the developing world, systems are under planning, design and construction. We must take the opportunity to change the Victorian-era model of water delivery, and configure our infrastructure and information systems for the 21st century and beyond. This includes developing a "right water for the right use" philosophy and configuring our data systems to work as conduits of behavioral change.

Water Reuse

From the perspective of conservation, the design of water distribution systems is inherently flawed. Providing only one piped source of water for use locks communities into a model where all water must be treated to potable standards; all water must be maintained at a suitable pressure for instantaneous use; and new water must be found and accessed for each new person.

The folly of this infrastructure model is evident when one considers that the majority of water provided to customers is not consumed. Rather, it is used as outside irrigation, or as a means of transporting waste away from homes, or in other non-consumptive tasks. Depending on location, 44 percent of water is used outside the home. Inside the home, toilet use represents 25 percent of the total water demand for a residence. These are ideal applications for recycled water and represent an opportunity to significantly reduce demand.

To achieve this off-loading of potable demand requires a re-imagining of the water delivery infrastructure (figure 1). While there is associated capital cost, it is more than offset in the long run through reduced potable treatment costs, reduced water abstraction costs and the reduced delivery costs.

Consumers Need Information

Infrastructure can only go so far. The economic value of water and the consumers' experiential understanding of where, when and how they consume water stands in the way of a sustainable future. There is simply not enough information available to generate the real-time behavioral changes necessary to reduce consumption.

To change behavior, consumers need data. More specifically they need relevant, time-sensitive data. This is the only way for consumers to connect their water use decisions with costs. It does little good from a customer or a water conservation perspective to inform consumers of the consequence of their actions 30, 60 or 180 days from now.

Given access to highly granular, time-relevant data, consumers can make dramatic changes in consumption. A recent study completed by California State University indicated that through the provision of instantaneous feedback on water consumption, average water consumption reductions in the order of 14 percent can be achieved.

Pricing

Discussions about conservation cannot exist without an effective pricing mechanism. If water does not have real monetary value, consumers will not conserve. On average, a 10 percent increase in the marginal cost of water can be expected to reduce residential demand by 3 to 4 percent in the short term and 6 percent in the long term.

However, the approach cannot be all "stick." Real behavioral change requires that desired outcomes be rewarded, while unwanted actions are discouraged – for both the consumer and the utility. The most effective way to do that is through economic incentives. In our case, we adopted a Rebate Threshold Rate structure using volumetric rebates (encouraging the consumer to remain below specified consumption gates); increasing the number and granularity of consumption tiers (increasing the number of "gates" through which the consumer has the option of passing – or not); and ensuring some form of revenue stability for the utility through higher minimum charges (as consumption decreases, revenue decreases).

But these innovative rate designs can only work in the presence of increased availability of data, allowing consumers to adjust, in real-time, their behavior.

Making these management choices today – infrastructure, appropriate pricing signals, innovative rate designs and real-time information to consumers – have resulted in a sustained reduction in demand of 30 percent for our utilities, proving that we have the ability to re-invent our water supply paradigm. We can change the way we interact with water. We can dramatically increase the visibility of water in our lives, and actively engage the end consumer in "direct-drive conservation." These are the necessary tools to manage volatility in our supply.

Graham Symmonds is the senior vice president of regulatory affairs and compliance and chief technology officer for Global Water. He has spent the last 17 years in a variety of utility engineering, operations and executive roles after having served for nine years as a Marine Systems Engineering Officer in the Royal Canadian Navy.