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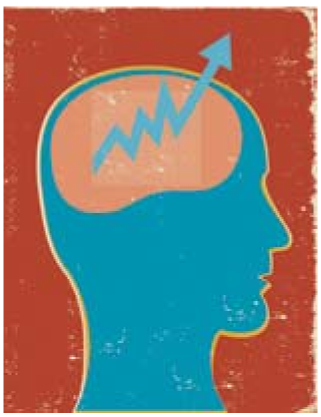
A New Paradigm

Demand forecasting and the art of resource management



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By Ed Ritchie

Fast-paced changes in the water industry are having a profound effect on demand forecasting. Whether it's new technologies, climate change, infrastructure repairs, or government regulations, water utilities are finding that simple formulas don't work as they once did. But there's plenty of help to sort it out. Powerful software, plus demographic data, and even cost sharing for public utilities that seek help from the United States Geological Survey (USGS), are some of the many resources utilities are discovering as they adapt to the new paradigm of demand forecasting.

The first step in reinvention is to look beyond the old methods, says R. Bruce Billings, coauthor of *Forecasting Urban Water Demand*, (published by the American Water Works Association, AWWA). "Forecasting isn't getting the attention it should, and a lot of water utilities are still using the most rudimentary methods," says Billings. "They're simply looking at last year, or the same month one year ago, and thinking that it'll probably be about the same as it was before. Of course, a lot of times it works, but it also breaks down."

The breakdowns are getting more costly, and it's not surprising to Billings. In his book, he cites factors such as population, weather, climate, water prices/rates, plus short and long-term conservation programs. Billings also notes some recent complex economic developments, such as the end of the housing bubble that resulted in many abandoned and foreclosed houses. Of course, many businesses have suffered similar fates. More long-term trends include government standards for low-use fixtures and advanced metering technology. "Many cities have experienced declining use per person," says Billings. "And there's a tendency to ignore the effects of pricing and metering. If they're just putting in meters, they should anticipate a substantial drop in water use once people start getting their water bills. So the utility could expect water usage to drop as much as 40%."

The Real Value Play of AMI
"The impact of advanced meter technology on customer water rates will continue to grow with the adoption of advanced meter infrastructure [AMI]," says John Sala, Neptune Technology Group, Tallassee, AL. "The long-term value play of AMI is to put information in the hands of the end-user," explains Sala. "Forecasting has typically utilized static modeling due to the low precision/granularity of historic data. AMI provides highly granular and precise data in near real-time, which will have substantial impacts on traditional approaches to forecasting. Additionally, AMI could be utilized to influence future customer usage and get people to reduce their water consumption. Utilities can know, for example, when the public is

using water excessively or in ways it's not supposed to, as in the case of water restrictions, and use a Web portal or e-mail alerts to alert the customers."

Neptune has meter registers that monitor with eight-digit high resolution at 15-minute intervals. So, for example, if the register records more than 46 "intervals" of water consumption, it would be a likely indication of an intermittent leak. "People aren't usually awake 24 hours a day," notes Sala. "But this system could catch a leaking toilet and send a flag to the customer within hours."

Forecasters should understand that not only can an AMI system see those leaks, but also confirm their repair status, because such high resolution or "granular data" allows a utility to literally see the hour when the customer has made their repair. "You could reach out to customers and potentially see 80% of the neighborhood's leaks fixed within one week," notes Sala. "So if after that week you saw a 15% reduction in a neighborhood's consumption, you can predict an overall utility-wide reduction. I think it's about as accurate as you can be in forecasting, because the assumptions you applied in the past are quickly and easily validated, and could be more confidently applied to the rest of the utility's customers."

The "End-to-End Solution"

The same philosophy could be applied to leak detection throughout the distribution system, adds Tom Galuska, product marketing manager for AMI Water Services at Sensus, Raleigh, NC. "It all ties into demand forecasting and water requirements to gain higher efficiencies," he says. "Typically, on a fixed-base system with an AMI solution, you're getting data at least four times a day, and maybe six; whereas before, it was once a month. Acoustic monitoring of your distribution lines can be reported within 24-hour periods. So you don't have to wait till the street collapses and you end up on the six o'clock news."

Galuska says forecasters should anticipate further gains from their larger distribution system meters that use supervisory control and data acquisition (SCADA) applications. "A good AMI system is going to allow you to tie in with a SCADA system, plus residential and business meters, and the distribution line," he explains. "This is what utilities are looking at to help justify the expense of an AMI system. They no longer look at AMI as just faster meter reading; they want a network that provides the ability to tie in all these components. From water coming into the utility, to customer delivery, distribution lines, measurements at customer sites, and then allowing access to that data so the consumer becomes more intelligent on their consumption. That's an end-to-end solution."

Forecasting at a Higher IQ

As consumers become more intelligent in their usage, forecasters will have the opportunity to access more intelligence about them. A new method using data from the spatial scale of census tracts can provide policymakers and planners with information useful for managing water resources. The project evolved from research by Austin S. Polebitski, Ph.D. candidate, Department of Civil and Environmental Engineering, University of Washington, Seattle, WA, and Richard N. Palmer, department head and professor, Department of Civil and Environmental Engineering, University of Massachusetts, Amherst, MA.

According to Polebitski and Palmer, the water demand model incorporates information about users within a census tract to create estimates. The model uses variables such as density, income, lot size, and water price to create predictions within each census tract. Census tracts provide a wealth of demographic and building characteristic information over multiple years (1990–2010), which satisfy model data needs and are a relatively stable prediction unit (their boundaries do not change significantly between measurement years).

Forecasters should find this model especially useful for regions with changing demographic characteristics and building stock, as forecasts of changes in these variables can be explicitly included in projected water demands. Coupling urban simulation models—such as UrbanSim at www.urbansim.org—with this water demand model can illustrate where changes in urban development will result in increases or decreases in per capita and total water consumption.

For example, regions expecting growth in townhomes and condominiums should see net decreases in water consumption as density increases. This is due to smaller lot sizes using less water outdoors for watering during summer months. These types of changes are not commonly included in water demand models, but can have a significant impact on overall water demands. Additionally, this model is useful in evaluating climate change impacts on water demands, and what water demand management strategies and growth management planning methods are useful to ameliorate increases in demands.

"In the past, a city like Seattle would just basically look at total system demand for the entire city and how it changes over time," explains Palmer. "Now we're able to see this neighborhood by neighborhood, and it can be aggregated up to the overall demand, so you can see where within the city demand is likely to change over time. For distribution services and for some other issues, that's a really important thing. Also, we can incorporate the impact of climate change and the impact of conservation on water demand on a neighborhood level."

Both researchers expect climate change to offer two challenges to forecasters. Expectations are for the changing climate to drive up the demands of water about 10 to 12%, explains Palmer. That could typically affect summer water use to maintain the green lifestyle that cities have become accustomed to. Ultimately, there could be a double impact from decreasing availability and increasing demand. Another side issue is that much more attention is being given to the maintenance of rivers for ecological purposes, and that can affect water availability.

Cooperative Water Program From the USGS

With all the new factors to be considered, some utilities might find the outlook a bit overwhelming, but help is available from the team at the USGS's Water Use Program. "The USGS has a lot to offer," says Eric Evenson, coordinator for the National Water Census. "And we maintain a number of databases, as well as doing special studies that include water demand forecasting. The USGS has worked in all 50 states, through programs such as the Cooperative Water Program, and in a number of cases it has assisted with demand forecasting.

As an example, Evenson points to a recently completed study of the seacoast region in New Hampshire. It's a rapidly growing region that has water availability issues with groundwater and surface water resources. The area's water managers needed a good understanding of future demands on a 20- and 30-year horizon. The USGS put together a water demand model that's part of an overall water availability study of current demand, plus 20 years into the future, and the availability of water supplies, plus their ability to meet future demands.

The seacoast study took a little over two years, and inventoried supplies from various categories or sectors of use, such as domestic self supplied water from individual home wells; domestic water for public supply, such as bigger public supply systems; and the infrastructure that stores and delivers the water for areas with population of 25 or more.

Also considered are industrial self-supplied water and any given area with wells or stream intake, or commercial self-supplied water such as that used for mining and irrigation.

"We have a system of categorizing water use to describe how much water is used in each one of those categories, because they represent demand," says Evenson. "Then you have to look at the source of the water to meet that demand, and after it's used, where is it discharged? You really need to track the water from its point of origin or withdrawal, then to the demand it satisfies, and ultimately, where the water is returned to the environment."

Other areas of impact include new building codes that could require low-flow appliances, water conservation measures, or mandates for future housing that can reduce water consumption for landscaping. Considering the depth of the study, it's not surprising that the overall project took around three years to complete. The report can be seen online at: http://nh.water.usgs.gov/projects/seacoast.

The seacoast report contains a good characterization of existing water use, and that allowed for a high level of accuracy in their future projections. But Evenson notes that there is no national requirement for reporting of water use data, and a wide range in state requirements for metering, monitoring, and reporting. When the USGS did a study in the eight states of the Great Lakes region, researchers found that only three of the states collected water use information on a monthly basis. "If you don't collect the data on a monthly basis, it makes it virtually impossible to come up with estimates of how much consumptive use occurs," notes Evenson.

Consumptive use is the amount of water incorporated into a product, or what is evaporated in the air or in some other way transferred out of the area. A good example would be a thermal electric plant with cooling towers and water visibly evaporating off into the air. "That water is not being returned," he explains. "It's been used and evaporates into the atmosphere. Of course, it will fall as rain somewhere else, but probably not in that area. The USGS had to use the three states that did have monthly information to estimate the rest of the region, and Evenson says that such estimations increase the degree of uncertainty.

Can the USGS help your public agency with its water demand forecasting? The organization's resources are available to governmental and agencies such as publicly owned utilities, municipalities, counties, tribal nations, states, and river basin commissions, as some examples. "We can work with them through a program, called our Cooperative Water Program, to develop a study of water demand forecasting," says Evenson. "We also have some limited funds for cost sharing on the studies. The USGS can put up to 50% of the cost of the study from federal dollars where those funds are available. We can work with utilities to look at their current water use and historical trends, and to develop water use demand projection." Utility forecasters can contact one of the local Water Science Centers of the USGS, located in every state of the US.

Monte Carlo Simulations Take the Gamble out of Forecasting

For private and commercial water agencies, there are many options to provide similar services such as those of the USGS. For those with volatile risk factors, there are services that can analyze water demand categories such as domestic, agricultural, and industrial to determine the inherent uncertainties that affect the demand forecast outcome.

Some areas could include: seasonal variation, distiller's unplanned outages, water losses, population growth rates, and demand for housing. Such uncertainties could have a critical impact for a region in the Middle East that depends totally upon desalinated water, as is the case of Emirate of Abu Dhabi, where The Abu Dhabi Water & Electricity Company (ADWEC) is the single buyer and seller of power and water.

The desalination process is challenging in terms of operation, costs, and environmental impact, so ADWEC must have accurate forecasts in their demand for water and electricity, in order to plan for the optimum expansion. The water company chose a risk-based methodology from Palisades Corporation, Ithaca, NY, to assess the water demand and required capacity and to model all feasible uncertainties in the variables that determine the quantity of water required over specific timescales, such as per capita water consumption rates and the rate of population growth. Palisades uses Monte Carlo simulations, a class of computational algorithms that rely on repeated random sampling to compute their results.

"The case study is fairly recent, but water demand in terms of hydroelectric generation has been around since the year 2000," notes Thompson Terry, a member of Palisade's training and consulting staff. "It's not a new concept, but the Monte Carlo simulation is fairly new to most people in general. It started in oil, gas, and electricity in the mid-80s and has branched out to almost any kind of forecasting application." It doesn't have to be tied to business and also finds use in government agencies and in the healthcare industry.

For ADWEC, undertaking risk analysis of the variables involved in assessing demand and supply was a critical balancing act. Over-production capacity is expensive, but at the other end of the scale, there's the need for sufficient water production capacity to support the government's development plan (Abu Dhabi Plan 2030). "It's a situation where you're dealing with population growth, or where you have a very fundamental change to the whole economy, such as a growth spurt over the past several years," says Terry. "Then, you have rainfall and the use of desalinization plants, and certainly, you need electricity to run those, so you have to account for the volatility of fuel prices in the cost of the generation of water. It's a very complex system, and that complexity makes it much harder to predict, yet they've been very accurate in what they've done so far."

A Monte Carlo simulation also can recognize the effects of conservation. The software allows forecasters to model and define scenarios flexibly, and the results of a conservation effort can be seen from various points in time.

The Buzz About Revenue

Using simulations, rather than looking at static data, could have saved money for a number of utilities, according to Thomas Chesnutt, Ph.D., president of A & N Technical Services, a national consulting firm specializing in empirical policy analysis, based in Encinitas, CA. Chesnutt spoke to *Water Efficiency* from Chicago, while attending ACE 10, the AWWA Annual Conference, and he noted that forecasting and revenue were on the minds of many attendees. "The big buzz around town is what people are doing about revenue, because there have been some ugly surprises," says Chesnutt. "We have a lot of things out there such as climate change, AMR technologies, and conservation, but utilities were just too comfortable in a static world."

From Chesnutt's perspective, it is the exception to find a demand forecast that includes calculations for conservation. "We typically see a utility sponsoring a large-scale conservation program, but they haven't quantified the magnitude of the impact." In his white paper, *Planning for Conservation's Effect on Utility Revenue and Costs*, Chesnutt notes that the revenue effects of water conservation are manageable when viewed from a planning perspective and when planning and ratemaking are integrated. Among the many methods to employ, Chesnutt advises utilities to use forward-looking data when establishing revenue requirements, taking planned usage changes and all program implementation expenses into account (including ratemaking expenses). Also, conduct a demand analysis based on alternative plausible scenarios to more accurately predict usage with the introduction of water conservation programs. And don't forget the customers.

It's important to communicate the long-term benefits of conservation to water system customers and explain the role of cost-based rates in achieving efficiency goals. "Utilities will see a higher payoff to water conservation, but it's going to be embedded as an integral part of customer service," says Chesnutt. "That's not something everybody is on board with yet. Customers like options and choices, and embedding water use efficiency as part of customer service is something that's going to be a winner for water utilities."

Finally, Chesnutt says utilities should consider funding of long-term conservation programs through long-term financing, because just as no one would consider funding a dam through current operating expenses, there is also a solid case for financing water conservation programs.

Certainly, the case for financing conservation is a solid one. Just consider the impact of new trends entering the industry, such as submetering of multi-family residential buildings. For example, in February 2010, the City Council of San Diego, CA, unanimously passed an ordinance requiring new apartments in the city to include water meters for each unit, effective June 1, 2010. City councilperson Marti Emerald estimated that those apartment dwellers responsible for their own water would use between 15 and 39% less water than those in unmetered dwellings.

Submetering isn't mandated for apartments in Charlotte, NC, but local real estate firm, Geller Associates, has had a number of multi-family properties retrofitted with submeters by American Water & Energy Savers, Boca Raton, FL. At a 161-unit complex, Geller reports savings coming in at just over $4,500 per month, resulting in an average monthly savings on water of 36%. The payback period for this project was just 13 months.

Conserving water is gaining widespread popularity in commercial and industrial sectors, according to Amy Vickers, president of Amy Vickers & Associates Inc., Amherst, MA, an international consulting practice specializing in water conservation. "In my experience, a lot of the larger industrial users are starting to get the point, particularly the Fortune 500 companies, and some are almost competitive with one another in terms of water use and sustainability," says Vickers.

Sustainability continues to grow as a mainstay of corporate responsibility, and the ideal of carbon neutrality is often cited as a goal. Could the same philosophy be coming to water usage? At the 2009 World Water Week in Stockholm, Sweden, organizers said the water sector has adopted the idea and, through water-neutral initiatives, commercial, and private organizations, could compensate for their water use by investing in projects that help improve access to water and efficient resource management.

Ultimately, whether it's conservation, technology, climate change, or regulatory measures, demand forecasters have many new complexities to consider. However, there are also many new tools and resources available from both the public and private sector. As new solutions to the challenges are tried and studied, case histories will provide better data for analysis and forecasting.

Topics: Data Integration,Resource-Management,Software