Is Water the New Oil?

Water. Is there anything more fundamental to sustaining life on this planet? Human survival, our livelihoods, and nearly all modes of economic production depend on it. And even though we inhabit a water planet, fresh water is not an abundant resource. According to the United Nations, there are about 1.2 billion people without adequate access to clean drinking water and 3 billion people who do not have access to adequate sanitation.

In spite of its fundamental importance to human society, an astounding amount of clean water is lost from our water distribution systems. In today's world, we cannot even imagine wasting 8.54 trillion gallons of oil. Yet according to the World Bank, 32 billion cubic metres -- 8.54 trillion gallons -- of treated water, critical to sustaining human life on this planet, is lost from distribution systems annually due to leakage. A further 16 billion cubic metres is unaccounted for each year due to theft, poor metering, or corruption.

Water loss also has an economic impact. It is estimated that water lost through distribution systems annually accounts for almost US$14 billion in potential revenues -- a staggering financial loss. In the developing world, the amount of treated water lost can approach 60% of the water entering the distribution system. On a global basis, including the developed world, an estimated 26% of the treated water is lost. Recovering just half of the water lost in this way would serve the water needs of an additional 90 million people, with no further investment in new water systems or further tapping into increasingly scarce sources of water.

It may be stating the obvious, but plugging the leaks would seem to be the most direct approach to solving the leakage. However, as water distribution systems are largely underground, locating the leaks is extremely difficult. Visual inspection requires excavating the piping. Even leak-detection technologies that don't require digging -- such as acoustic methods and step-wise testing -- are expensive, time-consuming, and not 100% effective. Clearly, meeting the impending water crisis with limited budgets and limited resources requires innovation.

As the United Kingdom's largest operator of water and wastewater networks, United Utilities Water has an added incentive to find and repair leaks. UK water leakage is measured and targets are set, and failure to meet goals results in severe financial penalties. So like other water utilities worldwide, United Utilities is serious about new methods of leak detection, but unlike others, it has entered into an interesting partnership to create these new methods.

United Utilities teamed up with the Bentley's Haestad Methods Solution Center in an applied research project that investigated the use of water system modeling in leak detection. The use of such models has become routine for analysis of a system's hydraulic characteristics, but applying model-based methods to leak detection was new territory.

Leakage can be modelled as a special instance of emitter flow, as per the formula Qi=KiPi^a, where Qi is the leakage aggregated at node i, Pi is the nodal pressure at node i, a is the exponent (usually 0.5 for leaks as a default), and Ki is the emitter coefficient. If the emitter coefficient, Ki, can be optimised usefully, then in theory it can be a good way to detect leaks in a system. But leakage tends to concentrate in relatively few hotspots, and in practice, optimising hundreds or thousands of nodal emitter coefficients in order to detect the handful of spots with significant leakage has proven to be a significant computational challenge.

United Utilities and Bentley engineers got around this by matching simulated flows and pressures with field-observed values and applying a genetic algorithm -- a search and optimisation method based on the principles of natural evolution and genetic reproduction -- to the problem. Initial results were promising, so Bentley engineers developed the algorithm into a user-friendly software tool. They then arranged for a real-world benchmark test and evaluation of the new method to be conducted on the United Utilities system by a third partner, the UK's Atkins Water and Environmental Group.

Existing leak-detection techniques, such as step-testing or acoustic devices, require a lot of apparatus and personnel. As a result, they are very time consuming and costly. The new leakage-detection feature identifies the locations and sizes of the leakage holes, emulated as emitters that allow water to spurt and seep out at different rates depending on prevailing pressure. With the effective and rapid prediction of the most likely leakage locations, consulting engineers and water utility owners and operators save time and money by focusing their site investigations on the model-predicted leakage areas to test for leakage hotspots using widely available leak-detection instruments.

David Turtle, leakage and demand strategy manager at United Utilities, noted, "The leakage detection optimisation model developed in collaboration with Bentley is an important tool in helping to reduce leakage and to achieve annual targets agreed on with Ofwat, the UK water industry regulator."

The new methodology developed by United Utilities and Bentley researchers, which won the Honour Award for Applied Research in the International Water Association Project Innovation Award 2008 competition for the European region, fills an important need by helping managers in mature systems to further reduce water leakage after other methods have been exhausted. It will also enable managers in any system to identify the water loss hotspots. The new version of Bentley's Darwin Calibrator modeling tool automates the new methodology, which is also included in the latest version of WaterGEMS V8i and is available for WaterCAD V8i.

Of course, fixing leaky pipes may not seem as inspiring as designing a green building or a wind turbine. But in a world in which water is becoming a precious and scarce commodity, the critical need to address the problem of water loss is clear. Solving the problem will require all the creativity and innovation that infrastructure professionals -- and their technology partners -- can contribute.

For more information, please visit www.bentley.com.