Introduction

Two main methods are currently in use for managing non-revenue water around the world:

- Smart water management systems
- Acoustic leak detection

Most water managers use these methods because they are the best solutions available; tried and tested, result-driven technologies. However, these approaches to monitoring non-revenue water are also notoriously time consuming and expensive, identifying leaks after a prohibitively high investment in infrastructure and equipment for the number of leaks that are identified.

A quick assessment of non-revenue water management in a majority of cities around the world indicates that most simply react to anomalies in their water management systems, such as measuring drops in pressure via a district metered area or smart water management system, or responding to a distressed call from a citizen advising that a burst pipe has turned into a fountain of water on their street. Vast quantities of non-revenue water are wasted each year, which has prompted some technology providers to suggest that water leakage in urban environments is now akin to an epidemic.

This isn’t good enough.

Meet Utilis, an innovative water management company based in Israel which has developed a revolutionary new way of detecting non-revenue water leaks by analyzing spectral images from satellites. This innovative technology has been adapted from the search for water on other planets, underscoring its high reliability and outstanding capability here on earth. Utilis offers a fresh approach which provides a non-invasive, innovative method to the problem of urban water leakage. When compared with any other current non-revenue water solution available to water managers, satellite based leak detection will identify more water leaks in the same amount of time spent.

Simply stated, Utilis is the fastest way to finding water leaks in urban water pipes.
Utilis uses remote sensing of subterranean water leakage based on a primary algorithm that detects underground leaks through the analysis of micro spectral satellite imagery. Thousands of square kilometers of a city environment can be assessed at once, with the ability to pinpoint a leak within a few meters radius. No field work is required at this initial step.

Microwave satellite images are received as the input, after which the Utilis team applies a mathematical manipulation and analysis to provide the exact coordinates of the leak. In addition, analysis estimates the size of the leak (from as little as 0.1 liter per minute), with the ability to detect non-revenue water leaks between 1-3 meters underground. At this depth, non-revenue water doesn’t usually exist without a reason, so after filtering out lakes, swimming pools, drainage assets, sewage assets and other interferences, this information allows for an accurate assessment of non-revenue water leaks.

By identifying leaks within a few meters radius, Utilis is able to detect leaks much more efficiently than currently used methods. The outputs of the Utilis software are used to analyze satellite images and display a layer of non-revenue water leaks with a web-based GIS application. This innovative remote sensing technology layer is unique and immediately accessible to water managers upon analysis and confirmation of the results by the Utilis team. Most importantly, Utilis does not require any prior investment or adaptation of existing distribution systems. As such, it is an extremely cost effective solution.

The result is much lower operational costs for reducing non-revenue water. Plus it allows for water managers to spend their budgets more efficiently by being able to look at an urban grid in its entirety, from up in space. Utilis provides an overall solution to the problem of non-revenue water, starting from the identification of a specific leak, right through to its repair. Utilis provides an opportunity to move beyond the outdated approach of plugging emergent leaks by offering a proactive solution to the reduction of non-revenue water leakage.
Throughout the world, an average of 20-30 percent of drinking water is lost through leakage. Utilis detects fresh-water leaks in urban water supply systems by analyzing multispectral images and presenting its findings on a web-based, Geographical Information System (GIS). With state-of-the-art technology that is known for finding water on other planets, Utilis locates leaks on earth by relying on airborne-mounted sensors (satellites). By overlaying a layer of identified leaks on a map together with streets, pipes and leak size information, the resulting leak detection technology can concurrently cover thousands of square kilometers.

To do this, Utilis searches for the spectral ‘signature’ of fresh water (a dielectric constant). This signature is the relation between an electromagnetic wavelength and its interaction with water. The satellite mounted SAR sensor works by sending electromagnetic waves which bounce back to it from earth. And depending upon the substance they touch, on or under the ground, the electromagnetic waves that bounce back have a wide range of spectral signatures. The key to Utilis' ability to detect leaks in urban distribution pipes is in its focus on the spectral signature of fresh water, filtering out everything else.

The Utilis system is based on microwave reflectometry, or microwave electromagnetic signals. Microwaves travel through atmospheric interferences such as clouds, dust particles and aerosols. They work well at any time of the day or night. They are particularly useful for water detection, as water exhibits a high value of relative dielectric permittivity, therefore enabling the discovery and measurement of water in soil. The Utilis solution works in this microwave wavelength not only for its ability to penetrate the ground, but also due to its high sensitivity to dielectric constants.

The core technology of Utilis exploits these physical findings and then removes undesired “noise” reflections of buildings, vegetation and other topographical features.

A high-level breakdown of the process Utilis implements is as follows:

1. A microwave sensor acquires images.
2. The Utilis team uses an algorithm to prepare raw data for analysis.
3. A corrected microwave image is then analyzed, with fresh water leaks identified. The size of the leaks are estimated by cross referencing the algorithm's output against local infrastructure.
4. Normalized data is presented graphically with findings displayed on a GIS web-based application. Field teams on the ground receive ‘Leaksheets’ generated by the Utilis system, to confirm and repair the leaks.

The microwave imagery used by Utilis is innovative, fast and scalable. Utilis' satellite based leak detection gives water managers accuracy, quantity and quality of information. It allows water managers to move away from reactive methods of detecting non-revenue water losses and reduce the long-term financial burden associated with leak detection of non-revenue water.

Utilis approach to finding leaks is analogous to a doctor basing diagnosis on imagery techniques, rather than just addressing a patient’s symptoms. Current leak detection methods rely on the “symptoms” of leaks, such as noise, a pressure drop or flow increase. The Utilis solution performs periodic scans of the network so any leak is detected as soon as it appears, thus reducing the “awareness time” of leaks to the period between scans, effectively reducing physical NRW and helping prevent bursts.
Fast Implementation

The key features of Utilis microwave imagery are:

1. Utilis provides an efficient and accurate survey of a very large area, the perimeter of which can cover an entire water system in a single screening. Instead of taking years to survey an entire system, Utilis provides periodic updates on the whole system over time.

2. A considerable number of leaks are identified for on-ground assessment. With Utilis’ findings, local acoustic teams identify and verify anywhere from 5 to 15 leaks a day. The results over time are consistent and lead to significant reductions of non-revenue water.

3. The minimal detectable leak size is 0.1 liter per minute.

4. Integration with GIS data: the system output is cross-referenced with data covering the location such as water mains in the distribution system.

5. No installation costs: Utilis remote sensing does NOT require installation or changes to existing infrastructure. Input is received from sensors and combined with data which is either publicly available, or managed by local authorities. Regardless, the technology is operated remotely.

6. Intuitive output: unlike other remote sensing technologies which require external consultation, the Utilis service is accessible and ready for use by untrained personnel.

7. Evaluate technology by its effectiveness in reducing non-revenue water, economically and logistically.

The Opportunity Cost

Unlike smart water management systems, Utilis does not require an initial investment in equipment on the ground. Instead, it uses electro-acoustic techniques to “mark an X on the ground where the leak is found.” When compared with other leak detection solutions, such as searching for leaks by randomly surveying large areas by foot (time consuming), or by analyzing data from a network of sensors (expensive), Utilis will just find water leaks.

Today, water utilities budget for lengths of pipes to be surveyed or monitored in the hopes of finding a leak. The Utilis remote sensing leak detection solution delivers leaks by automatically surveying the whole network up to 12 times per year. Since no capital investment is required, Utilis effectively offers a “Pay per Leak” approach.

Utilis surveys an entire network periodically, providing 4-12 sets of findings annually. Each one of these sets requires 2-4 days of acoustic surveying on the ground, raising the effectiveness of acoustic teams so that they can focus on the last few meters of a detected leak.

With Utilis there is no upfront cost for hardware, and it has the unprecedented benefit of finding more leaks in the same time period when compared with using a smart water management system or an acoustic leak detection probe. The lower opportunity cost is a result of lowering non-revenue water, in particular from finding those small leaks that have the potential to run a very long time without detection.
Australian Case study: Melbourne and Sunbury

For the past five years Melbourne, Australia has been ranked as the World’s Most Livable City by the Economist Intelligence Unit. However, the city suffers from a loss of approximately 12% non-revenue water each year.

In December 2015, Utilis had the opportunity to work together with Detection Services and the Intelligent Water Networks Program, a partnership of seventeen water corporations in the state of Victoria, to advance water management, verify the technology and prove leaks can be detected from space.

In the preliminary run, Utilis and Detection Services found 18 leaks in the Melbourne suburbs during four days of verifying leaks that were identified using Utilis’ satellite imagery and algorithm. Utilis was able to provide crews with a detailed Leaksheet for every suspected location. Almost half of the identified leaks were repaired at the conclusion of the study.

“We based on this pilot, we estimate Utilis remote sensing technology will substantially improve our leak detection process, saving us time and resources which we use today to detect leaks”

Dean Barnett, Program Manager, Pipe Rover & Leak Detection

During the pilot, Utilis benchmarked two metrics:

1. Location accuracy: field staff were able to verify a suspected leak’s location, within a 24 meter radius buffer of the original coordinates.
2. The minimum detectable leak size was 0.1 liters per minute.

“We were able to confirm that our minimum detectable leak size is 0.1-0.3 liters per minute. Based on our microwave imagery, Utilis not only detected leaks accurately, it also provided a reliable indication of leak sizes. This pilot confirmed that it is considerably more efficient to head directly to a specific location and verify a leak, rather than surveying a large area.”

Utilis CEO, Elly Perets
Be Proactive, Not Just Reactive

The Utilis solution is novel, patented and unique. It enables a utility company, a municipality, a local authority or even a state or a region to monitor an entire water distribution system in an accurate manner, without any changes or installations in existing infrastructure.

Think about non-revenue water from the top down, instead of the bottom up. Use Utilis to look at your water distribution area from space.

The Utilis Method

1. Image acquisition and analysis
2. Leakage report and delivery of findings
3. On ground findings confirmation
4. Mark spot to excavate for repair
5. Leak repair

Utilis findings are presented in four ways:
- Utilis web-based GIS
- Leaksheets for fieldwork
- Lists exported from Utilis software
- GIS files

The bottom line is that Utilis finds 5-10 leaks a day with one team on the ground.

To contact Utilis, email info@utiliscorp.com