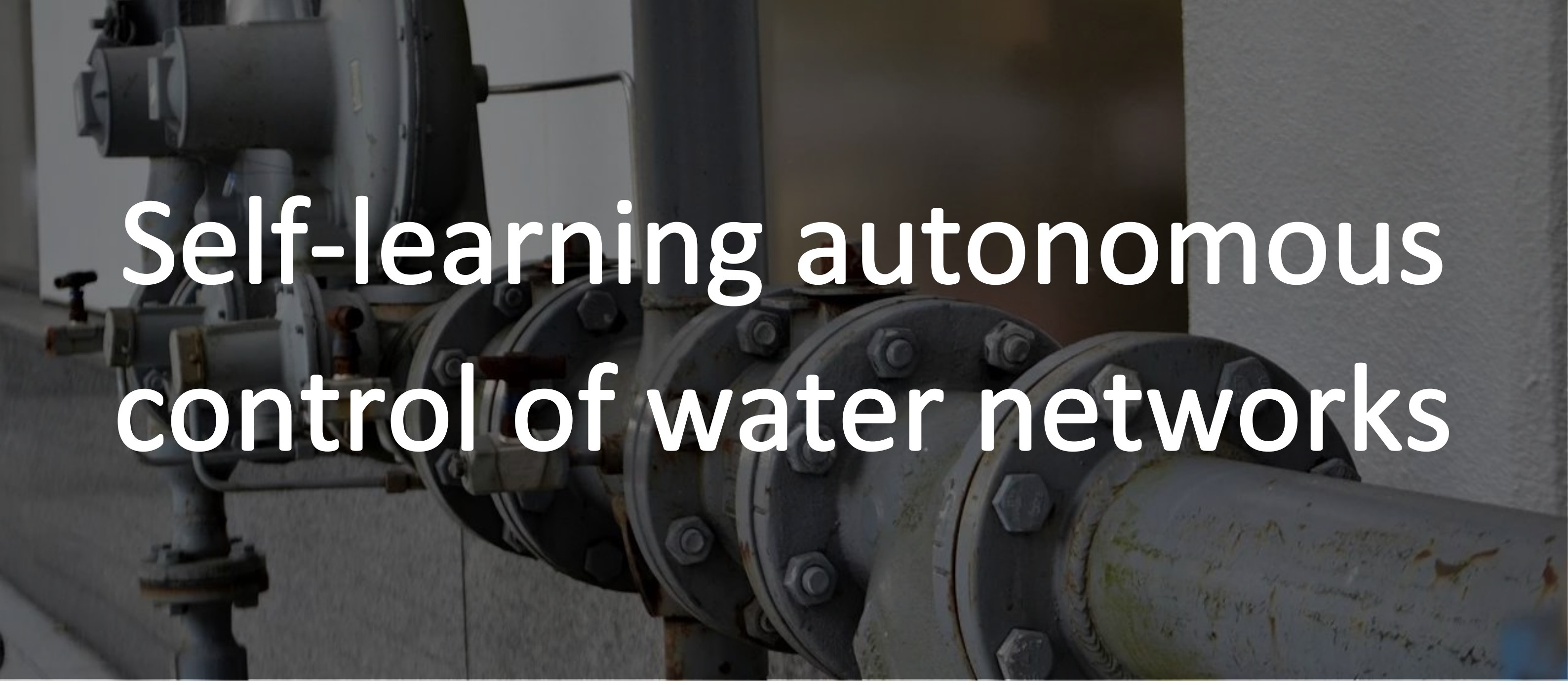

# Self-learning autonomous control of water networks

**DETAILS**

**SECTOR |** Water
**STAGE |** Operations and Maintenance
**TECHNOLOGIES |** AI Augmentation, Data & Analytics, Sensors / IoT

**SUMMARY**

This use case focuses on using Artificial Intelligence (AI) technology to optimise water network performance in terms of pressure and water quality. Self-learning AI technologies analyse network data and patterns in real time to control networks, increasing process efficiency in terms of operations and energy.

The emergence of AI and machine learning technologies in the water industry can provide a step-change improvement to water networks from catchment to tap.

Operating water networks efficiently is a challenge for water utilities due to their size and complexity, having to manage and optimise factors such as pressure and water quality. Traditional manual control of network assets, such as operating valves and pumps, is inefficient, labour intensive and slow to respond to changes or emergencies in the system which can lead to increased health risk and reduced level of service for customers. This happens in the form of insufficient water pressure at the tap, poor water quality (in terms of microorganisms, colour and odour) and increased service interruptions due to leaks and bursts.

Activities such as valve and pump operation can now be managed to suit network and customer demands in real time, without the human bias and the time required to respond to changes in operating conditions.

In the future, developments in sensors and IoT technologies (related to scaling up manufacturing and deployments) are making technologies cheaper, enabling better returns on investment. Additionally, research and development into data and sensing technologies is increasing resolution. Granularity of data is training AI and machine learning control algorithms to be more efficient, as well as provide predictive capabilities.

**VALUE CREATED**

**Improving efficiency and reducing costs:**

- Provides operational data, valuable analytics for business and operational insights. This improves the efficiency of network operations
- Moving water is usually the highest operational cost for a water utility. Value is created by reducing operational expenditure in energy consumption for pumping. For example, an AI installation in the Netherlands has improved energy efficiency in operations by 5-10%.
- These technologies optimise pressure, which results in a reduced number of bursts and leaks. Bursts and leaks, known as non-revenue water, are essentially lost product and lost revenue potential.

**Enhancing economic, social and environmental value:**

- Reduces human error, resulting from capability and conflicting work priorities, resulting in improved safety and fewer catastrophic asset failures such as major bursts.
- Enables a higher level of service to customers through a consistent water pressure, lower operating costs, less leakage, and a more reliable supply due to less main breaks.

## POLICY TOOLS AND LEVERS

**Legislation and regulation:** Regulation of both water quality and asset management can drive the implementation of these smart solutions. Government regulations, social responsibility, and sustainability targets drive utilities to be more efficient and sustainable in their operations to reduce emissions and water loss to combat climate change and water security risks.

**Transition of workforce capabilities:** Training and upskilling of workers is required to effectively explore the real-time recommendations from AI, sense-check these recommendations (AI cannot truly sense-check in its current form), and action the recommendations if appropriate.

## IMPLEMENTATION

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|---|---|
| Ease of Implementation  | A major challenge to implementation is a lack of sensors in water networks and the lack of high-resolution data which prevents the training of AI on historical data. However, as the cost of sensors decreases and sensors become more ubiquitous, this problem will fade. Controllable valves and pumps may also be another issue as some of these only have a few predetermined settings or can only be manual controlled these may need to be changed to action the finer control needed with AI determined operating points. |
| Cost  | Sensors are inexpensive (relative to the cost savings that can be achieved) and are becoming even more so over time. The cost and effort incurred with the data analysis programs and implementing variable pumps and remote-controlled valves also needs to be considered. |
| Country Readiness  | There are technologies available that cater for both developed and developing markets in terms of differing complexities. While fully developed water and communications infrastructure is needed to realise the full potential / benefits of the technology, there are technology providers catering for developing markets that can achieve benefits using existing infrastructure. |
| Technological Maturity  | AI technology is becoming more advanced but early implementations are still building trust with current operators. It is still especially important that operators can sense-check the AI calculations, particularly if the networks experience unusual conditions. As AI advances, it may be possible for the AI to do this sense-checking, even in never-before seen circumstances. |

## RISKS AND MITIGATIONS

### Implementation risk

Risk: Artificial intelligence is trained based on historical data. However, if the historical data is of low quality (e.g. due to short time frame of data, incorrectly calibrated sensors, gaps in the data, etc.), then the AI is also likely to be of low quality.

Mitigation: Any proper implementation of artificial intelligence requires skilled data scientists, software, and water treatment specialists to analyse historical data and ensure that it is accurate and of a sufficient quantity for the training of the AI. The AI should also be thoroughly validated through trials with operators.

Risk: Automation can create the need for re-training of workers to operate, maintain and oversee automated systems and focus on more strategic activities focusing on longer term planning of network maintenance and operation.

Mitigation: Water network operators should be upskilled to learn how to interpret, make sense of, and action any insights that are provided by the AI.

### Social risk

Risk: Artificial intelligence is trained based on historical data and can be bad at providing decision support if it receives data that is dissimilar to the historical data that it was trained on. This can lead to poor customer outcomes in terms of poor water pressure and water quality when conditions haven't been seen by the software before.

Mitigation: This can be mitigated using highly skilled operators who can make sense of the decision support provided by the AI and ensure that it makes sense based on their knowledge of the system.

### Safety and (cyber)security risk

Risk: Control systems, especially those located in the cloud, are at risk of cyber-attacks that can leave critical infrastructure vulnerable.

Mitigation: Training of AI is generally done in the cloud, however, once training is complete the AI can be easily run on a desktop machine. Therefore, it is possible to have the AI in a desktop computer on-site at the operations centre and to not have it connected to the internet, or to only have limited access to the cloud.

## EXAMPLES

| Example | Implementation | Cost | Timeframe |
|---|---|---|---|
| i-2O | i2o is in use in the City of Cape Town to optimise pressure in critical network points, where it has resulted in a 58% reduction in bursts and 38% reduction in water lost through leaks. It is estimated the water network asset lifespan was extended by 5 years.[1] | Saving £300,000 per year in operations and maintenance costs. | AI pressure optimisation can typically be achieved within a few months. |

[1] City of Cape Town Case Study. i-2O Water. Accessed 1 April 2020

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|---|---|---|---|
| R-TAP | The technology is being used in multiple Philippine Water Districts to monitor and optimise pressure through pump control. | Calumpit Water District saw an increase of more than PHP2 million (Philippine Pesos) in revenue through billed volumes and nearly PHP 200,000 in energy costs. Tagaytay City Water District has seen a 70% reduction in water lost through leaks and PHP 1.4 million savings in energy and operations cost[2]s. | These projects can be implement within 2 months and provide an ongoing service. |
| Aquasuite By Royal HaskoningDHV | Aquasuite OPIR is widely acknowledged as a valuable tool by Dutch water authorities. Currently, OPIR provides control solutions over 50% of all water systems in the Netherlands, including Amsterdam supply network[3]. | Aquasuite OPIR has been shown to improve water quality by 20% and improve energy efficiency in operations by 5-10% | The timeframe for Aquasuite implementation is relatively short but will depend on individual sites. Overall implementation is typically a matter of months and then provides an ongoing service. |

**CONTACT INFORMATION**

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[2] Case Studies. Hiraya Water. Accessed 2 April 2020
[3] Information for this example was gathered via communications with commercial technology stakeholders.