YORKSHIRE PARTNERSHIP
AT THE HEART OF INNOVATIVE AI POLLUT

Yorkshire Water, the University of Sheffield and Siemens Digital Industries have joined forces to use Artificial Intelligence (AI) and the Internet of Things (IoT) to reduce wastewater network blockages and pollution.

ADAM CARTWRIGHT, HEAD OF IOT APPLICATIONS, SIEMENS UK

Cutting-edge technologies like artificial intelligence in industry and the Internet of Things (IoT) are helping to safeguard the high value of natural water systems by preventing them from pollution. A visual story.

Natural water systems carry a high value. They support a diverse ecosystem for flora and fauna; they keep people healthy by preventing water-borne diseases; and they protect and create tourism and recreation opportunities.

However, in cities all over the world – and particularly in older cities – stormwater runoff and household sewage are transported to water treatment plants in the same piping network. An advantage of these so-called combined sewage systems (CSS) is that runoff water, which could be polluted with oil, pesticides, fertilizer, and more, is purified before it is released into nature. That's good news for the environment.

There is a downside, however: During heavy rainfall or snowmelt, a CSS piping network can be stretched to the limits and untreated water may escape into waterways via the combined sewer outlet (CSO). But the chances of this happening are greatly diminished when blockages in the CSO are removed in

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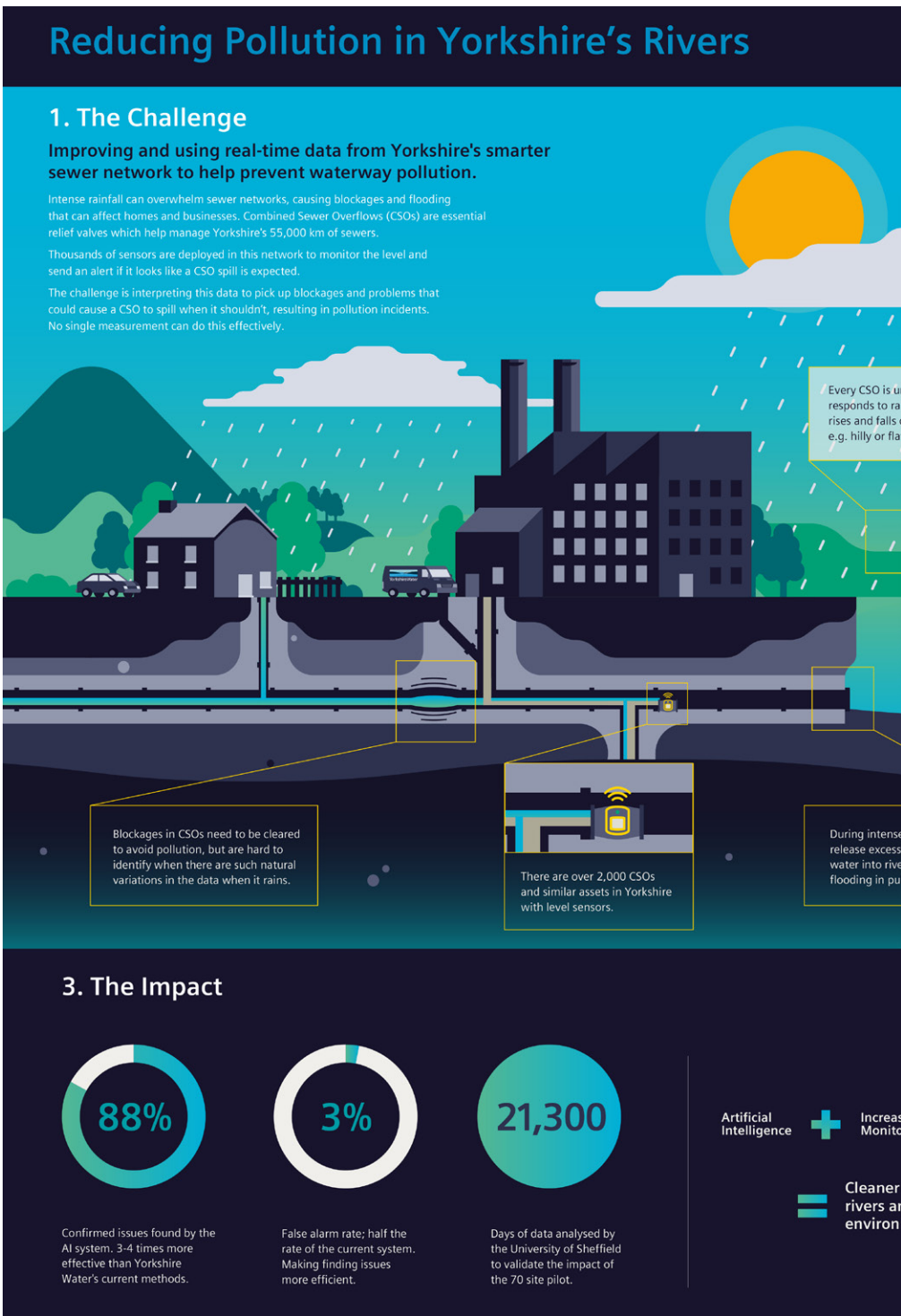
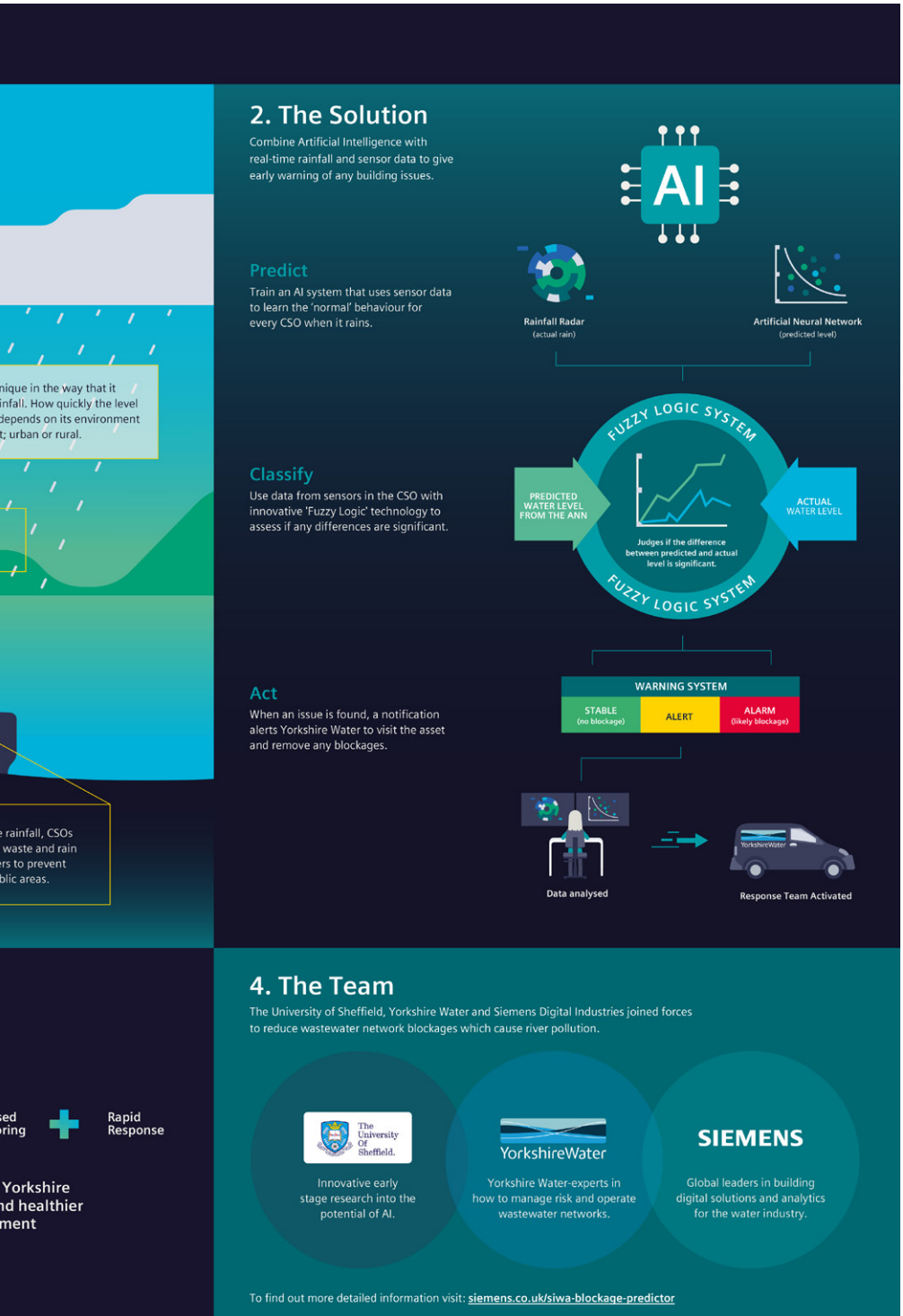


ION PREVENTION SOLUTION

time. Siemens, Yorkshire Water, and the University of Sheffield have joined forces to develop a system that employs artificial intelligence (AI) and the Internet of Things (IoT) to locate blockages before overspills can occur.



Cut pollution incidents by 50 per cent

The British water company Yorkshire Water operates 55,000 km of sewers. In times of intense rainfall, CSOs are designed to release excess water and sewage into rivers to prevent flooding in public areas. Of course, these incidents need to be kept to an absolute minimum. In the framework of Yorkshire Water's Pollution Incident Reduction Plan 2020-2025, the goal is to cut pollution incidents by 50 per cent. The key to attaining this objective is to remove blockages in sewers and thereby minimize the probability of a release.

For some time now, over 1,500 sensors on CSOs have been monitoring sewage levels and issuing alerts when an overspill has happened. But wouldn't it be better to know where blockages are most likely to occur so that debris can be removed before an overspill has a chance of developing? Until now, experts at Yorkshire Water have been trying to make predictions by evaluating data from the sensors with statistical methods, but that often led to false alarms and late detections.

The analytical challenge is how to account for the personal character of every CSO. Each one responds differently to rainfall, so it is difficult to know if the observed changes in level are normal or not. A number of factors come to play here, such as the design of the upstream and downstream network, or whether the area is hilly or flat, urban or rural.

Therefore, the utility took the bold step of replacing statistical methods with AI and IoT – an approach that has now been tested at over 2,000 CSOs and manholes across the region.

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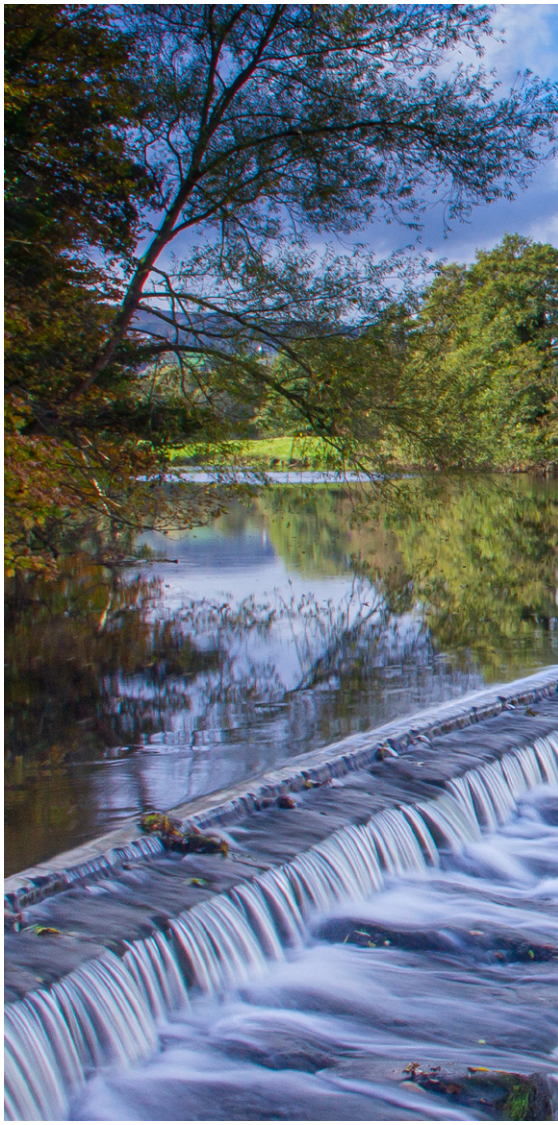

Cloud-based data analytics with AI and IoT

The data from the sensors on the CSOs along with real-time information on rainfall is delivered to SIWA Blockage Predictor. This application – which runs on MindSphere, Siemens' open, cloud-based IoT operating system – identifies anomalies in sewer system behaviour.

Initially, an AI system was trained with sensor data to learn the normal behaviour of a CSO when it rains. Now, a new AI model has been trained for each site to learn its unique pattern of behaviour in response to rainfall. Fuzzy logic technology is then employed to automatically interpret the data to detect any significant differences in behaviour. When an issue is found, a response team at Yorkshire Water receives a notification to visit the asset and remove the blockage or forming blockage. Because SIWA Blockage Predictor is embedded within a web application, users can access it on mobile devices and PCs.

Yorkshire Water replaced statistical methods with AI and IoT; an approach that has now been tested at over 2,000 CSOs and manholes

"Artificial intelligence is not magic. It requires experts in data science to come together with people who really understand the issue and engineers who can build software, connect the hardware, and knit together a solution that is secure against cyberattacks. This project is a textbook example of how all strands should come together," says Adam Cartwright, head of IoT application delivery at Siemens.

Greater effectiveness in several ways

Now deployed in 24/7 operations, SIWA Blockage Predictor gave up to two weeks advance notice of blockages – blockages that could have potentially led to undiluted effluent being released into the environment. What's more, the predictor found nine in ten potential issues, which makes it three times more successful than the prediction processes that relied on statistical methods. Another boon to operations teams is an extremely low false alarm rate of just 3 per cent. That's half the rate of the current statistics-method-based approach.

Co-creation: a team effort

A challenge of building any new digital solution is the chance that it might be something customers don't want or need. For that reason, involving clients in a co-creation process leads to better outcomes. Yorkshire Water was engaged in this project from the start of 2020.

The journey from idea to product began with a series of research projects between Yorkshire Water and the University of Sheffield. Over a number of years, the core analytics concept was proven on a sample of Yorkshire Water assets.

"By building a personalized fingerprint for the wastewater assets that reflects how the local network responds to rainfall and overlaying that on patterns of daily behaviour, we have been able to establish what each asset's "normal" response is", says Joby Boxall, professor of water infrastructure engineering at the University of Sheffield.

River Wharfe Siemens: Clean waterways with artificial intelligence and IoT: River Wharfe in Yorkshire, UK.

While the analytics worked, as an academic project it was not designed to be scalable nor secure, and it wasn't optimised for easy daily use. When Siemens joined the project team, the data science knowledge was transferred and the university team took on a second important role – validating the effectiveness of how Siemens had developed the analytics and how this compared to the existing Yorkshire Water solution. After analysing 21,300 days of data, this independent analysis by the university further boosted Yorkshire Water's confidence in this new tool.

From market launch to a scalable solution

The AI has also been advanced so it can work on new sensor installs and not have to wait for months of training data. The solution is now being piloted outside of the UK, including a solution for new sites that don't already have a level sensor installed. Here, Siemens low-powered radar sensor Sitrans LR110 can be integrated into a remote terminal unit ready connected to MindSphere and SIWA Blockage Predictor saving time, cost and reducing risk. This simplified deployment puts digitalisation within the reach of every utility.

To learn more about SIWA Apps

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