

Real-time Detection and Diagnosis of Blockages in Smart Wastewater Systems

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1. Introduction and Objectives

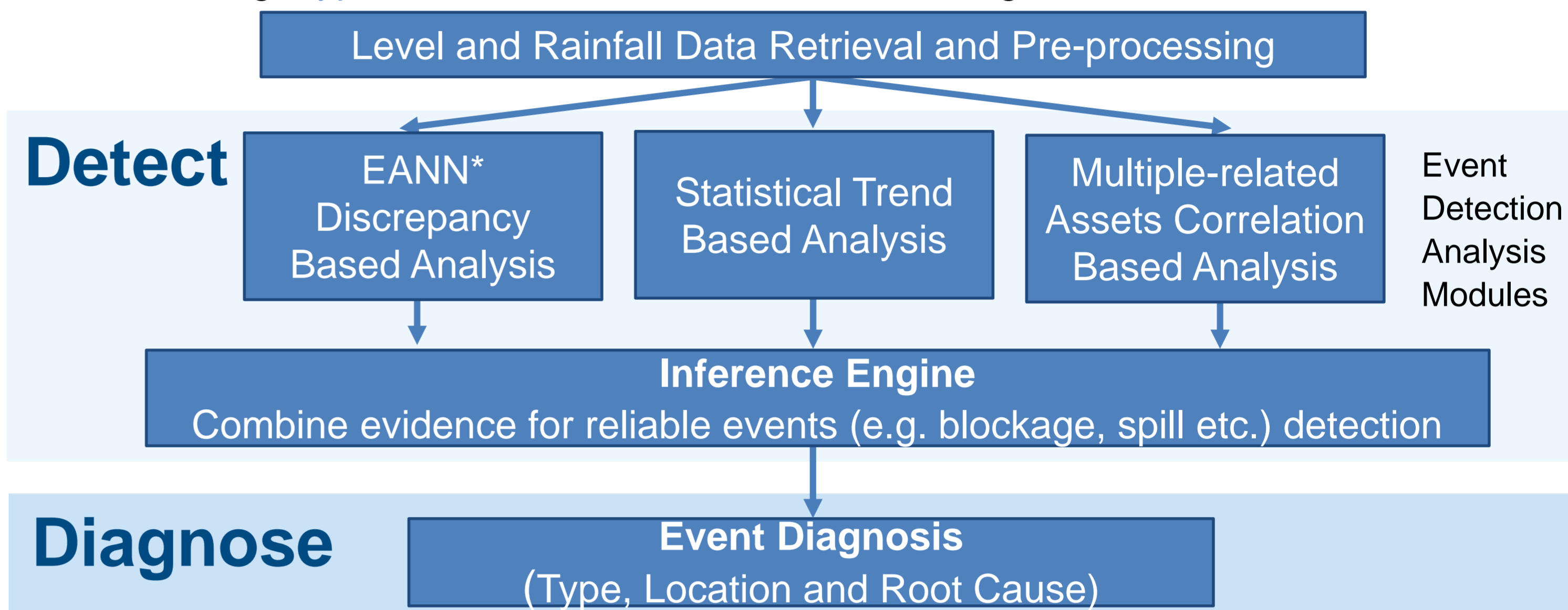
- There are 370,000 blockages in the UK each year, causing flooding in over 3,000 properties.
- Historically, utilities relied on customers to report blockages, responding with reactive repair and maintenance. This causes service interruptions, pollution and increased customer complaints.
- If blockages can be predicted/ detected in real time proactive maintenance can be implemented.
- Developments in hydraulic sensors and data acquisition systems enable collection of sewer level data in near real time.



A new methodology has been developed for the automated detection and diagnosis of blockages and other unusual events, at or in the proximity of CSOs in near real-time.

2. System Overview

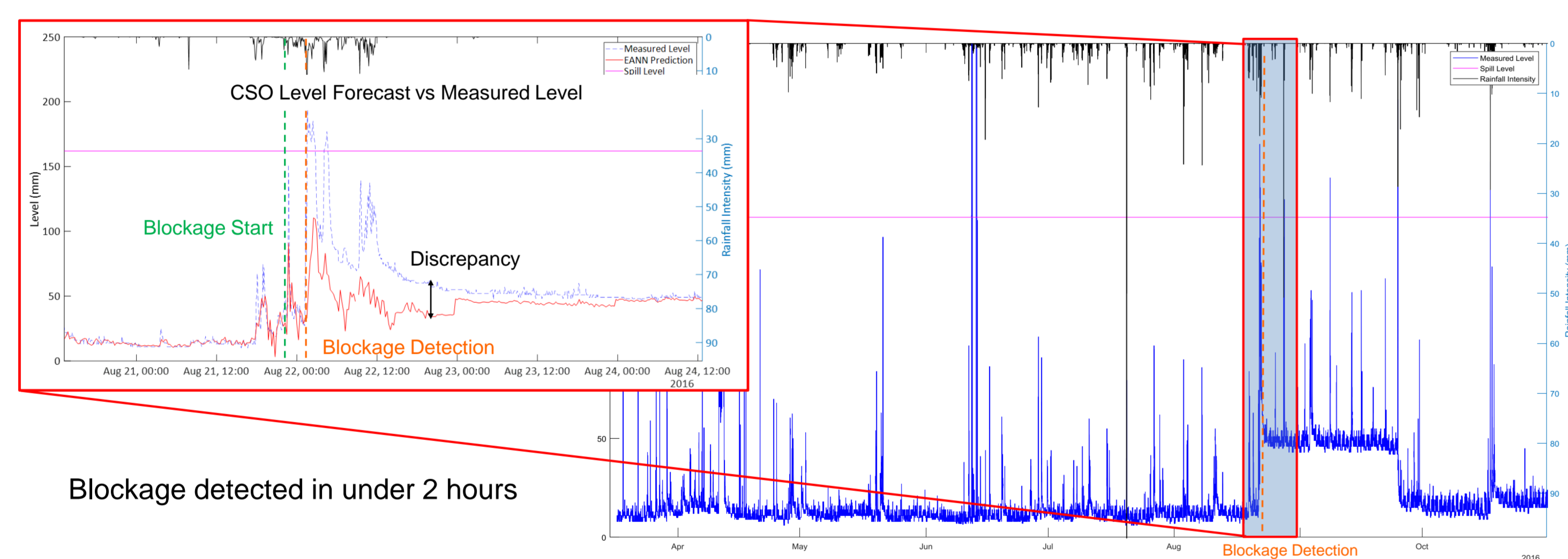
- The Blockage Detection and Diagnosis System (BDDS) consists of a combination of three event detection modules based on statistical analysis and data-driven modelling.
- Evidence collected by the modules is combined and an inference engine determines if a blockage has occurred.
- The blockage type, location and root cause is then diagnosed.



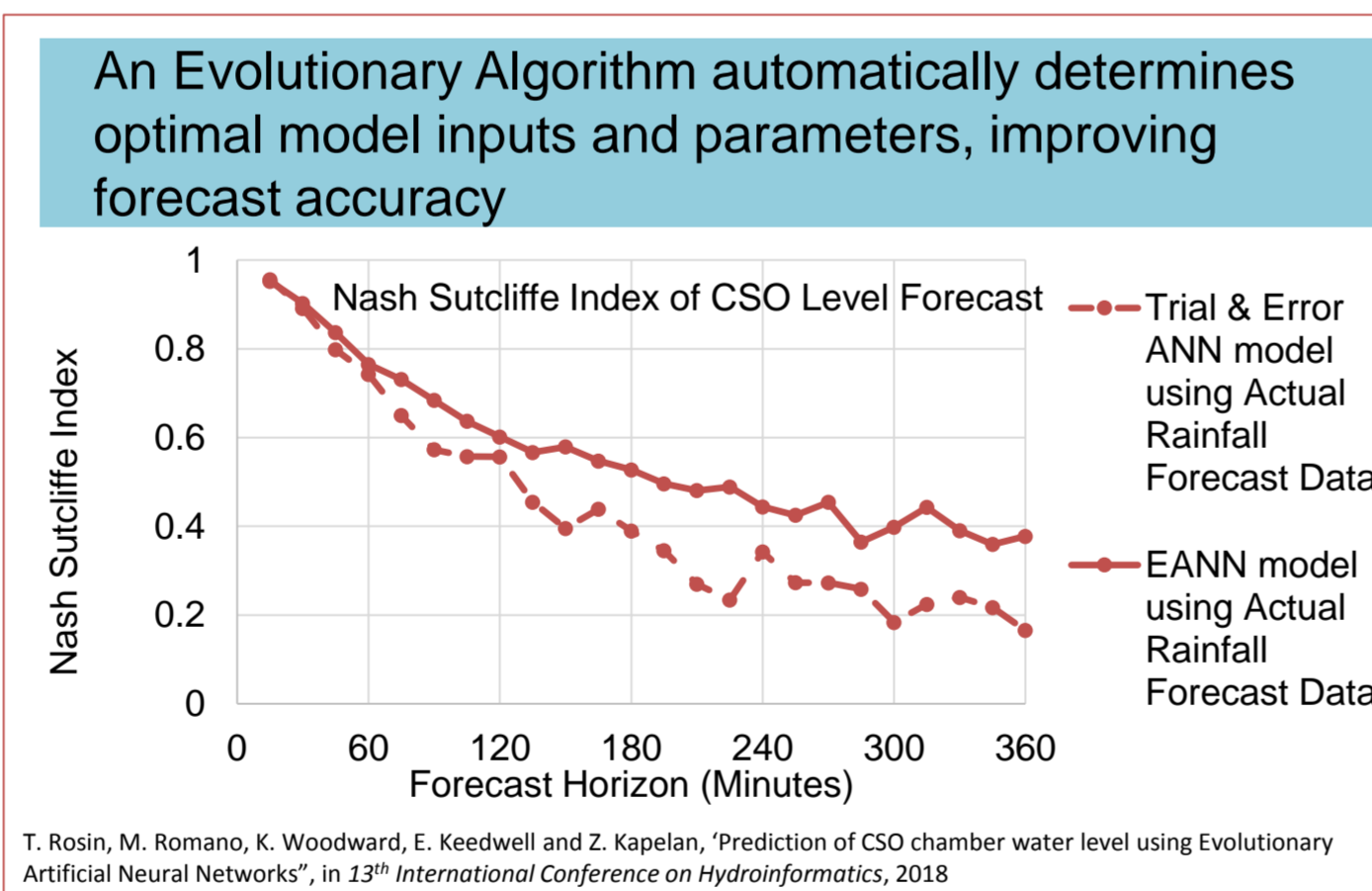
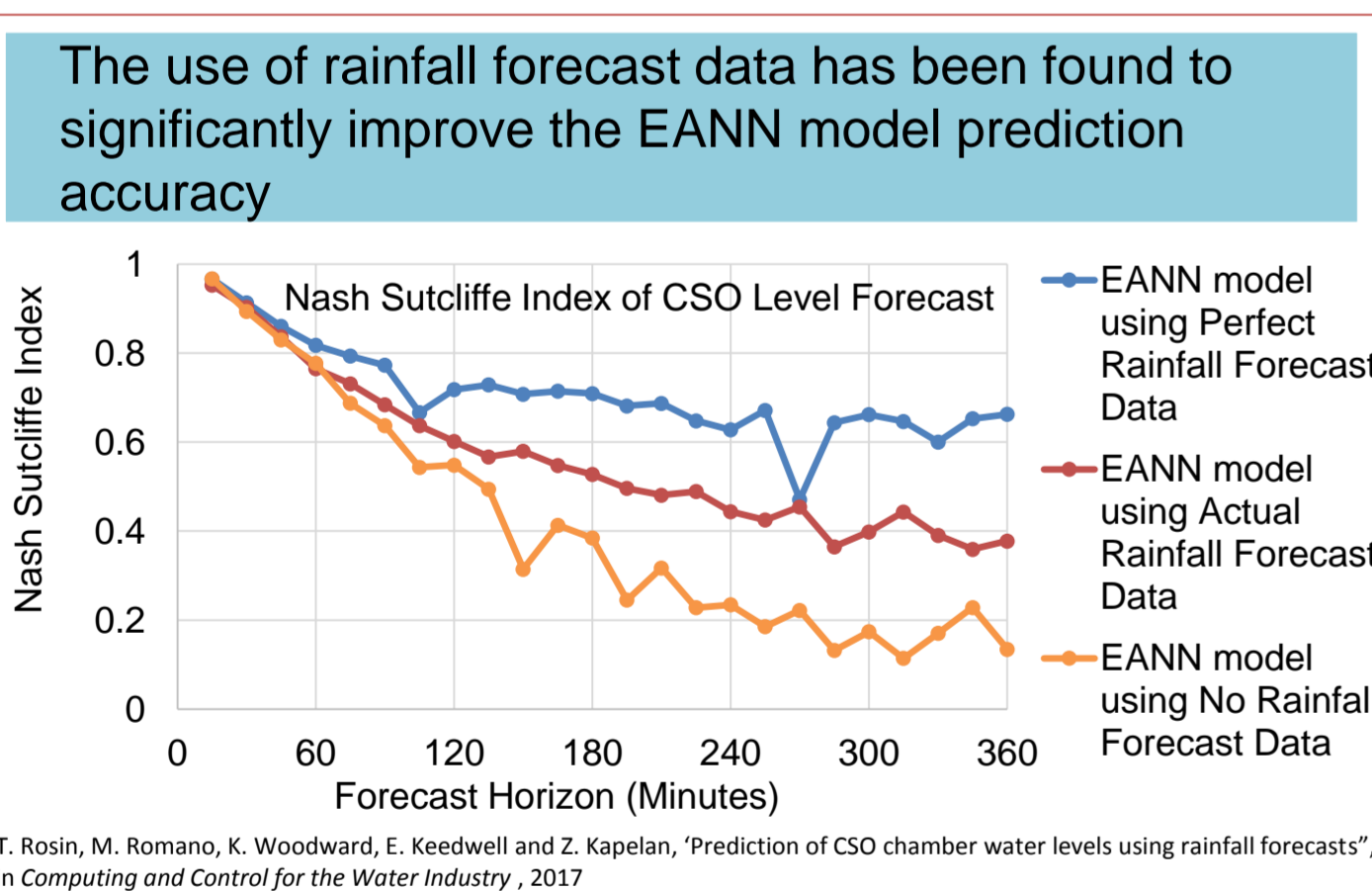
3. Methodology

3a EANN Discrepancy Based Analysis Module

- This module is most suitable for detecting sudden blockages, e.g. caused by collapses, snagging of foreign objects or debris.
- An Evolutionary Artificial Neural Network (EANN) forecasts Combined Sewer Overflow (CSO) chamber level in real time, assuming normal operating conditions.
- Blockages are detected by identifying discrepancies between observed and predicted CSO level which exceed predefined limits.

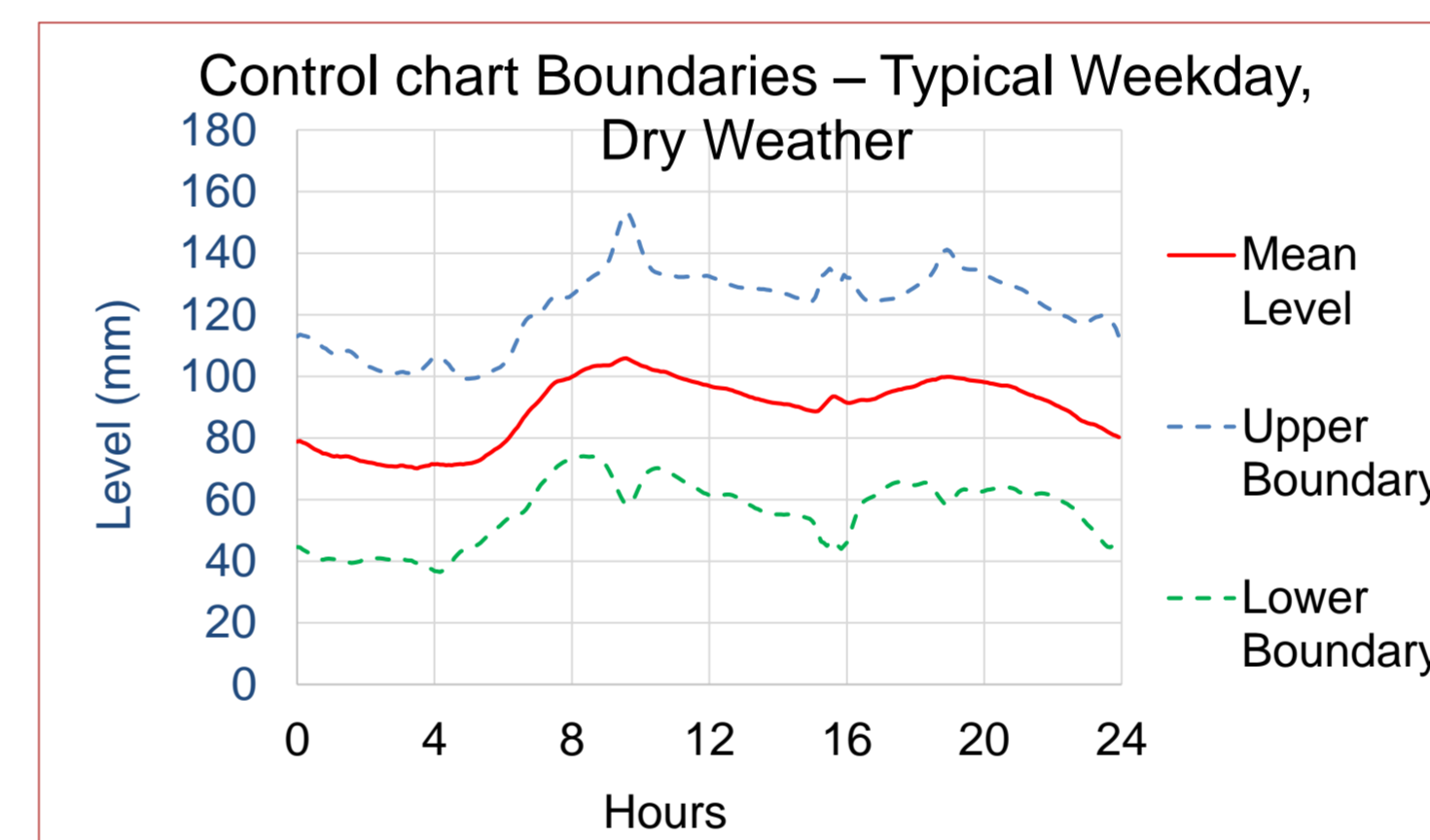
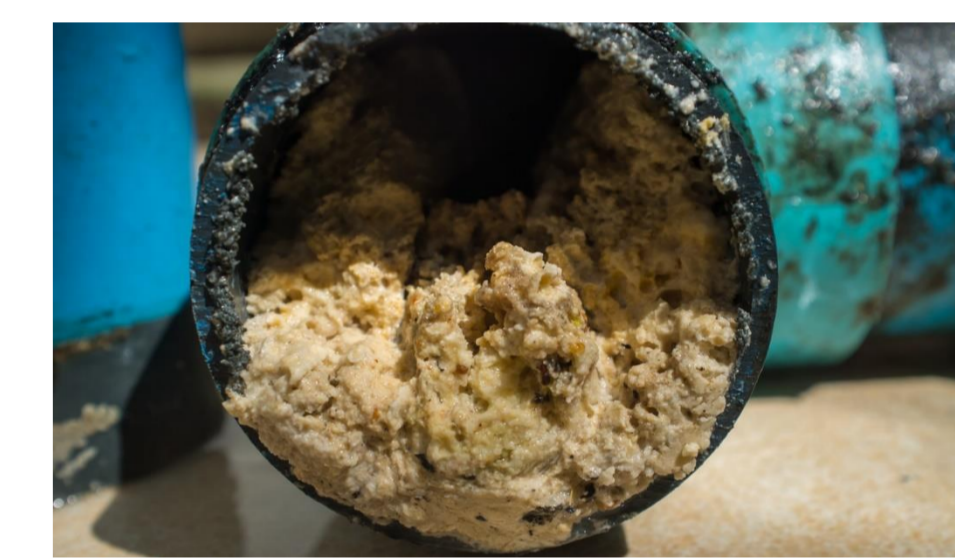


Scientific Advances

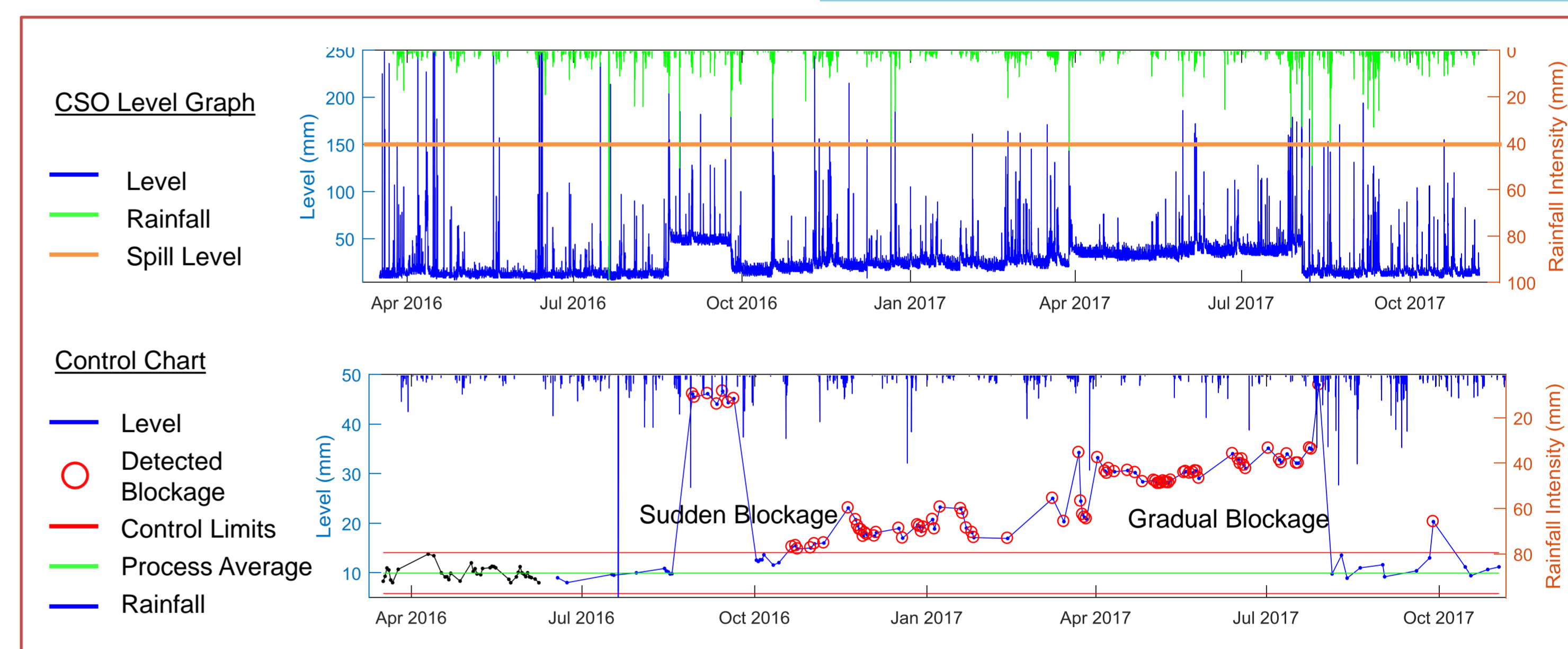


3b Statistical Trend Based Analysis Module

- This module is most suitable for detecting gradually forming blockages, e.g. caused by siltation or fats, oil & grease (FOG).
- A control chart analyses change in sewer level over time, classifying incoming level data as in control or out of control – indicating a blockage.

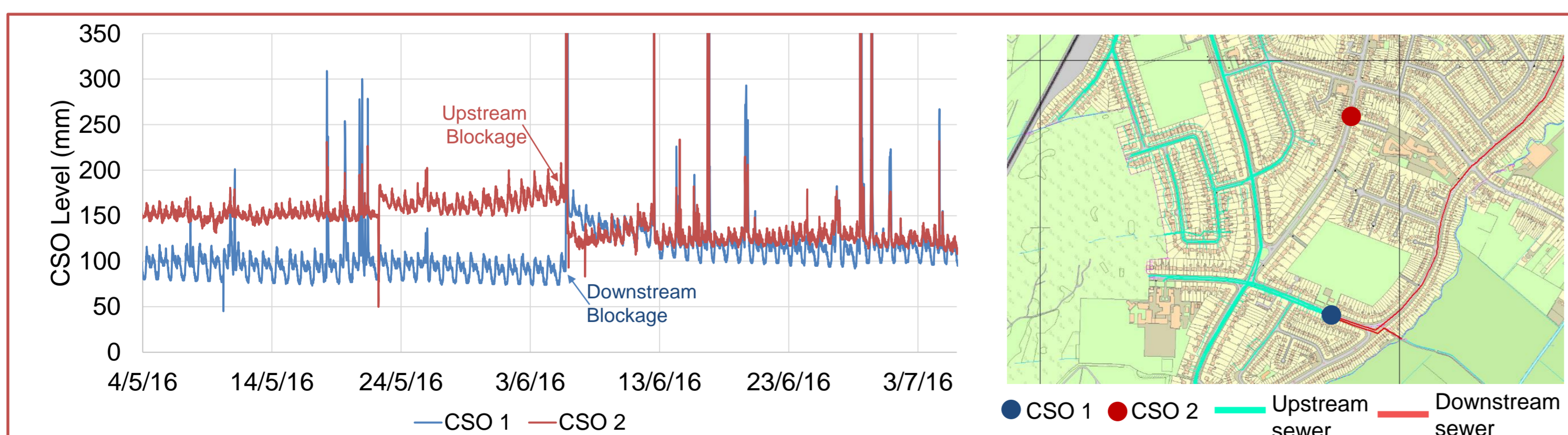


- Control chart statistical boundaries are calculated based on the mean and standard deviation of level data.
- Boundaries are tailored to the time of day, the day of the week, and the weather conditions (dry or wet) based on rainfall intensity and rainfall duration.



3c Multiple-related Assets Correlation Based Analysis Module

- This module compares level data from multiple signals from hydraulically related assets.
- Blockage events may affect multiple sewer pipes and CSO chambers.
- Corresponding level changes provide further evidence of blockage occurrence and information for event diagnosis and localisation



4. Conclusion and Future Work

- A decision support system has been developed to detect and diagnose blockage events in real time.
- The methodology is generic - thus can automatically be applied to different CSOs/catchments.
- The technology has the potential to enable proactive management of blockage events, reducing operational, maintenance and capital costs and decreasing the impact on the customer and environment.
- Testing of the system on historical events and artificially engineered blockage events in pilot areas of the United Utilities network is ongoing.

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