Royal HaskoningDHV Digital

SES Water

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Leak detection and localization through AI and hydraulic modelling

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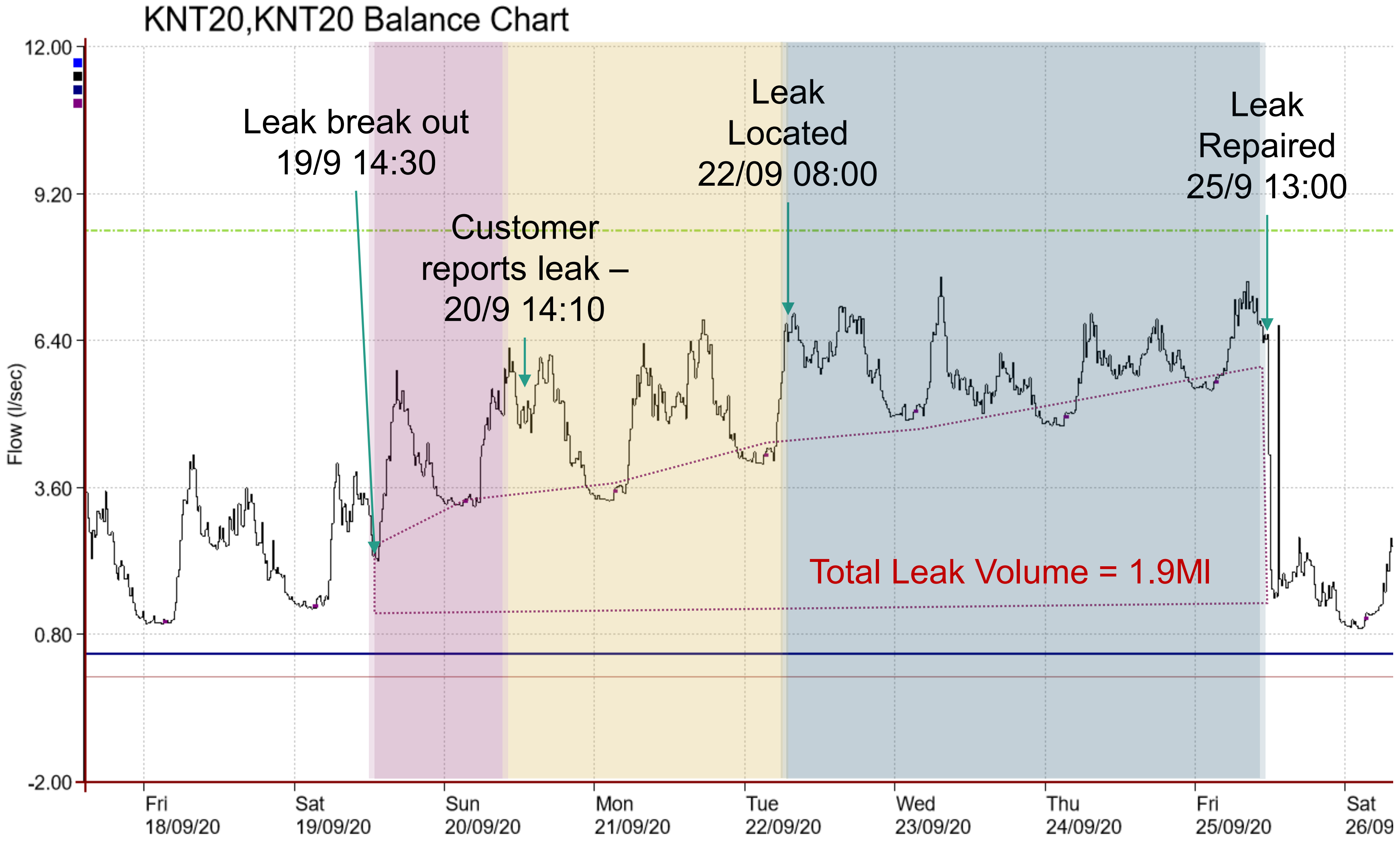
Leakage detection & localization benefits

Case study: SES Water (UK)
Burst of 3 l/s (initially) at KNT20

1. Detection runtime = 24 hours
2. Location runtime = 42 Hours
3. Repair runtime = 77 Hours
4. Total leak runtime = 143 hours
5. Total leak volume 1.9Ml lost

Goals:
1. 24/7 surveillance
2. Awareness before client call
3. Reduce non-revenue water



Contents

Research on 3 topics:

1. Demand forecasting: weather features
2. Leakage detection through demand anomalies
3. Leakage localization through hydraulic modelling

Demand forecasting: weather features

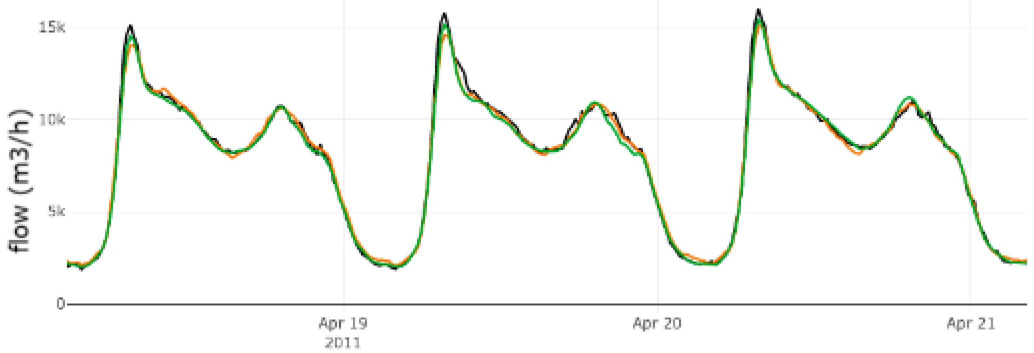
Methodology

1. Heuristic feature model vs. Hybrid/ANN model
2. Input for both models: Time features & historical demand
3. Addition for Hybrid/ANN: Weather data
4. Performance evaluation: R^2

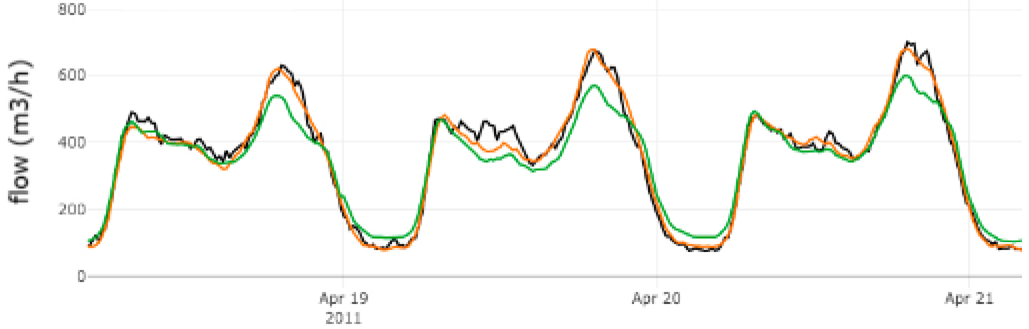
Expectation: Effect of weather depends on type and size

Area	Average demand (l/s)	#Consumers	Type
Amsterdam	2100	950,000	Urban
Helden	80	39,000	Rural

Amsterdam



Helden



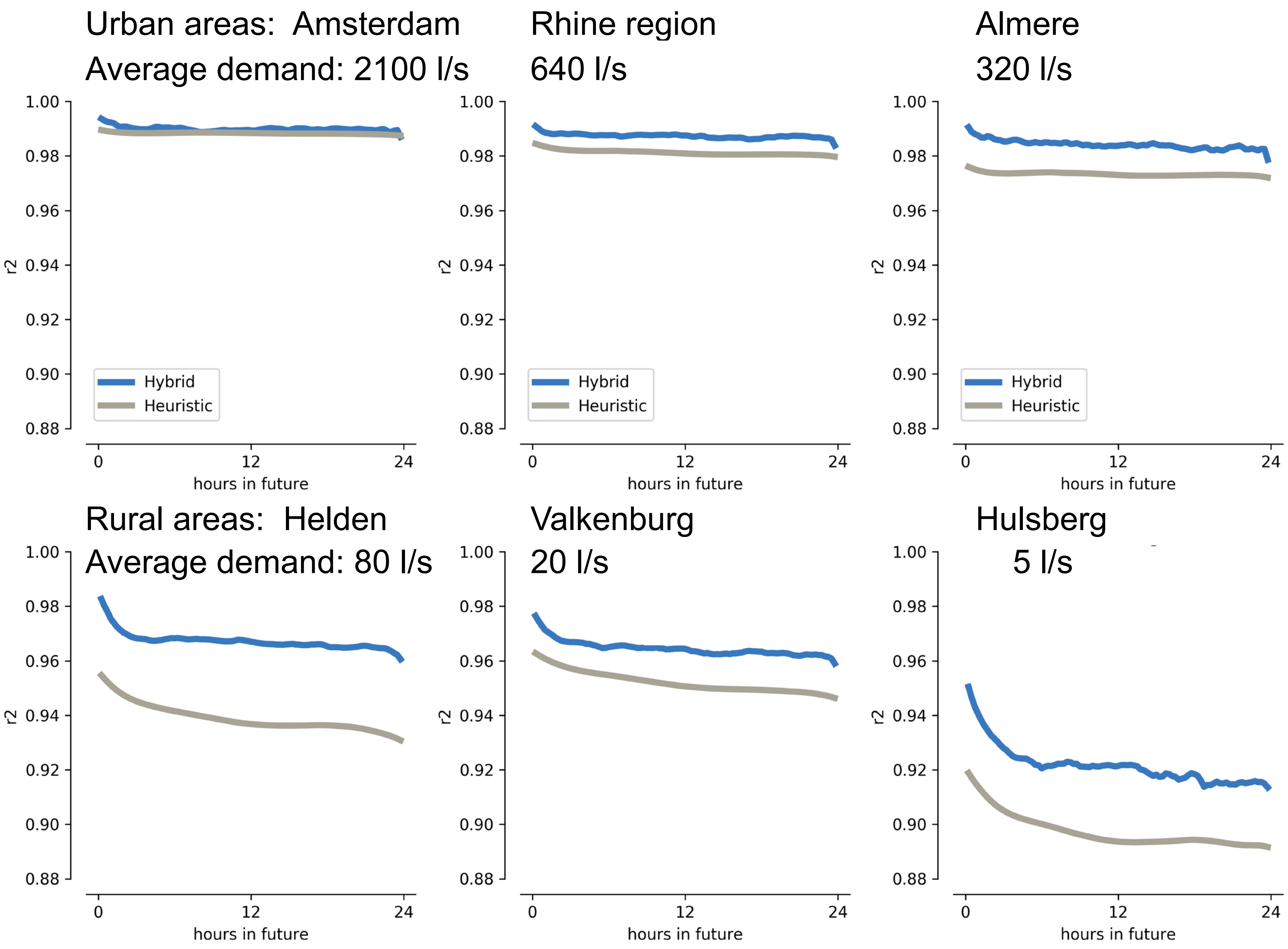
Results

Yearly average accuracy per time step

1. Hybrid (with weather data)
2. Heuristic (no weather data)

Largest improvements seen for:

1. Small/rural areas
2. 1-hour prediction (nowcast)



Leakage detection through demand anomalies

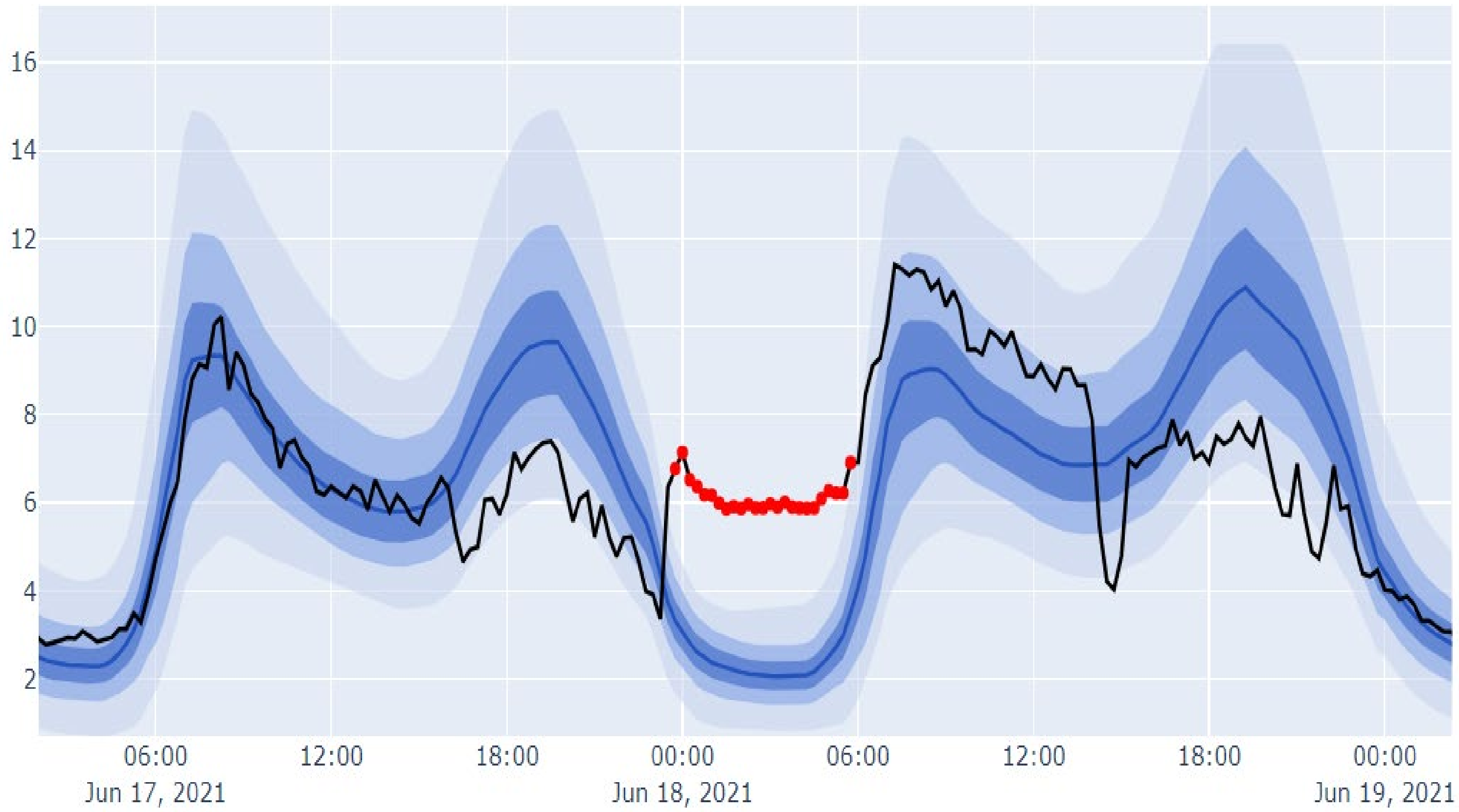
Methodology:

1. Neural network with quantile regression
2. Applied to small areas (DMA) of UK water utility SES (average demand 2 to 20 l/s)
3. Model input:
   - Demand
   - Temperature
   - Time

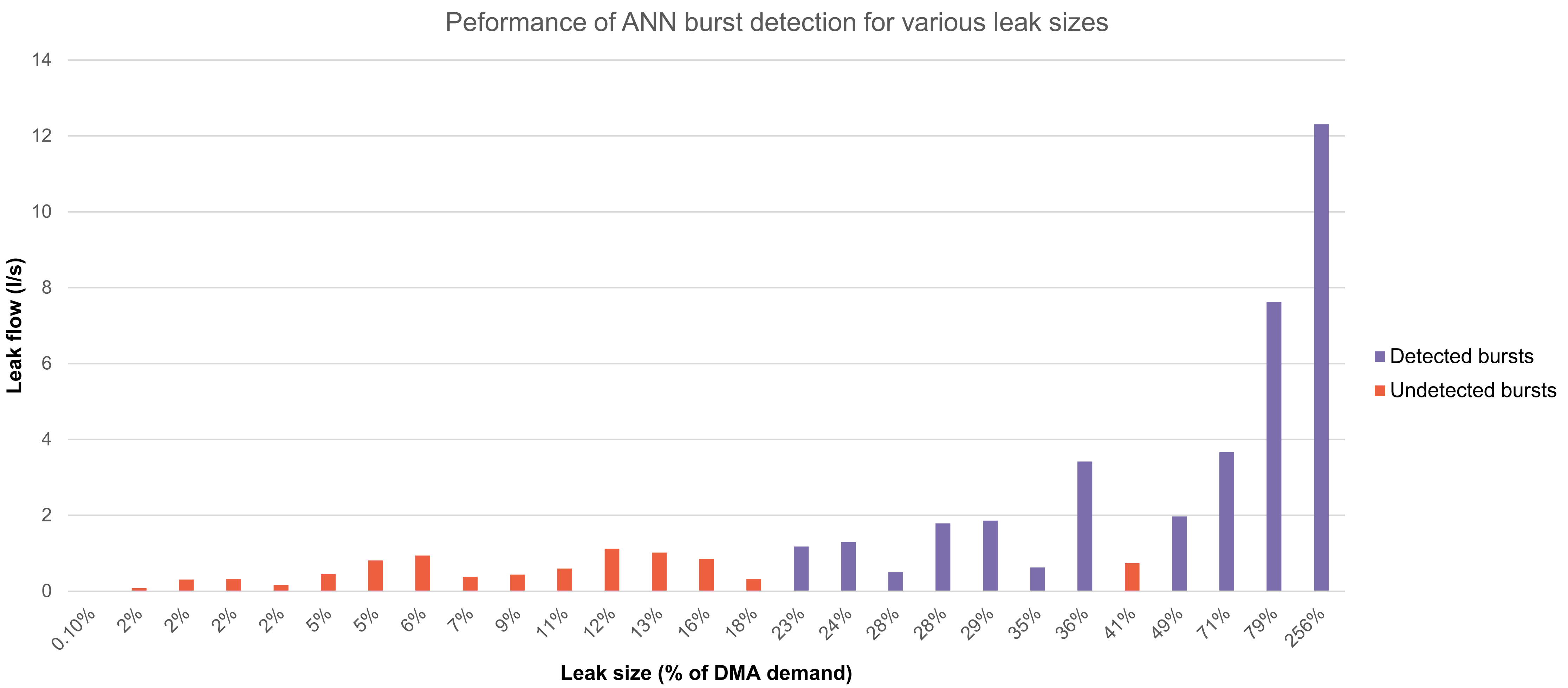
4.Model output:
   - Demand prediction
   - Confidence interval
   - Leak size

5.Alarm if demand>confidence interval

6.Detection performance tested on leak jobs provided by SES

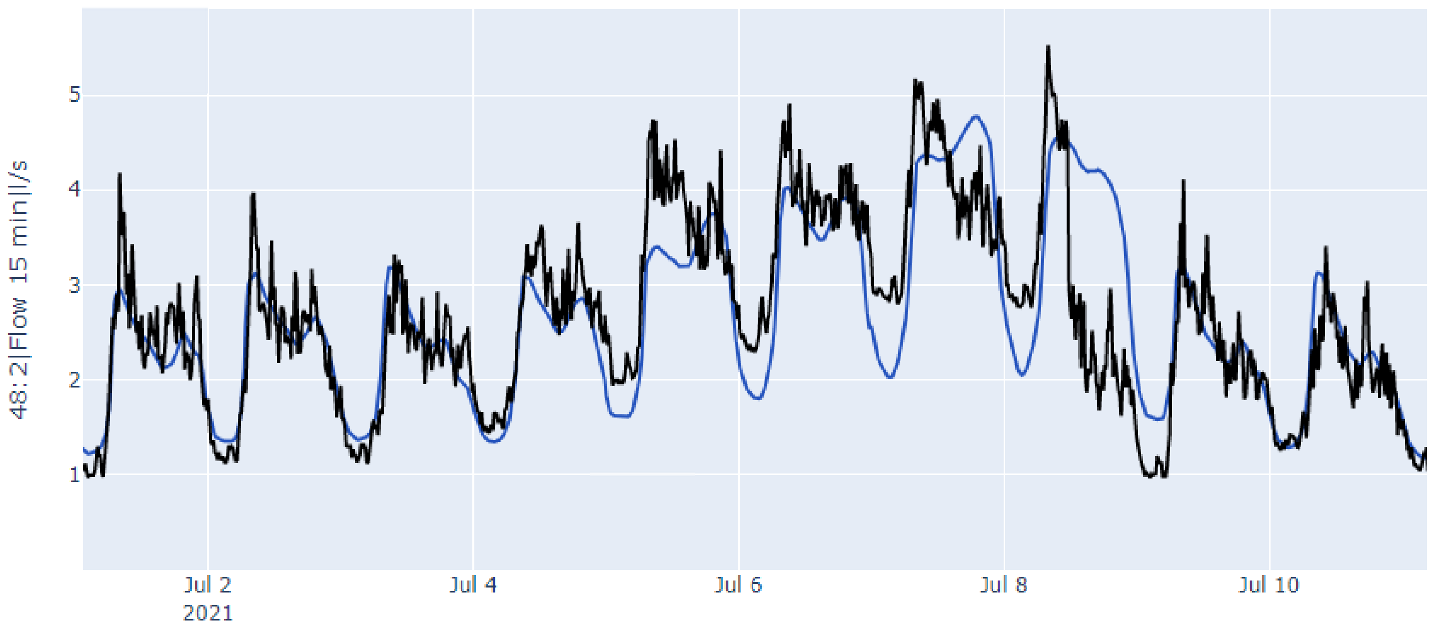


Results: relative leak size most important driver



Results: challenges

1. Balance false alarms & false negatives (missed bursts)
2. High unpredictable demand variability -> Wider confidence intervals
3. Recent demand affects prediction -> Gradual leak growth hard to detect



Localization

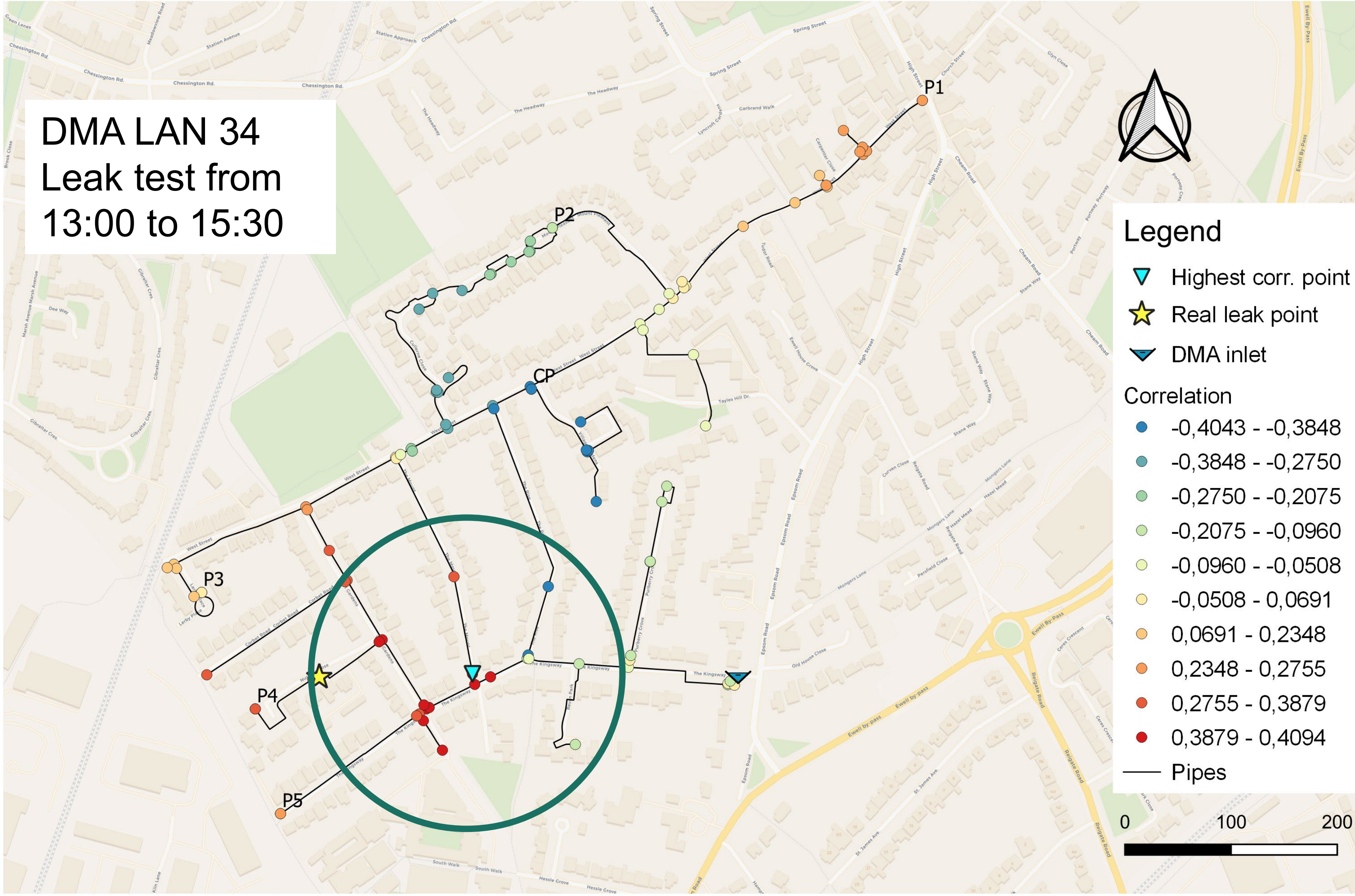
Methodology

Localization through hydraulic modelling:

1. Correct model based on night pressure
2. Provide leak size
3. Simulate leak at each node
4. Measure pressure at 5-8 locations in DMA
5. Score correlation of modelled pressures to measured pressure

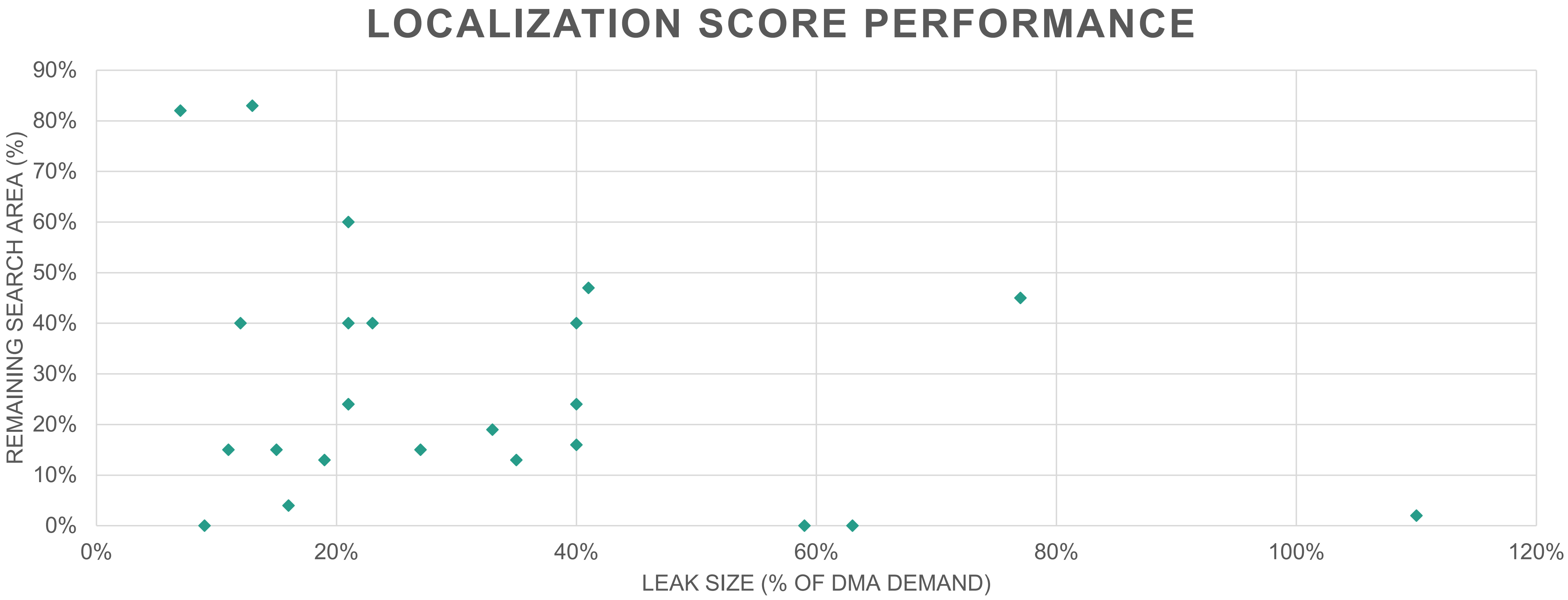
Performance validation:

1. Leak tests at fire hydrants (0.8 and 1.5 l/s)
2. Scored localization on remaining search area of DMA (%)



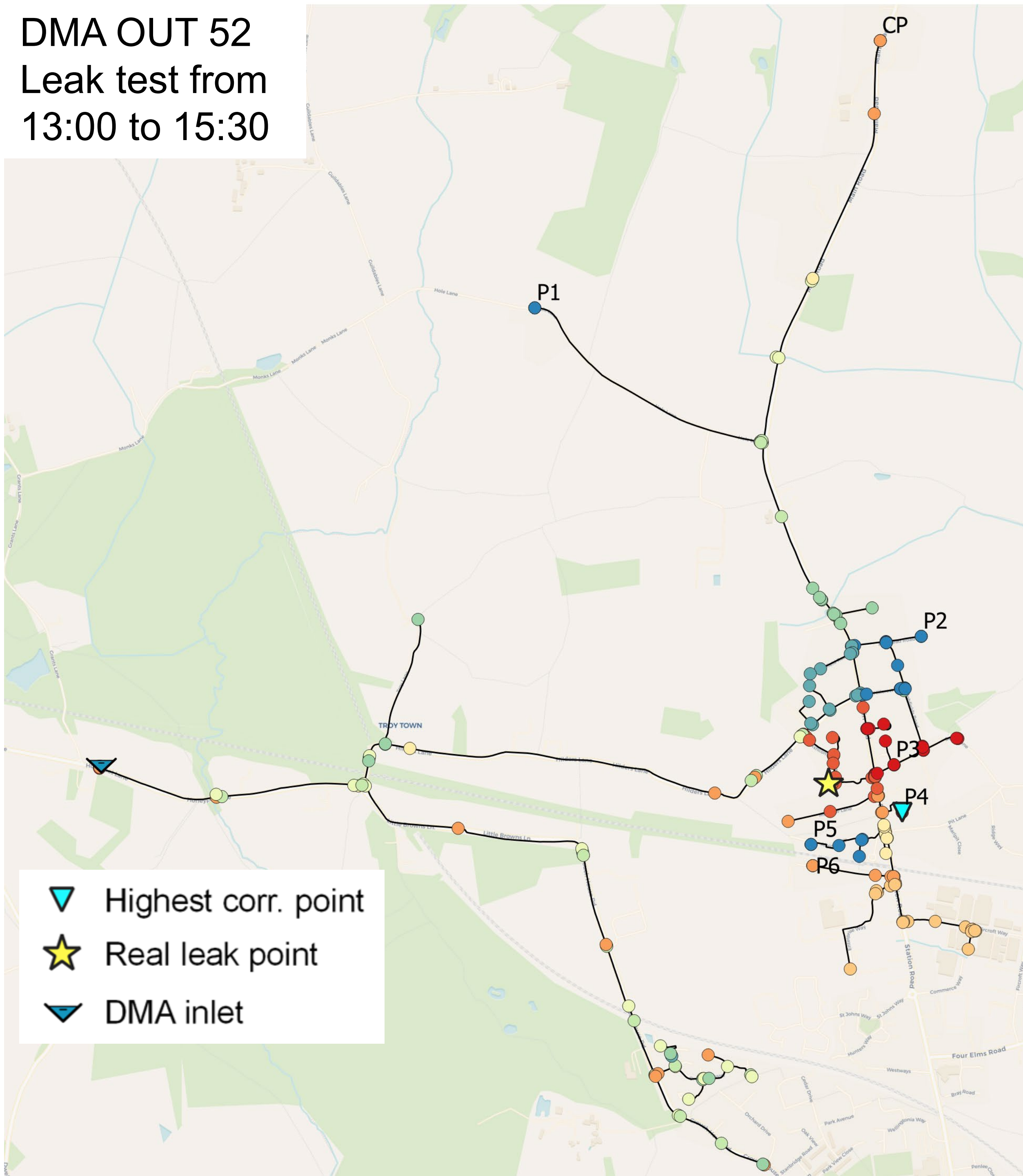
Results:

1. For most bursts (3 out of 5), less than 25% of the DMA would need to be searched
2. For every burst > 25% of average DMA demand, search area was reduced by at least 50%



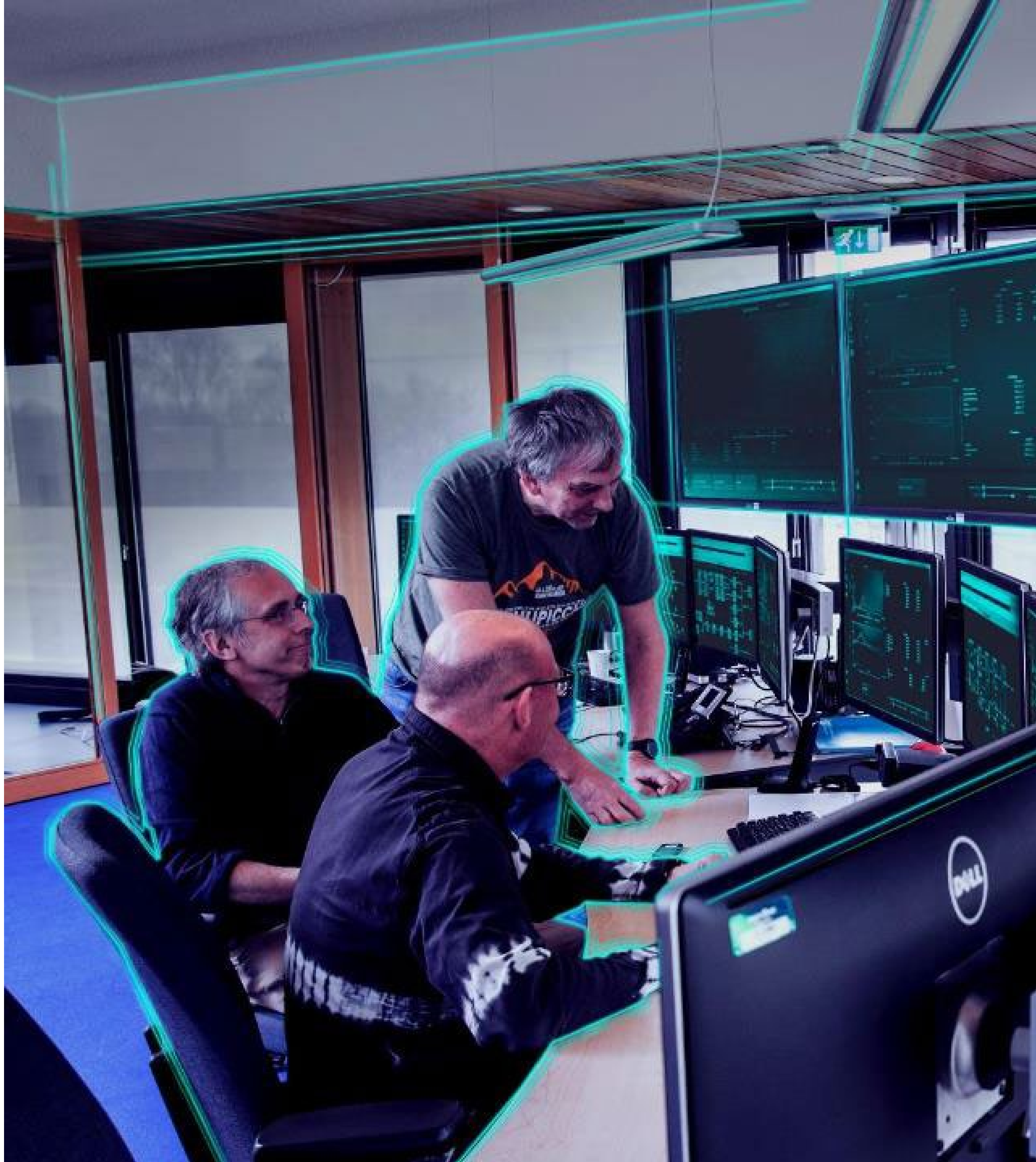
Results: challenges

1. Additional head loss due to leaks is small (ca. 0.2 mwc)
2. Uneven distribution of nodes

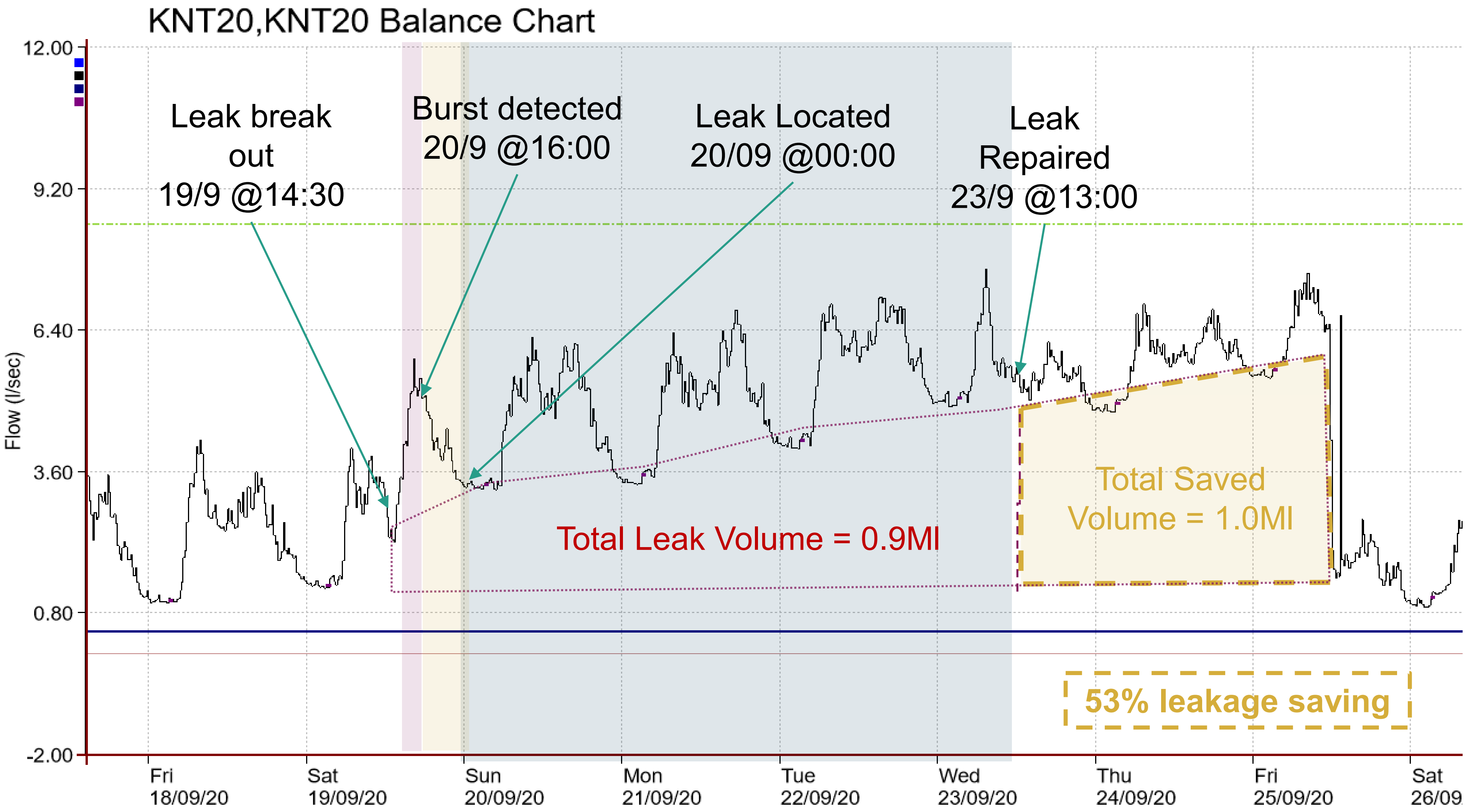


Leakage detection & localization benefits

1. 24/7 monitoring: leakage detection within 1 or 2 hours
2. Localization time typically reduced by >75 %
3. Reduced time, effort and non-revenue water
4. With only 5-8 additional sensors in DMA



KNT20 case if leakage detection and localization would have been applied



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