AI applications in the water industry: From isolated to integrated AI

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University of Exeter - UK
University of Belgrade - Serbia

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Bridging Science to Practice

University of Belgrade

University of Exeter


It works perfectly
Just not in the real world

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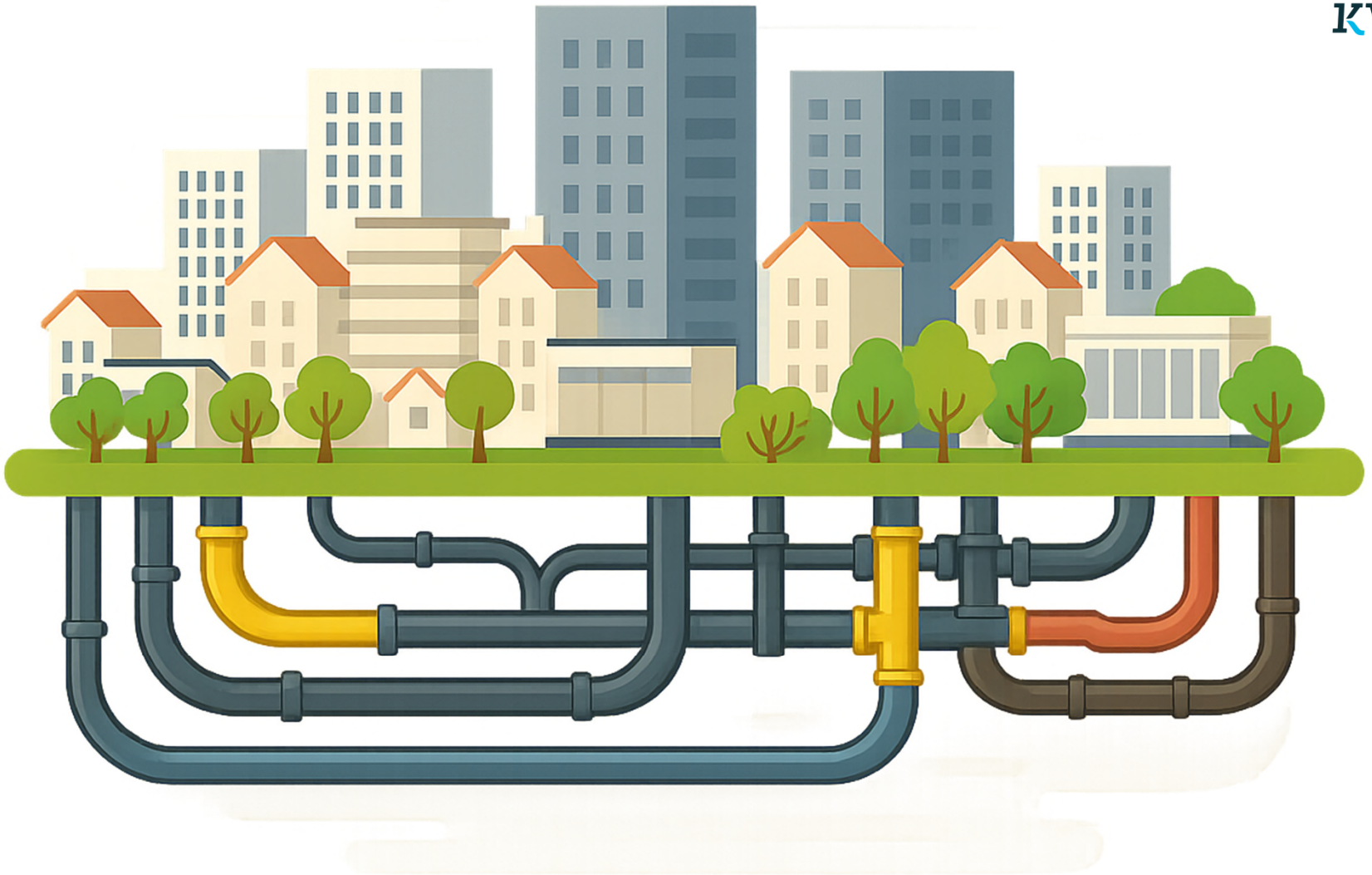
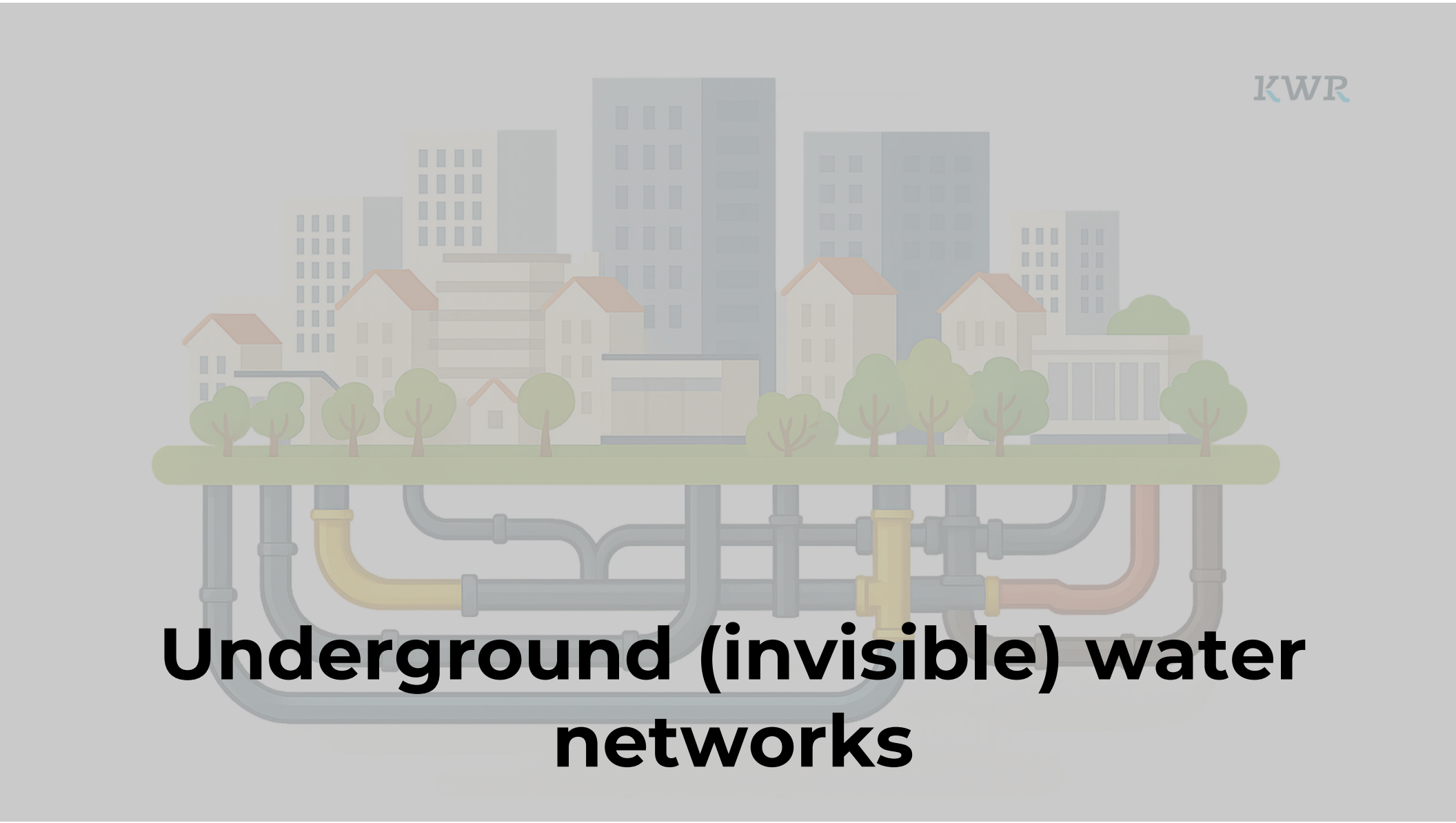
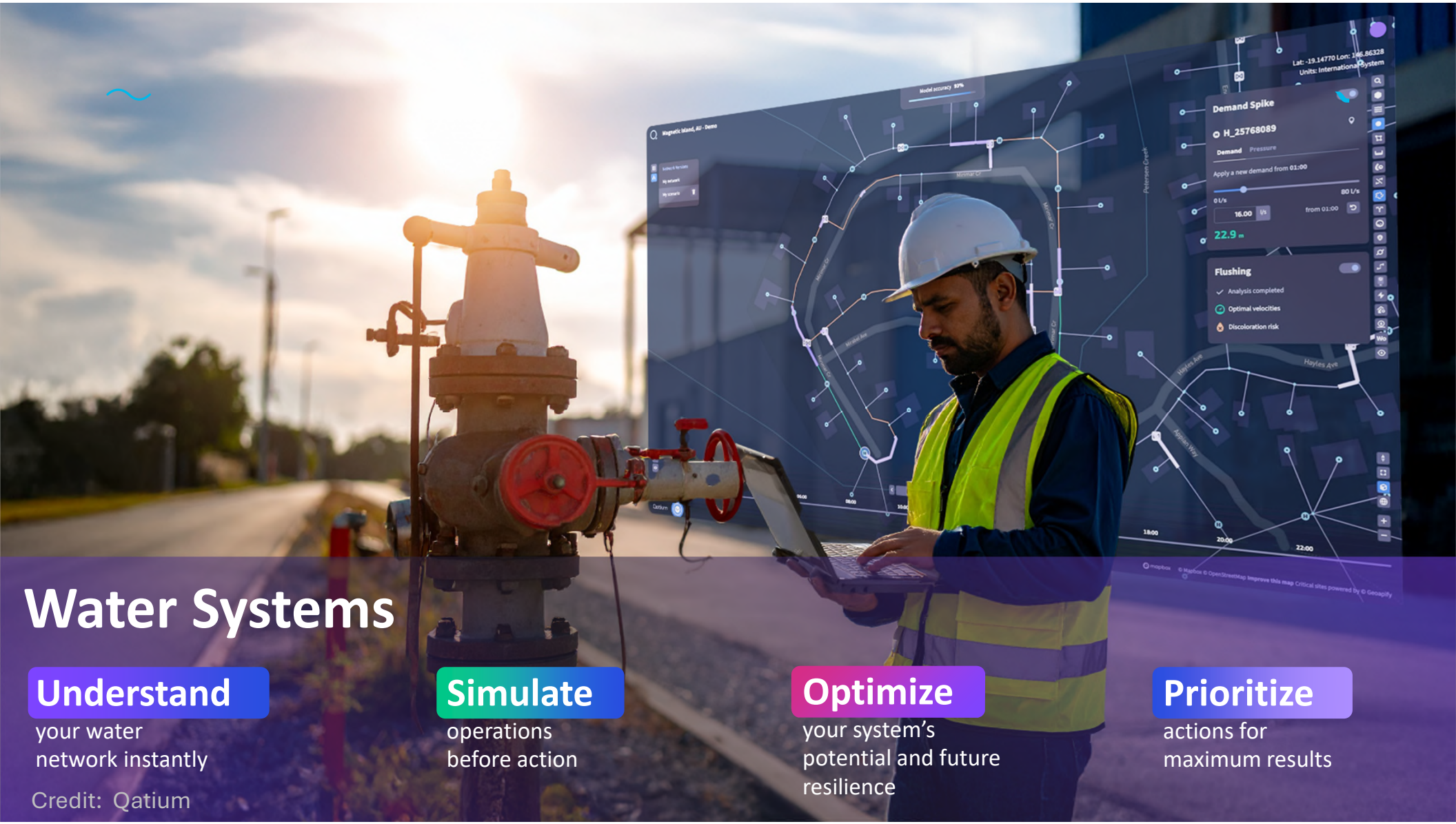




Underground (invisible) water networks



Water Systems

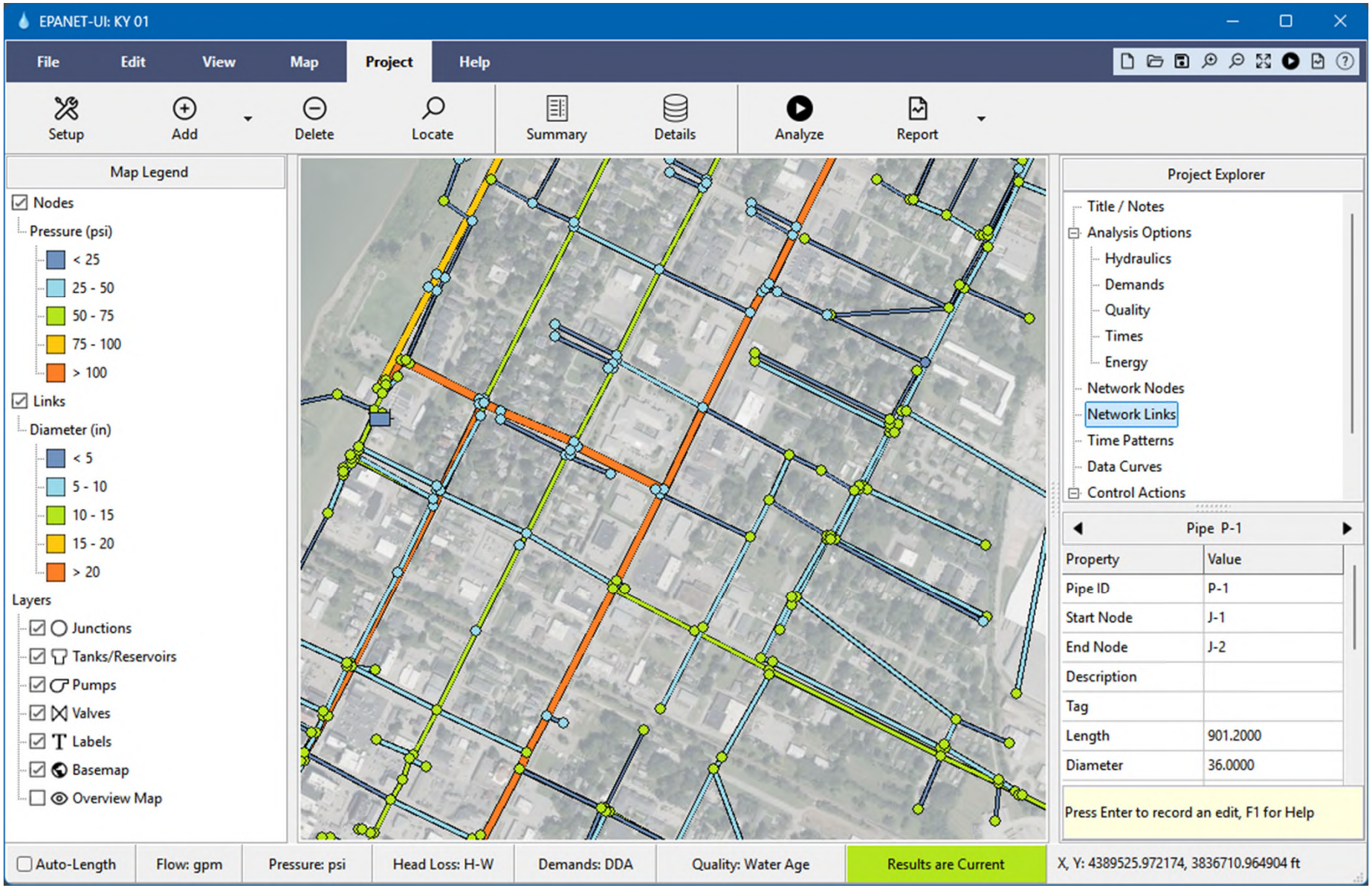
Understand your water network instantly

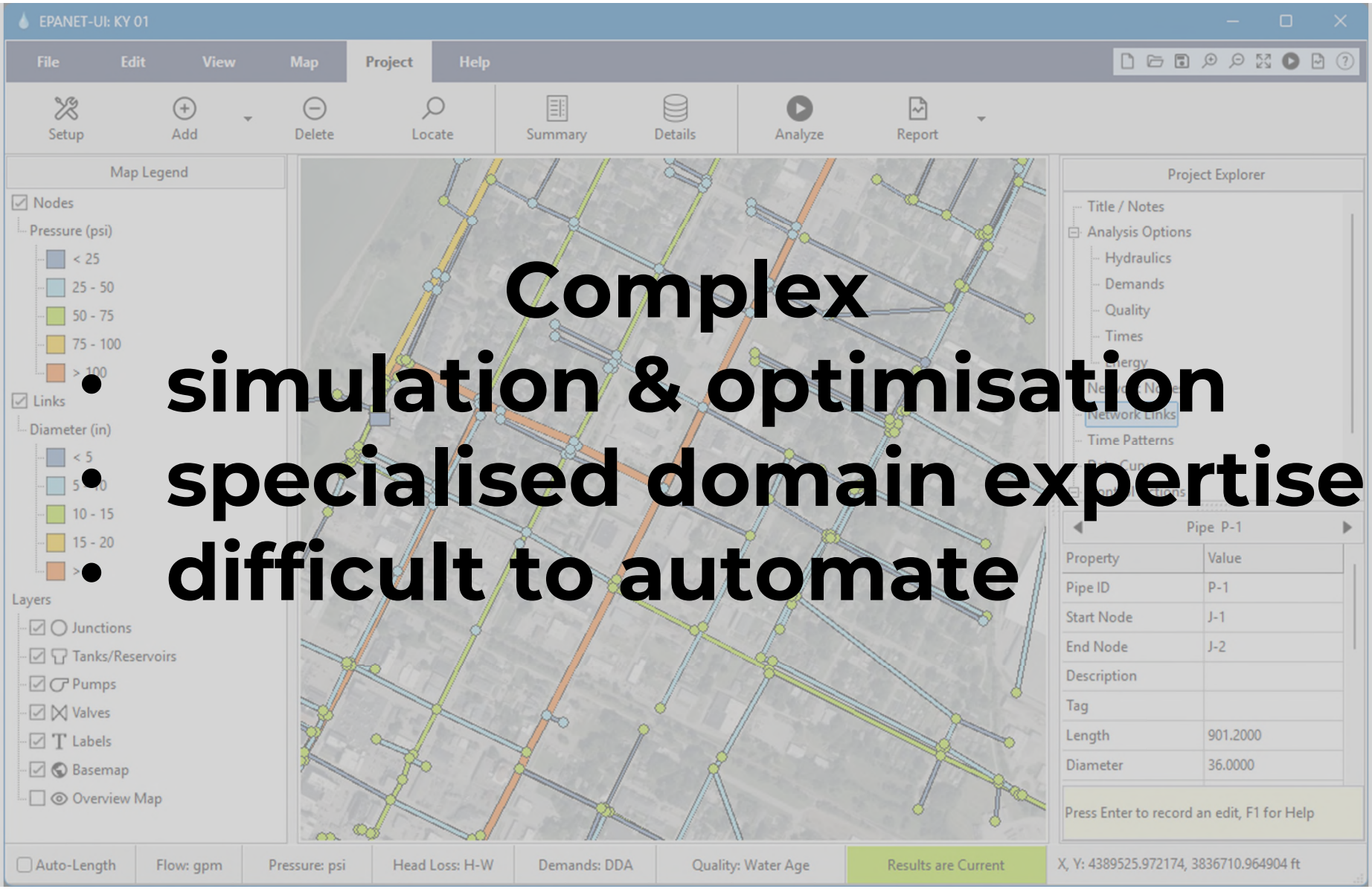
Simulate operations before action

Optimize your system's potential and future resilience

Prioritize actions for maximum results

Credit: Qatium


EPANET-UI: KY 01
File
Edit
View
Map
Project
Help
Setup
Add
Delete
Locate
Summary
Details
Analyze
Report
Map Legend
Nodes
Pressure (psi)
< 25
25 - 50
50 - 75
75 - 100
> 100
Links
Diameter (in)
< 5
5 - 10
10 - 15
15 - 20
> 20
Layers
Junctions
Tanks/Reservoirs
Pumps
Valves
Labels
Basemap
Overview Map
Project Explorer
Title / Notes
Analysis Options
Hydraulics
Demands
Quality
Times
Energy
Network Nodes
Network Links
Time Patterns
Data Curves
Control Actions
Pipe P-1
Property
Value
Pipe ID
P-1
Start Node
J-1
End Node
J-2
Description
Tag
Length
901.2000
Diameter
36.0000
Press Enter to record an edit, F1 for Help
Auto-Length
Flow: gpm
Pressure: psi
Head Loss: H-W
Demands: DDA
Quality: Water Age
Results are Current
X, Y: 4389525.972174, 3836710.964904 ft



Complex

- simulation & optimisation
- specialised domain expertise
- difficult to automate

The Predictive Era: How AI Learned to See, Predict and Decide

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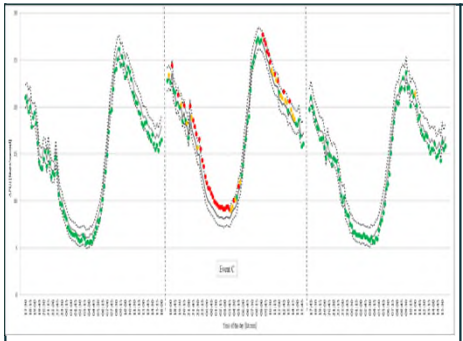
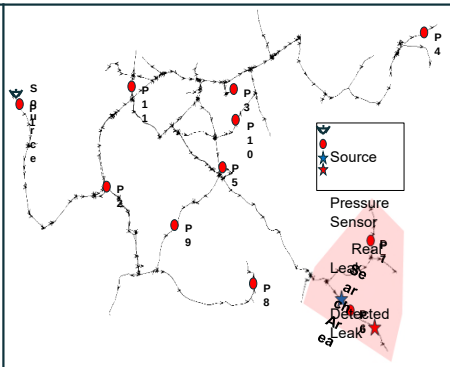
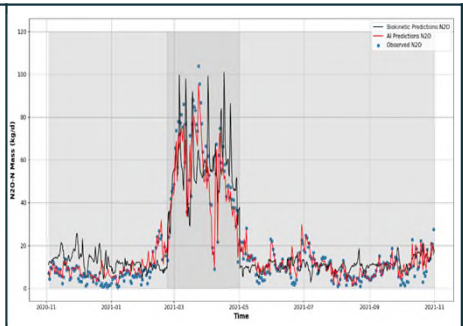


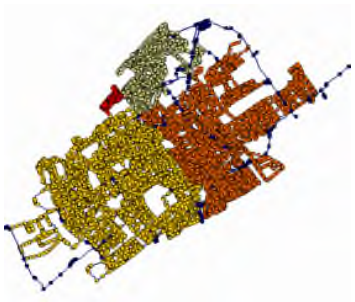
Leakage detection



Leakage localisation



N_2O prediction

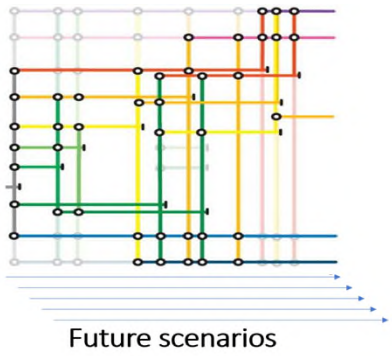


DMA design

Network strengthening

Rainfall intensity from image recognition

Super fast flood simulation



DM under deep uncertainty

The Generative AI Era

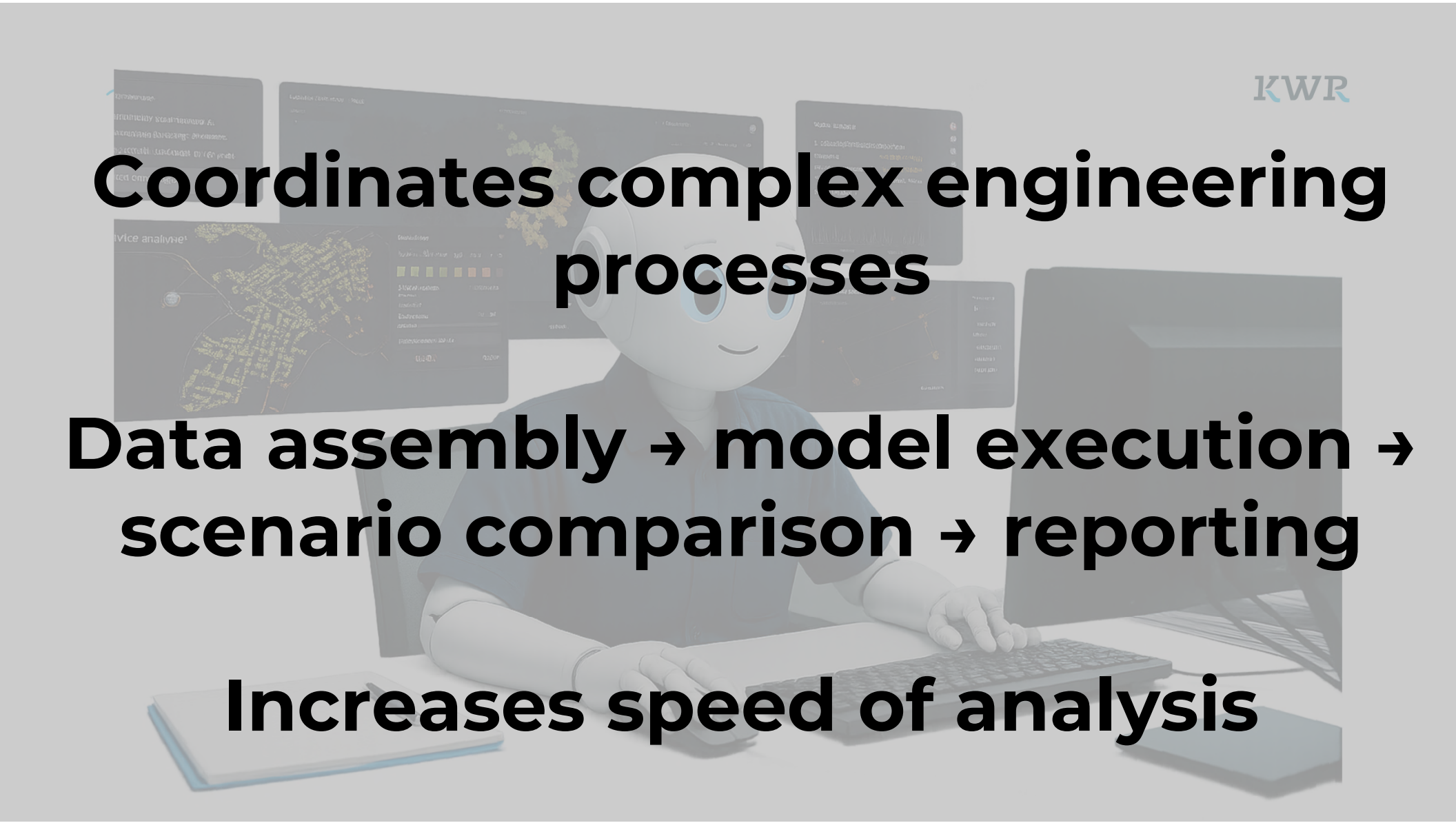
Can AI Agents help with automation?

AI Agent:
a smart digital helper that

observes
“thinks”
acts

AI Agent:
smart digital helper

Learns from data
Adapts to new situations
Makes decisions on its own



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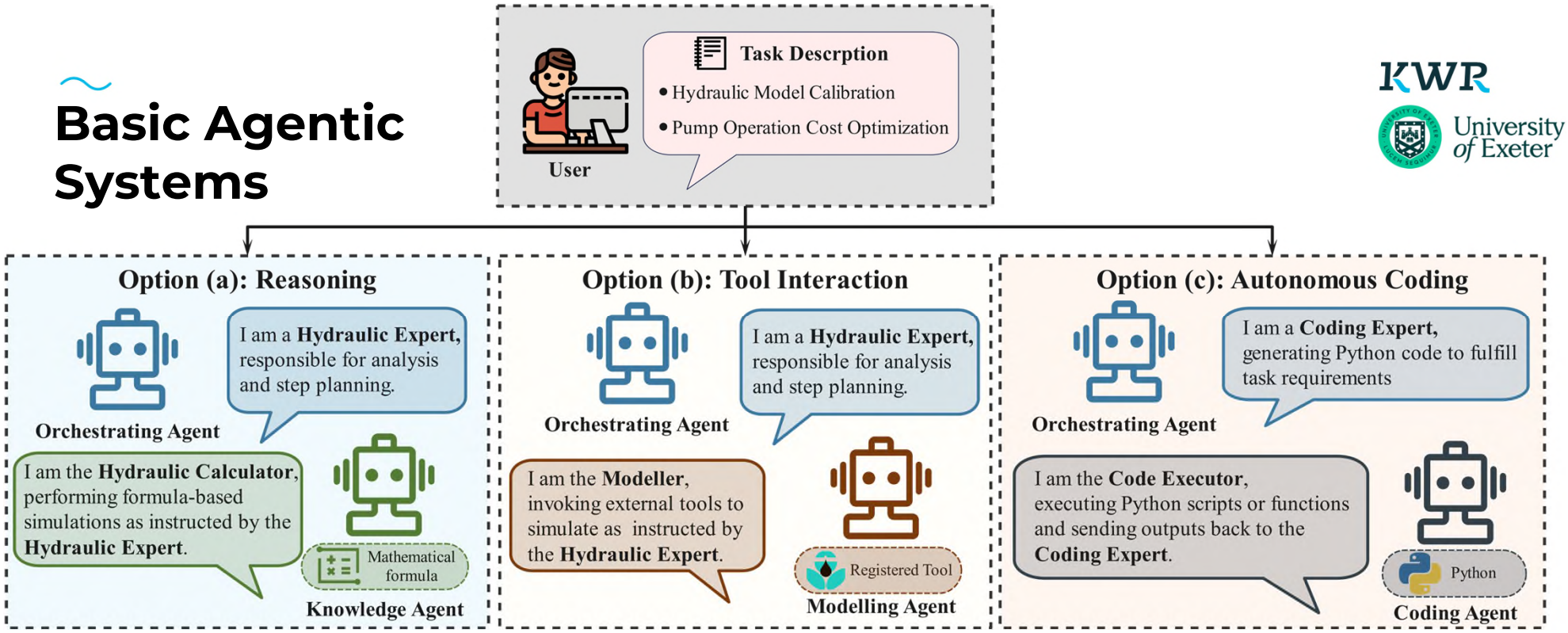
Coordinates complex engineering processes

Data assembly → model execution → scenario comparison → reporting

Increases speed of analysis

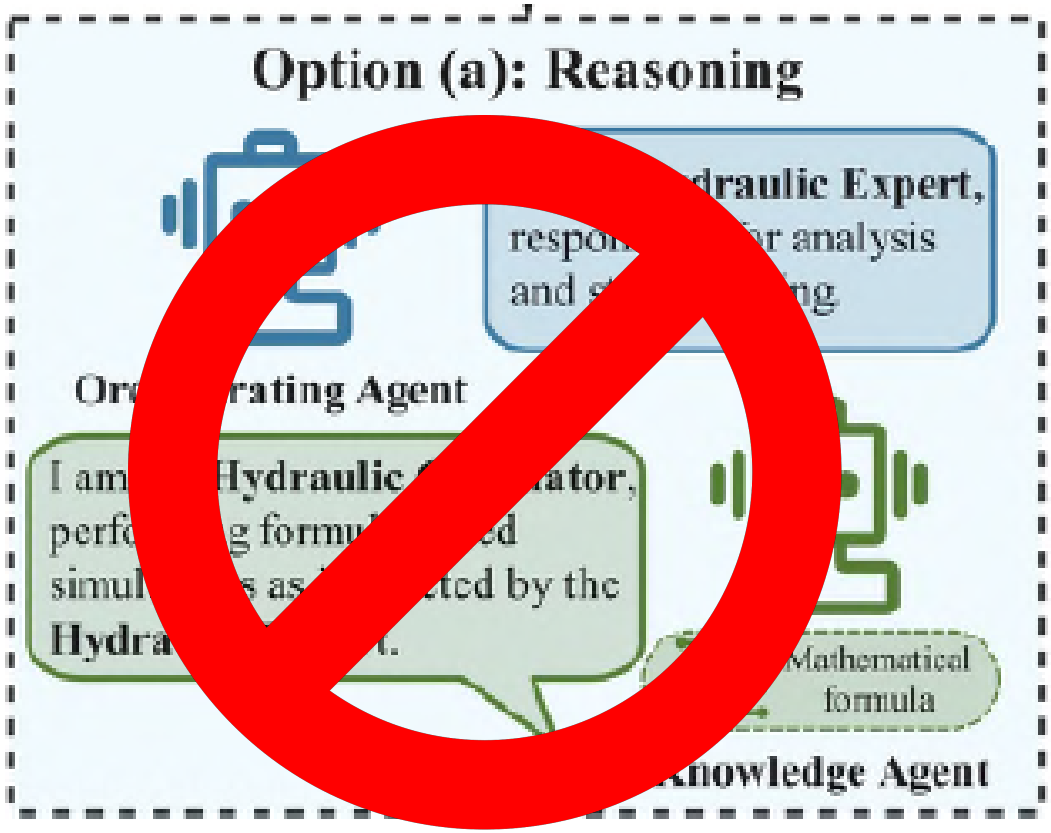
Basic Agentic Systems



Three separate modes

Wang, J., Fu, G. and Savic, D., 2025. Leveraging large language models for automating water distribution network optimization. *Water Research*, p.124536.

Basic Agentic Systems



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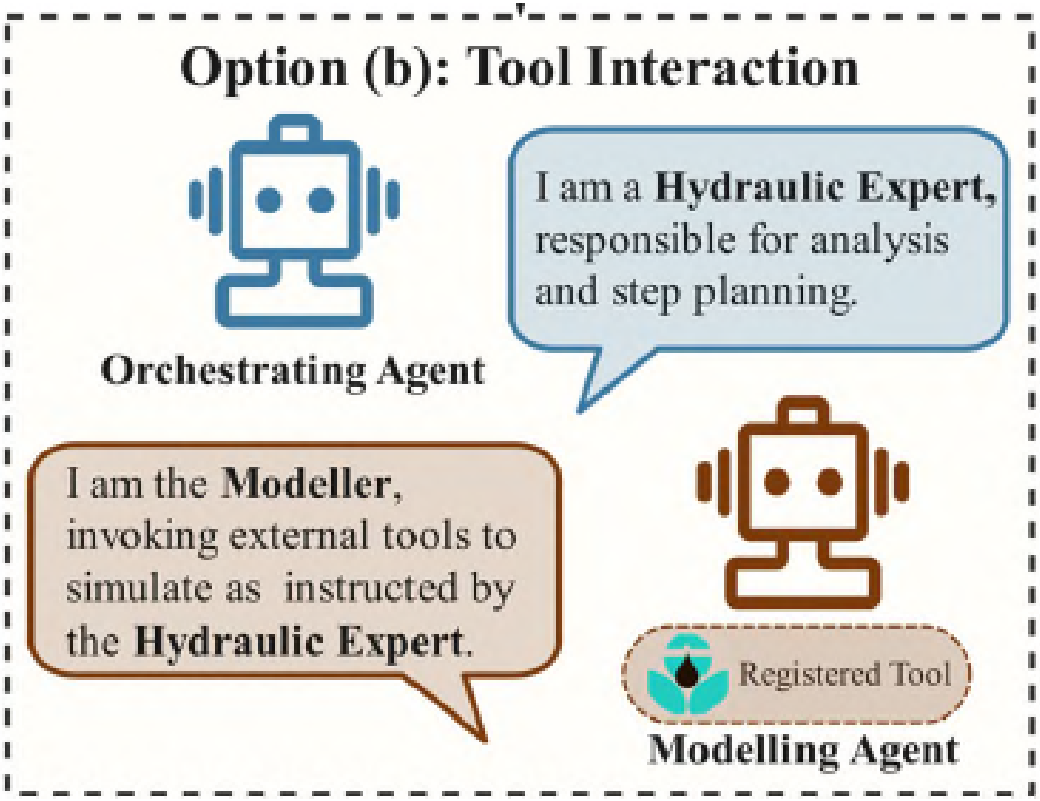
Basic Agentic Systems



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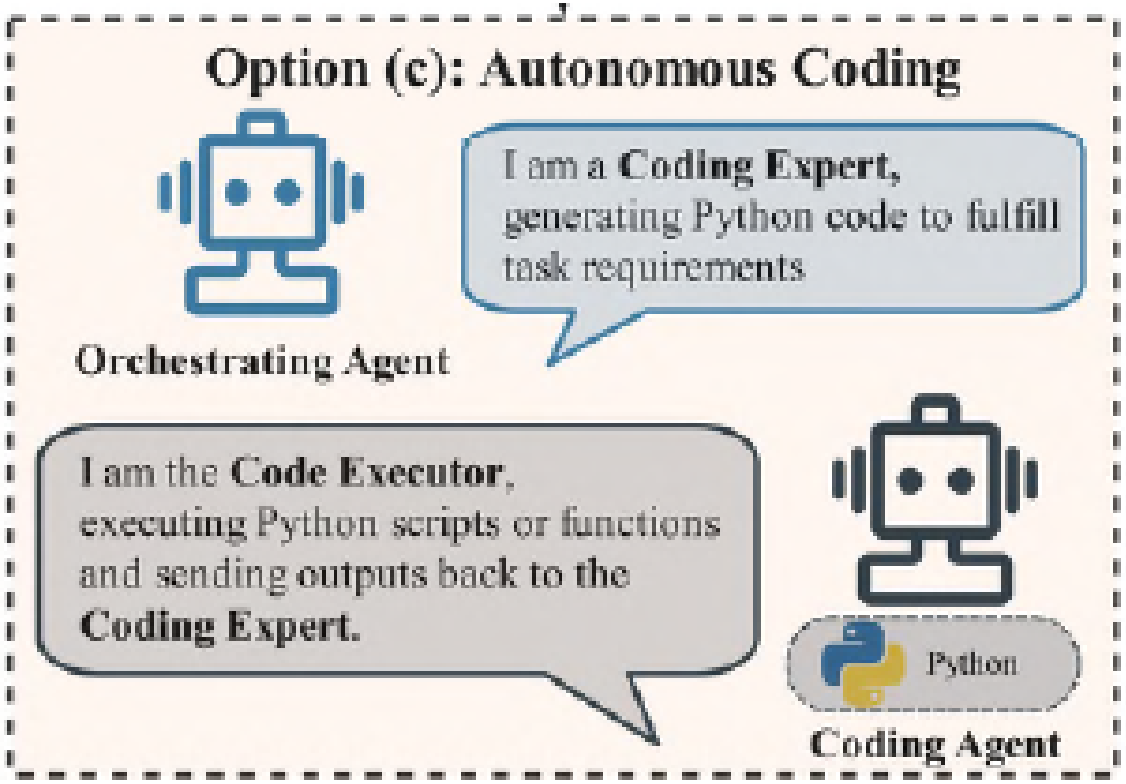
Basic Agentic Systems



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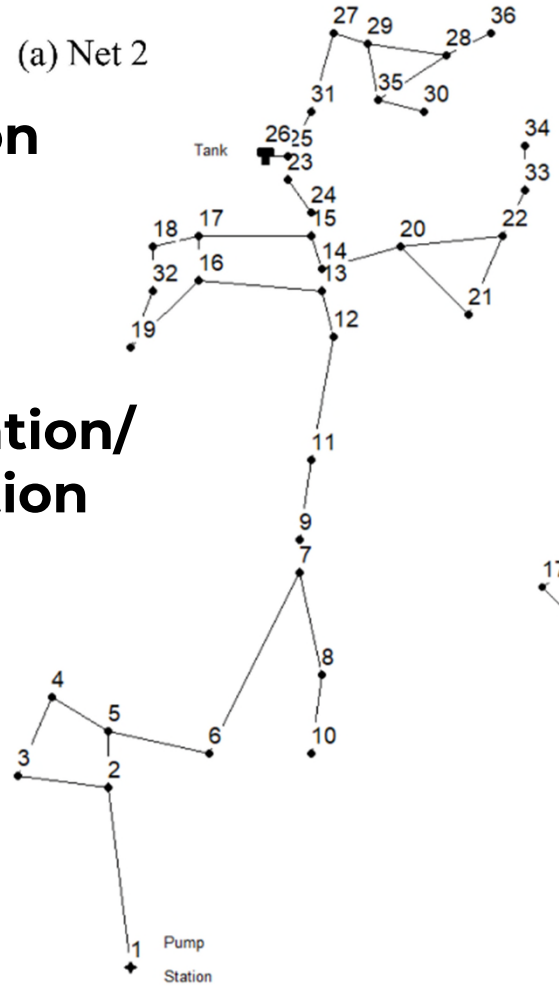
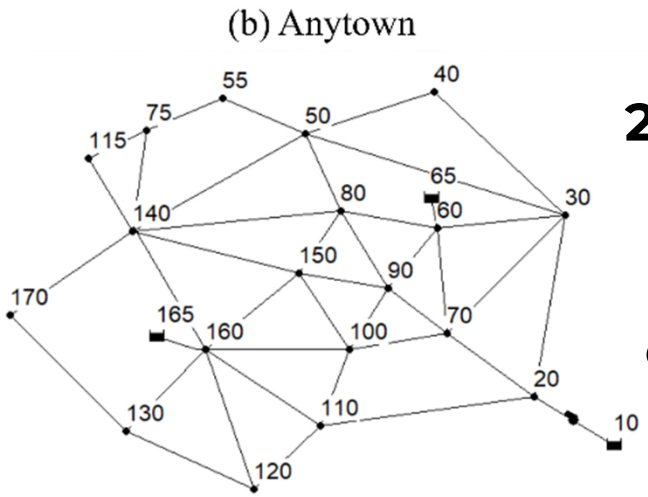
Water Distribution Systems





1. Calibration/ Validation

2. Calibration/ Validation

3. Pump optimisation

Wang, J., Fu, G. and Savic, D., 2025. Leveraging large language models for automating water distribution network optimization. *Water Research*, p.124536.

WDS Results (5 AI Agents)

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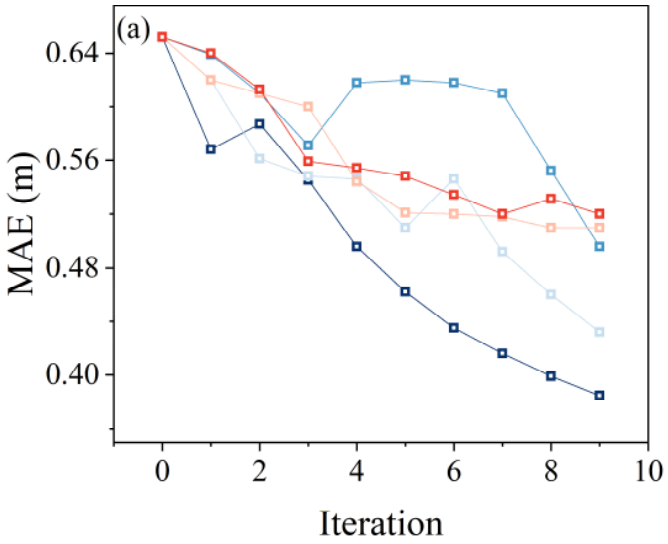
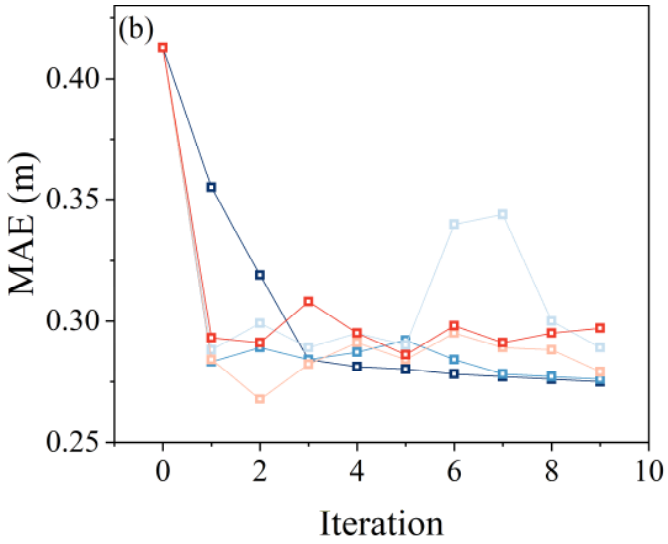
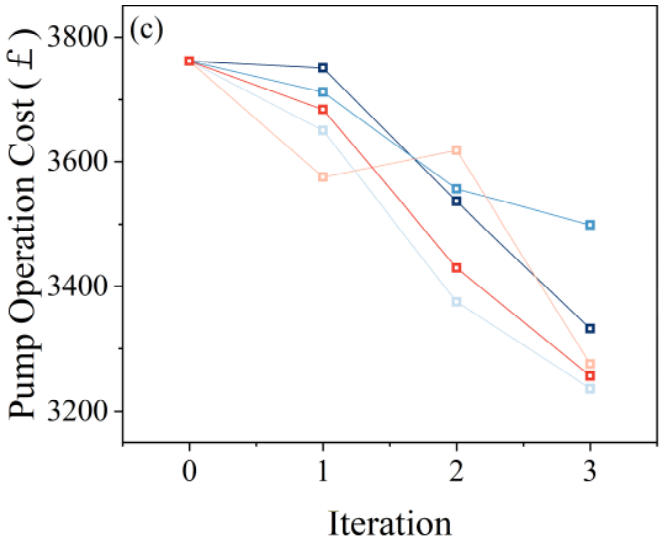
Net2 Calibration



Anytown Calibration



Anytown Pump Scheduling



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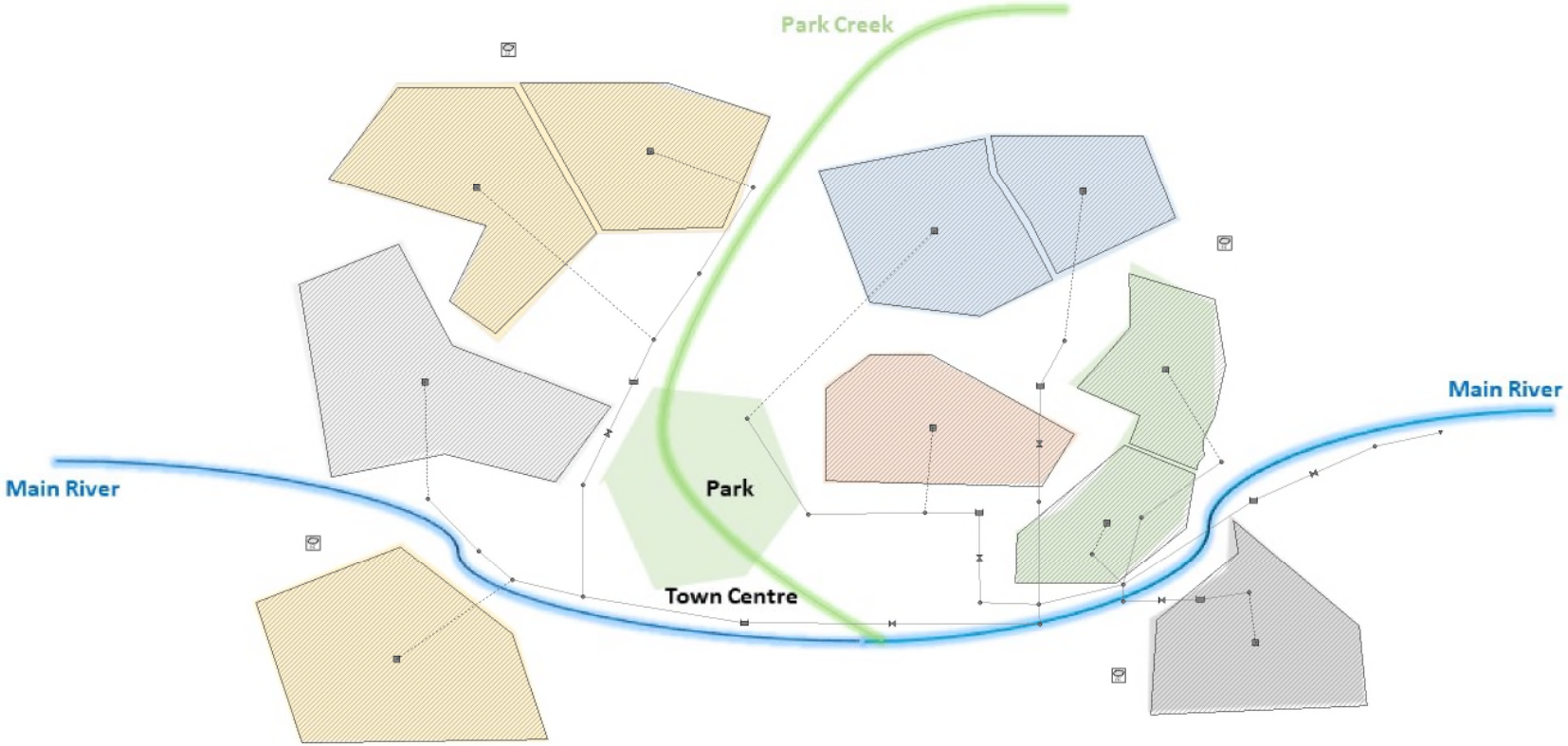
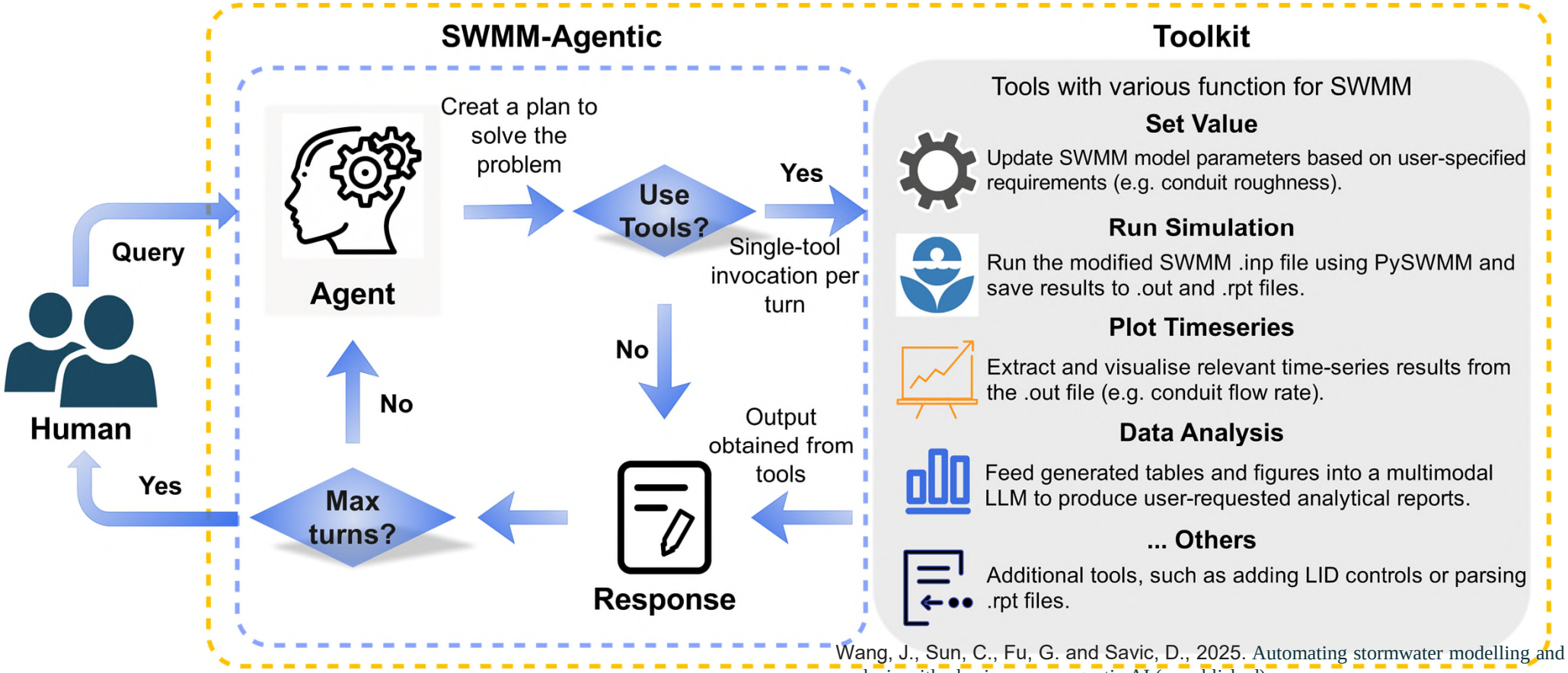
Urban Drainage Systems



Astlingen benchmark network

Wang, J., Sun, C., Fu, G. and Savic, D., 2025. Automating stormwater modelling and analysis with physics-aware agentic AI (unpublished)

More Advance Agentic Systems



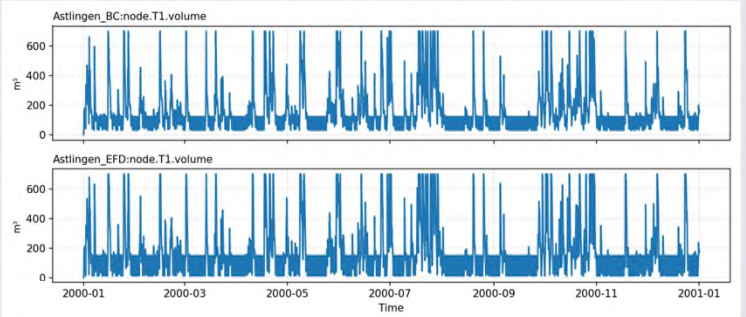
Wang, J., Sun, C., Fu, G. and Savic, D., 2025. Automating stormwater modelling and analysis with physics-aware agentic AI (unpublished)

Results

(a) Question: For the Astlingen drainage network, there are currently two orifice control strategies: (1) BC: The following rule-based logic is already embedded in the **{original .inp file}**; (2) EFD: Provided in the file **{.txt path}**
Please follow the steps below to carry out the analysis:
Step 1: Run the simulation using the original .inp file.
Step 2: Modify the orifice control strategy to EFD and run the simulation again.
Step 3: Extract the following data and generate comparison plots (6 comparison figures total):
- **(a) Total Inflow at outlet node Out_to_WWTP**
- **(b) Depth at outlet node Out_to_WWTP**
- **(c) Volume at outlet storage unit T1**
- **(d) Discharging at storage units T1**
- **(e) Flow in conduit C23 (inlet to storage unit T1)**
- **(f) Capacity in conduit C23**

Step 4: Analyse the generated figures and creat a concise comparative report to compare double control strategies to support decision-making.

(b) One of the Graphical Outputs Generated by the SWMM-Agentic: Volume at the Storage Unit T1



Multi-Modal Analysis of this Figure: EFD enhances T1's utilization by increasing total volume released, suggesting more responsive and prolonged use of storage capacity during events.

(c) Compact Results

Storage Unit	Strategy	Discharging Duration (hours)	Total Discharging Volume (10^6 L)	Avg Fill Percentage
T1	BC	102.1	79.46	23.6%
T1	EFD	241.04	99.72	25.1%

Metric	BC Strategy	EFD Strategy	Change
Total Volume to WWTP (10^6 L)	3736.96	3754.61	+0.5%
Total System Discharging Volume (10^6 L)	264.72	247.79	-6.4%

(d) Interpretation

The EFD control strategy provides better distributed storage management than the BC rule, while keeping outlet hydraulics almost unchanged (similar peak flow and total volume at the WWTP outlet).

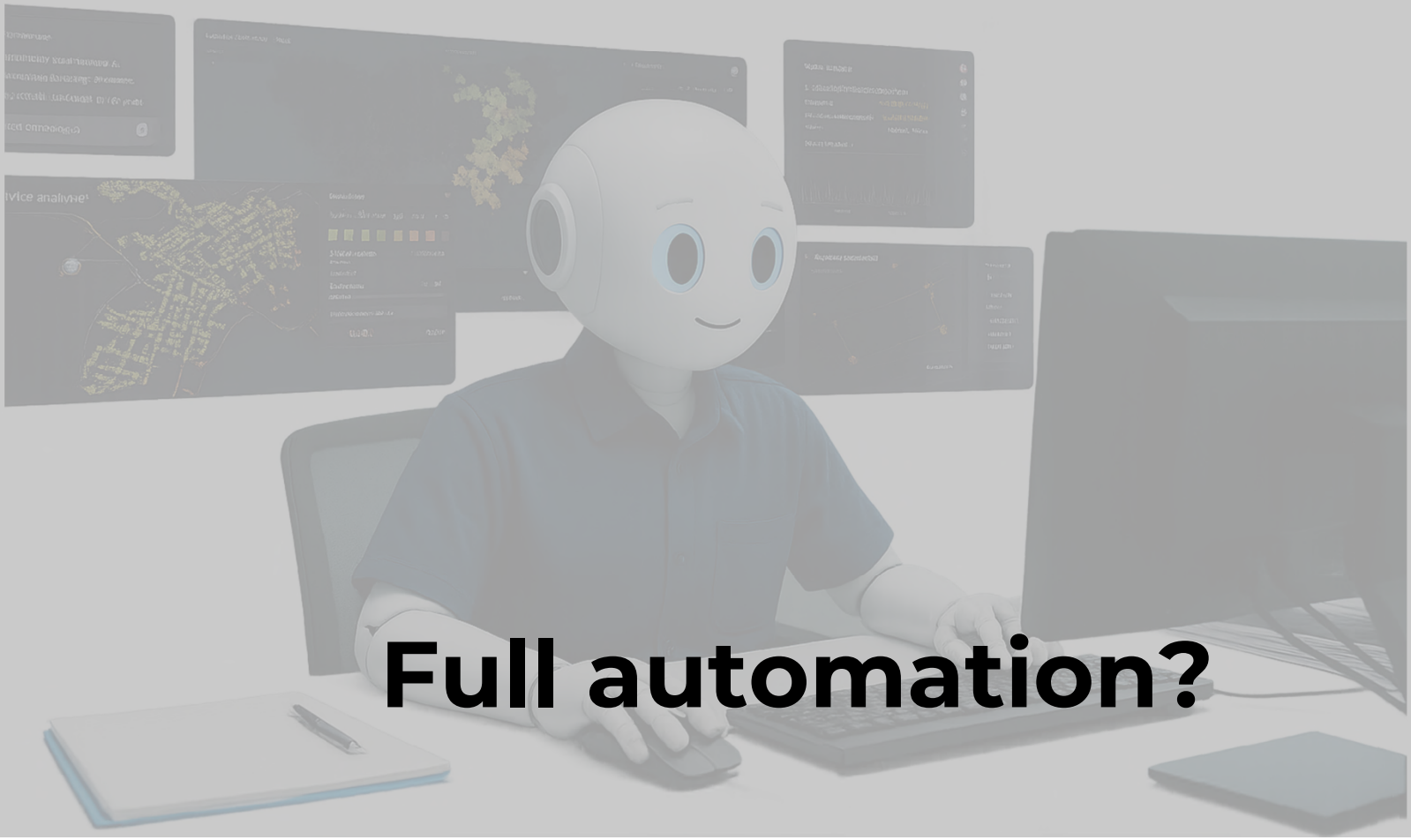
1. Storage use: EFD increases T1's active role so that it acts as a stronger flow attenuator, while the overall system discharging volume is reduced (≈6.4%).

2. Flow redistribution: Depth-based rules shift discharge away from upstream tanks (T2, T3, T4, T6) and make better use of centrally located T1, giving a more balanced storage pattern across the network.

3. Operation: EFD offers dynamic response to tank levels, priority-based opening for high-depth tanks and conservative openings for low-depth tanks, which improves synchronisation between storage units.

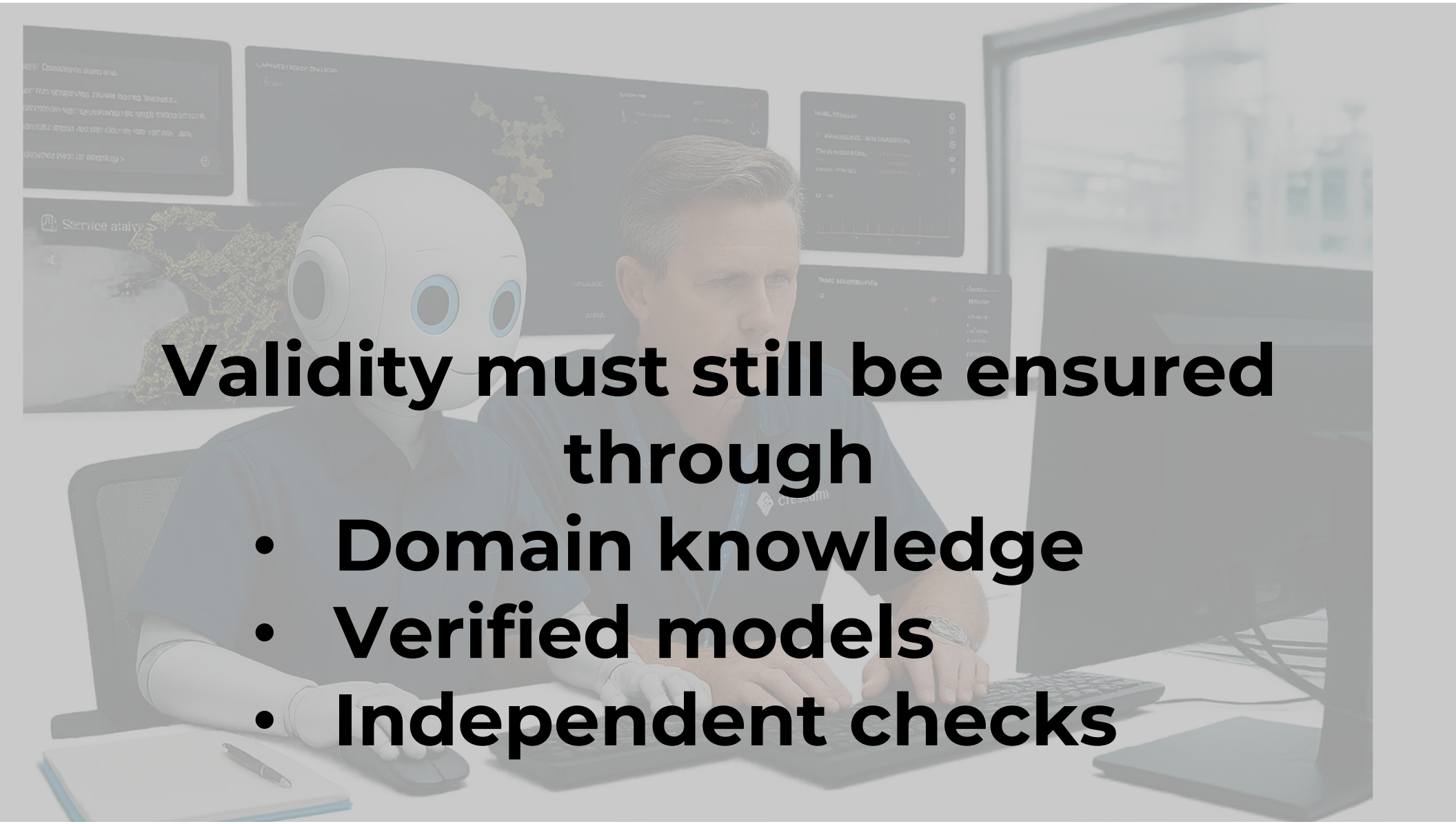
Overall, EFD is the preferred strategy, as it reduces total system discharging volume, balances storage utilisation and enhances attenuation, without increasing downstream hydraulic stress.

Wang, J., Sun, C., Fu, G. and Savic, D., 2025. Automating stormwater modelling and analysis with physics-aware agentic AI (unpublished)



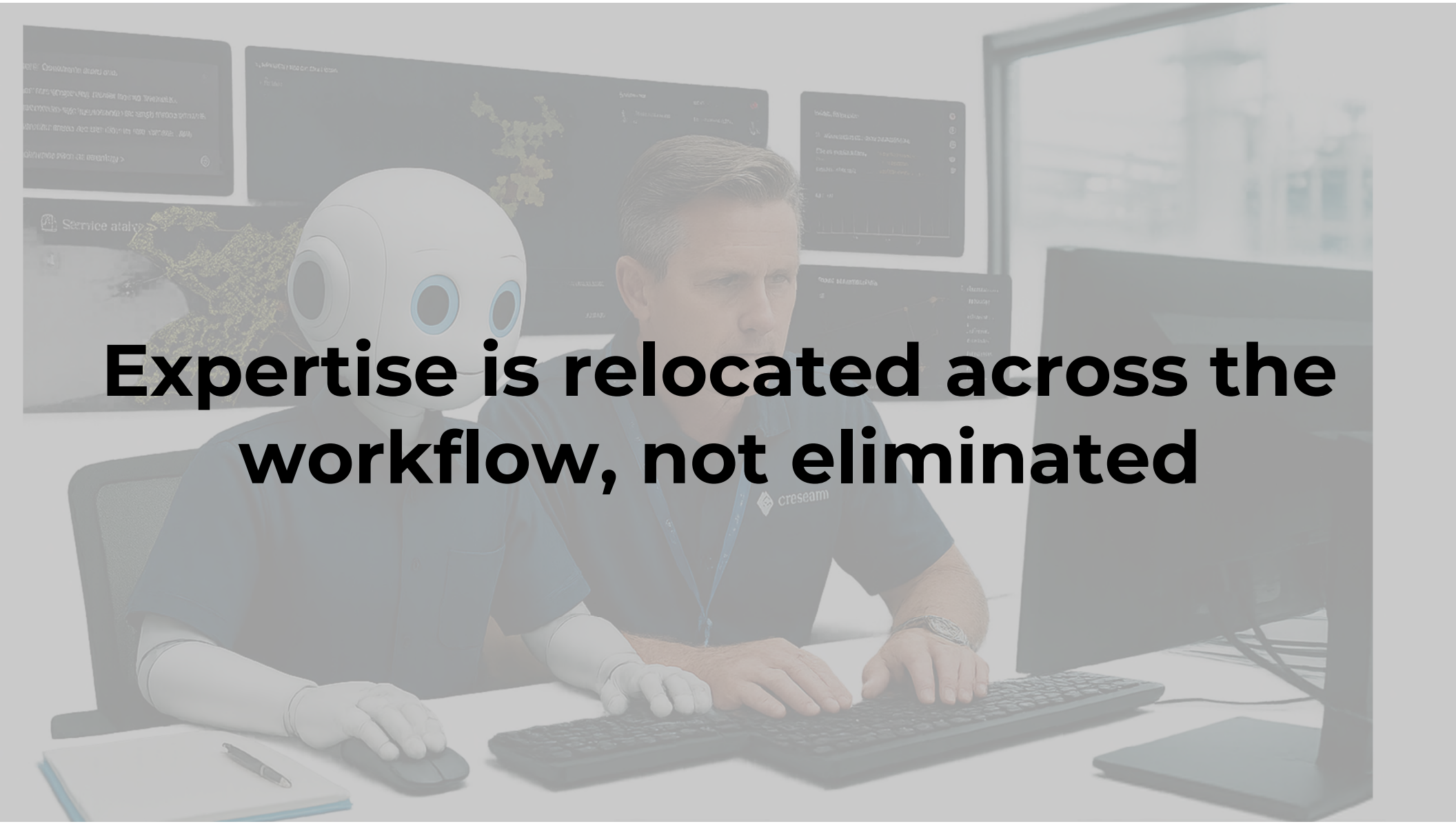
Full automation?

Collaboration, not replacement!

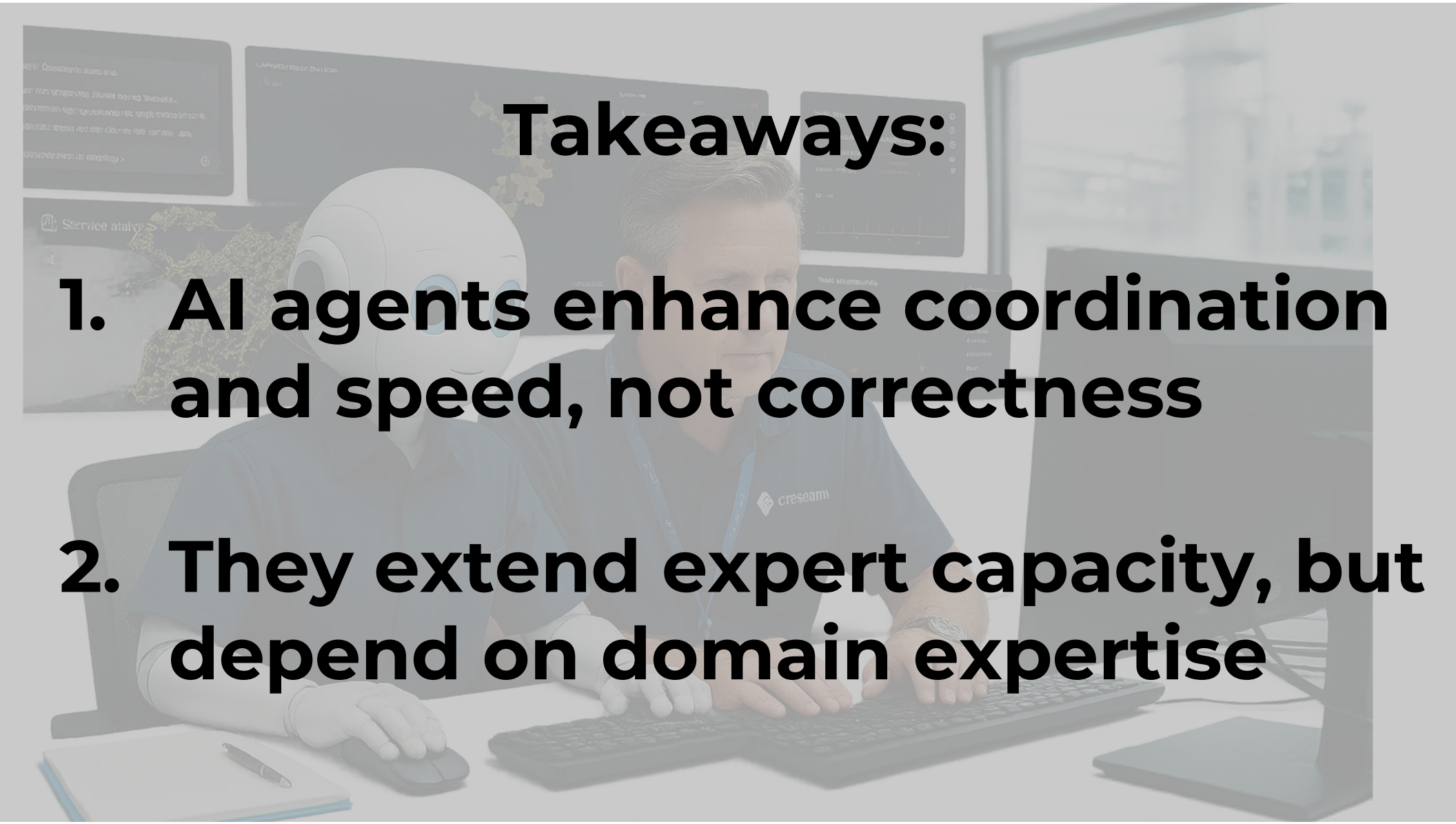


Validity must still be ensured through

- **Domain knowledge**
- **Verified models**
- **Independent checks**



Expertise is relocated across the workflow, not eliminated



Takeaways:

1. AI agents enhance coordination and speed, not correctness

2. They extend expert capacity, but depend on domain expertise

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AI in water management:

- **Human-verified validity**
- **Expanded capacity, unchanged responsibility**

Thank you!