A toolbox for designing Blue Green Solutions

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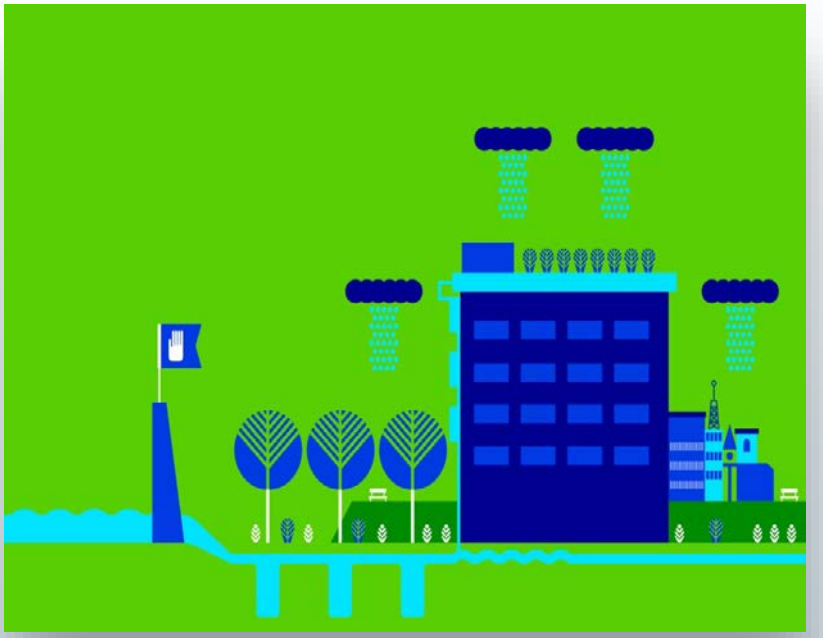
The aim: the BlueGreen City Vision

Smarter and more system-oriented approaches needed

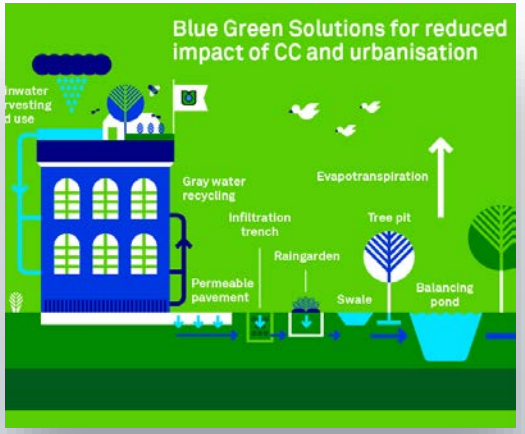
- We need to make cities (and their infrastructure) **smarter**, more **efficient** (water and energy), more **proactive** (leakage/bursts/demands), more **resilient** (failures, security), more **integrated** (blue-green infrastructure, closing the 3 flows, turning waste into resource).
- To do this we need to **think ahead**, **design more sustainable water cycles**, **supported by enabling new options (**from **hard engineering** to **nature based solutions).**



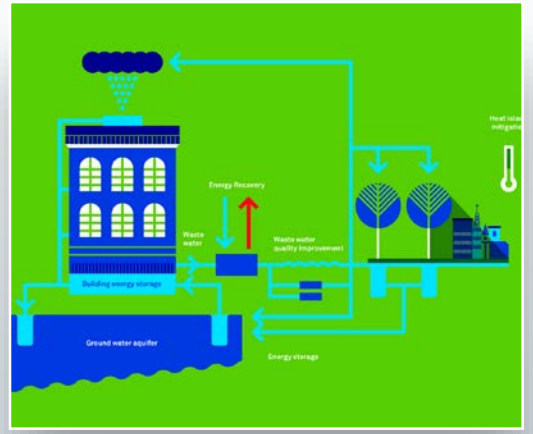
WATER, GREEN, ENERGY, TRANSPORT AND TELECOM **INFRASTRUCTURE** NEED TO BE BUILD TO **INTEGRATE** AND **BENEFIT** FROM EACH OTHER

What interventions are we thinking about?

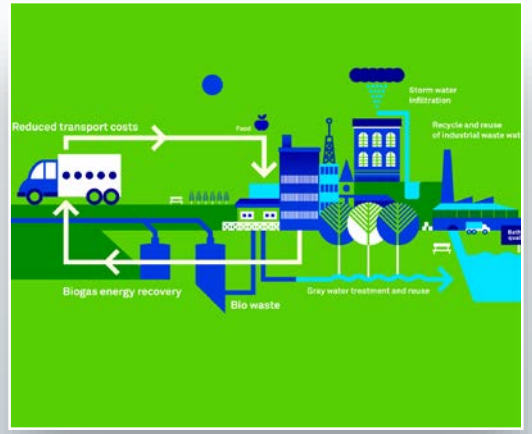
Blue green options/Nature based solutions



Integrate blue and green infrastructure to minimize flooding and increase ecosystem services



Exploit groundwater not only as source but also as water and energy reservoir

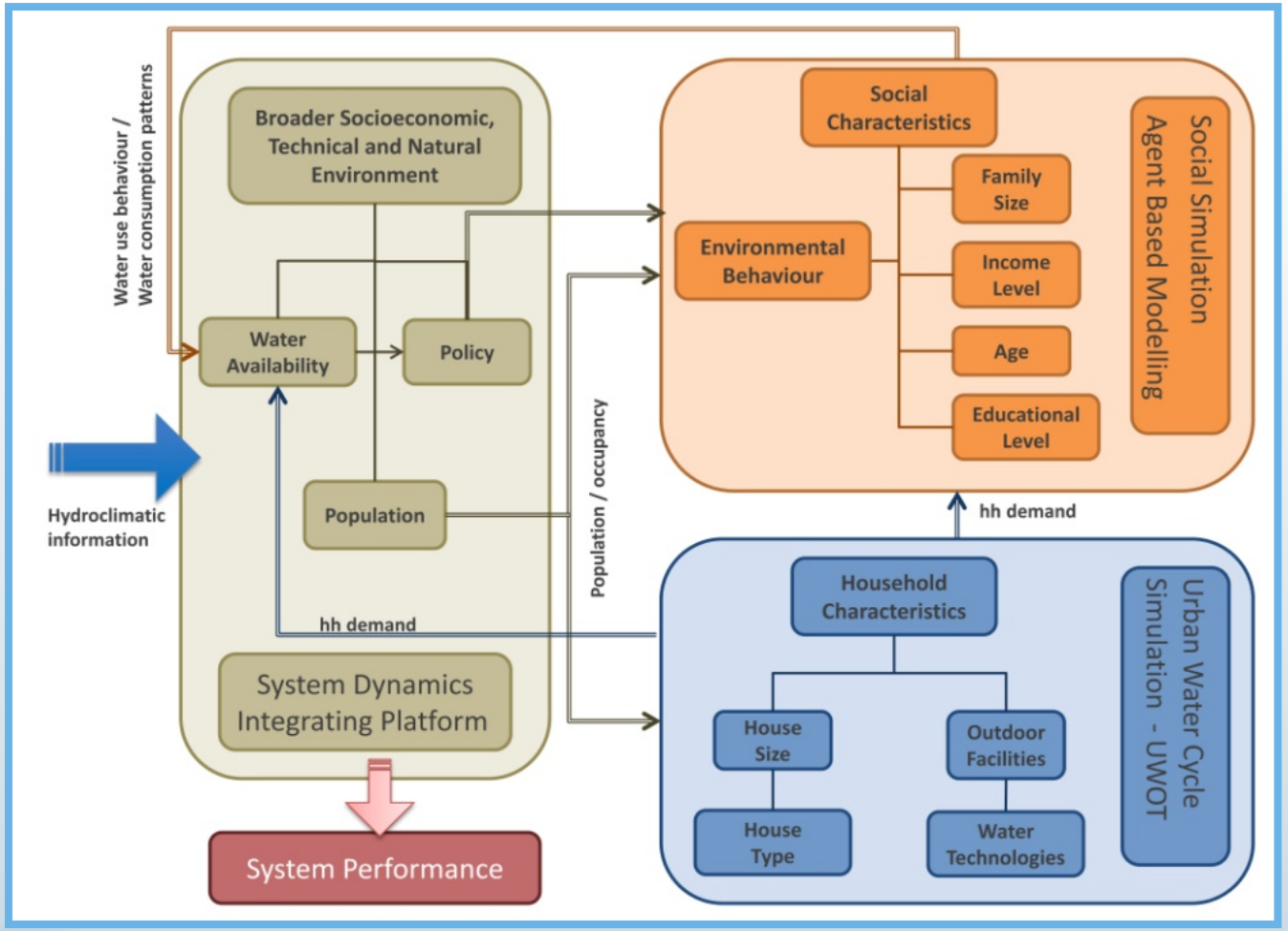


Turn waste into resources

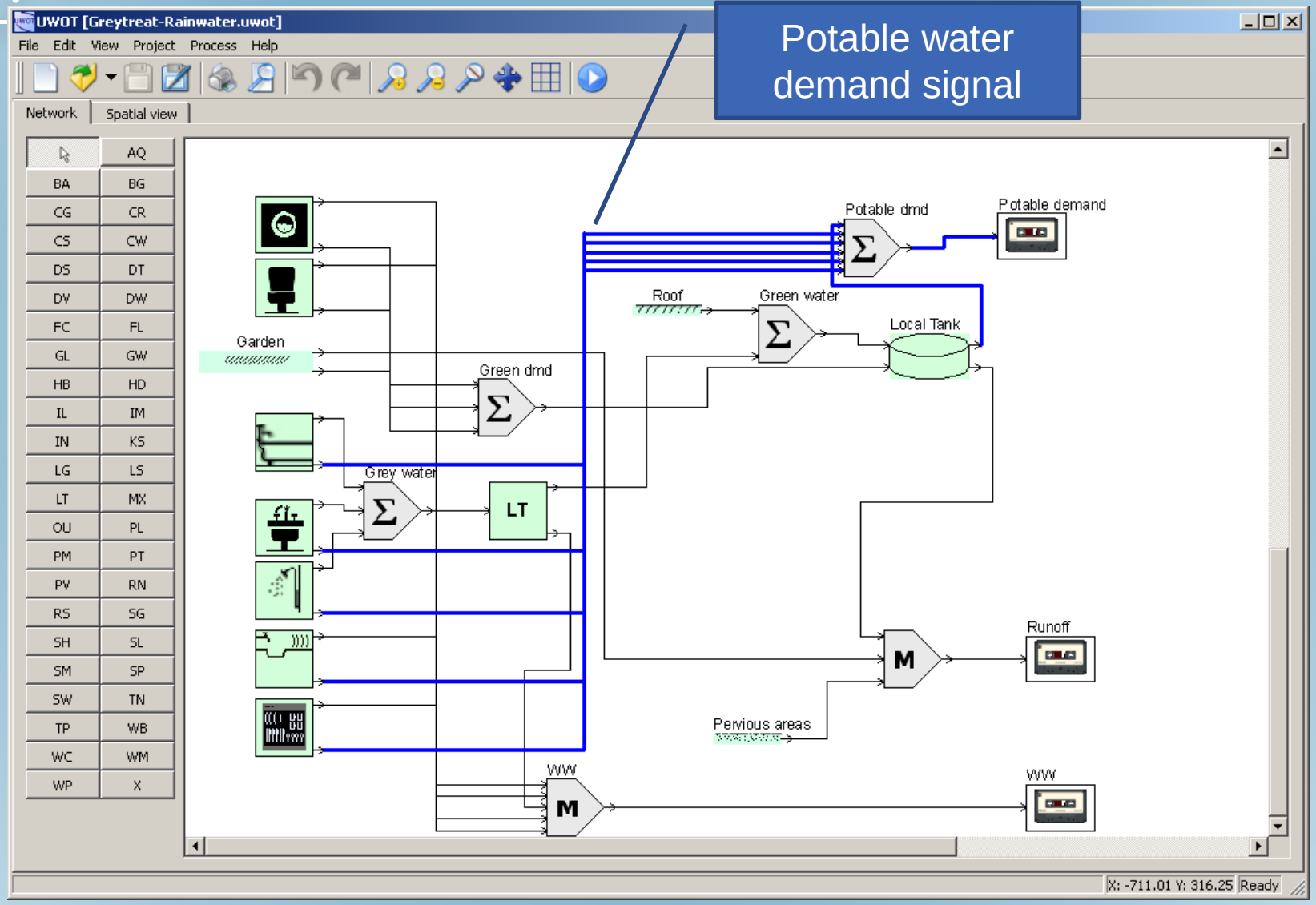
Do we have the tools to design these new more integrated approaches?

The UWM toolbox

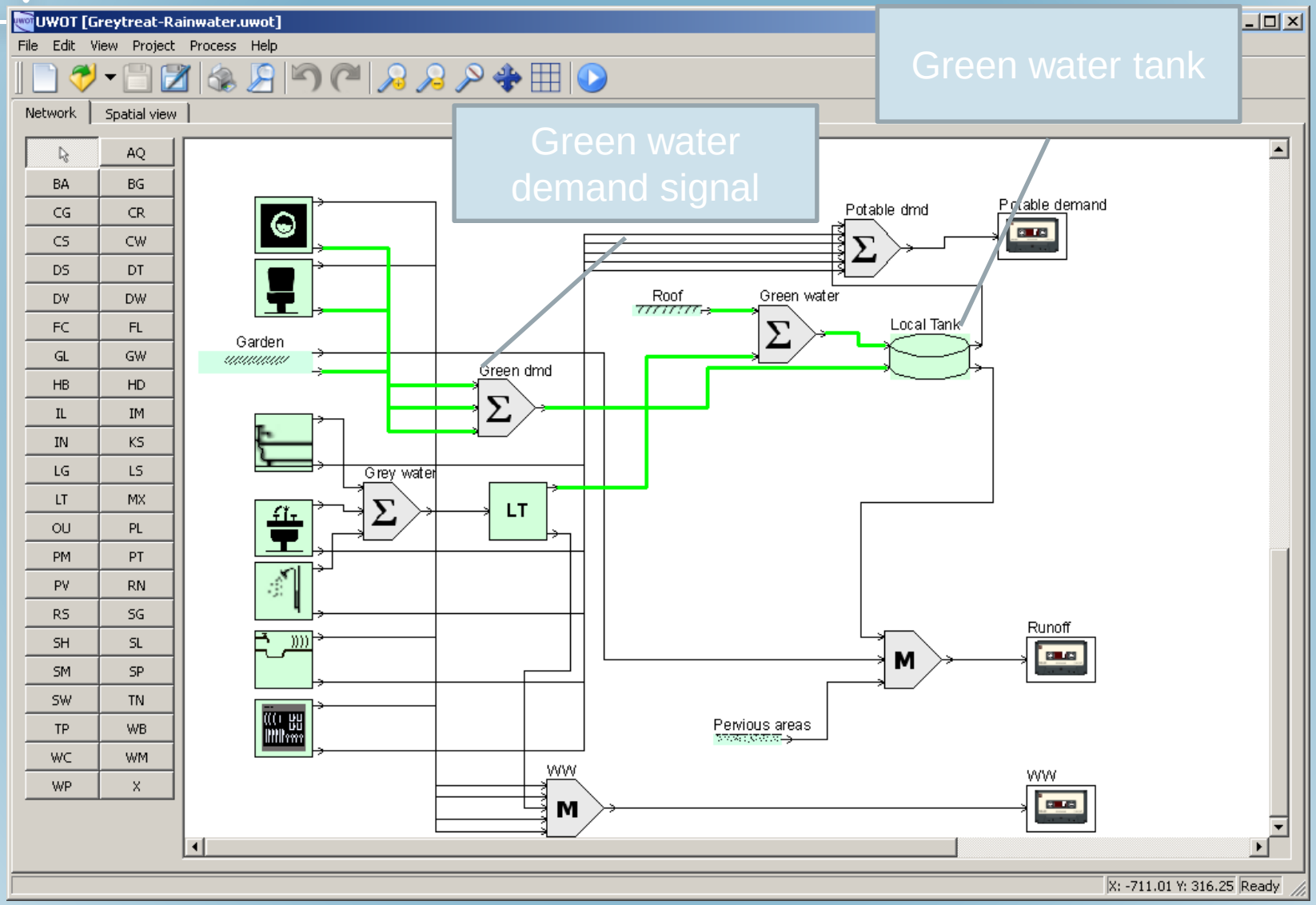
- The UW Optioneering Tool (**UWOT**)
- The UW Agent Based Modelling Platform (**UWABM**)
- The UW System Dynamic Environment (**UWSDE**)



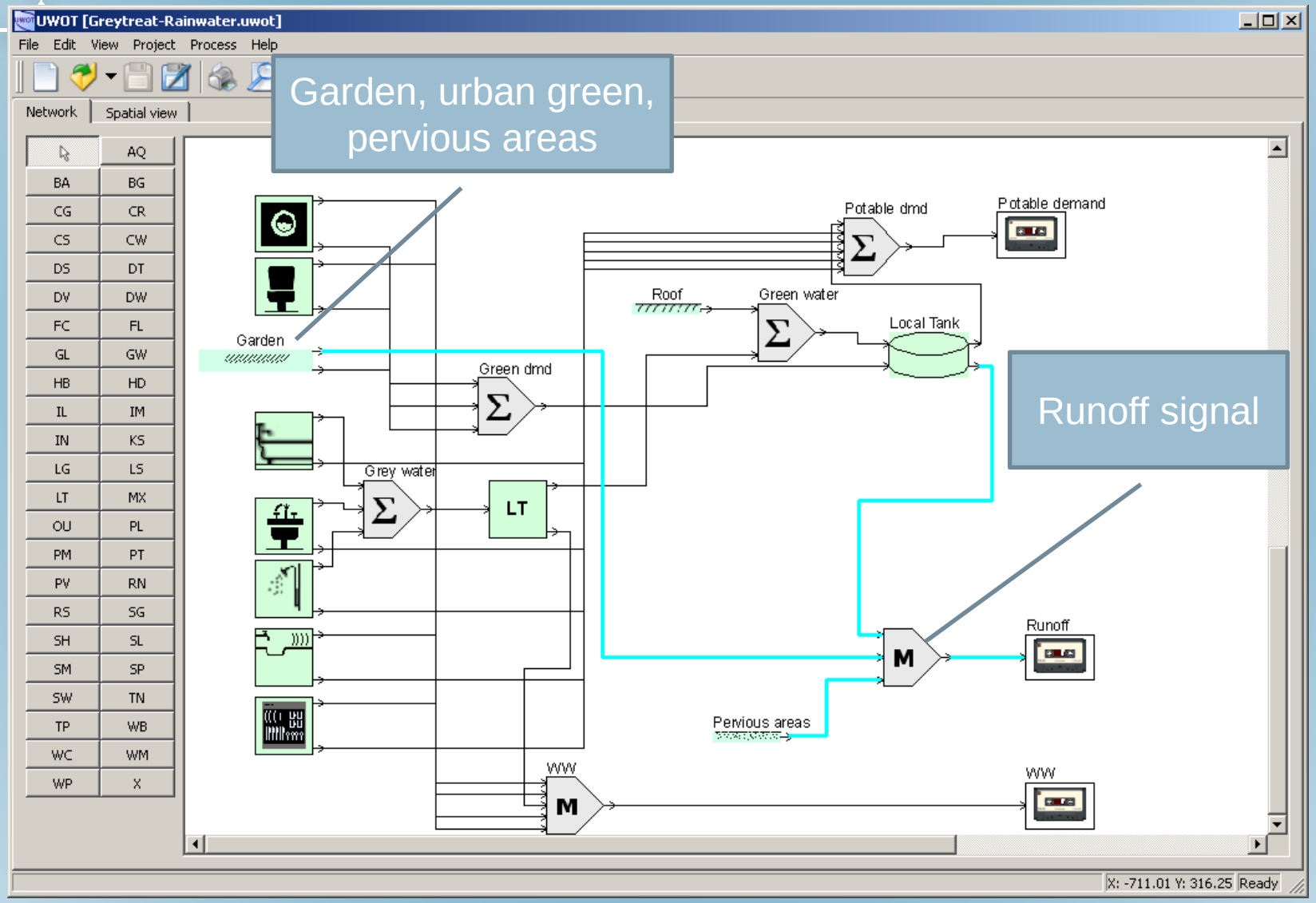
Household level simulation: potable water



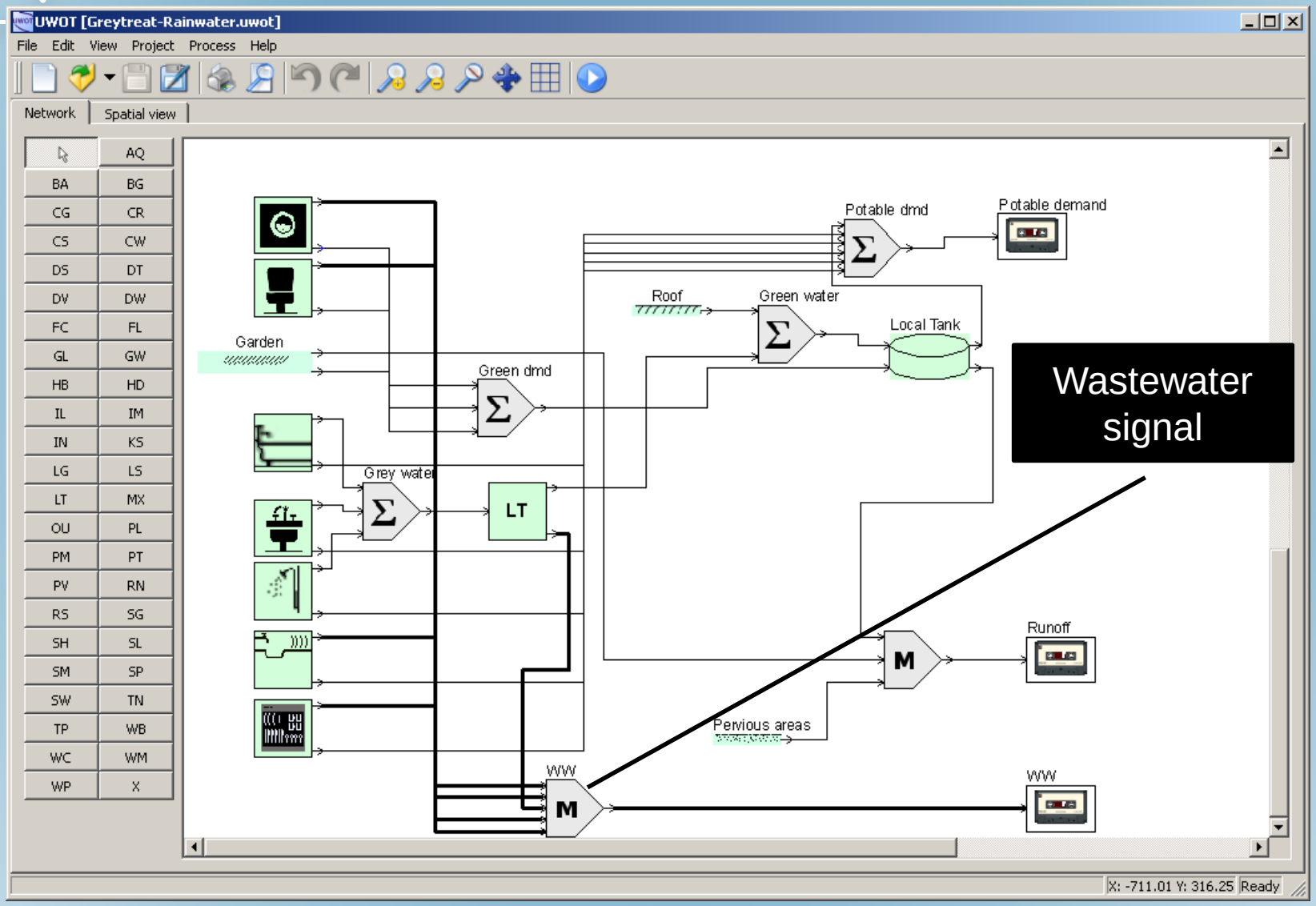
Household level simulation: green water



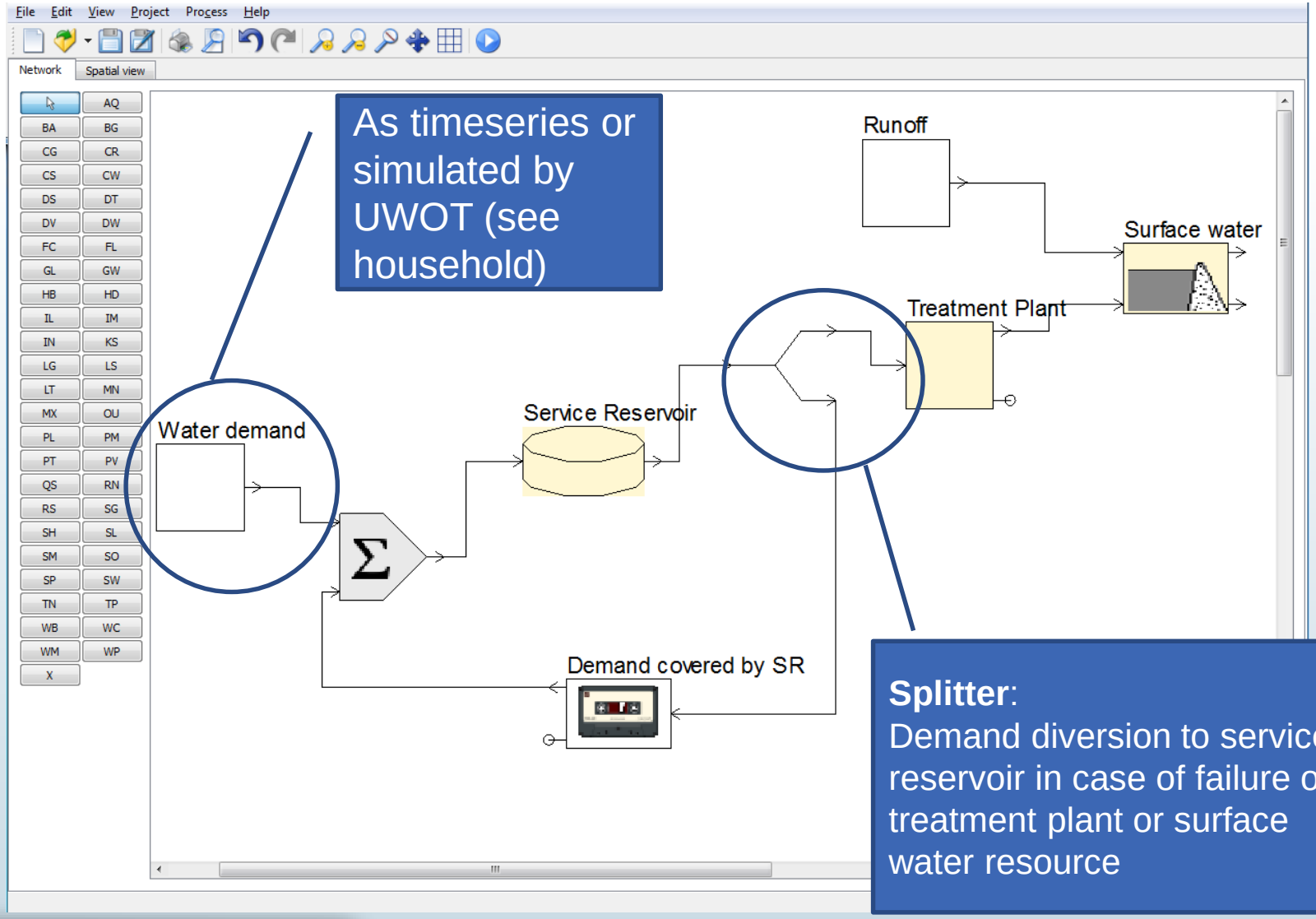
Household level simulation: stormwater



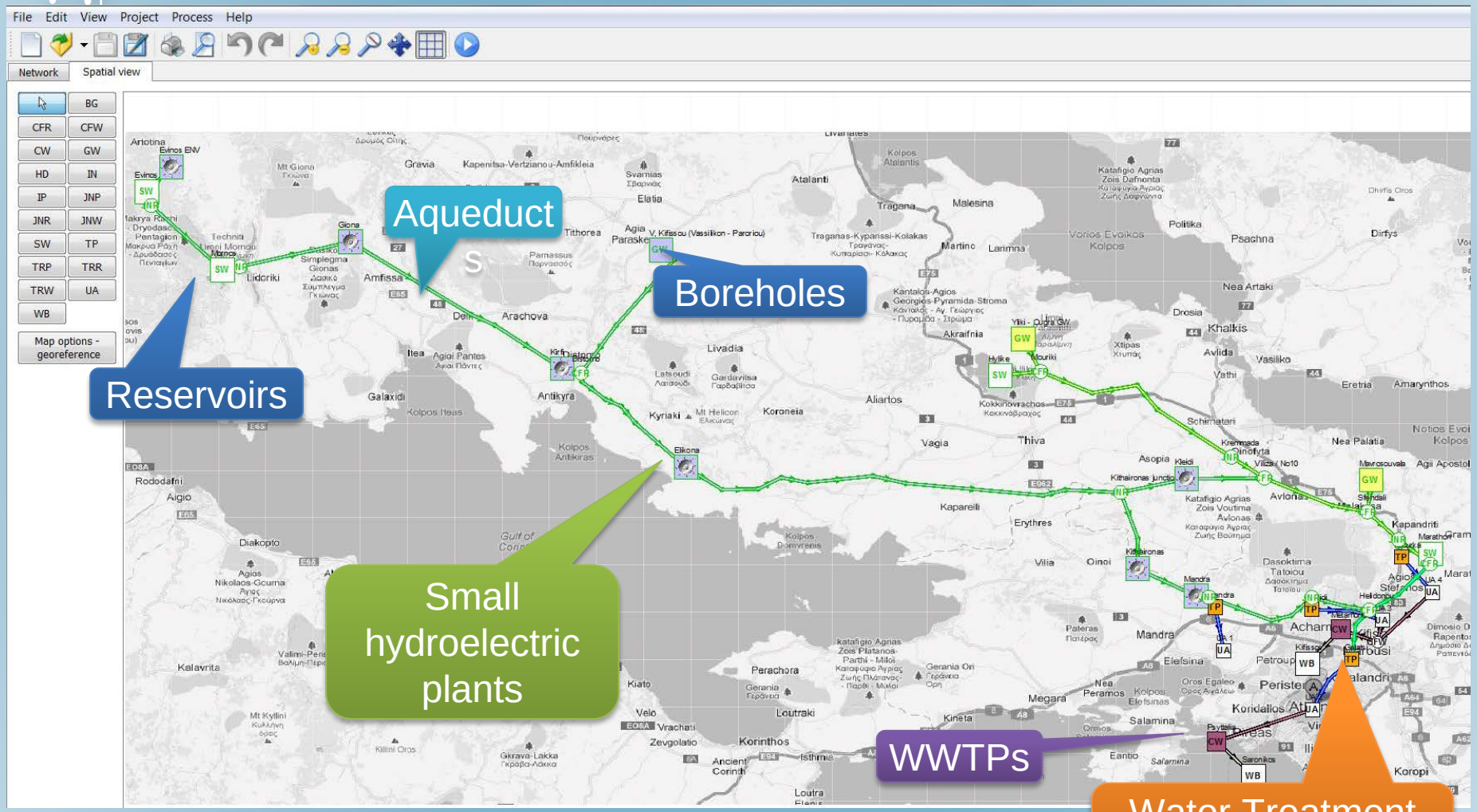
Household level simulation: wastewater



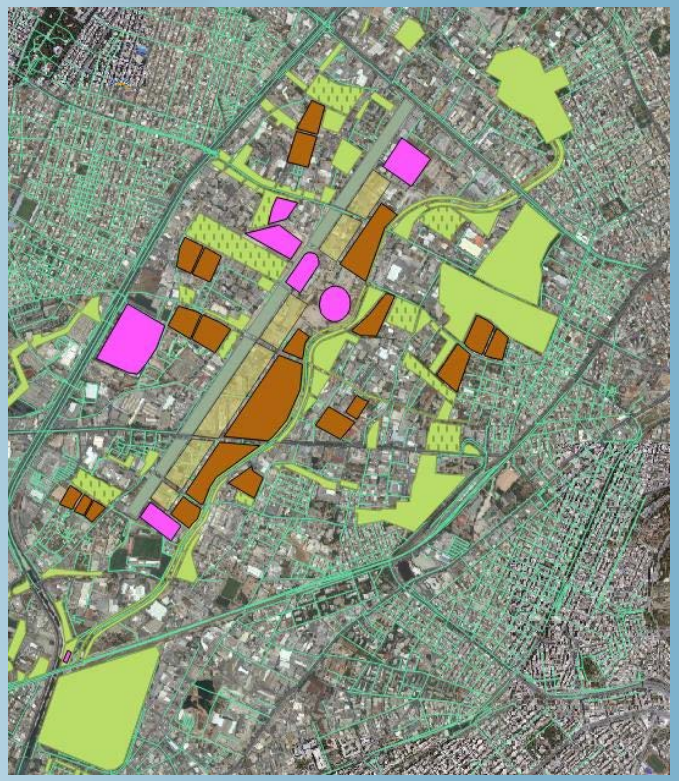
City scale simulation

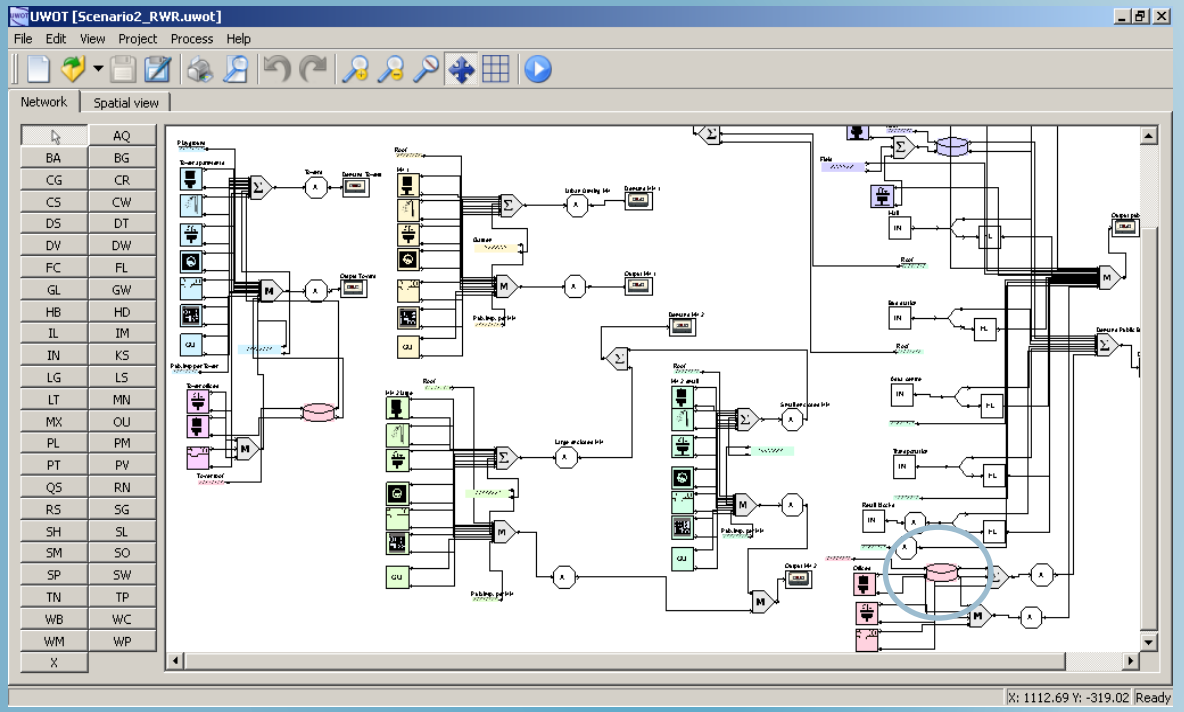


Water supply management



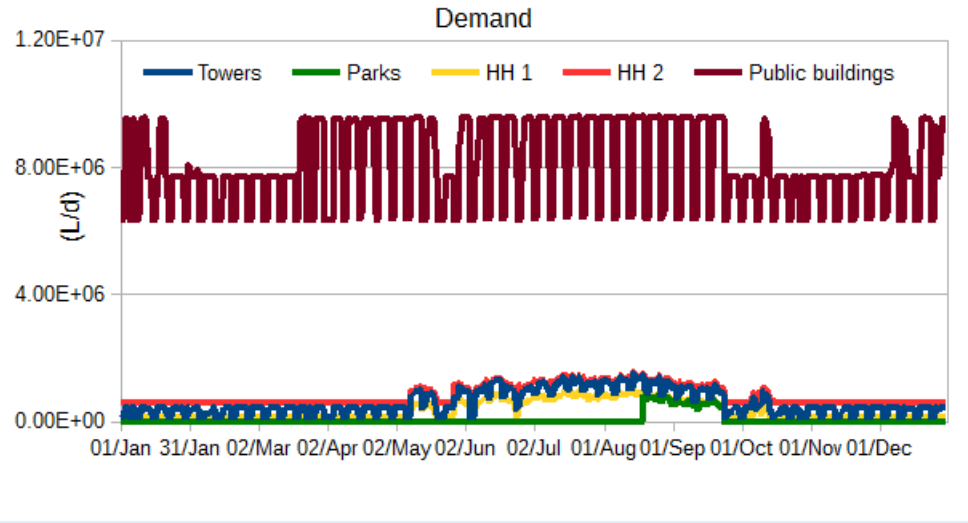
Water Demand Management:
the case of a new urban development in Athens





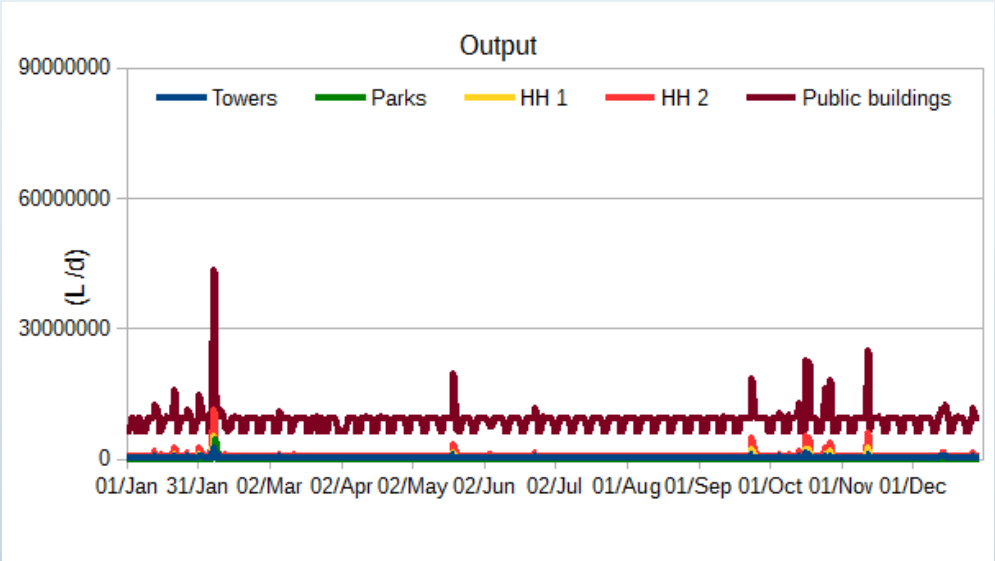
In the case of Eleonas (Athens) we investigated **three alternative urban designs** (from a very green to a more “traditional” dense) and looked at water management options for each one.

Assessing the effects of Water Demand Management

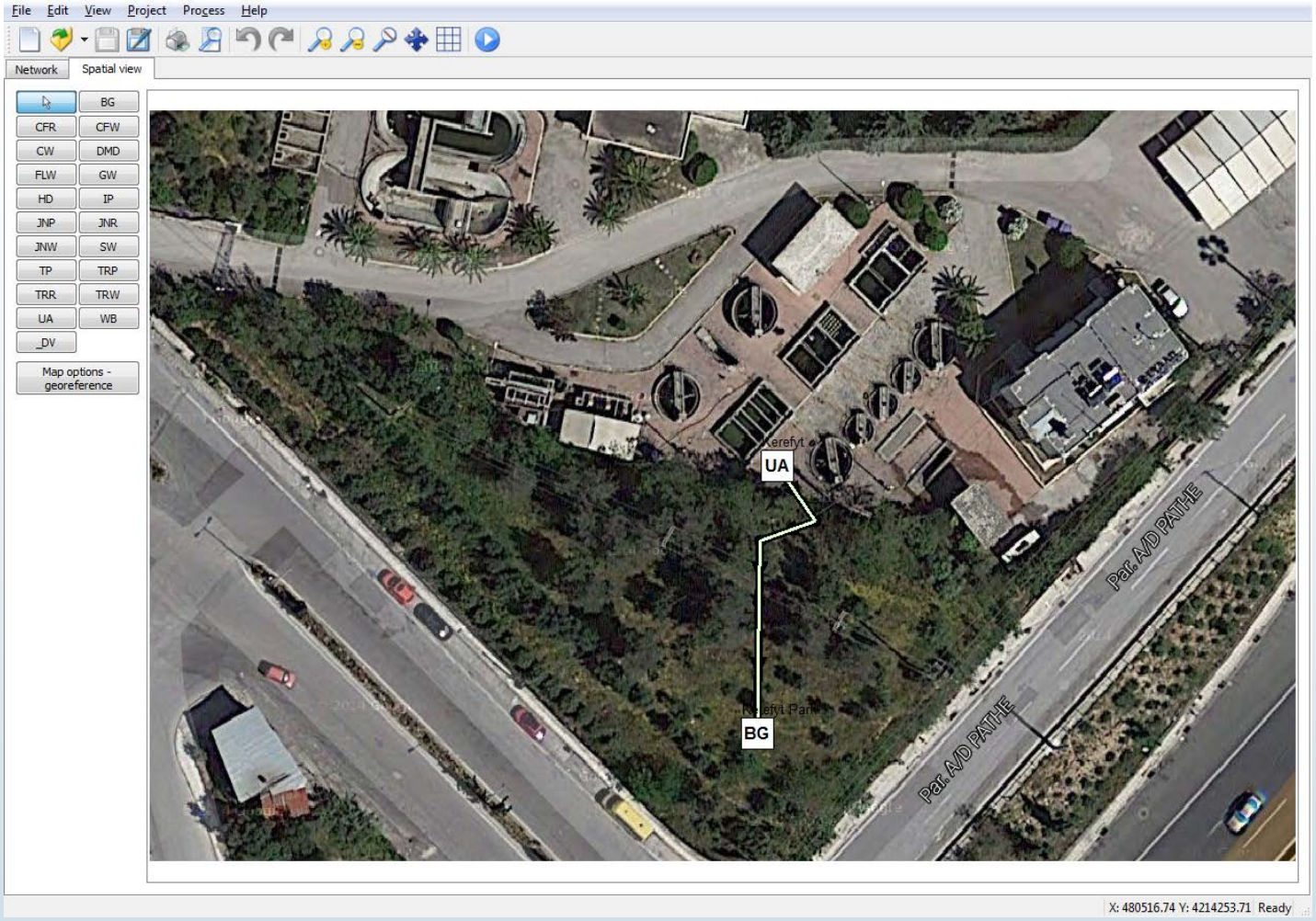


Reduction of potable water demand through reuse and rainwater harvesting

Reduction of peak runoff volume through rainwater harvesting and SUDS



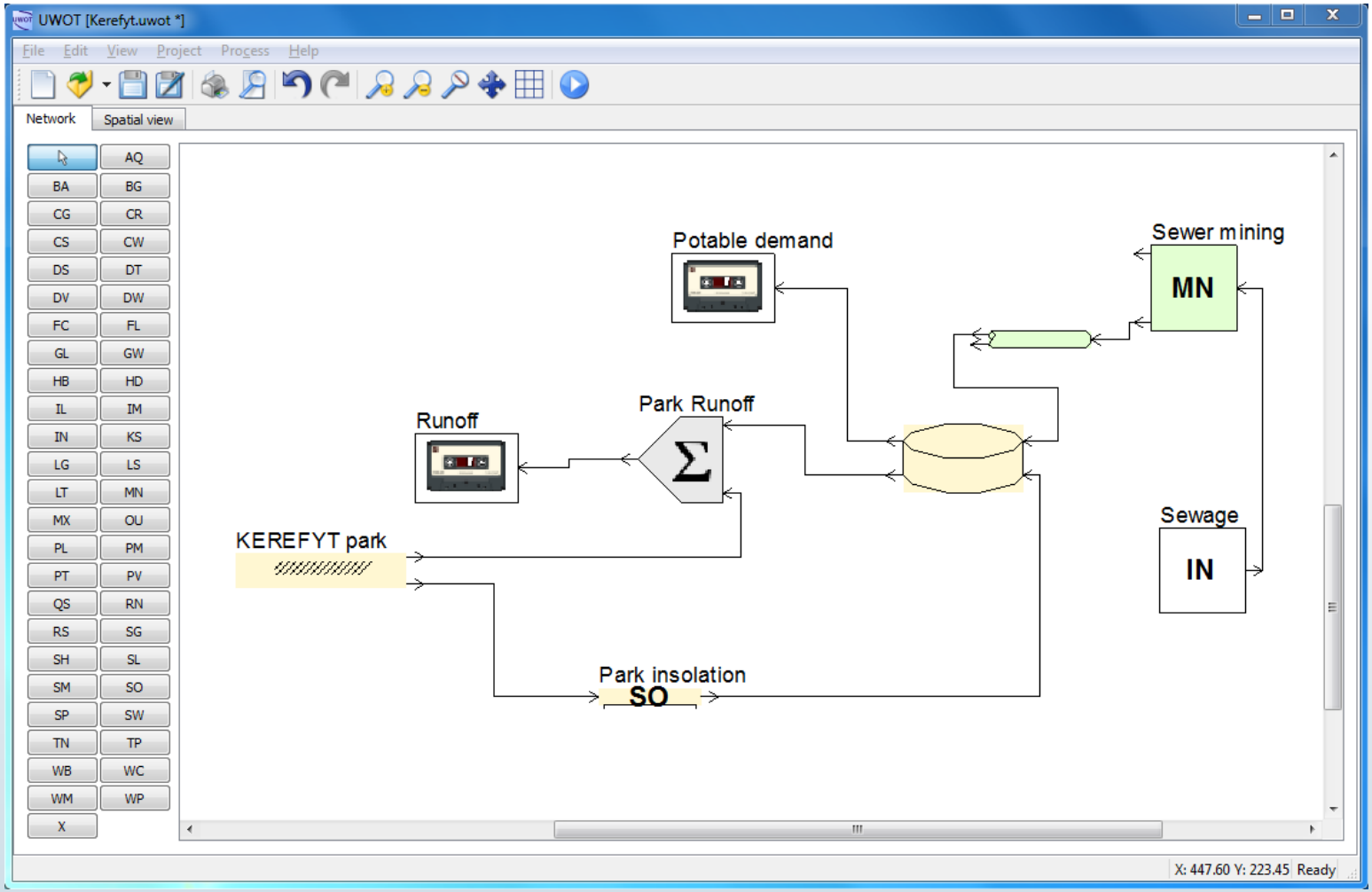
Blue-Green Infrastructure: Heat Island Effect



Assess the **urban heat island effect** and help in finding a viable solution to mitigate adverse effects of urbanization and climate change.

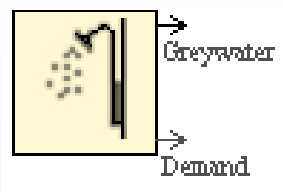
In this case: **sewer mining for irrigation and MAR**

Blue-Green Infrastructure: Heat Island Effect



Evaporative cooling is simulated. In this configuration we use treated wastewater for irrigation (from a **sewer mining** unit)

Backup up by a technology library



Brand "Power shower" properties

no	Descr	i	j	value	unit
1	Water Usage/capacity	1	1	60	L/use
2	Water Loss	1	1	0.03	0 to 1
3	Energy Use	1	1	2.23	kWh/use
4	Chemical Use	1	1	0	
5	Land Use	1	1	0	sq. m
6	Lump sum cost	1	1	0	
7	Capital Cost	1	1	45	pounds
8	Operational Cost	1	1	0.01	pounds/use
9	Risks to human health	1	1	2	
10	Output Quality	1	1	182.8	mg/L

OK

For **each component** (from a shower to a treatment plant) there is a **table with specs** in the tech library (including **capital, operational and energy costs**)

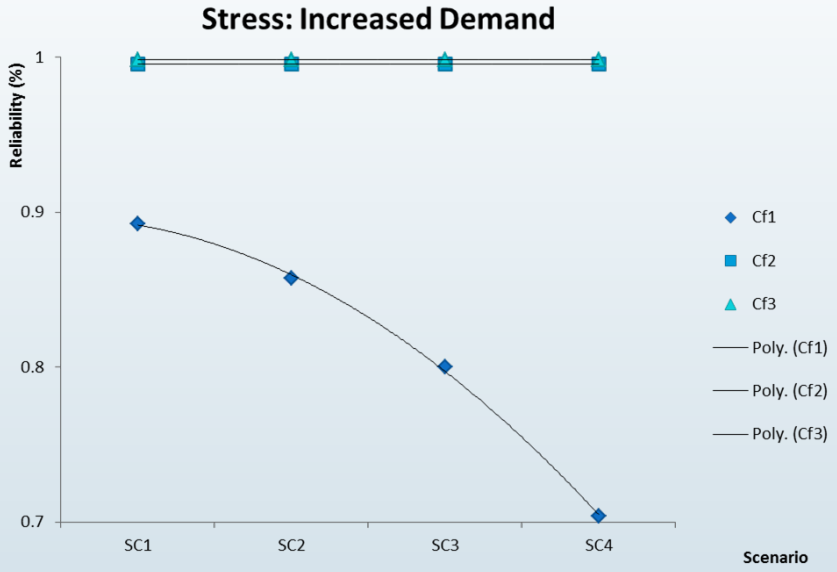
Brand "Raymondville TP" properties

no	Descr	i	j	value	unit
1	Water Usage/capacity	1	1	17034000	L/d
2	Water Loss	1	1	0	0 to 1
3	Energy Use	1	1	0.000371	kWh/L
4	Capital Cost	1	1	4800000	pounds
5	Operational Cost	1	1	1376816.2	pounds/year

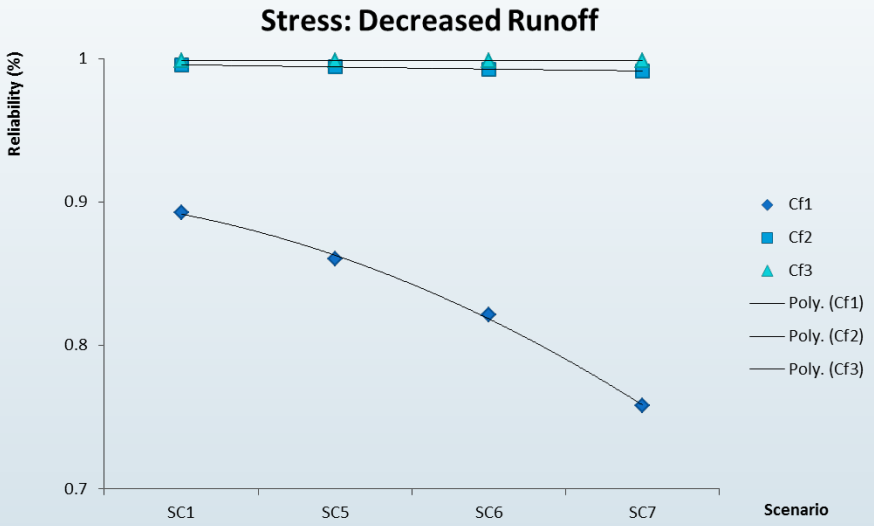
OK

We are able to compare alternative system performance against (rather sophisticated!) scenarios

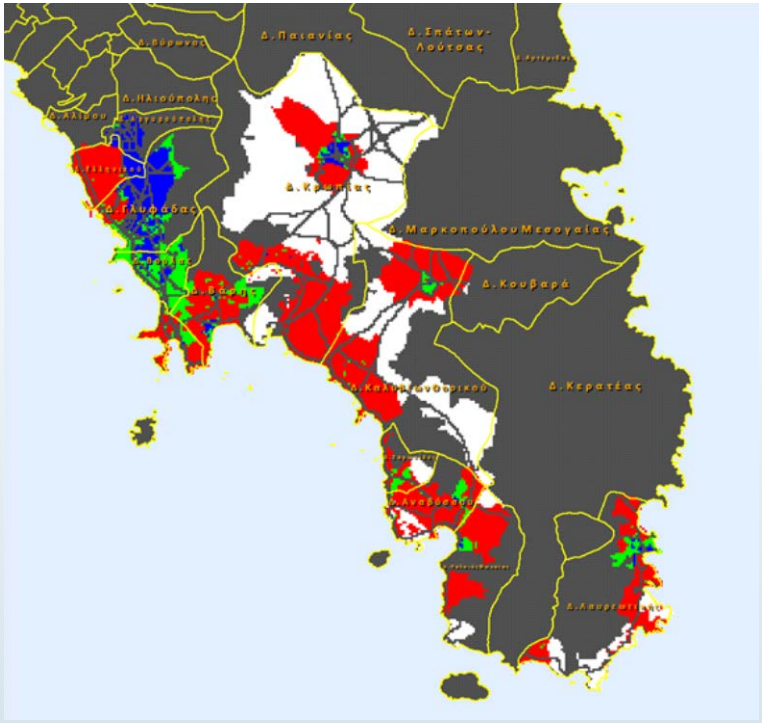
DEMAND SCENARIOS



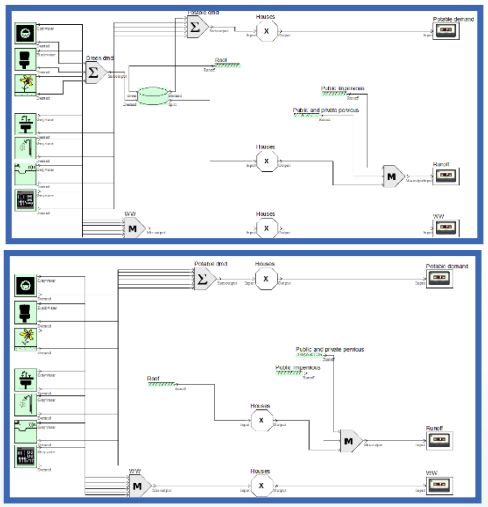
SUPPLY SCENARIOS



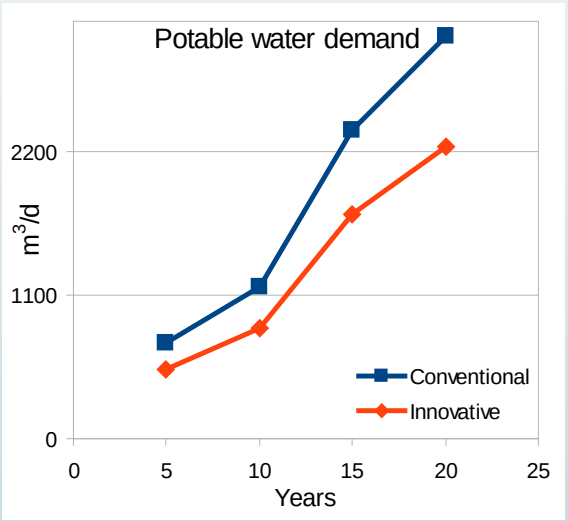
Also link to Urban Development modelling (scenarios)



Urban Growth (Cellular Automata) Model



House typologies



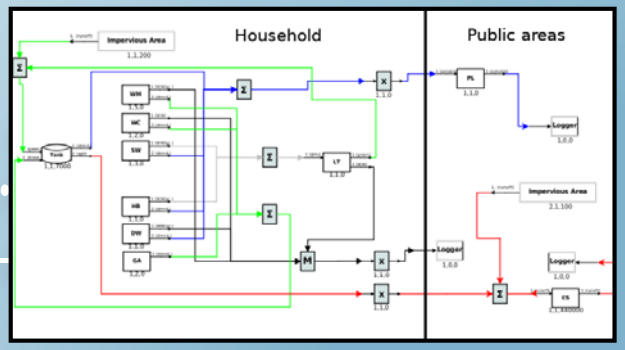
But also ww generation, drainage etc

UWOT is modular and extensible

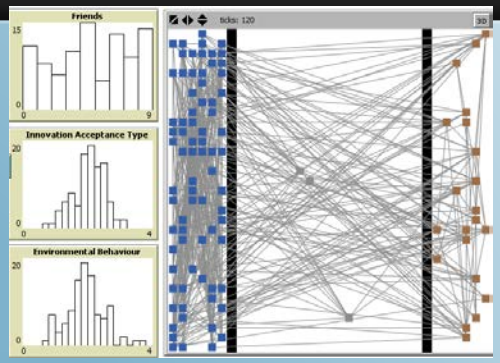
UWOT engine in **C** (4k lines) and interface in **Python** 2.7 /Qt 4.8.6 (10k lines). Engine has been implemented in:

- dll (called from UWOT python interface or other applications)
- Mex (run from within **MATLAB**)
- **OpenMI**
- Django

- New components can be easily added (couple of hours of coding).
- Through OpenMI it can be coupled in run time to other (legacy) software



UWOT can provide quantification of impacts for different **BG interventions** to the urban water cycle

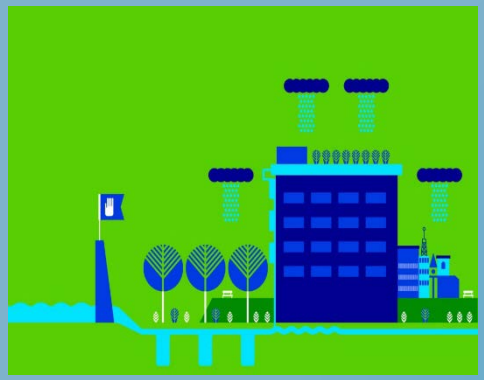


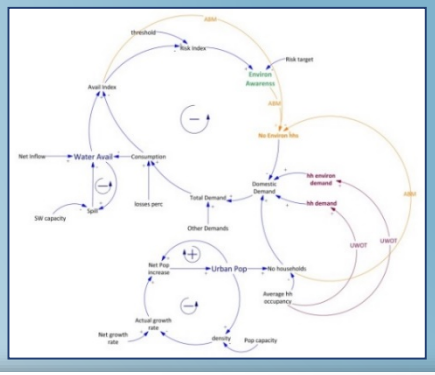
The **Agent Based model** can be fed social environment variables and provide it with user behaviors (e.g. to different policies or technologies)

New Data: Distributed Sensors – Data Analytics & Mining

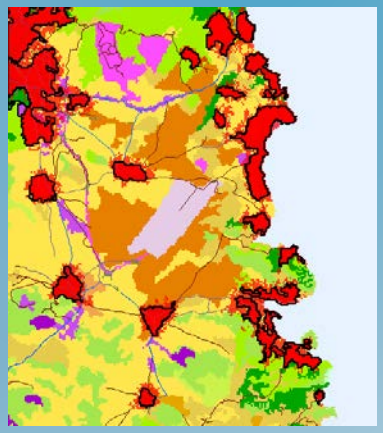
MO Optimisation (Evolutionary Optimisation on a Budget)

Roadmapping (Real Options Algorithms)





System Dynamic Environment (blocks, processes, interactions, cause effects, graph theory)



The **CA urban growth model** to more accurately account for spatial patterns in city changes.

Take away message:

The toolbox can be used to improve the City's **"BlueGreen -print"**

Technologies and Design

- **Centralised** or **decentralised** options?
- What is the impact of Demand Management on Reliability?
- What is the impact of combined BG on demand? (are there regional answers to this?)
- What are the **optimal operating** rules for my system?
- Would increasing **redundancy** in the system make a difference and when?

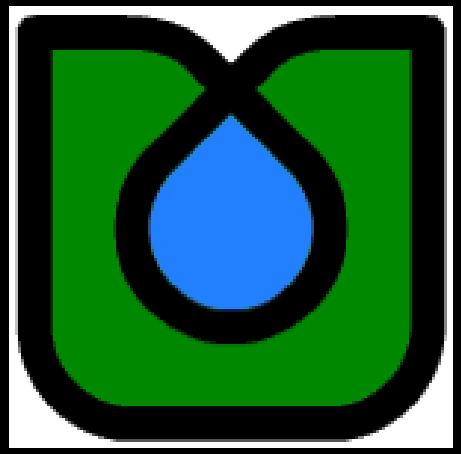
Soft Measures

- What will be the impacts of alternative **awareness raising measures** to demand management (with ABM)
- When to **trigger** a campaign and what its link to other policies will be?
- What would be the impact of different **subsidies** to technology adoption rates? (with ABM)

Under Scenarios, Policy Mixes and also looking at Energy

- How would my system behave under different "**world" scenarios**? How does it behave under **pressure**?
- What are is an "optimal" mix of hard and soft engineering interventions for sustainable UWM
- What are the **energy/cost/risk** implications of decentralised systems?
- How **Resilient** can a given mix make my city under a range of scenarios (climatic and socio-economic)

BGD



Natured based solutions

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