Urban Water Optioneering Tool (UWOT)

Design and simulation of smart water systems

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National Technical University of Athens

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Presentation Contents

- **Introduction**

Context and role of UWOT

- **Methodology**

The way UWOT works

- **Results**

Case studies – insights from past projects

- **Conclusions**

Smart water systems need (smart) tools

- Different technologies, centralized and decentralized, applied at different spatial scales (household, neighborhood, region, city).
- Complex systems where multiple water flows interact (DW, RW-SW, GW, WW).
- Water systems become digitized – more sensors, higher resolution data, more data integration.
- Energy, environmental and social (behavioral, end-user) aspects need to be considered as well.

- Holistic models that provide an overview on the water systems (and their multiple interactions) are needed.
- These models are used to support decisions on the optioning, design and preliminary assessment process.
- The models need to be able to receive data from multiple sources (and be F4W-aware)

UWOT: A modular simulation engine for smart water systems

Bottom-up, component based urban water circle model.

Multiple components, multiple technologies (DW, WW/GW, RW/Runoff)

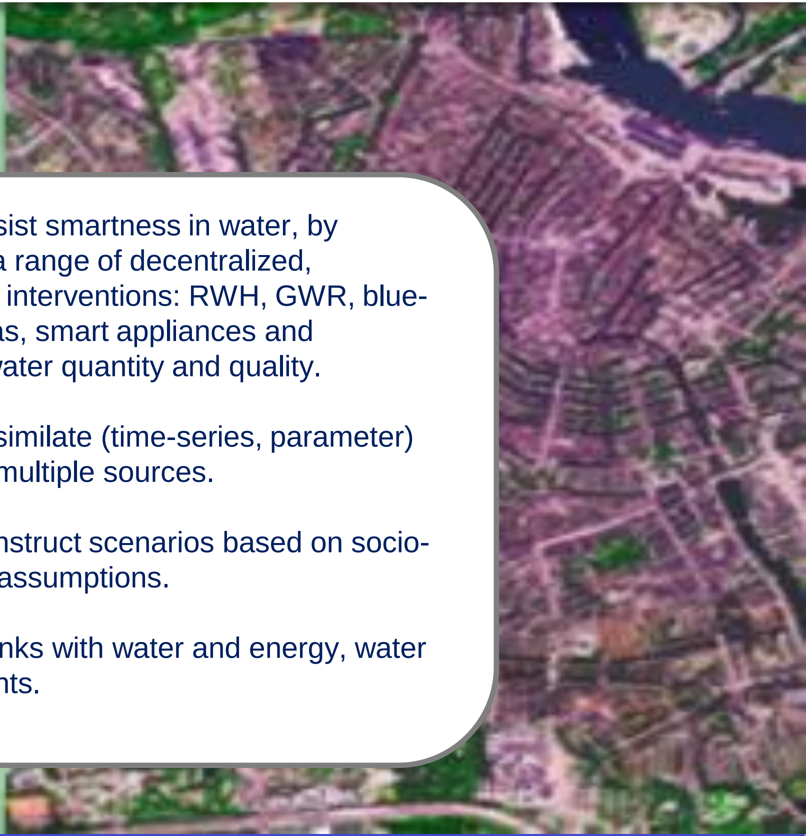
Built in C/Python, able to simulate flows on a daily/hourly time step, in scenarios that span years to decades.

Able to assist smartness in water, by modeling a range of decentralized, distributed interventions: RWH, GWR, blue-green areas, smart appliances and estimate water quantity and quality.

Able to assimilate (time-series, parameter) data from multiple sources.

Able to construct scenarios based on socio-economic assumptions.

Provides links with water and energy, water and nutrients.



UWOT as part of Watershare: expert tools for global water challenges

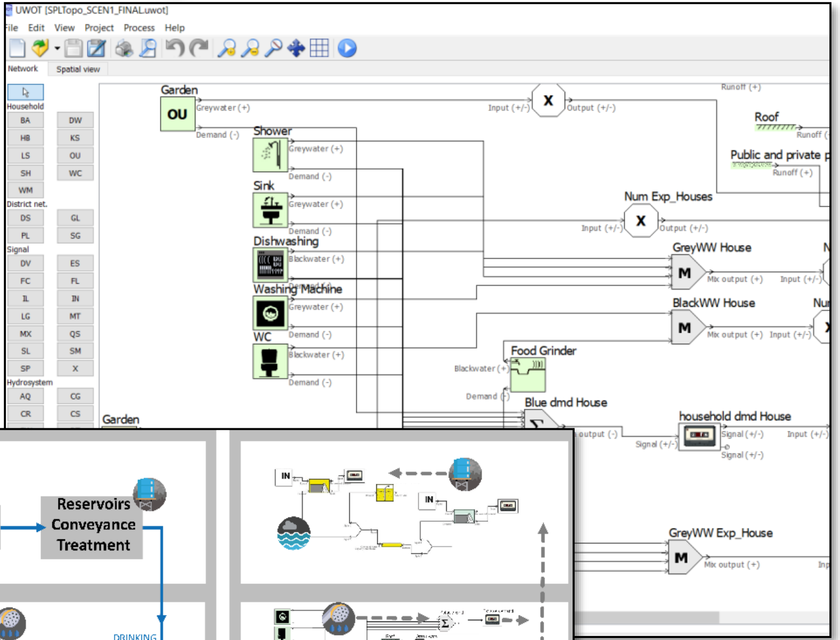
- Part of a toolbox that addresses water issues in various thematic areas.
- Accessible to Watershare partners (https://www.watershare.eu/)

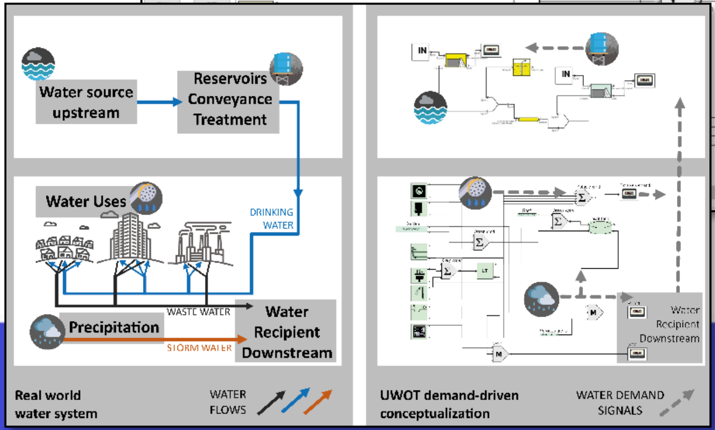
Categories and components

UWOT models components across five categories:

- **Household Appliances** (conventional vs. water-smart)
- **District Network** (pipe networks, pumping, WW networks)
- **Signal** (water flow aggregation and mixing)
- **Hydrosystem** (water sources)
- **Nexus** (smart components, such as blue-green areas)

UWOT models **from tap (household or neighborhood level) to source**, matching clean water demands with available sources (central or decentralized).

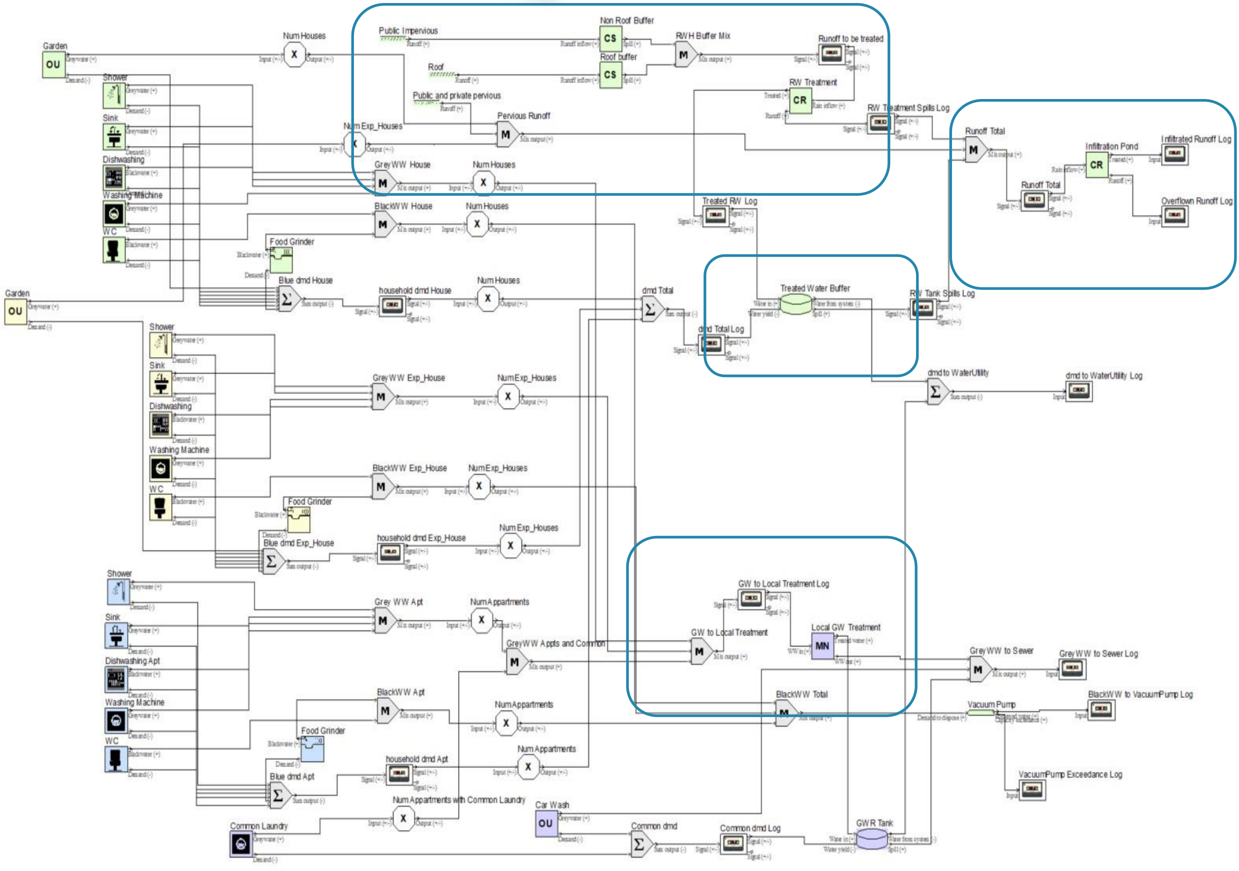




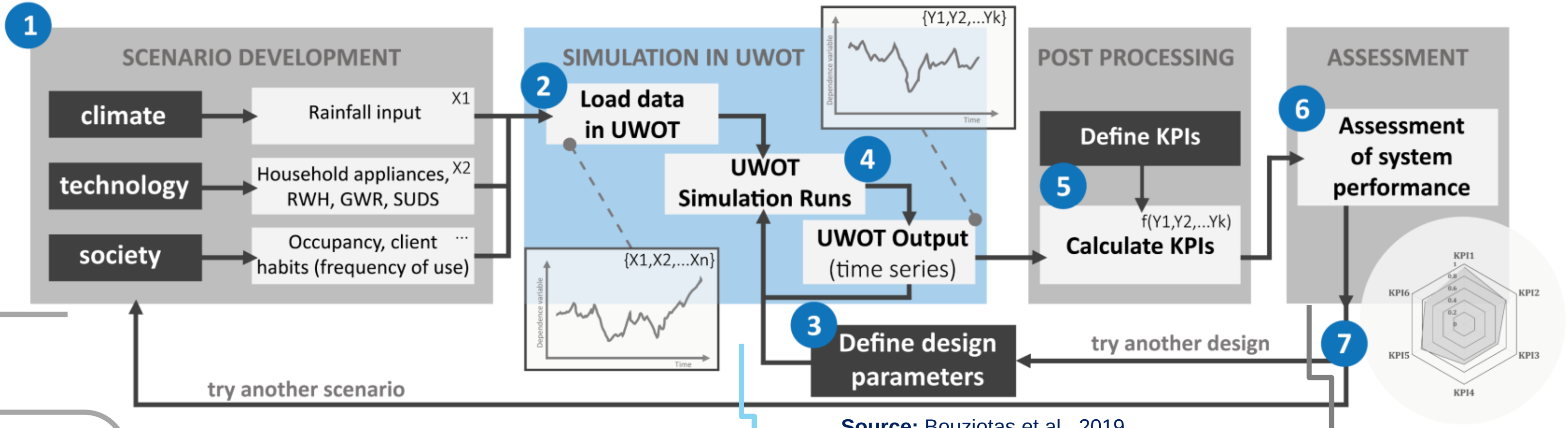
How does it work?

Signal-based, from demand nodes to sources

- Add household appliances, mix them together under different households.
- Include rainwater management and (potential) greywater recycling components.
- Log stored water, covered demands, required energy at each time step.
- View results for a specified scenario-topology (set of techs).



Not only simulation…



Source: Bouziotas et al., 2019

Allows comparison of scenarios that are derived from different climate, technical and socio-economic backgrounds.

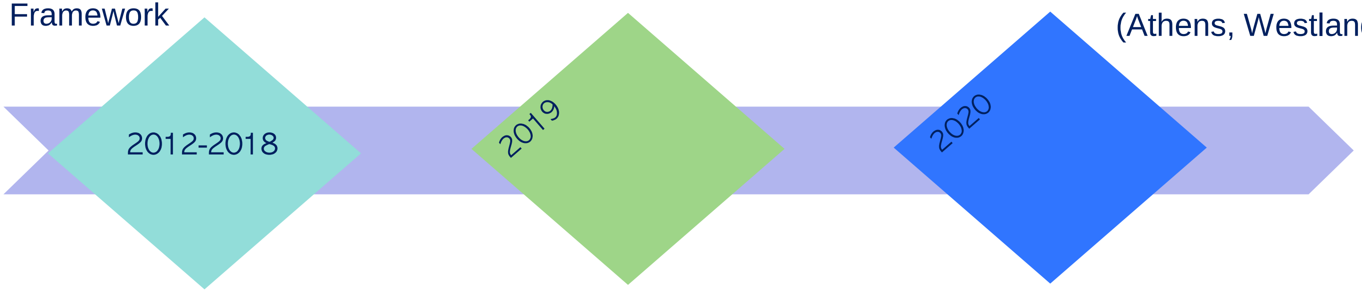
Allows fine-tuning the design in a particular scenario (capacity of different components, sizes of tanks etc.)

Includes dashboard tools to aggregate outcome and present it to stakeholders.

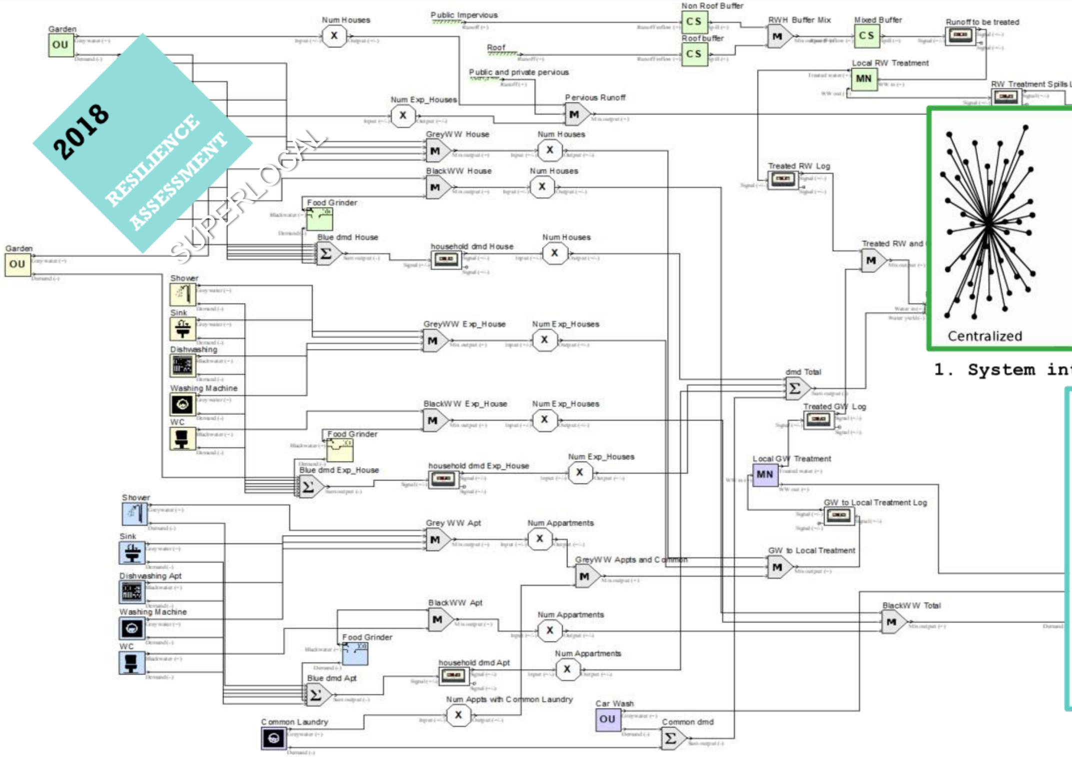
Applications (2012-present)

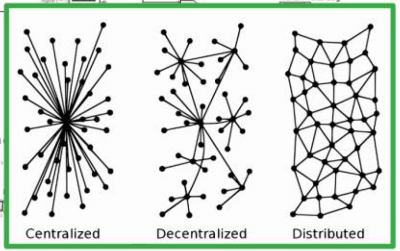
Early applications (NTUA)
Resilience Framework

NextGen demo cases
(Athens, Westland)

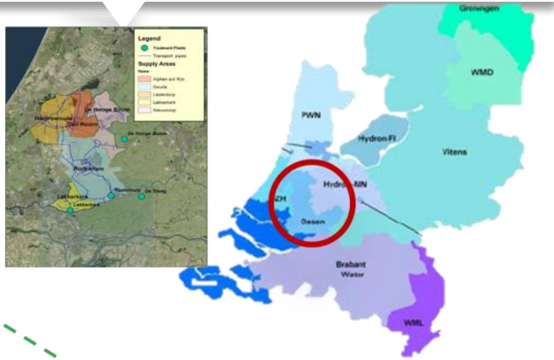


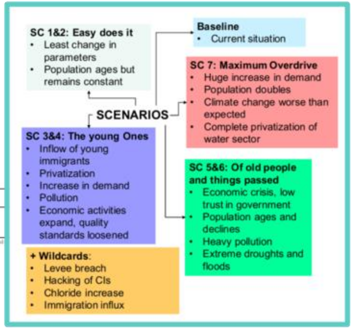
Circular water neighborhood
design SUPERLOCAL-WiCE



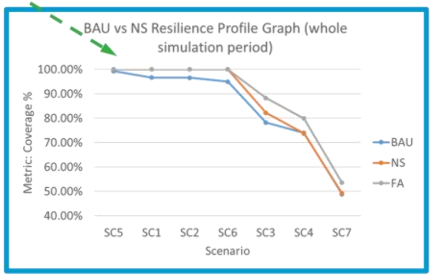


1. System interventions (pathways)





2. Scenarios



3. Resilience Profiles

Source: BTO Report (2018)

2019 SUPERLOCAL

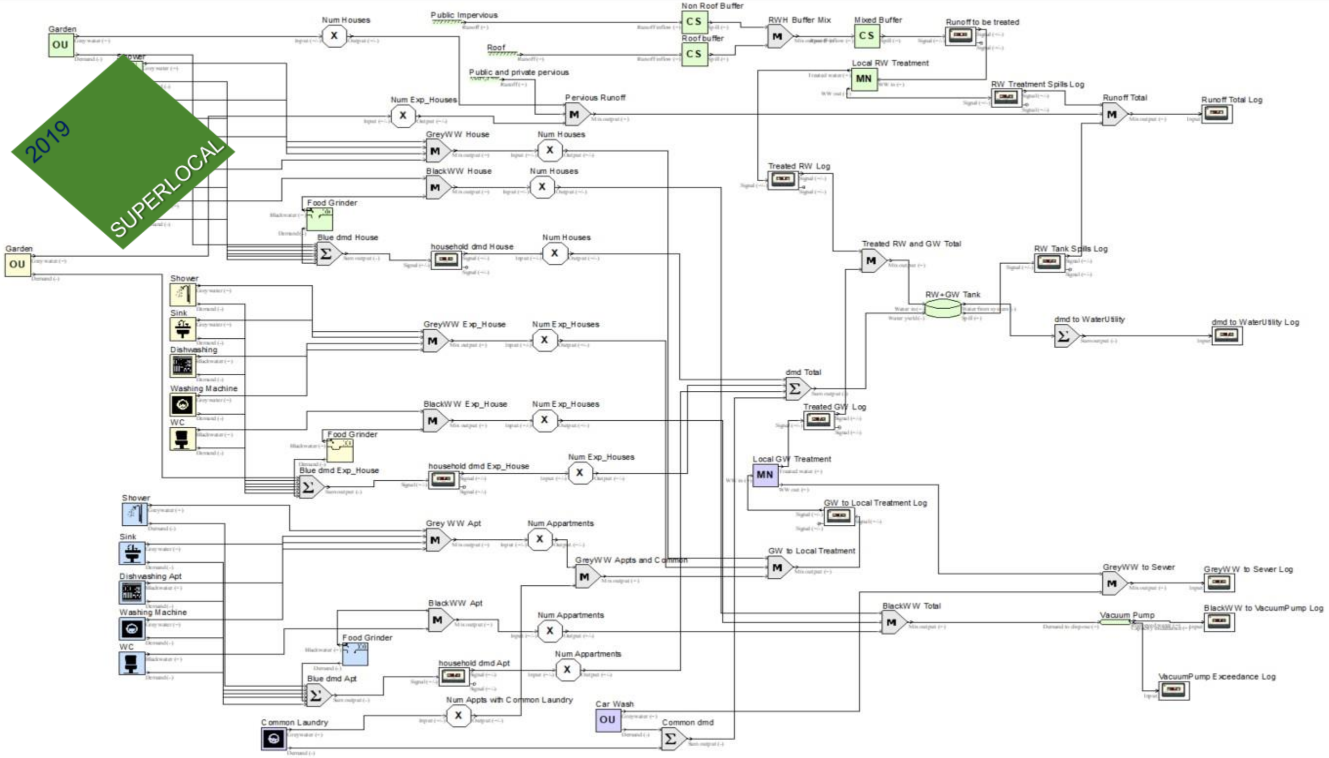
Circular neighborhood design

SUPERLOCAL (Limburg, NL)

	Target	Way
SLOW	• Slower runoff response • Lower flood peaks • Rainwater absorbed locally	• RWH • Local RW buffer (storage) • Infiltration basin (SUDS)
LESS	• Less water use per household	• Vacuum toilets • Water-saving/recirc. showers • Common laundry space for some units
LOCAL	• Water recycled locally • WW treated locally	• RWH to DW • GWR / treats WW back to specific uses • Local treatmentunits for RW/GW • BW stream (toilets, food grinders)

PARTNERS

wml Limburgs drinkwater



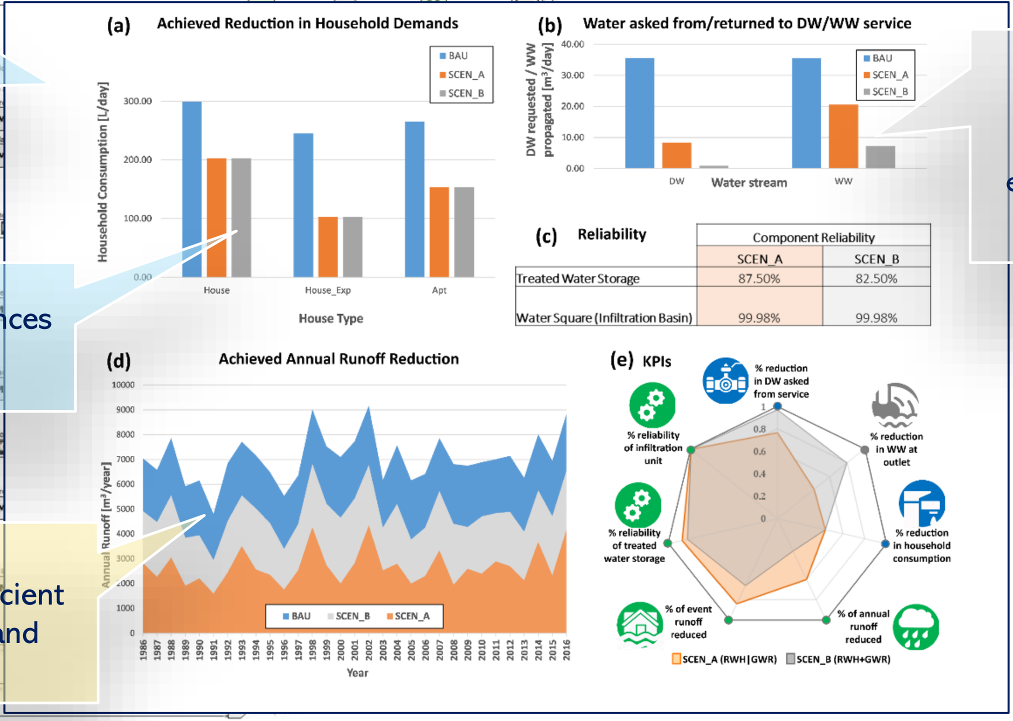
Scen A:
Distinct decentralized systems (RWH/GWR)

Scen B:
Combined recycling (RWH+GWR)

Reduction of
- 32% (houses)
- 58% (exp. houses)
- 42% (apartments)

Dependence on mix of appliances (household type)

Runoff reduction
- SCEN_A (RWH|GWR) for efficient at retaining flood volumes and peaks

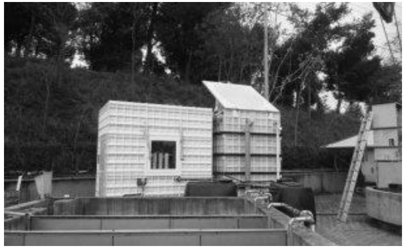


DW asked centrally / WW propagated
- SCEN_B (RWH+GWR) more efficient / relies on a 'steadier' source of treated GW

2020

NEXTGEN-ATHENS

Demonstrating circular economy principles in water: a local pilot for sewer mining in **Athens Urban Tree Nursery** area



Sewer mining pilot in Athens Nursery area:

- decentralized WW treatment option (MBR treatment)
- Intermediate, localized water reuse option
- modular treatment units that can be placed anywhere on the network
- production of non-potable treated water (25 m³/day)
- placement at point of demand (urban green spaces)

EYDAP

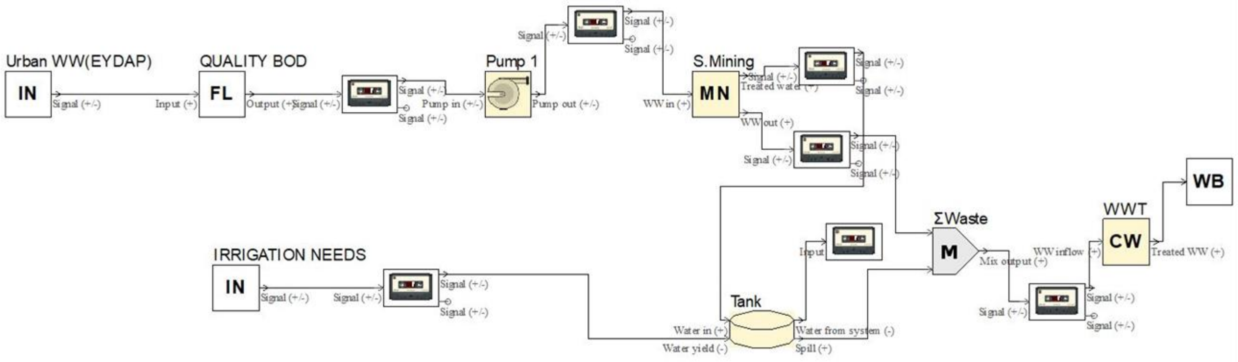
BIOPOLUS The Living Technology Alliance

CITY OF ATHENS

CHEMiTEC Water and Environmental Technologies

National Technical University of Athens

2020 NEXTGEN-ATHENS



Role of UWOT in Athens:

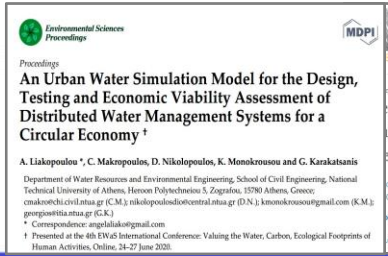
- Support model for different pilot layouts (multiple modular units)
- Calculation of BOD concentration based on WW influx


water MDPI

Article

Sewer Mining as a Distributed Intervention for Water-Energy-Materials in the Circular Economy Suitable for Dense Urban Environments: A Real World Demonstration in the City of Athens

Argyro Plevri [1,*], Klio Monokrousou [1], Christos Makropoulos [1], Christos Lioumis [2], Nikolaos Tazes [2], Efthymios Lytras [3], Stylianos Samios [3], Georgios Katsouras [3] and Nikolaos Tsalas [3]


Environmental Sciences Proceedings MDPI

Proceedings

An Urban Water Simulation Model for the Design, Testing and Economic Viability Assessment of Distributed Water Management Systems for a Circular Economy †

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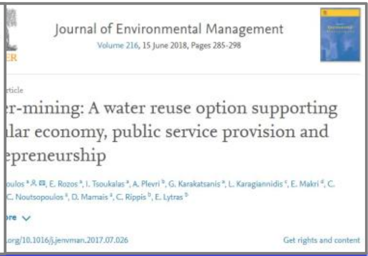
† Presented at the 4th EWaS International Conference: Valuing the Water, Carbon, Ecological Footprints of Human Activities, Online, 24–27 June 2020.


Journal of Environmental Management

Volume 216, 15 June 2018, Pages 285-298

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...r-mining: A water reuse option supporting ...lar economy, public service provision and ...epreneurship

...oulos, E. Rozos, I. Tsoukalas, A. Plevri, G. Karakatsanis, L. Karagiannidis, E. Makri, C. ... C. Noutsopoulos, D. Mamais, C. Rippis, E. Lytras

...org/10.1016/j.jenvman.2017.07.026

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2020

NEXTGEN-DELFLAND

Demonstrating circular economy principles in water: towards a circular water province

Circular system interventions (pathways)

Baseline
hh's follow linear WM
Greenhouses rely on RW basins

A – Rain-proof
25% of hh's have RWH
GHs rely on RW basins

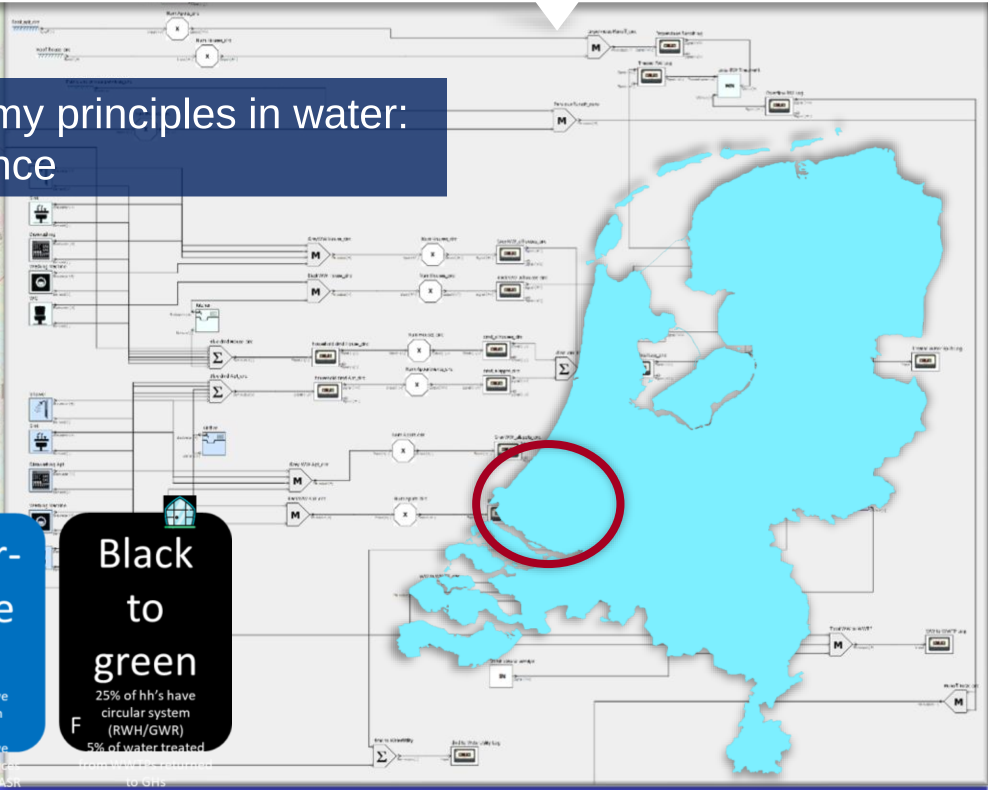
B – Circular
25% of hh's have circular system (RWH/GWR)
GHs rely on RW basins

C – Water-aware
25% of hh's have circular system (RWH/GWR)
25% of hh's have water-saving devices
GHs rely on RW basins

D – Green roof
25% of hh's have RWH
50% of public impervious spaces have green roofs
GHs rely on RW basins

E – Water-aware ASR
25% of hh's have circular system (RWH/GWR)
25% of hh's have water-saving devices
10% of GHs have ASR

F – Black to green
25% of hh's have circular system (RWH/GWR)
5% of water treated from WWTP is returned to GHs



Conclusions

- UWOT is a **bottom-up** (component-based), spatially agnostic water balance (watercycle) model. It simulates urban water demands, for purposes of optimizing the planning and assessment of distributed interventions in the urban water cycle.
- Suitable for generic **smart water system** studies at different scales (household, neighbourhood, region, city).
- Tested against **multiple cases**, developed over diverse projects (household smart water applications, city-scale modelling, green-blue area design, innovative pilots, circular neighbourhood design)
- **Applications in B-WaterSmart**: Flanders (regional, multiple smart water options), East Frisia (local, industrial waste reuse)

Thank you for your attention!

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B-WaterSmart

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