13 APRIL 2023

15:00 CEST

IWA Specialist Group on Modelling and Integrated Assessment Webinar Series

Modelling and integrated assessment tools for water sensitive urban planning

Speakers

Ulf Jeppsson
Lund University

Nataša Atanasova
University of Ljubljana

Peter M. Bach
Eawag / ETH Zurich

Tony Hargreaves
University of Birmingham

David Martínez
ICRA/UdG

The webinar is going to be recorded and shared on the MIA SG Youtube channel afterward.

MIA Welcome Note

IWA Modelling and Integrated Assessment Specialist Group

Dr. Ulf Jeppsson (Chair of MIA SG)

Dr. Elena Torfs (Vice-chair of MIA SG)

inspiring change

Lund University

Ghent University

MODELLING AND INTEGRATED ASSESSMENT SPECIALIST GROUP (MIA SG)

"This group targets people from research, consulting companies, institutions and operators to think along ***the use of models and computing tools to support the understanding, management and optimization of water systems****."*

PRIORITIES

- Interact with other IWA SGs and other professional organizations
- Organize specialized conferences, sessions and workshops
- Engage and activate YWPs in the domain.

CURRENTLY 2160 MEMBERS

How to find us

Website: http://iwa-mia.org/

https://iwa-connectplus.org

MIA SG: ACTIVITIES

Task Groups (TGs)

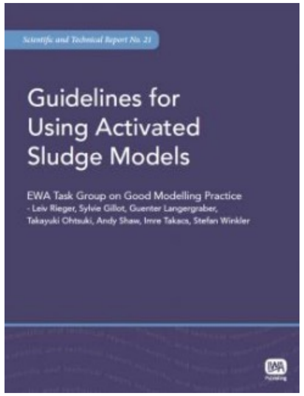
- Benchmarking of Control Strategies (BSM) AND Good Modelling Practice (GMP) AND Design and Operations Uncertainty (DOUT) AND Use of Modelling for Minimizing GHG Emissions (GHG) AND Generalised Physicochemical Modelling (PCM) (all five finished)
- Membrane Bioreactor Modelling and Control (MBR)
- Good Modelling Practice in Water Resource Recovery Systems (GMP2)

Working Groups (WGs)

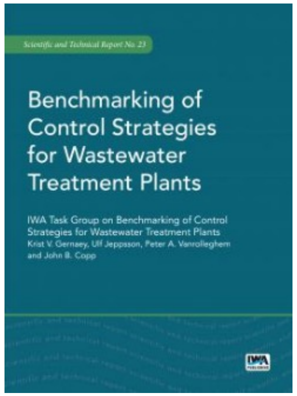
- Integrated Urban Water Systems (IUWS)
- Computational Fluid Dynamics (CFD)
- Good Modelling Practice (GMP)

Conferences / Events

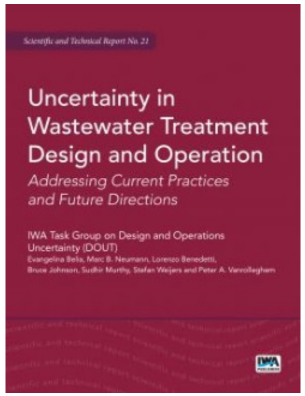
- WRRmod
- Watermatex



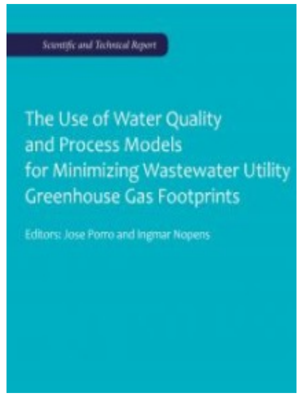
STR (2012)



STR (2014, open access)

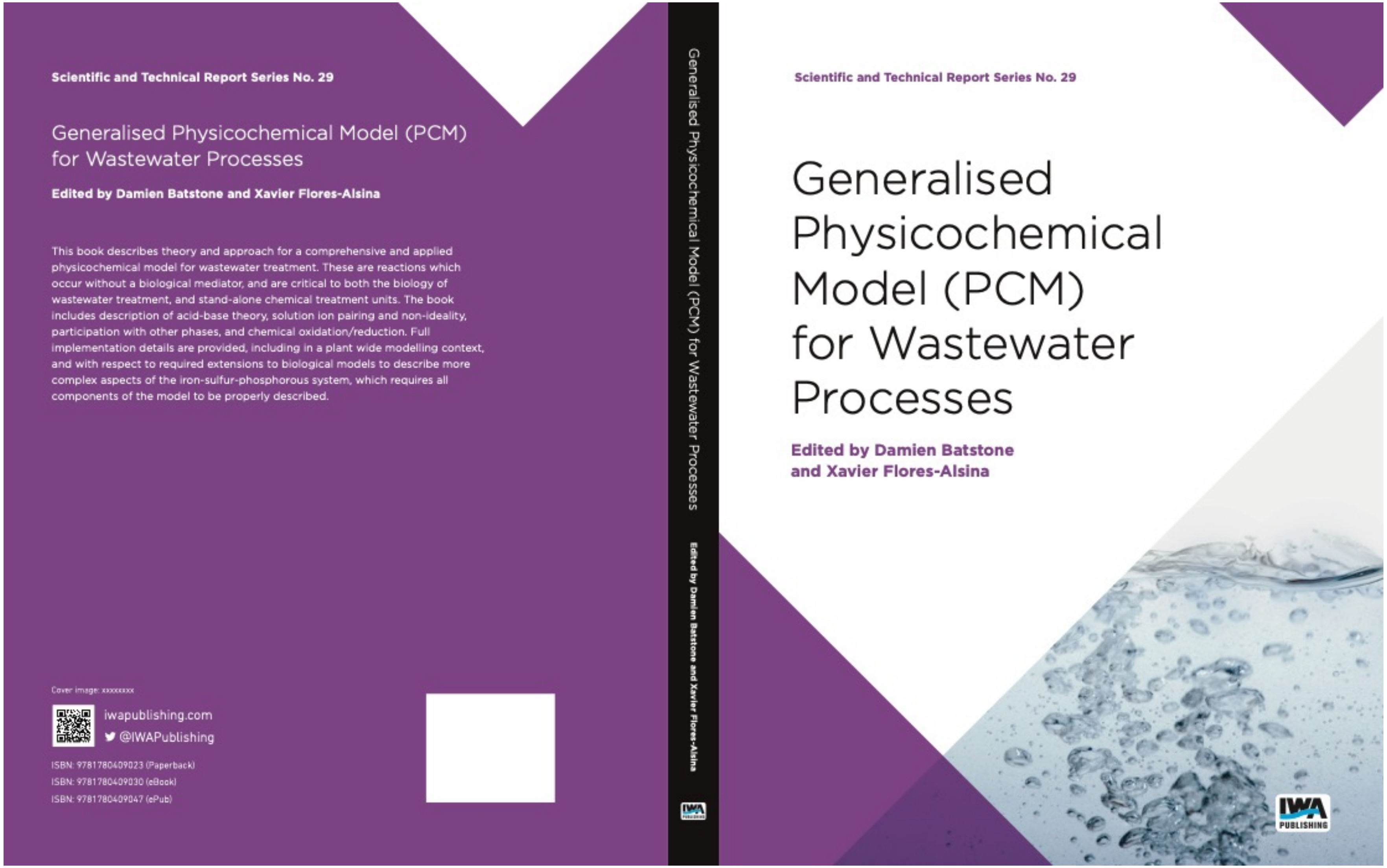


STR (2021, open access)



STR (2022, open access)

RECENTLY PUBLISHED: PCM STR – OPEN ACCESS



MIA SG: UPCOMING CONFERENCES

11th Symposium on Modelling and Integrated Assessment (Watermatex2023)

- Location: Québec City, Canada, 23-27 Sept. 2023
- Chair/vice-chair: Prof. Peter Vanrolleghem (Univ. Laval)/Dr. Elena Torfs (Univ. Ghent)

9th Water Resource Recovery Modelling seminar (WRRmod2024)

- Location: Notre Dame, Indiana, USA, 6-10 April 2024
- Organisers: Adrienne Menniti, Leon Downing, Tom Johnson, Rob Nerenberg

- **CALL FOR WRRmod2026 soon to appear**

FIND MIA SG ON SOCIAL MEDIA

Follow the Modelling and Integrated Assessment Specialist Group on:

– https://iwa-connect.org/group/modelling-and-integrated-assessment-mia/timeline

- https://www.linkedin.com/company/iwa-mia-specialist-group-on-modelling-and-integrated-assessment

– https://twitter.com/iwa_mia_sg

– **MIA SG open web site** http://iwa-mia.org

to get informed about our latest events, publications and news!

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MODELLING AND INTEGRATED ASSESSMENT TOOLS FOR WATER SENSITIVE URBAN PLANNING

Nataša Atanasova

natasa.atanasova@fgg.uni-lj.si

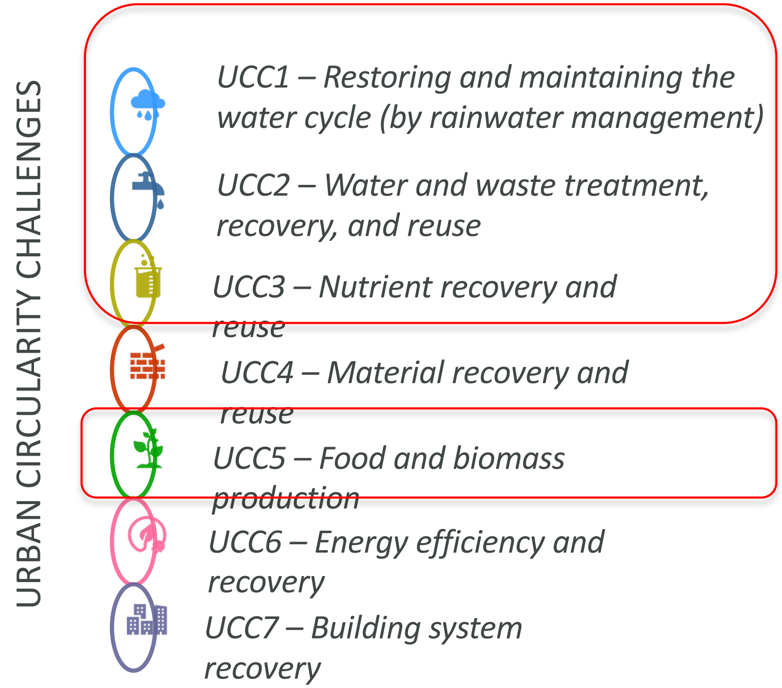
University of Ljubljana
Faculty of Civil and Geodetic Engineering

INTRODUCTION

WSUD: a set of principles, concepts and technologies toward sustainable water management.

- Rainwater is not drained, but allowed to recharge groundwater and feed green spaces
- There is no wastewater, only a resource being recovered and reused
- Both, rainwater and (waste)water are alternative water sources and thus, reduce water demand, which impacts existing water supply systems

Circular City
circular-city.eu
cost
EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY



Langergraber et al., 2021, A Framework for …, *Water* 13, 2355; https://doi.org/10.3390/w13172355 .

WSUD can be implemented:

- *Sporadically; trial and error*
- *By taking informed decisions supported by models*

WSUD MODELS: SCOPE (1)

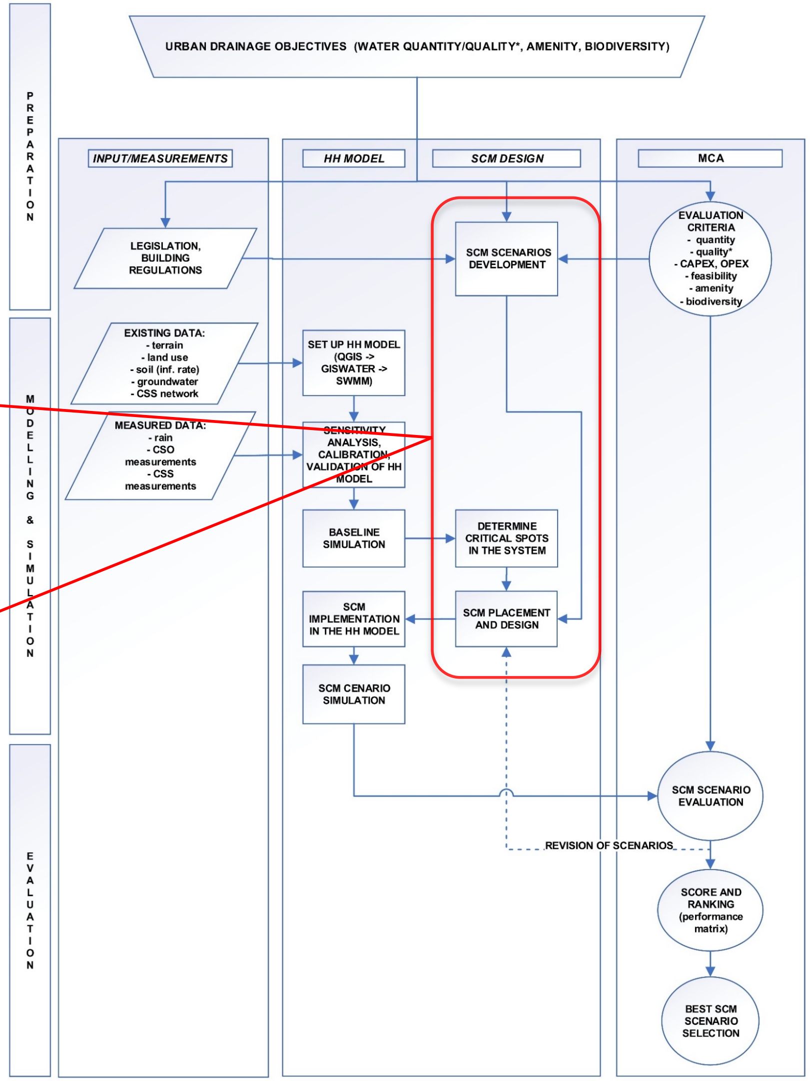
Example: supporting decisions on implementing storm control measures (SCM) or WSUD elements

spatial planning submodels;
placement optimization;
SCM design methods.

RWH at building scale and retention and detention based SCMs.

Addition: their impact on water demand

spatial planning and its impact on RWH potential



WSUD MODELS: SCOPE (2)

Alternative water sources: wastewater treatment and reuse requiring new distribution network

Water supply

Modelling the impacts of reduced water demand on the water supply system and water quality in the water supply distribution network

Edible Cities Network

URBAN AGRICULTURE ? https://toolbox.edicitnet.com/

RESOURCES DEMANDS

WATER
NUTRIENTS
ENERGY
HUMAN

PRODUCTS, YIELD

VEGETABLES
FRUITS
ENERGY VALUE
CARBOHYDRATE S
FATS
PROTEINS

ENVIRONMENTAL BENEFITS

AMOUNT OF LOCAL FOOD
AVOIDED RW TO SEWER SYSTEM
HH WASTE USED
WW USED: RECOVERED NUTRIENTS
AVOIDED P, N RELEASE

Mino, E.; Pueyo-Ros, J et al. Tools for Edible Cities: A Review of Tools for Planning and Assessing Edible Nature-Based Solutions. *Water* **2021**, *13*, 2366. https://doi.org/10.3390/w13172366

AGENDA AND HOUSEKEEPING

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A PALETTE OF MODELLING TO SUPPORT A PLANNING NARRATIVE FOR MULTI-FUNCTIONAL BLUE GREEN INFRASTRUCTURES

Peter M. Bach (peter.bach@eawag.ch)

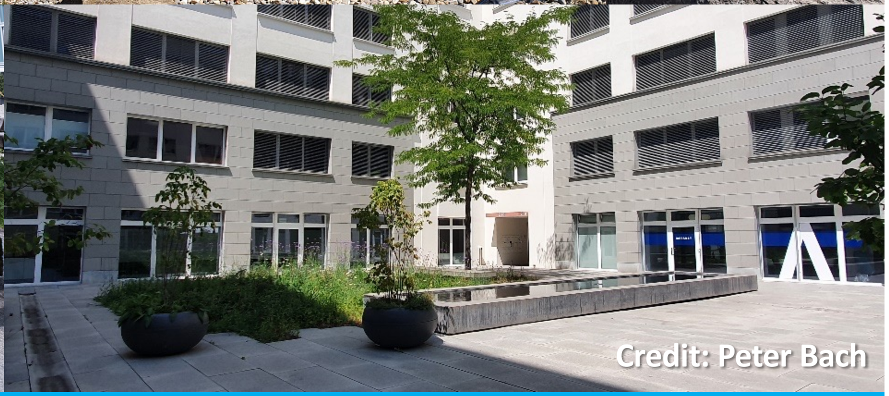
eawag aquatic research
ETH zürich


Credit: Lucas Gobatti


Credit: Peter Bach

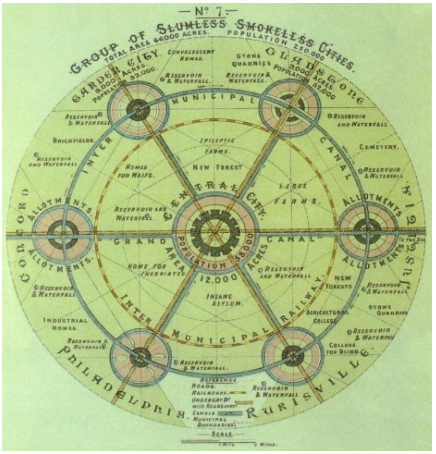

Credit: Peter Bach


Credit: Lucas Gobatti


Credit: Peter Bach

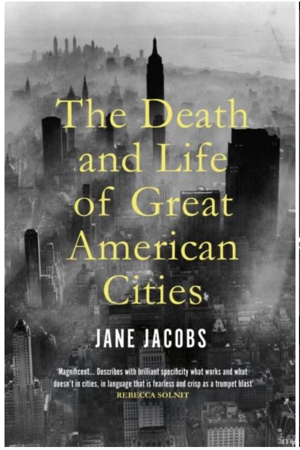
NATURE IN CITIES – NOTHING NEW!

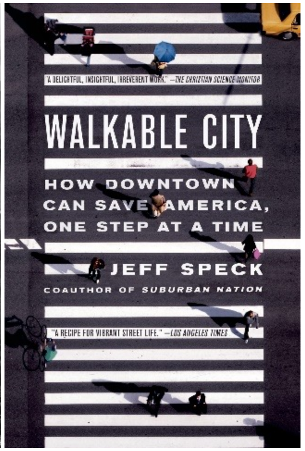
Johann Heinrich von Thunen: 1826



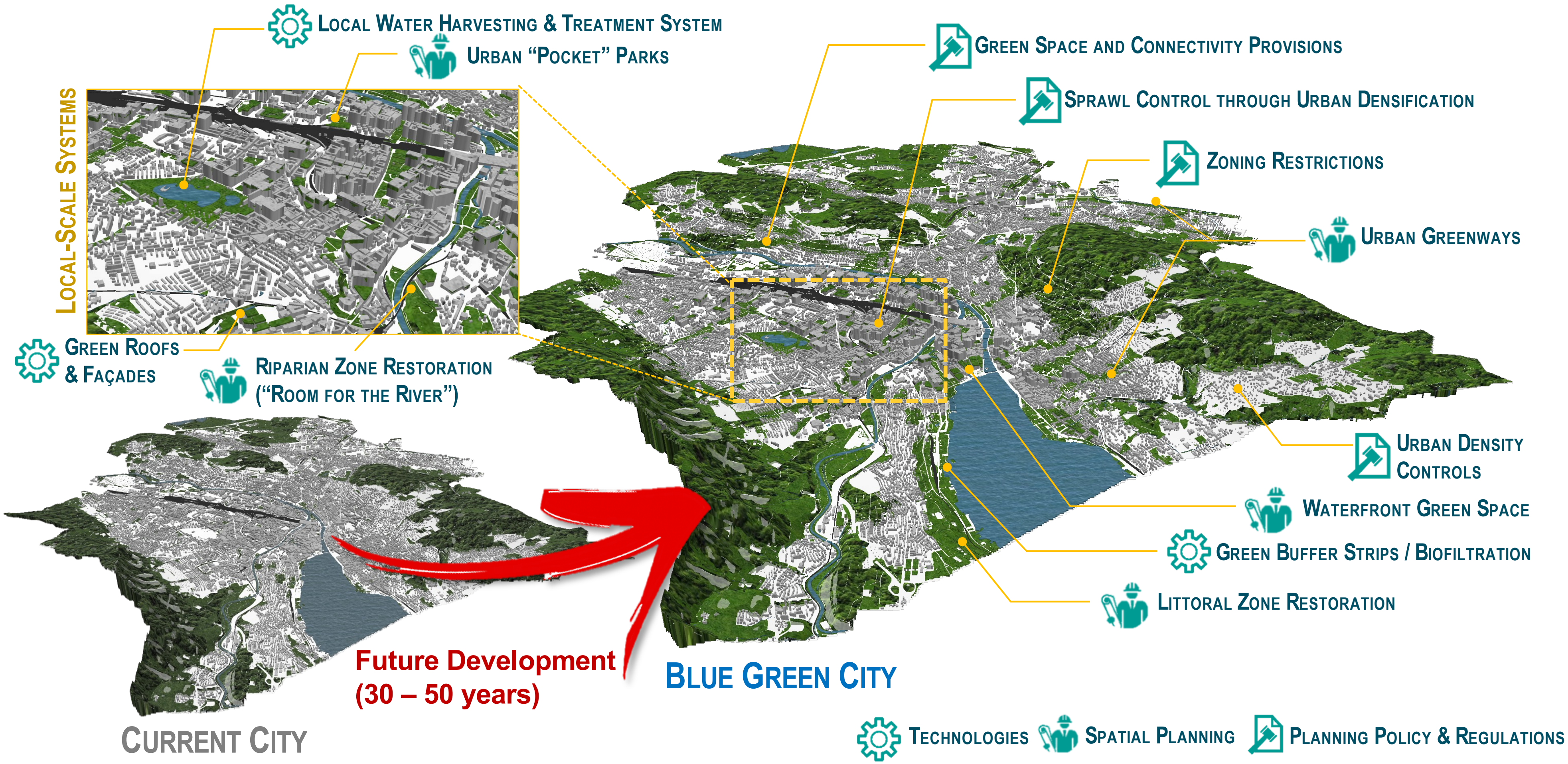
Ebenezer Howard's Diagram of a "Garden City" (1898).

John Claudius Loudon's 1829 proposal for London





THE VISION FOR A BLUE GREEN CITY

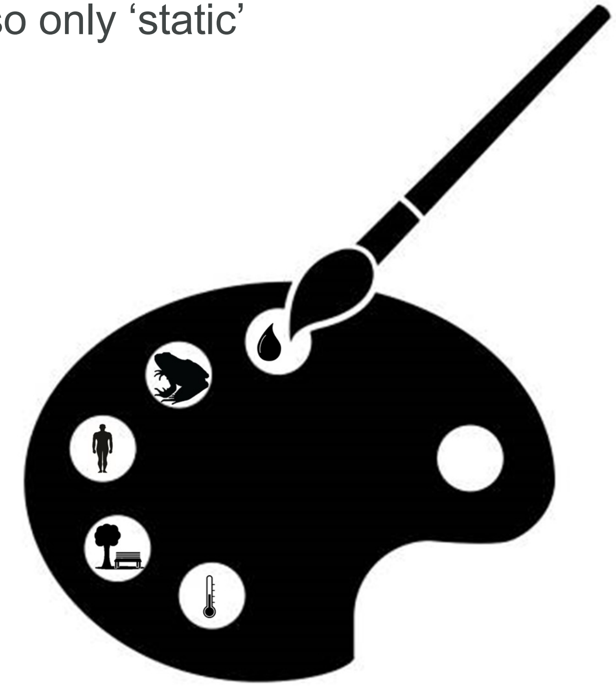


MODELLING AND PLANNING-SUPPORT

- Evidence-based support for guiding decision-making around BGIs
  - Multi-functionality (urban water management, heat mitigation, biodiversity)
  - System types, selection, location (balance of solutions and scales)

- Current approaches too simplistic
  - Proxy maps and indicators assumed ‘representative’ – but also only ‘static’
  - How to inform design and decision-making?
  - Integrated assessment or integrated modelling or both?

- WE NEED A PALETTE
  - Back to first principles
  - Holistic/Big Picture
  - ‘Pick and match’



ASSESSING BGI MULTI-FUNCTIONALITY

Urban Water Management – ‘green’ needs ‘blue’

- Drainage, Flooding, Water Quality
- Alternative water supply

Urban Heat Mitigation – cooler environments

- Active irrigation of areas to promote evapotranspiration
- Human thermal comfort and amenity
- Implications for urban energy use *

Biodiversity protection and enhancement

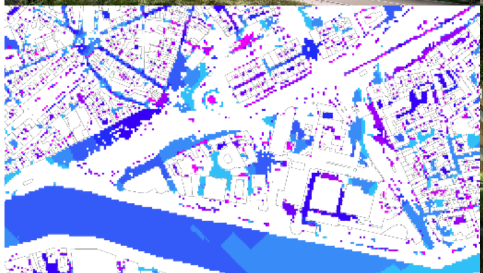
- Landscape greening
- **Connectivity** as ‘safe passage’

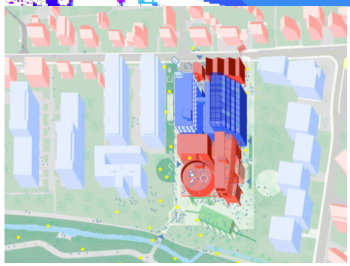
Liveability and amenity

- Access to green spaces for physiological and psychological health
- Future land use planning to ensure provision of blue-green spaces

EPA-SWMM
EPANET
CADDIES-2D
Water balance modelling
TARGET
ENVI_MET
ANSYS FLUENT
CIRCUITSCAPE
Omniscape.jl
Urban BEATS

SUPPORTING ARCHITECTURE PLANNING & DESIGN





51N4E

LO
LA

Djurdjevic+Florean Architectes

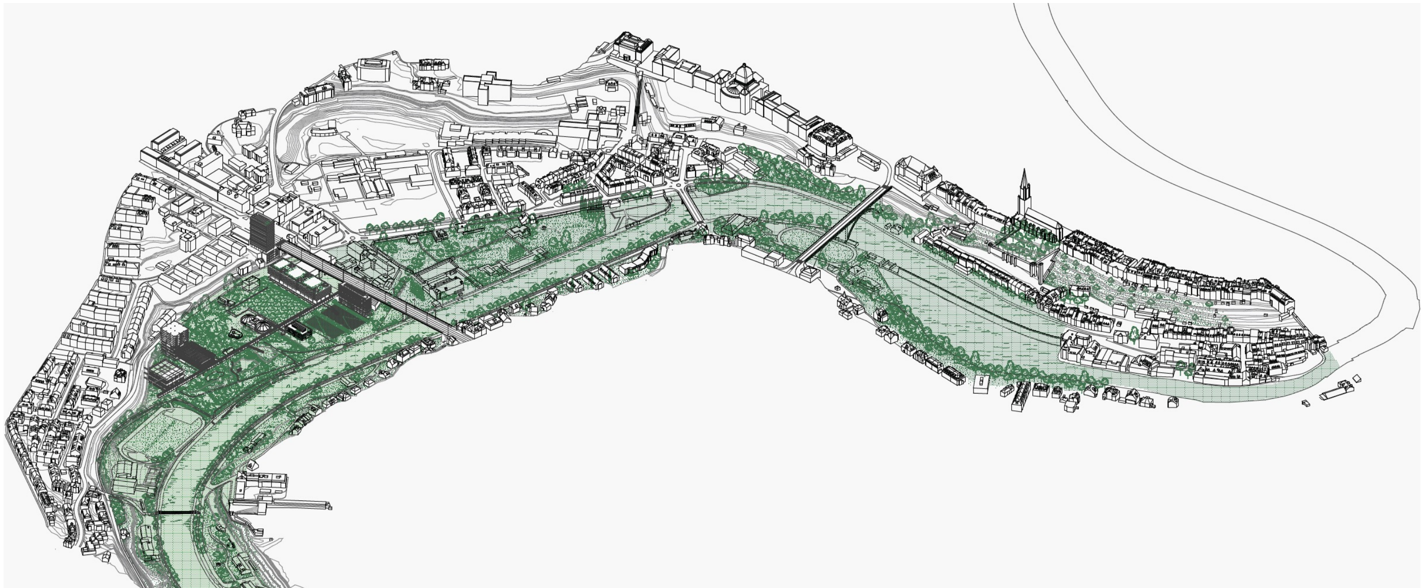
X = (T = E = N)

Ganz

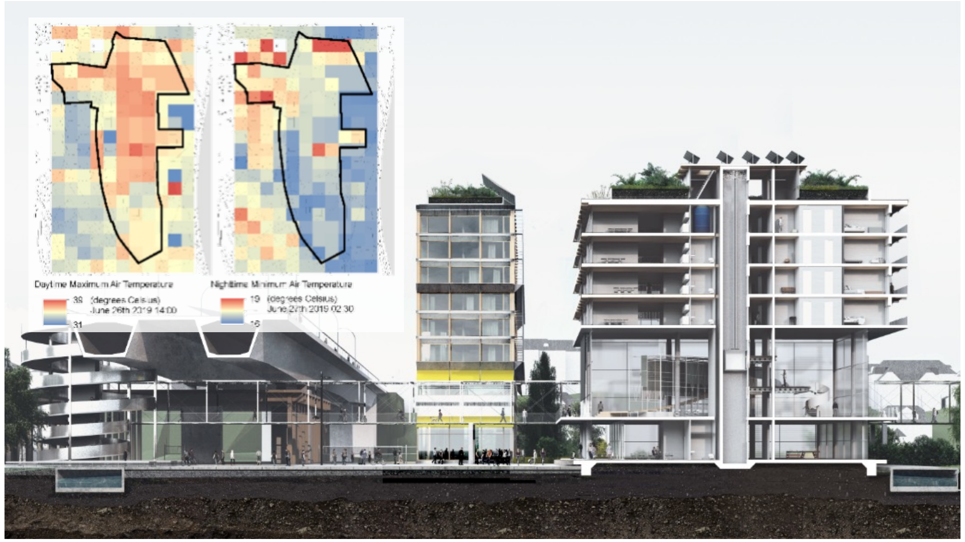
2001

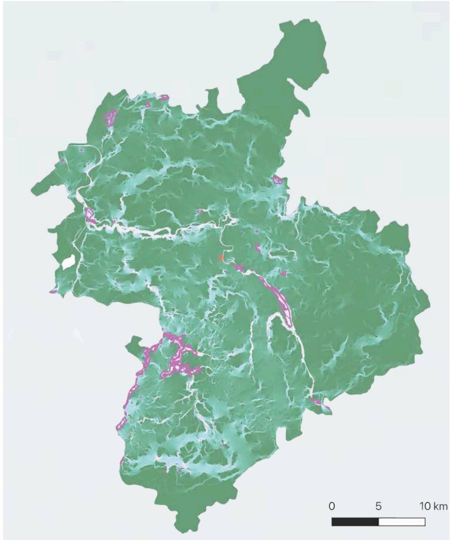
Studio Urbane Strategien

CASE STUDY EXAMPLE – SITE
HABITATE (GASWERKAREAL, BERN CH)



Renderings and Plans © TEN Studio

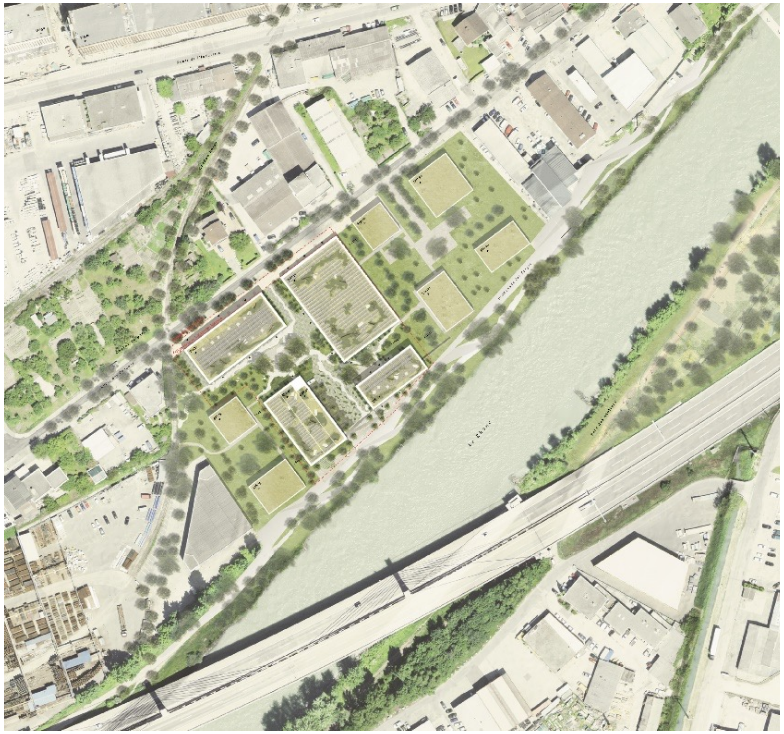


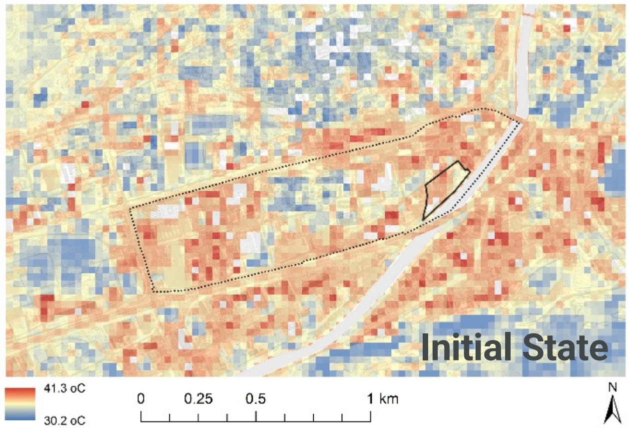


X = (T = E = N)

Studio Urbane Strategien

CASE STUDY EXAMPLE – SITE
COPERNICUS (RONQUOZ 21, SION CH)



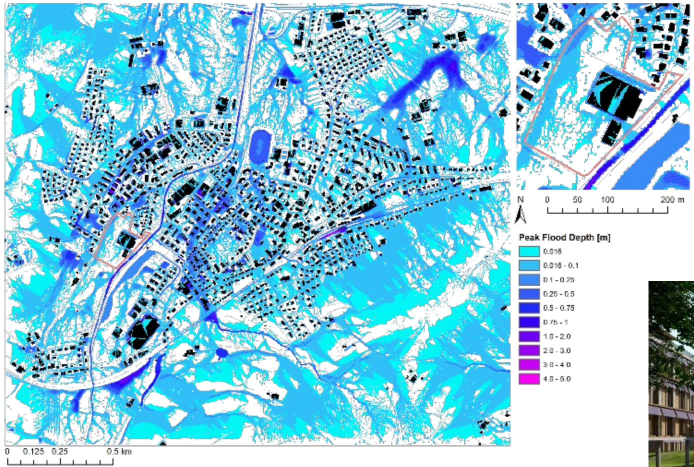


Renderings and Plans © Djurdjevic+Florean Architectes

CASE STUDY EXAMPLE – DEVELOPMENT

AM WASSER (HOFEN, SIRNACH, CH)

X = (T = E = N)



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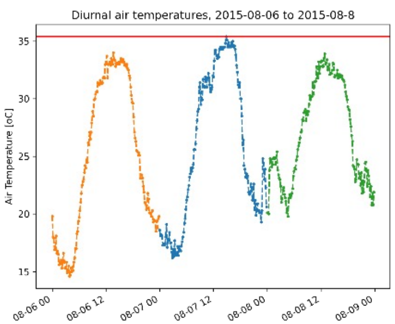

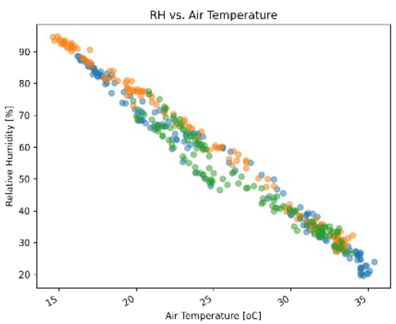

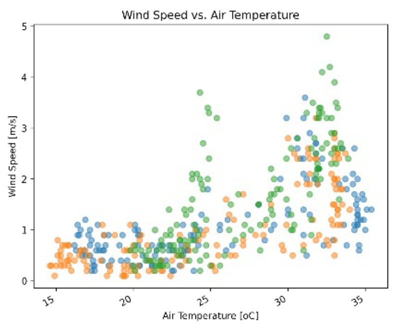

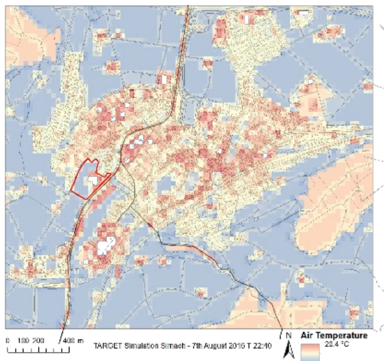

OTHER ONGOING PLANNING NARRATIVES

- Redefining the Greenbelt and its urban-rural gradient (Luxembourg)

2001 51N4E LOLA uni.lu UNIVERSITÉ DU LUXEMBOURG
LE GOUVERNEMENT DU GRAND-DUCHÉ DE LUXEMBOURG
Ministère de l'Énergie et de l'Aménagement du territoire

- BGI Validation Study for a future Residential Development (Bern, CH)

eawag aquatic research
ETH zürich
Stadt Bern
Direktion für Tiefbau
Verkehr und Stadtgrün
WSL
UNIVERSITÄT BERN

- Future Urban Corridor Planning (Belgium)

51N4E

LESSONS LEARNT

- **Modelling challenges:**
  - Current state assessments – data limitations and assumptions needed
  - Model calibration and validation – creative approaches needed, time constraints
  - Workflow – ‘quick & dirty’ followed by refinements where possible
  - Design evaluations – relative comparisons and showing change
  - Integration – in many cases not necessary, but need an overarching framework

- **Communication challenges:**
  - Expectation management!
  - Complexity and presentation of results
  - Output formats – cross-disciplinary challenges

KEY TAKE-HOME MESSAGES

- **Multi-functionality** addresses space challenges and the business case for BGI
- **'Quantified'** and interdisciplinary approaches becoming the norm – modelling more powerful than ever
- Scientific **evidence-base** supports design plausibility – more 'bang for buck' – but must do from **'first principles**!'
- Integrated models and assessment provides a sense of **'dynamism'** to guide otherwise 'static' design
- **Key Recommendation:** Identify the first 'entry point' stakeholder and demonstrate the power of integrated assessment
- A **'palette'** implies that not everything needs integration

THANK YOU FOR JOINING!

Get in touch!

peter.bach@eawag.ch

youtube.com/c/PeterMarcusBach

@petermbach

@petermbach87

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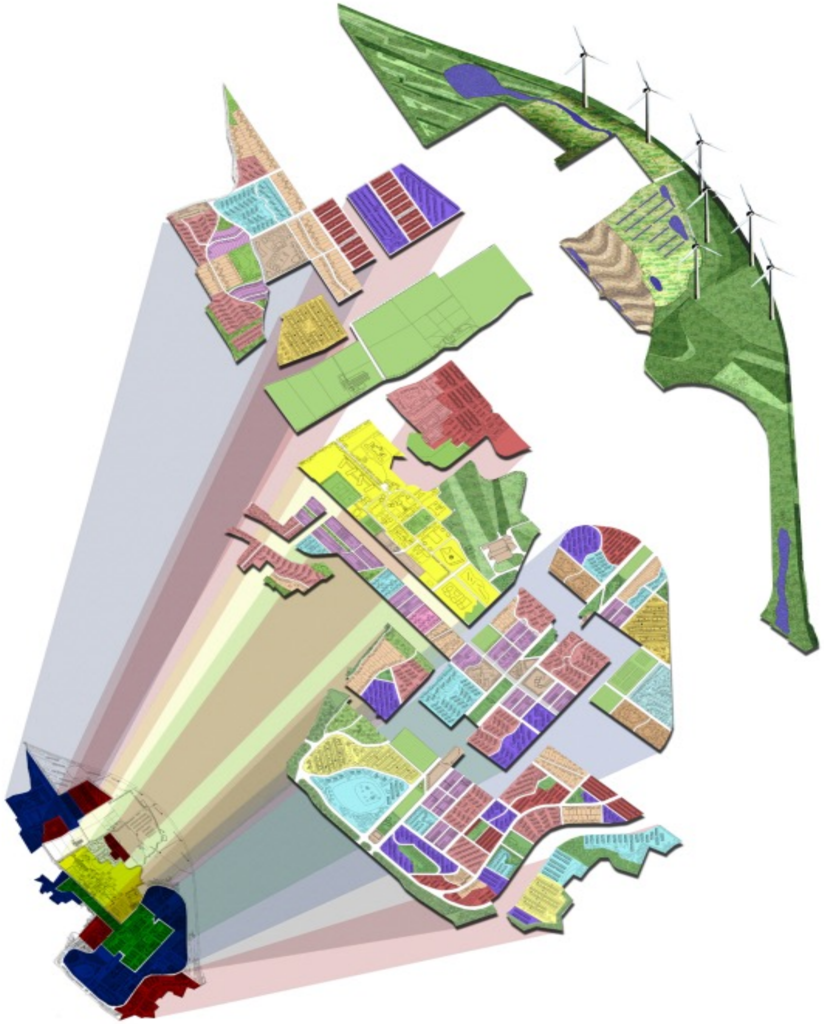


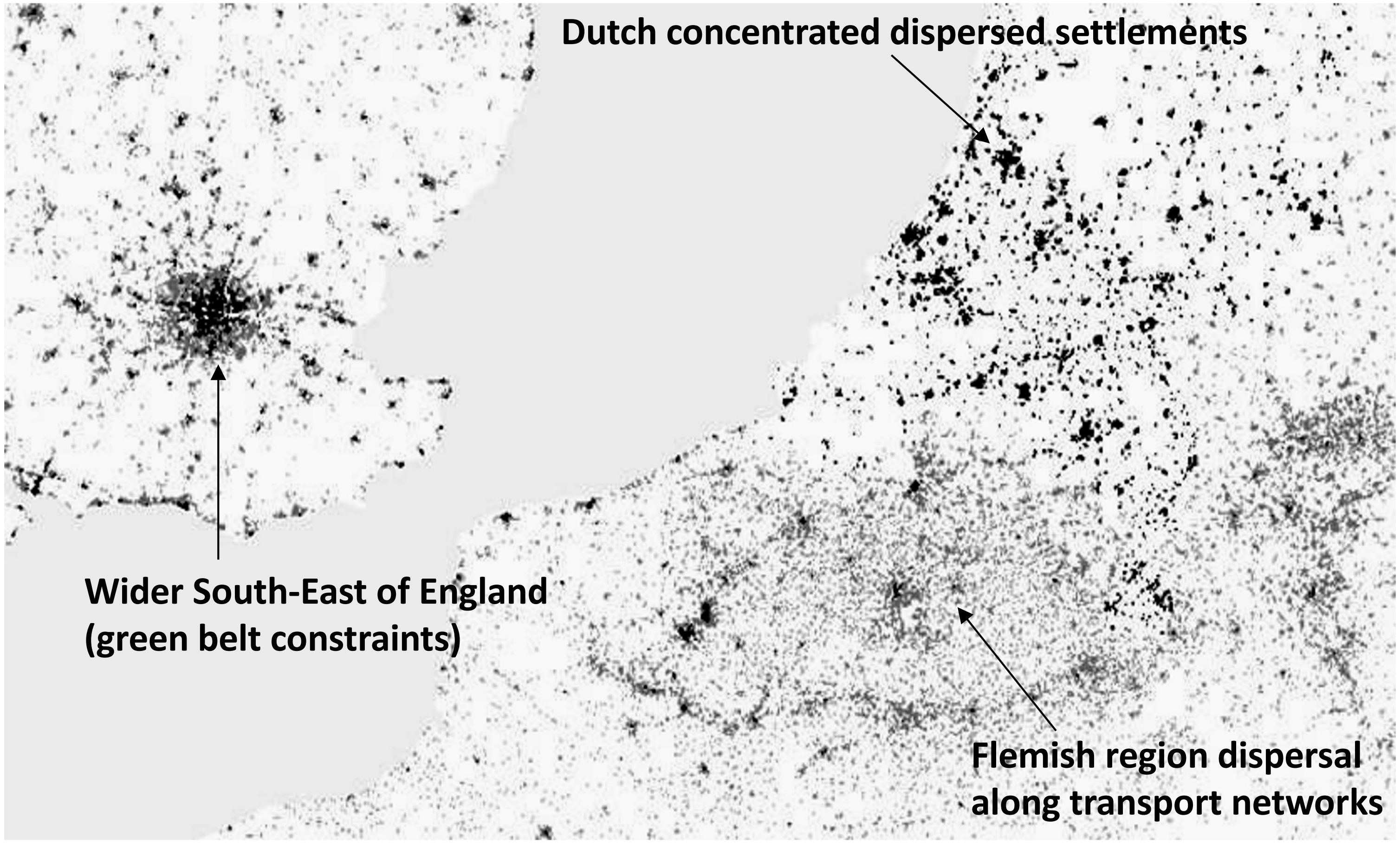
An integrated modelling framework to forecast how regional spatial planning affects the viability of building-scale alternative water supply systems

Dr Tony Hargreaves

Department of Civil Engineering
University of Birmingham

IWA MIA webinar - Modelling and integrated assessment tools for water sensitive urban planning

Spatial planning policies affect urban development



(adapted from Corine land cover maps European Environment Agency)

2

Land supply versus floorspace demand affects urban densities

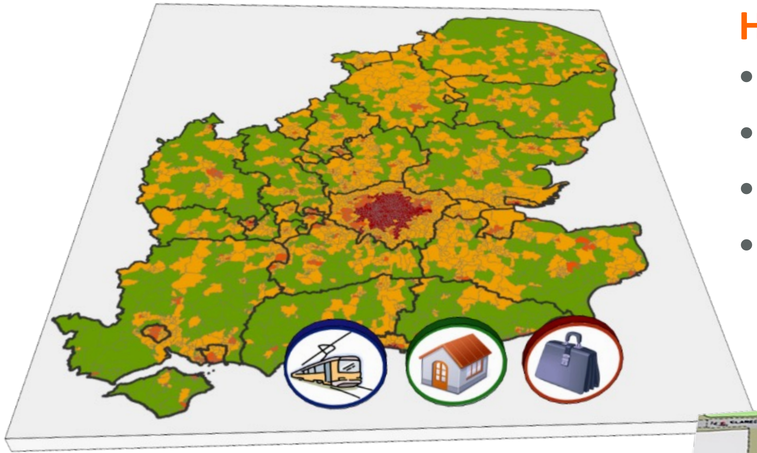
(photographs from Harrison, 2008)

Affects:-

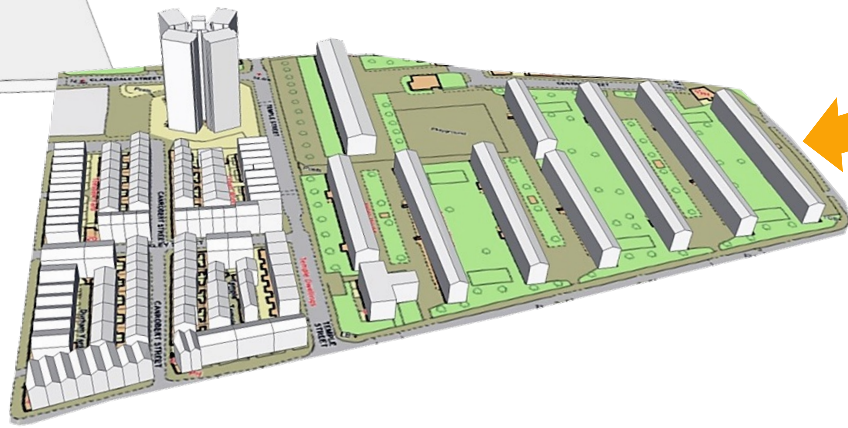
- Building types, dimensions, plot size, and land cover
- Number of occupants and water demands per building
- Feasibility and potential of different water systems
- Permeability, runoff and flood risk

3

Linking regional planning to building-scale alternative water supply

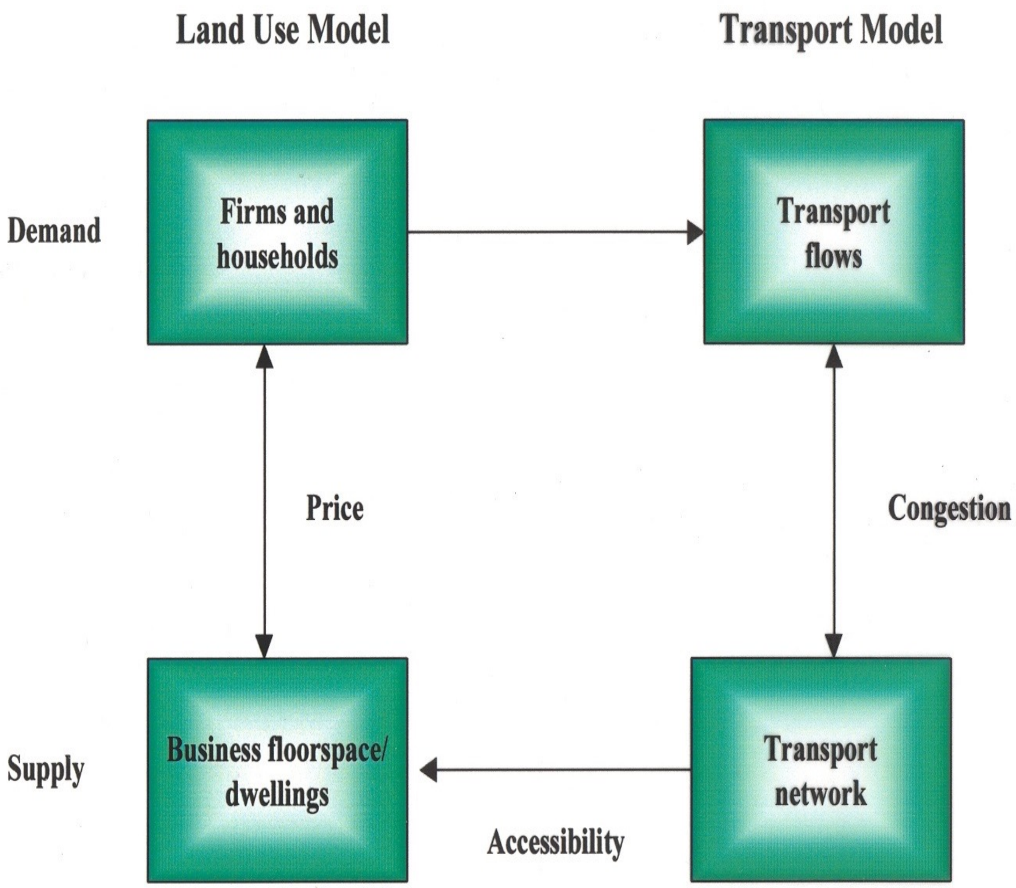


High level Planning:
- Growth (population, economic, etc.)
- Spatial development pattern
- Land use and transport
- Employment and households



Local Decisions:
- Urban form
- Infrastructure design (energy, water, waste, etc.)

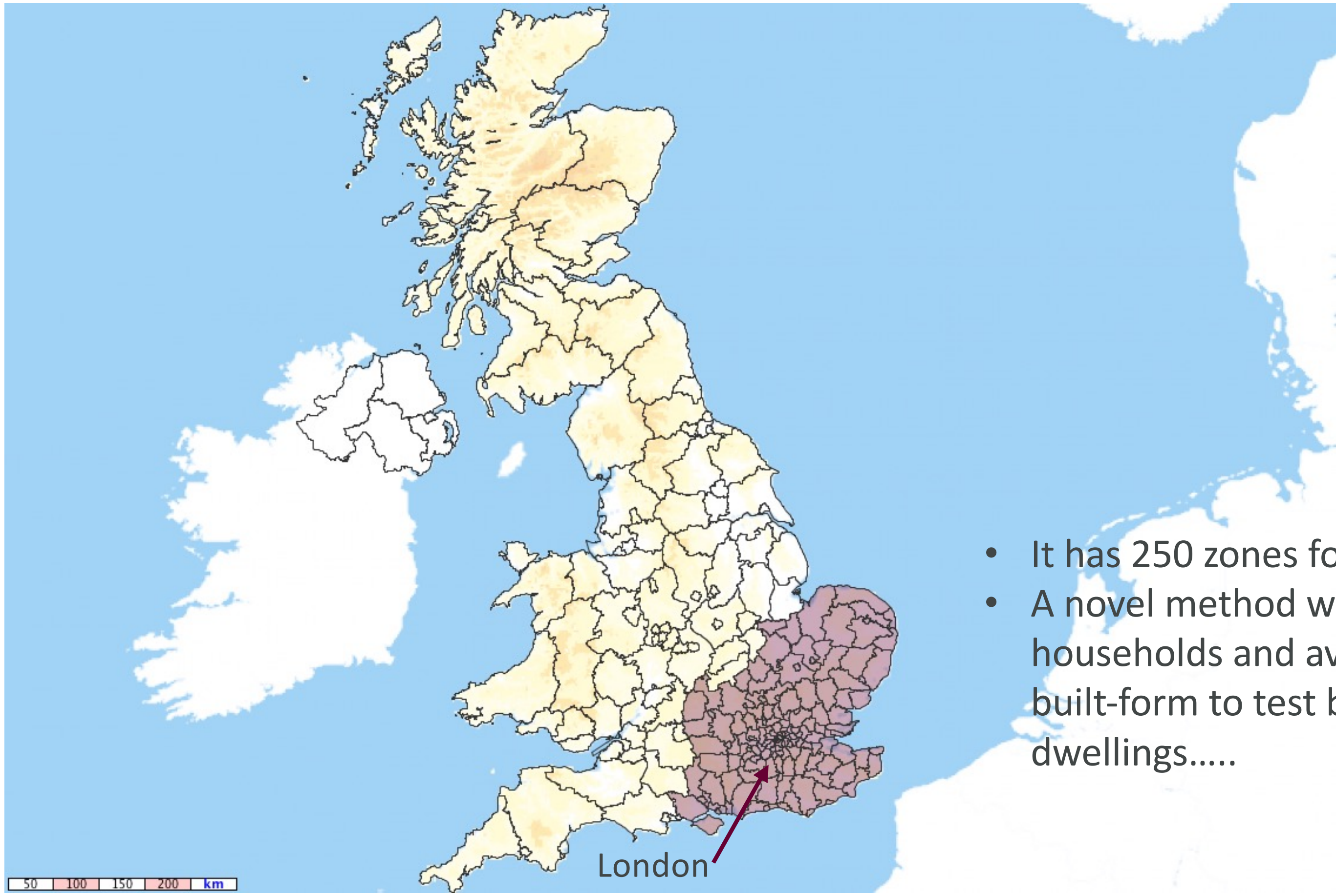
Overview of the regional-scale model



- It models the interaction between land use and transport
- It simulates the market for land (Echenique, et al., 2013)
- It is useful for understanding relationships between variables and for forecasting the relative differences between options.
- This type of model is well established and used by some national and regional planning authorities for testing spatial planning and economic development strategies
- It provides aggregate outputs per zone, such as employment and households per sector and residential density.

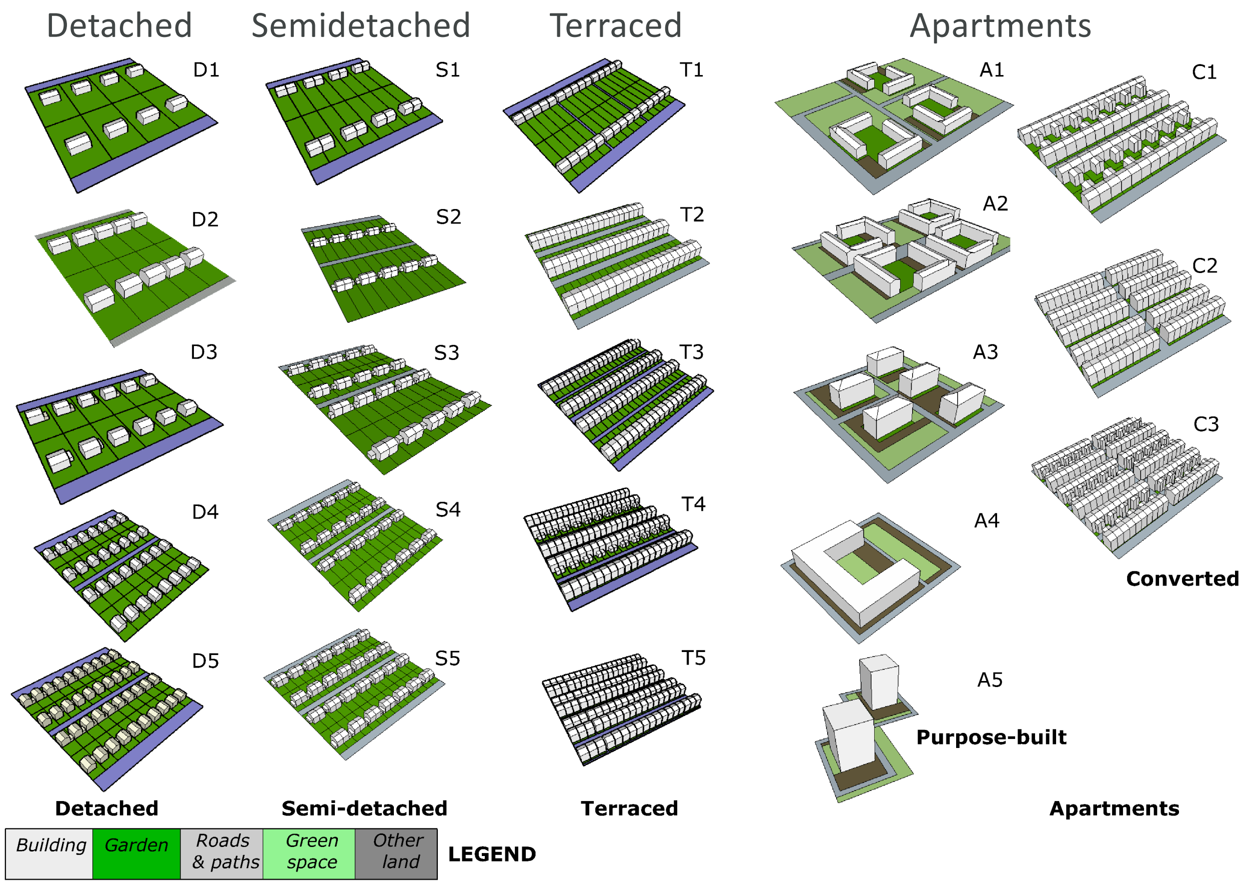
5

Zone of the regional scale model



- It has 250 zones focused on the Southeast regions
- A novel method was needed to convert the households and average density per zone into built-form to test building-scale technologies for dwellings…..

Generic 'tiles' (1 hectare)



The tiles are designed using English Housing Survey data, to represent;

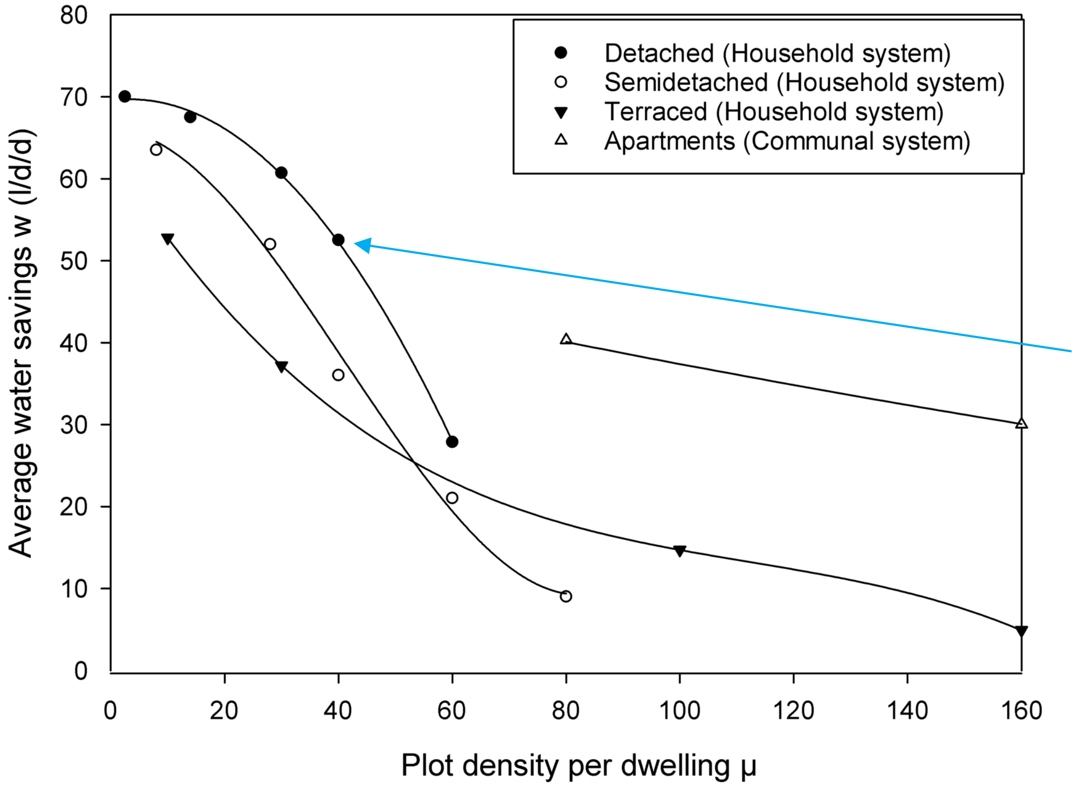
- Building dimensions & plots sizes
- Permeability of land cover
- Potential for communal systems

They provide a useful medium for interdisciplinary working and for selecting, modelling, and sizing building-scale systems.
They are used as abstract objects for spatial accounting (Hargreaves 2015 & 2021).

7

Modelling building-scale alternative water supply

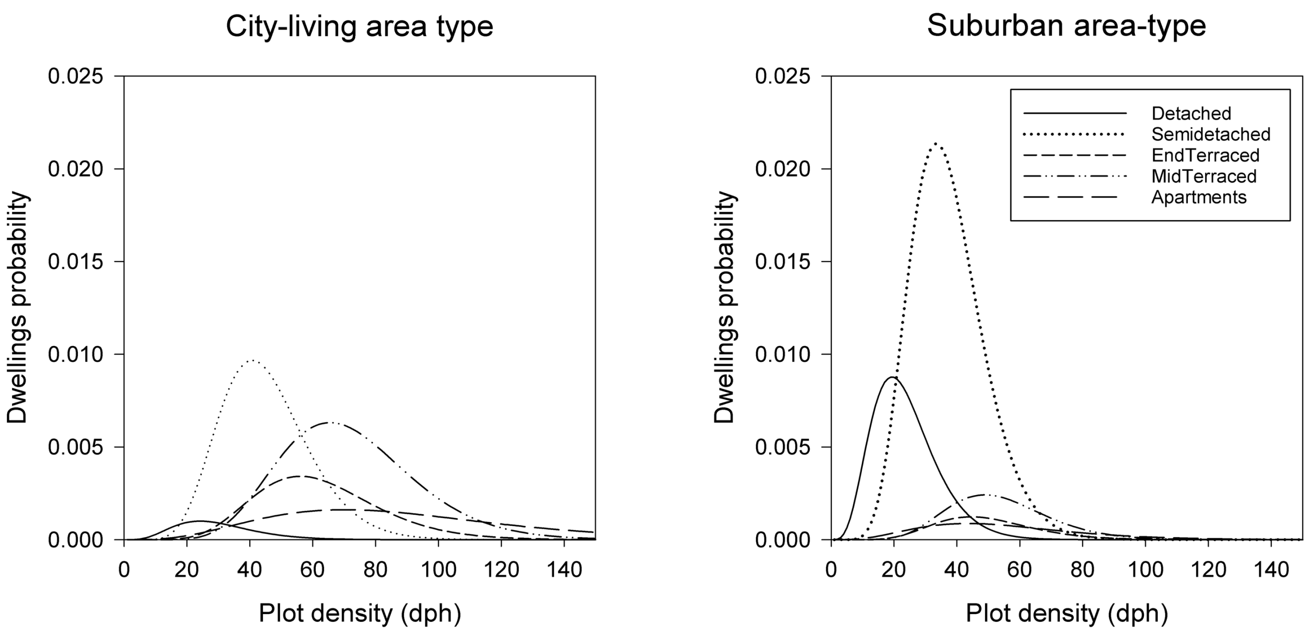
Example for rainwater harvesting (RWH)



- The regional modelling provides the inputs of population and floorspace per zone.
- Data was also available on water demands and rainfall per local area.
- The tile type provides the household size and dwelling dimensions, e.g., roof area suitable for harvesting rainwater.
- Water savings and cost per RWH system are then modelled per tile type per zone.
- The average water savings depend on the likely uptake of RWH (i.e., its cost effectiveness) and the water savings per system.
- A non-linear function is fitted to these discrete points.

Note that this example is for the New-build dwellings and results depend on the study area and assumptions

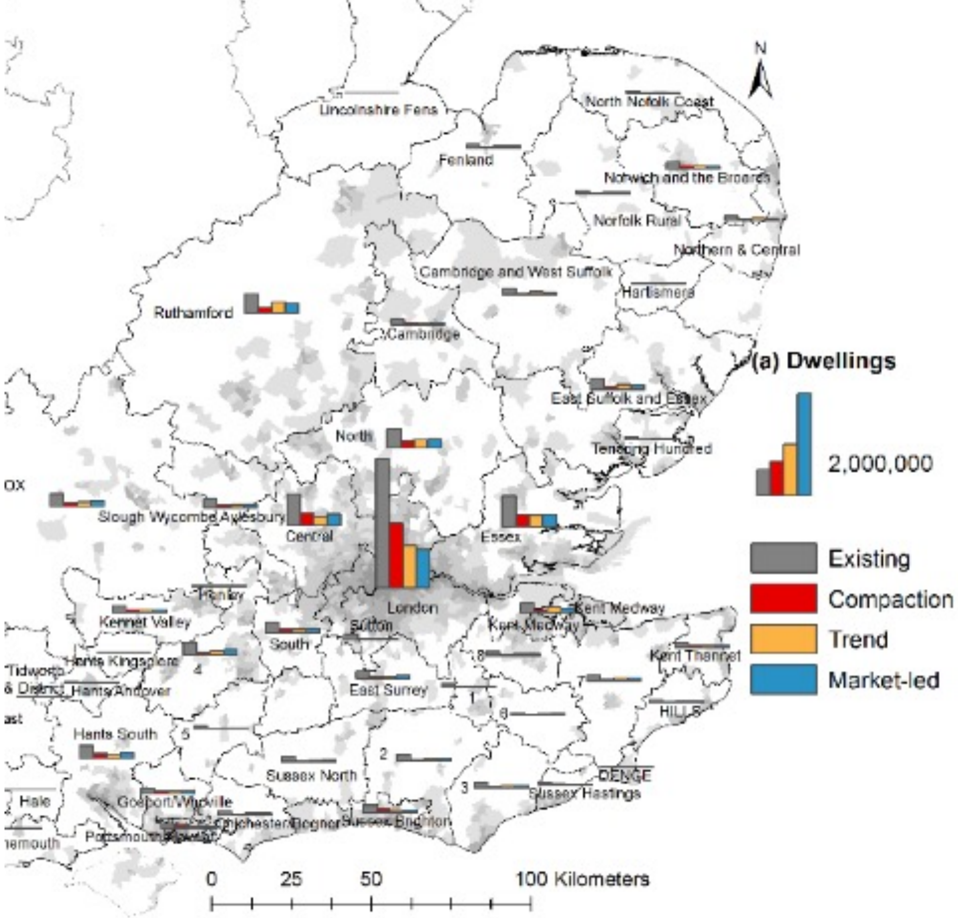
Modelling the dwellings
(comparison between 2 of the 7 Output Area types)



- From analysis of the English Housing Survey, if the dwellings are disaggregated by dwelling type, area type and age-band, then their ‘plot density’ distribution is similar to a gamma distribution and the shape parameter can be calibrated per dwelling type. The dwellings can then be modelled using the average residential density of the zone as the input (Hargreaves, 2015)
- The water savings functions from the previous slide are combined with these dwelling distributions to model the total water savings of the zone (Hargreaves, 2021).

Testing the impacts of spatial planning on the future potential of alternative water supply

Existing dwellings in 2001 and New-build per option 2001 to 2031



The bar for ‘Existing’ shows the dwellings in 2001 that would still exist in 2031 for each Water Resource Zone (WRZ).

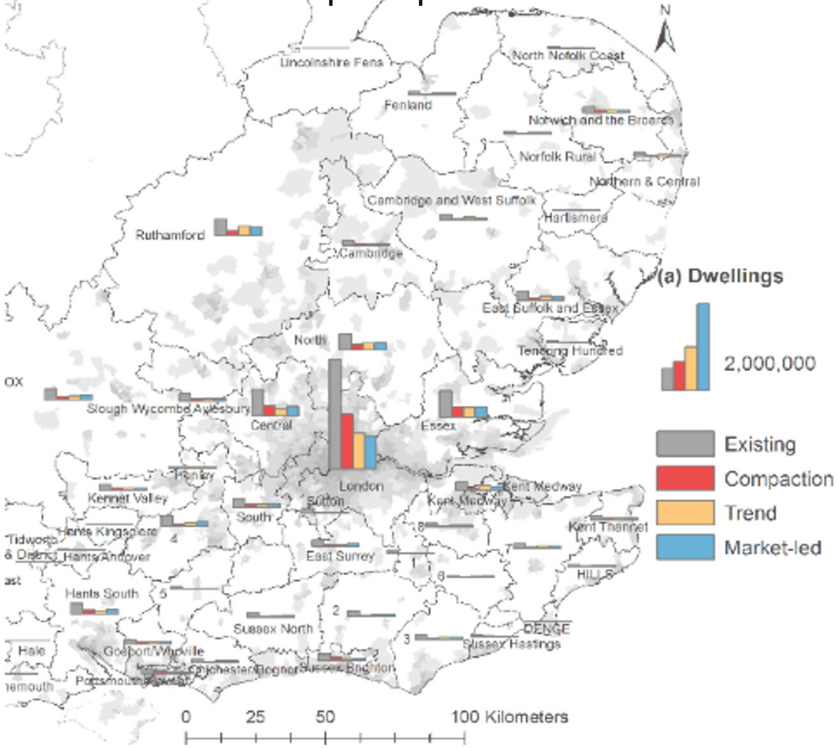
The bars for the three spatial planning policy options show the modelled ‘New build’ dwellings over this 30 year period:-

- Compaction – development within existing urban boundaries at higher densities
- Trend – based on the planning policies of the local authorities
- Market-led – develop where the demand for housing is greatest – mostly at lower densities

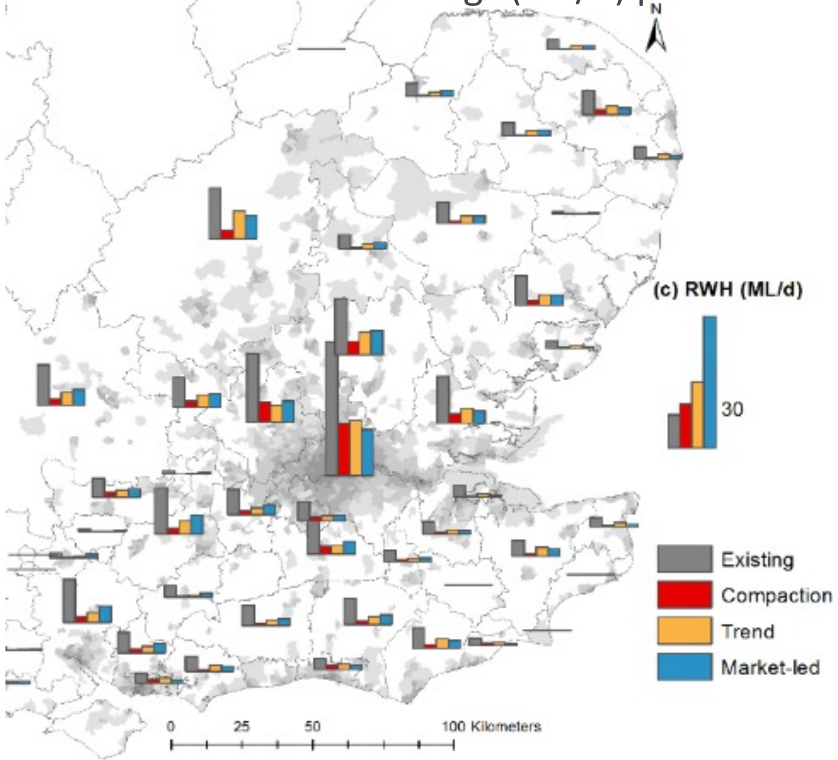
10

Results from joint research with the Centre for Water Systems, University of Exeter (Hargreaves, Farmani, Ward, & Butler, 2019)

Existing dwellings in 2001
and New-build per option 2001 to 2031



Modelled water savings of rainwater harvesting (RWH)
Total water savings (ML/d) per WRZ



The water savings per dwelling of RWH would be less in the dryer eastern areas than in the wetter western areas. These water savings would be greater in the lower density outer areas (e.g., 'Market-led' option) and less in higher density areas (e.g., Compaction option).

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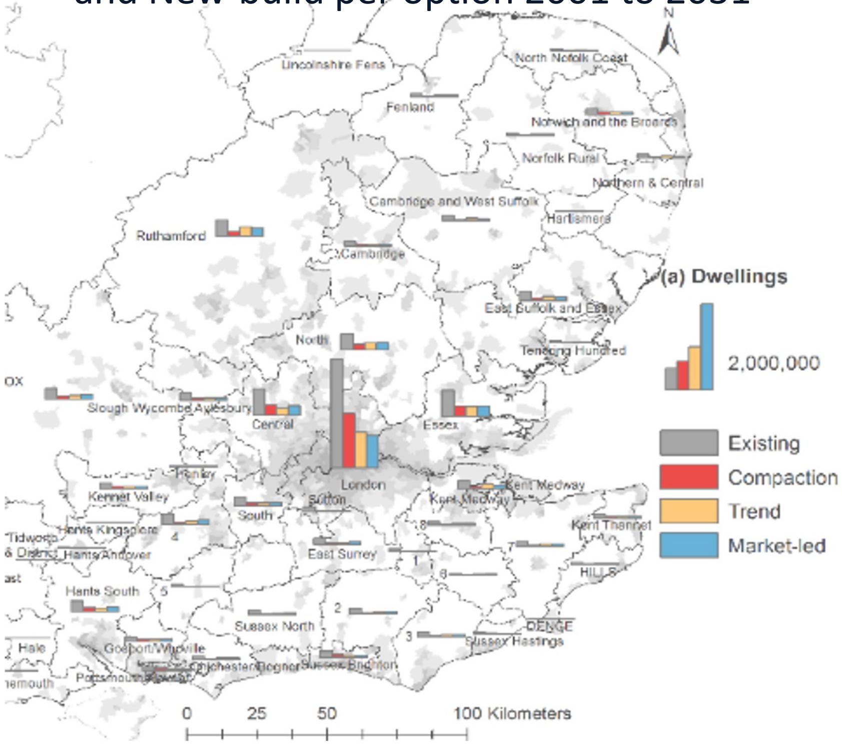
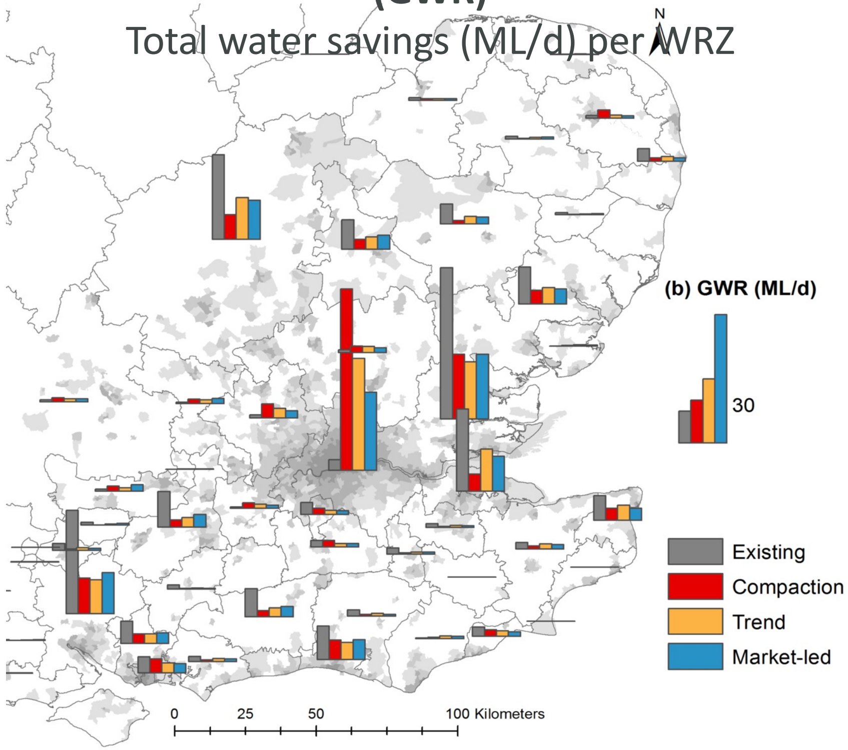
Results from joint research with the Centre for Water Systems, University of Exeter (Hargreaves, Farmani, Ward, & Butler, 2019)

Existing dwellings in 2001
and New-build per option 2001 to 2031



Modelled water savings of greywater recycling (GWR)

Total water savings (ML/d) per WRZ



Water saving per dwelling of GWR would be greatest in New-build' in higher density areas that would have a high percentage of apartments suitable for Communal GWR (e.g., 'Compaction' in London).
GWR would be less viable for areas lower water demands per person and dwellings with small households (e.g., 'Existing' dwellings in London.

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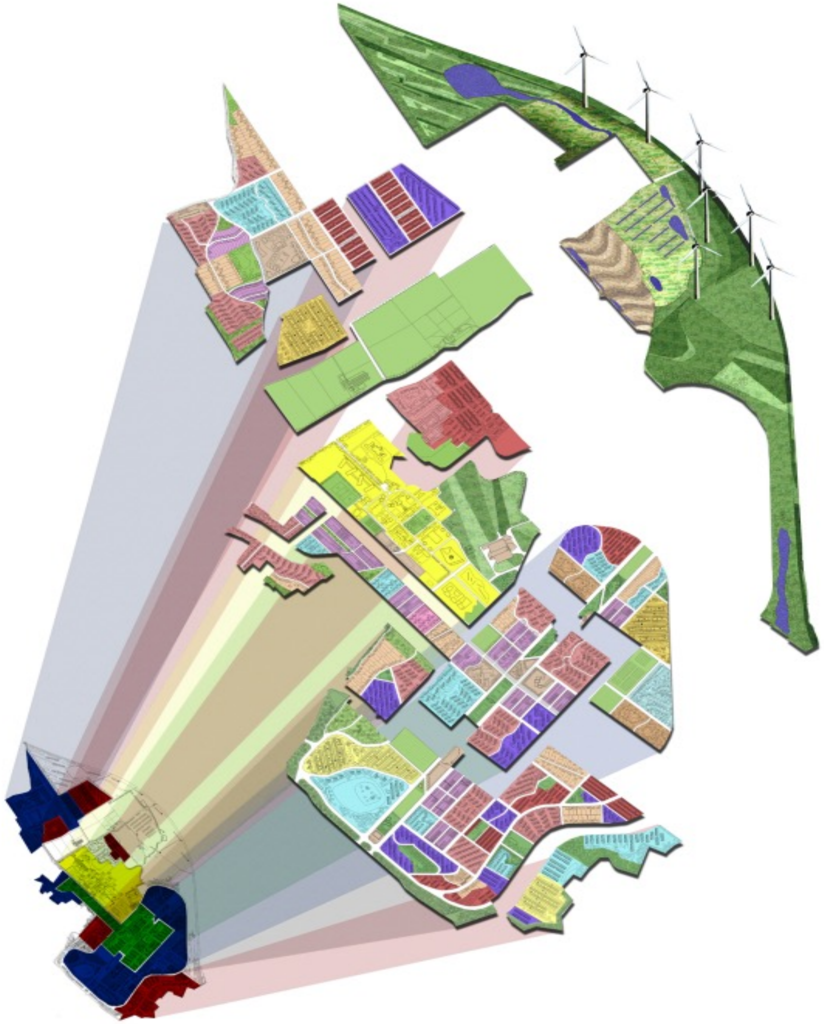
CONCLUSIONS

- This integrated modelling framework achieves the difficult challenge of linking regional scale planning to future built form at the building scale.
- It succeeds because it represents the variability of built form without attempting to model the spatial layout of urban areas – the buildings, plot areas and water savings are modelled abstractly, which is sufficient for modelling building-scale systems.
- It could be used for focused optioneering to better understand how spatial planning options would affect the future potential of sustainable technologies (e.g., to reduce the demands on the conventional water networks).
- It could provide useful inputs for the planning of water management for water sensitive cities and what infrastructure will be needed for the future.
- It could enable constructive engagement between water companies and planning authorities on high-level scenario analysis to better coordinate spatial planning, building regulations and policy support to improve the future sustainability and resilience of urban areas.

FOR FURTHER INFORMATION, SEE THE FOLLOWING PUBLICATIONS:

- Hargreaves, A.J.* 2021. A parametric model of residential built form for forecasting the viability of sustainable technologies. Sustainable Cities and Society, 69, 16, 102829*. – validates the tiles method and gives an example for rainwater harvesting*
- Hargreaves, A.J.*, Farmani, R., Ward, S., Butler, D. 2019. Modelling the future impacts of urban spatial planning on the viability of alternative water supply. Water Research, 162, 200-213 – *compares the impacts of regional scale planning on the viability of rainwater harvesting and greywater recycling*.
- Hargreaves A.J.,* Cheng V., Deshmukh S., Leach M., Steemers, K. (2016) Forecasting how residential urban form affects the regional carbon savings and costs of retrofitting and decentralized energy supply. Applied Energy. 186(3), 549-561 – *shows how the same method can be used for building-scale energy supply.*
- Hargreaves A.J.* (2015) Representing the dwelling stock as 3D generic tiles estimated from average residential density, Computers Environment and Urban Systems, 54 280-300. – *presents the tiles method*
- Echenique M.H., Grinevich V., Hargreaves A.J.*, Zachariadis, V. (2013) LUISA: A Land Use Interaction with Social Accounting model; presentation and enhanced calibration method. Environment and Planning B, Vol. 40, 1003-1026. – *provides details of the regional scale model.*



Thank you

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AGENDA AND HOUSEKEEPING

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IWA on Modelling tools for water sensitive urban planning

April 13th, 2023
Webinar

Optimal design of water reuse networks in cities: decision support tool development and testing

David Martínez, PhD Candidate (UdG/ICRA)
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the international water association

Broadband Communications and Distributed Systems

Universitat de Girona

Institut Català de Recerca de l'Aigua

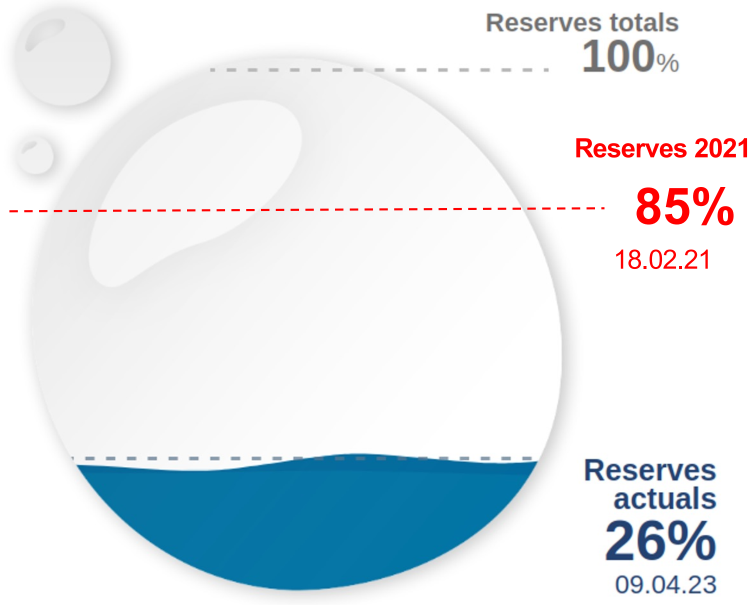
Water reuse cannot wait any longer!

What is the problem?

- **Water scarcity and draws** cause an urgent need for reuse.
- The design of reclaimed water networks is **expensive** and **complex**.

How can we solve it?

- **Can you imagine** an optimal planning of water reuse networks (maximum of served water with minimum cost)?
- Now is the time, we present a novel decision support system (DSS) to automatically design optimal water reuse networks: **REWATnet**.



State of water reserves in Catalonia (Source: ACA)

Centralized or decentralized approach?



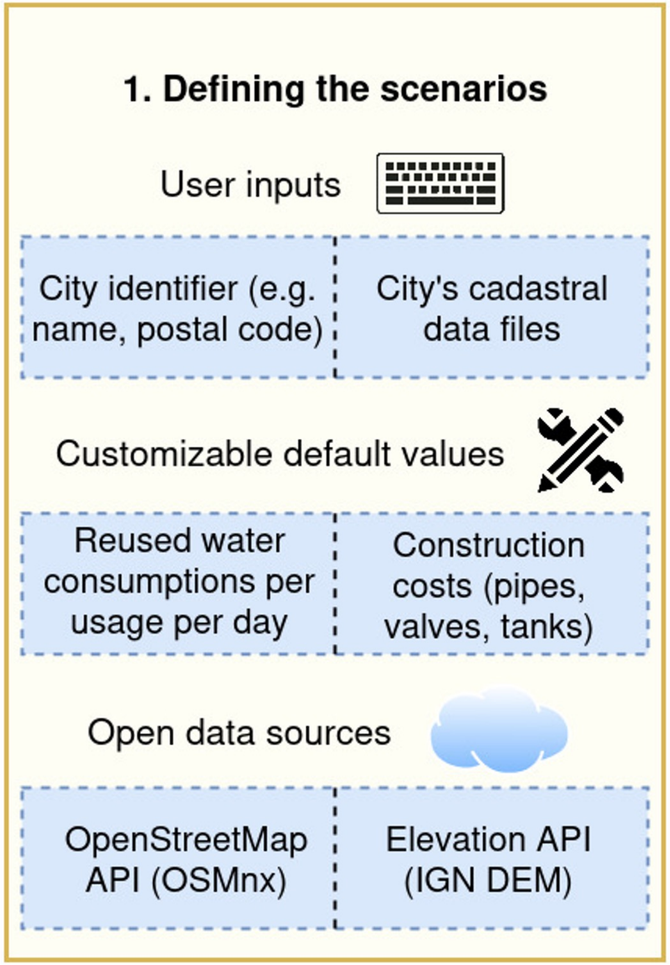


REWATnet: Defining the scenarios

- REWATnet: A novel tool to design optimal water reuse network.

- The tool considers the following reclaimed water uses:
  - **Economic operations**: Commercial applications (toilet flushing and industrial consumptions).
  - **Public**: Urban equipment and public garden irrigation.
  - **Domestic**: Toilet flushing and private garden irrigation.

Example of city's cadastral data



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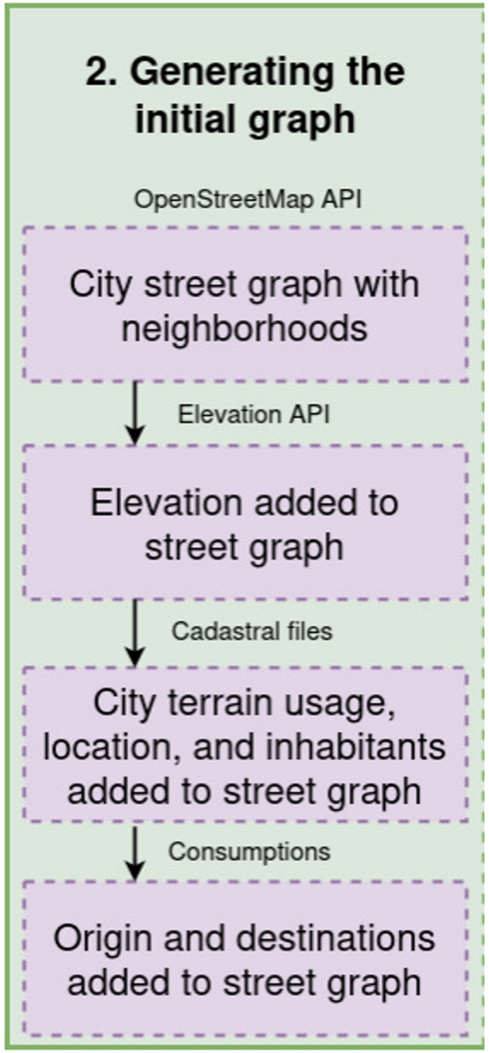
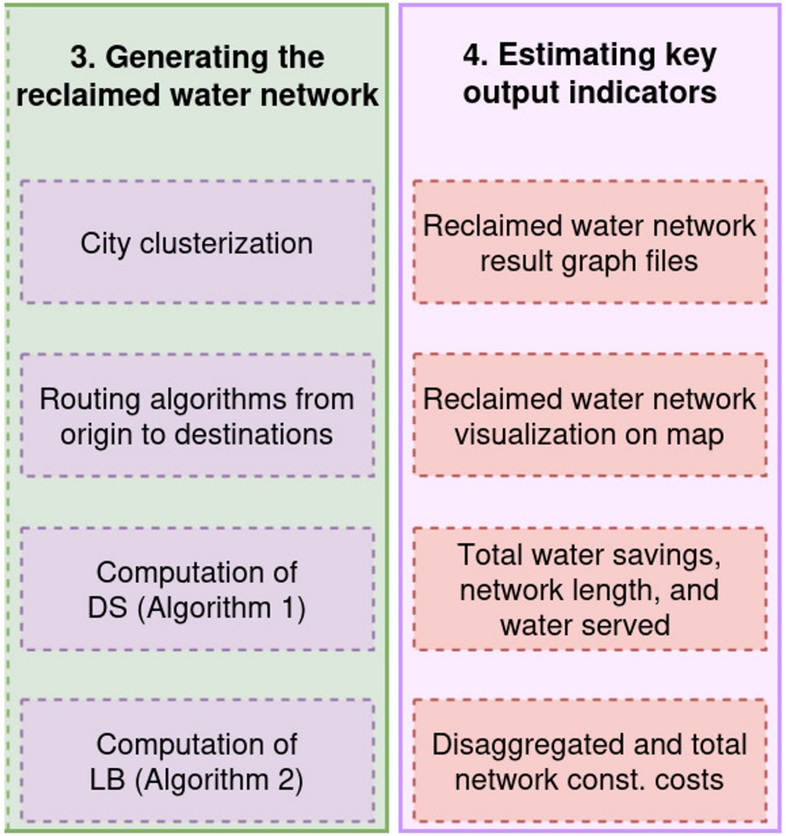
REWATnet: Generating the initial graph

- An **initial graph** is generated from city street graph, cadaster files, and elevations database.
- The **source** (water tank) and **potential destination nodes** (reclaimed water demand points) are added to the graph.



REWATnet: Application of the algorithms

- The **algorithms** start from the initial graph and are based on the application of graph theory [1].
- **City clusterization** is applied in large cities through the Louvain algorithm [2].
- **Routing algorithms** are used for the design of the reclaimed water network, to route the source with destination nodes through minimal trees (Mehlhorn algorithm [3]).
- The **Diameter selection (DS) algorithm** selects an optimal diameter for each pipe of the reclaimed water network based on the destination consumptions.
- The **Limited Budget (LB) algorithm** is an iterative greedy algorithm that maximizes the water served (m^3) with a limited budget. Evaluates the addition of potential consumption nodes considering their consumption and the cost of adding them to the network.



[1] Kesavan, H. K., & Chandrashekar, M. (1972). Graph-theoretic models for pipe network analysis. Journal of the Hydraulics Division, 98(2), 345-364.
[2] Blondel, V. D., Guillaume, J. L., Lambiotte, R., & Lefebvre, E. (2008). Fast unfolding of communities in large networks. *Journal of statistical mechanics: theory and experiment*, *2008*(10), P10008.
[3] Mehlhorn, K. (1988). A faster approximation algorithm for the Steiner problem in graphs. Information Processing Letters, 27(3), 125-128.

REWATnet: Girona case study

- **Girona case study**: Application of REWATnet in the entire city considering (i) all water uses with five clusters and (ii) all water uses with limited budgets.

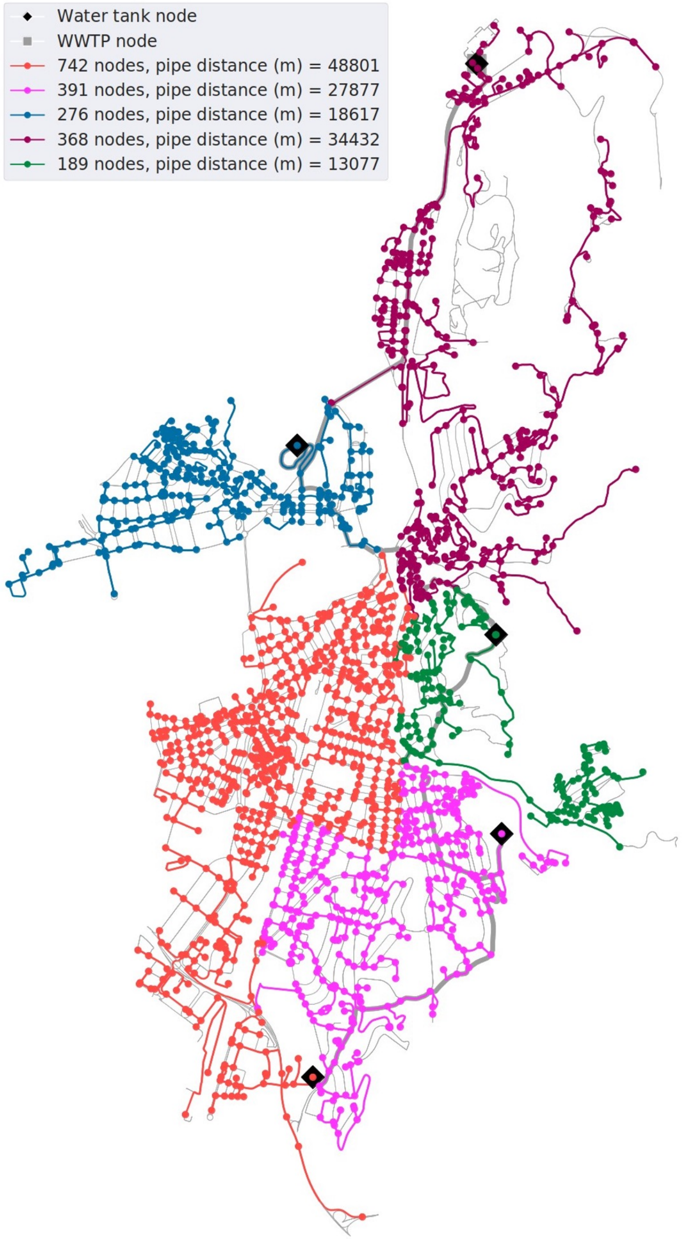
- A **validation study** was carried out to calibrate the model comparing the model consumption and the actual consumption of the current water distribution network provided by the authorities.

Water use categories	**Model consumption (m^3/year)**	**Actual consumption (m^3/year)**	**Error**
Economic operations (Domestic with operations + Large industrial consumption)	530,564	525,588	2.8 %
Public uses (Urban equipment + Public garden irrigation)	251,405	203,064	23.8 %
Domestic (Housing + Private garden irrigation)	1,690,877	1,594,735	6 %
All validated uses* (Economic operations + Public uses + Domestic)	2,472,846	2,323,387	6.4 %

*All validated uses do not include the vegetable garden irrigation model consumption (estimated as 269,005 m^3/year) as there is no actual consumption data to be compared.

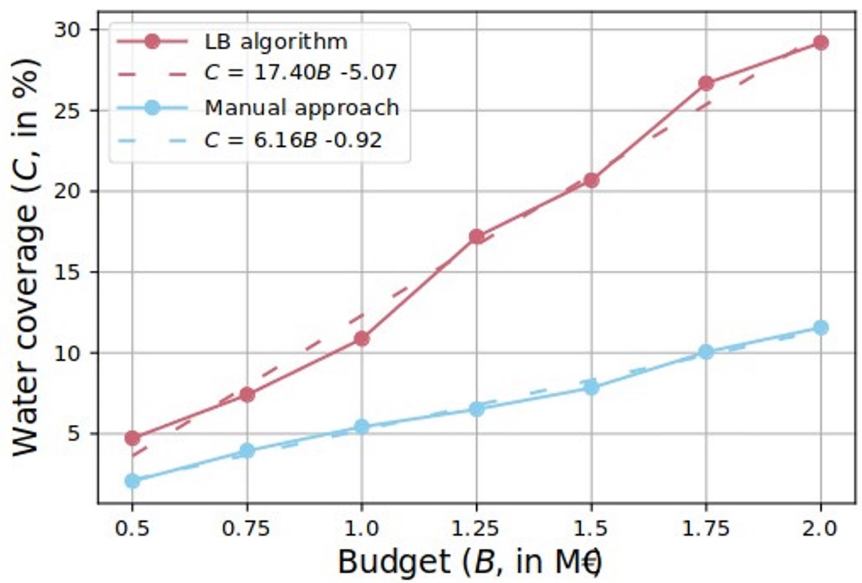
REWATnet: Results for Girona case study (i)

- Entire city considering (i) all water uses:
  - The total daily reclaimed water **demand** is estimated to be 7,142 m^3.
  - The total **length** of the resulting pipe network is 155 km.
  - The total **construction costs** to cover all the water demand ascends up to 16M€.
  - The positioning of water tanks **match the real locations** of the city water distribution network.



REWATnet: Results for Girona case study (ii)

- What if only a limited budget is available?
  - The algorithm maximizes the water served (m^3) with a limited budget.
  - 30% of the water demand can be covered with only a 2M€ budget (12.5% of the original cost).
  - Compared with current practice, based on a manual approach, REWATnet increases the water served by a factor of three in limited budget scenarios.



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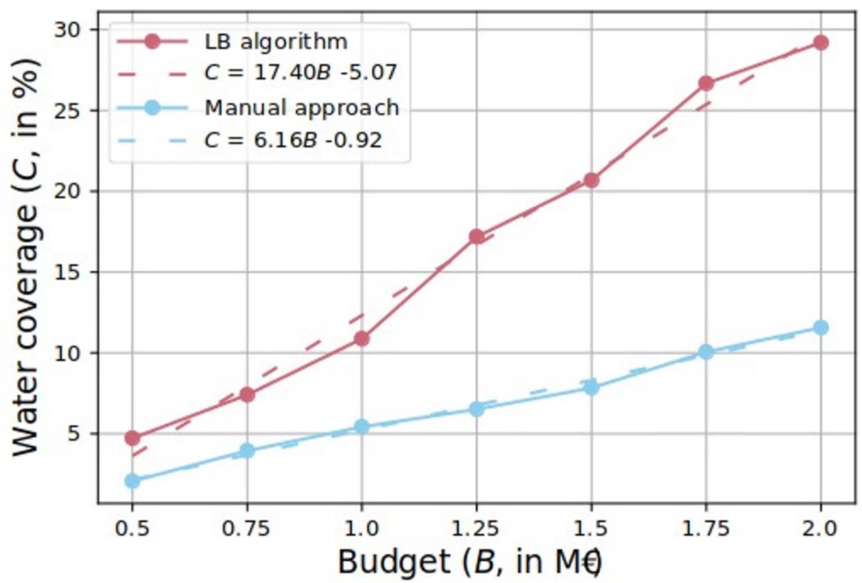
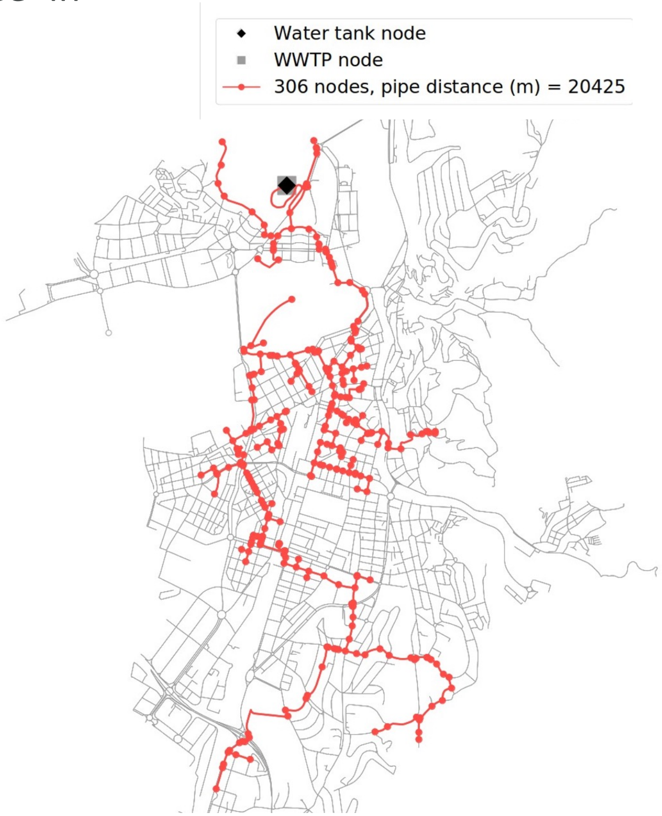


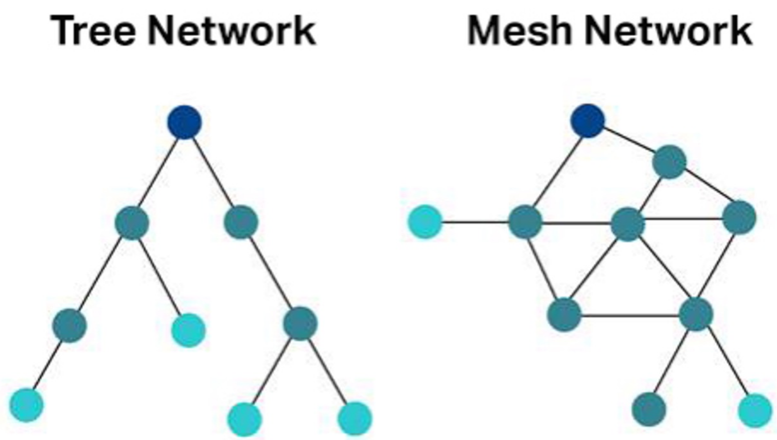


Girona (2M€)

REWATnet: el Prat del Llobregat case study

- **el Prat del Llobregat case study**: Application of REWATnet in the entire city considering all water uses with limited budgets with:
  - An **improved** version of the Limited Budget (LB) Algorithm. The profit function has been adapted from c^3/l to c/l and some implementation issues were solved.
  - A novel algorithm (LBR or LB Resilient) that prioritize **resilience** and provides more **meshed** networks.

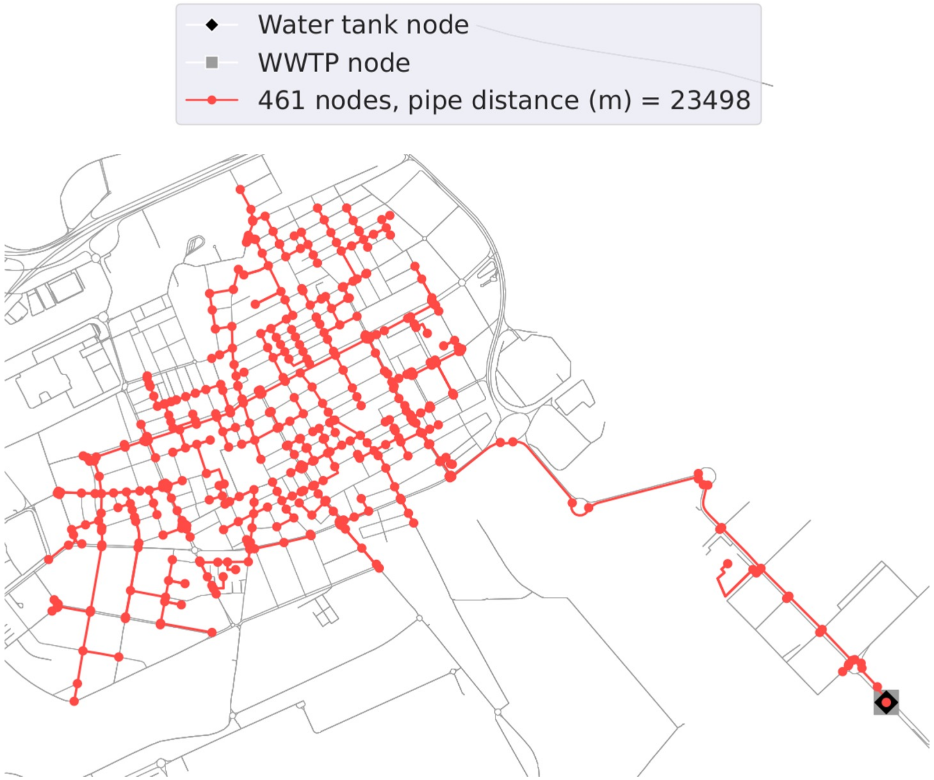
- We present the novel measure of **Availability** (TU Delft) for performance evaluation of resilience in water distribution networks. The **Availability** of a **water distribution network** is the probability that all water demand nodes in network G are served by (or connected to) a water tank with pipe operating probability p.



LB v2 Algorithm: More accurate and fast

- The LB algorithm has been improved and now it's more accurate and fast.
- For a 2M€ limited budget, the improved version serves 20% more water compared to the original.

El Prat del Llobregat (2M€)	LB v1 Algorithm	LB v2 Algorithm
Pipe network length (m)	**19734**	**23498**
Transported water (m^3)	**1816**	**2530**
Water served / total demand (%)	**52**	**73**
Execution time (s)	**203**	**68**

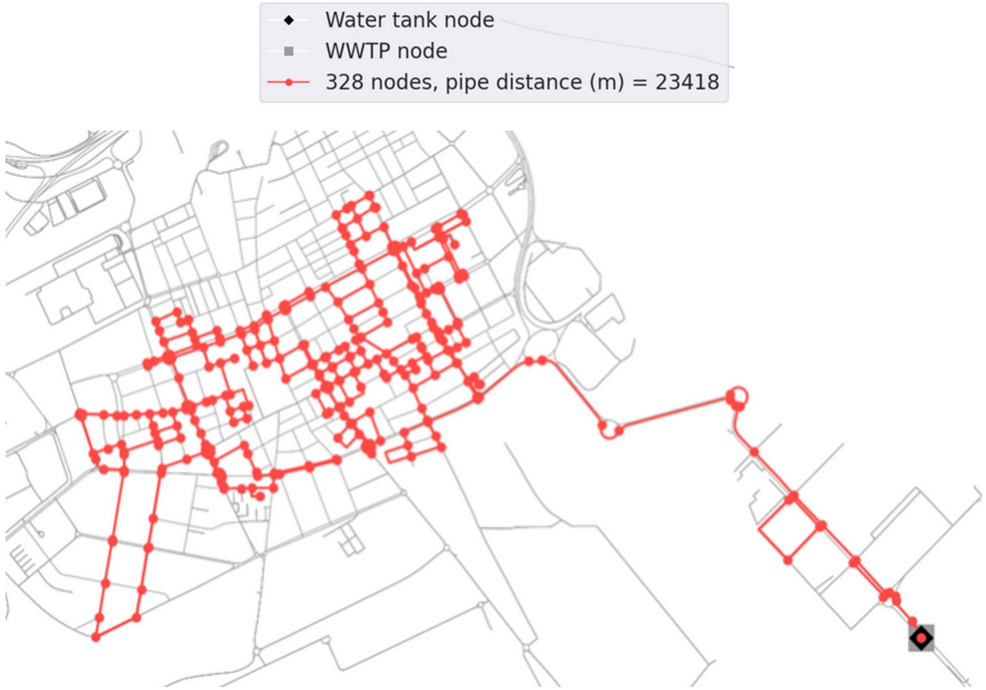


el Prat de Llobregat

LBR Algorithm: Let's make LB more resilient

- The LBR (LB Resilient) algorithm is an adjusted LB v2 algorithm that improves network resilience.
  - Finds an independent route for each iteration.

El Prat del Llobregat (2M€)	LB v2 Algorithm	LBR Algorithm
Pipe network length (m)	**23498**	**23418**
Transported water (m^3)	**2530**	**1785**
Water served / total demand (%)	**73**	**51**
Network Availability *p=0.99* (%)	**1**	**76**
Execution time (s)	**68**	**58**



el Prat de Llobregat

Conclusions

- REWATnet: Tool for an **optimal design** of water reuse networks.
  - With **very few** user inputs, automates the design of reclaimed water networks.
  - It uses clustering and routing algorithms based on **graph theory**.
  - The **Diameter Selection** (DS) algorithm selects the optimal diameter for each pipe based on the destination demands.
  - The **Limited Budget** (LB) algorithm maximizes water served (m^3) and minimizes construction costs (€). The improved version is **more accurate** (+ water served) and **fast** (- computation time).
  - The new **LBR** (**LB Resilient**) algorithm creates more **meshed** and resilient network designs.

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Optimal design of water reuse networks in cities through decision support tool development and testing

Eusebi Calle[1], David Martínez[1,2], Gianluigi Buttiglieri[2,3], Lluís Corominas[2,3], Miquel Farreras[1], Joan Saló-Grau[1,2], Pere Vilà[1], Josep Pueyo-Ros[2,3] and Joaquim Comas[2,4]✉

Water scarcity and droughts are an increasing issue in many parts of the world. In the context of urban water systems, the transition to circularity may imply wastewater treatment and reuse. Planning and assessment of water reuse projects require decision-makers evaluating the cost and benefits of alternative scenarios. Manual or semi-automatic approaches are still common practice for planning both drinking and reclaimed water distribution networks. This work illustrates a decision support tool that, based on open data sources and graph theory coupled to greedy optimization algorithms, is able to automatically compute the optimal reclaimed water network for a given scenario. The tool provides not only the maximum amount of served reclaimed water per unit of invested cost, but also the length and diameters of the pipes required, the location and size of storage tanks, the population served, and the construction costs, i.e., everything under the same architecture. The usefulness of the tool is illustrated in two different but complementary cities in terms of size, density, and topography. The construction cost of the optimal water reclaimed network for a city of approximately 100,000 inhabitants is estimated to be in the range of €0.17–0.22/m^3 (for a payback period of 30 years).

npj Clean Water (2023)6:23 ; https://doi.org/10.1038/s41545-023-00222-4

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CLOSING REMARKS

Great thanks to all presenters for a wonderful show!

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