Urban Futures

Presentation at REAL CORP 2012
Re-mixing the city:
Towards Sustainability and Resilience
Multiversum Schwechat, Vienna, Austria

TESTING THE RESILIENCE OF UNDERGROUND INFRASTRUCTURE SOLUTIONS THROUGH AN URBAN FUTURES METHODOLOGY

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14th to 16th May

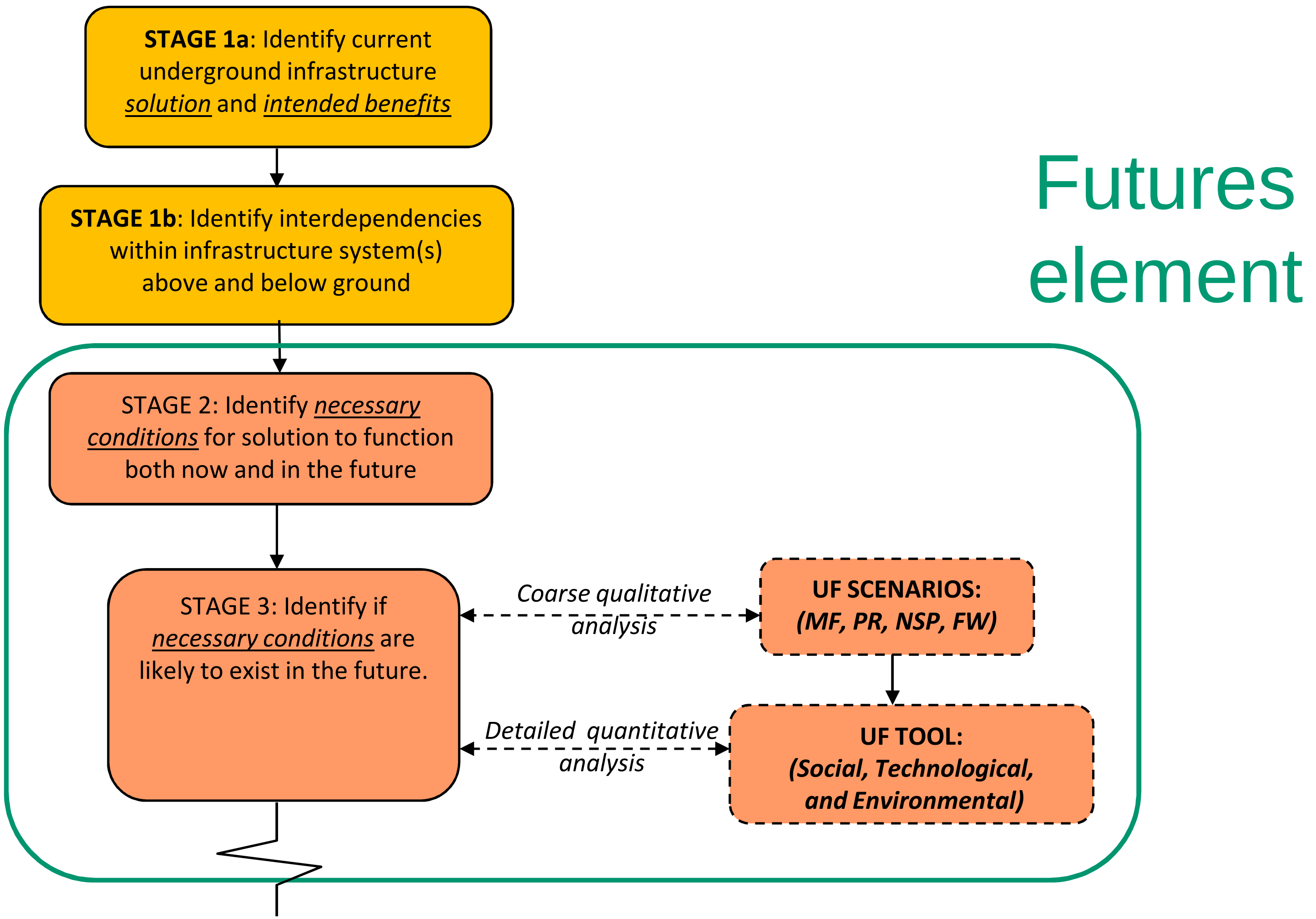
Sustainable Regeneration: From evidence-based urban futures to implementation

Research aim:

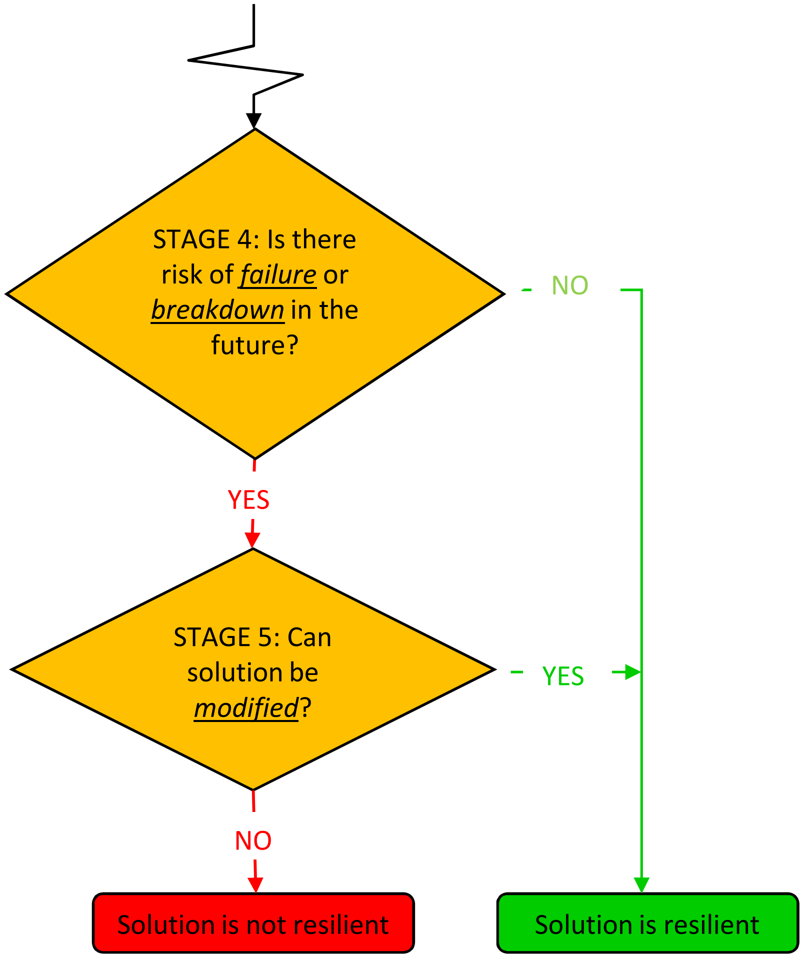
*This paper presents an **Urban Futures (UF) methodology** that facilitates testing the **future resilience** of any **underground water infrastructure solution** (e.g. potable and non-potable mains water, wastewater and stormwater).*

…. to ensure that the solutions we put in place today in the name of sustainability are robust, not matter what the future holds.

UF Methodology:



UF Methodology:



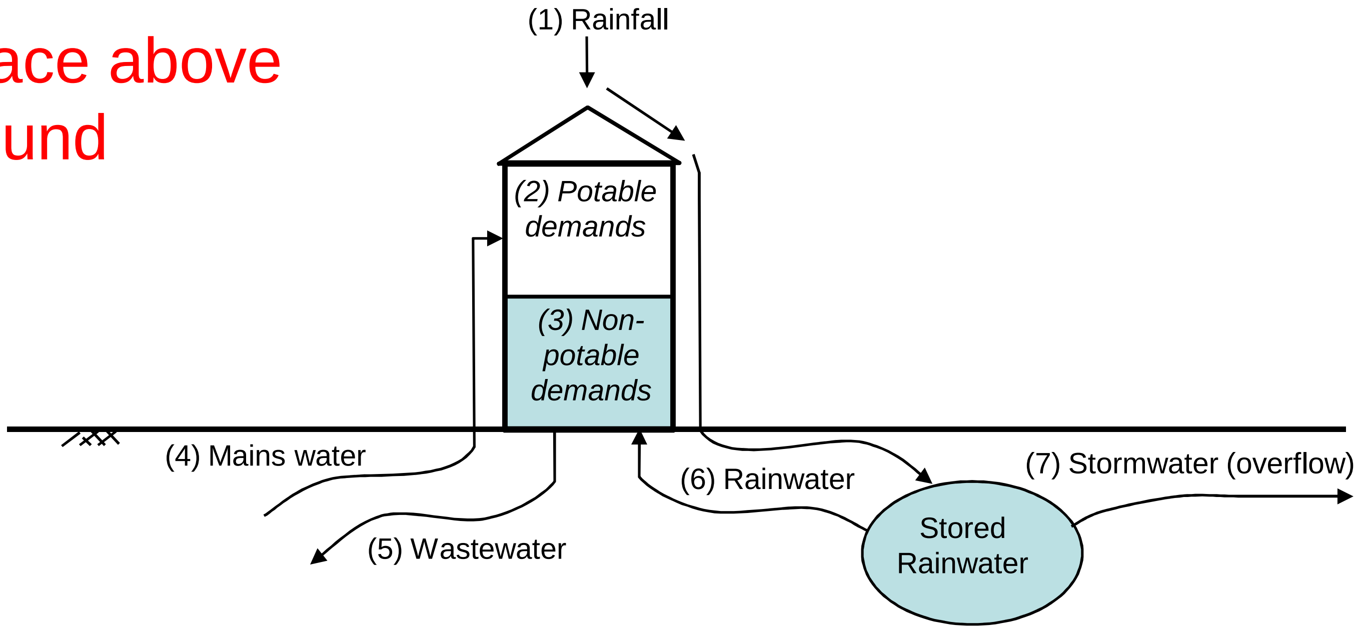
Stage 1a: Solution selection

In this example urban engineers have proposed the introduction of an underground non-potable water supply network (i.e. rainwater harvesting) in order to achieve the following sustainability benefits within the local area:

- **Reduced** consumption of potable (i.e. drinkable) mains water;
- **Reduced** requirements for stormwater outflow;
- **Increased** water storage in times of drought and mains water failure;
- **Increased** pluvial flash flood protection.

Stage 1a: Interdependencies

Space above ground



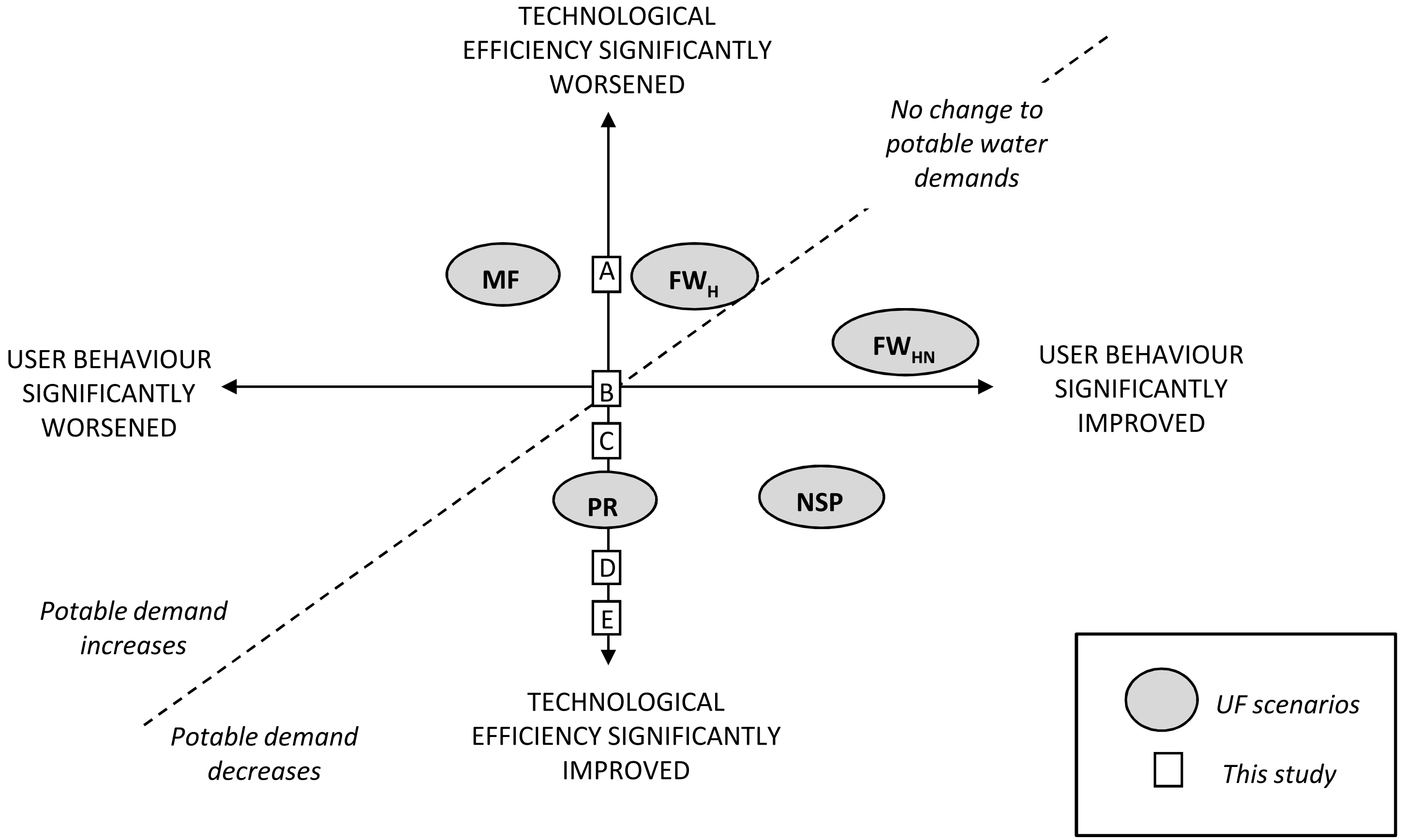
Underground space

Stage 2: Identify Necessary conditions (NC)

- ***S*ocial** *(e.g. demographics, values, equity, public attitude, user-behavior)*
- ***T*echnology** *(e.g. type, efficiency)*
- ***E*nvironment** - *Natural and Built (e.g. climate, local resources, built form)*
- ***E*conomic** *(e.g. cost, affordability, payback)*
- ***P*olitics** *and Governance (e.g. regulations, laws, standards)*

NC1 - Non-Potable demand must remain
NC2 - Enough water must be collected
NC3a - Enough water must be stored for supply
NC3b - Enough water must be stored for pluvial flash flood protection
NC4 - System must be economically viable
NC5 - System must be publically acceptable
NC6 - Policy for adoption of systems must remain in place
NC7 - Systems must be maintained

Stage 3: Necessary conditions (future demand)



Step 3: Necessary conditions (future demand)

Driver	Operating condition(s)		Units of measure	Scenarios				
				A	B	C	D	E
Social	End-user behaviour [2]	WC	*Flushes/day*	4.42 (all scenarios)				
		Bath	*Capacity filled**	0.11 (all scenarios)				
		Shower	*Minutes/shower**	4.37 (all scenarios)**				
		Washing machine	*Frequency of use*	2.10 (all scenarios)				
		Dishwasher	*Frequency of use*	3.60 (all scenarios)				
Technology	Technological efficiency [1]	WC	*Liter/flush*	6	6	4.5	4.5	2.6
		Bath	*Liter capacity*	230	230	230	160	97
		Shower	*Liters/minute*	24	12	8	8	6
		Washing machine	*Liters/kg*	13	13	10	6.1	6.1
		Dishwasher	*Liters/place setting*	1	1	1	1	0.7
Total potable water demand			*l/person/day*	199	148	117	101	76
Total non-potable water demand			*l/person/day*	54	54	48	41	24

→ Increasing efficiency

What happens to demands in the future?

Step 3: Necessary conditions (localised)

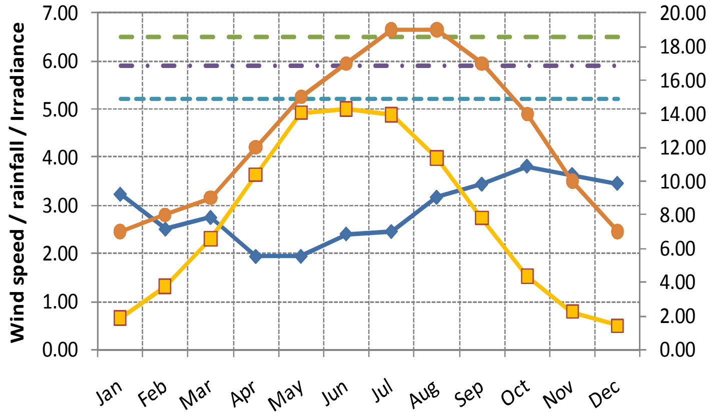
Driver	**Operating condition(s)**		***Units of measure***	**Scenarios**				
				A	**B**	**C**	**D**	**E**
Environment	Climate	Rainfall	*mm/day*	(Lancaster scenarios)				
			mm/day	(Birmingham scenarios)				
			mm/day	(Barcelona scenarios)				
			mm/day	(Malmö scenarios)				
	Built form	Roof space	*m^2*	50 (all scenarios)				
		Roof type	*% water capture*	90 (all scenarios) [5]				
		Roof material	*% water capture*	90 (all scenarios) [5]				
Social	Demographics	Occupancy	*Occupants/dwelling*	2.4 (UK scenarios) [3]				
			Occupants/dwelling	2.6 (Barcelona scenarios) [4]				
			Occupants/dwelling	2.0 (Malmö scenarios) [3]				

What other conditions should we include?

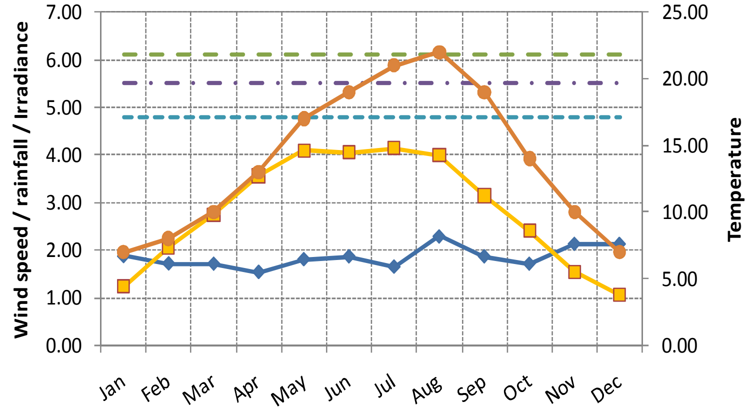
Step 3: Necessary conditions (localised)

Location	Demand type	*Units of measure* (hh = household)	Scenarios A	B	C	D	E
UK	Potable	*l/hh/day*	418	311	246	212	160
	Non-potable	*l/hh/day*	113	113	101	86	50
Spain	Potable	*l/hh/day*	517	385	299	270	198
	Non-potable	*l/hh/day*	140	**140**	125	107	62
Sweden	Potable	*l/hh/day*	398	296	230	208	152
	Non-potable	*l/hh/day*	108	108	96	82	48

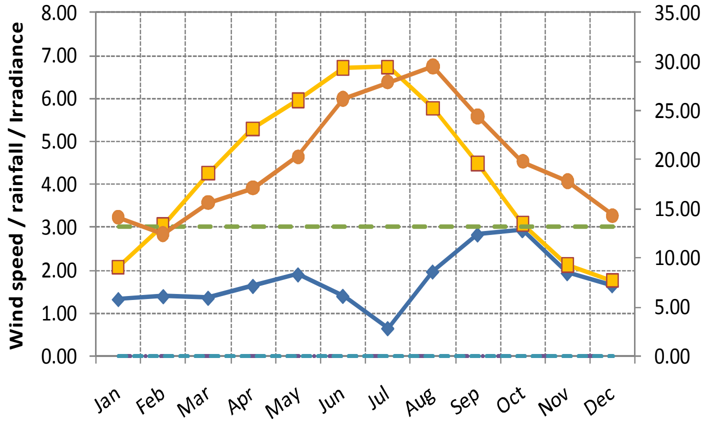
Step 3: Necessary conditions (weather)



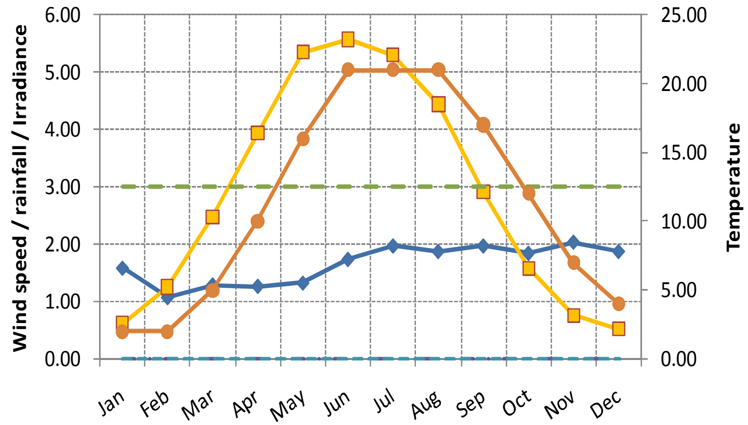
a) Lancaster, UK



b) Birmingham, UK



c) Barcelona, Spain



d) Malmo, Sweden

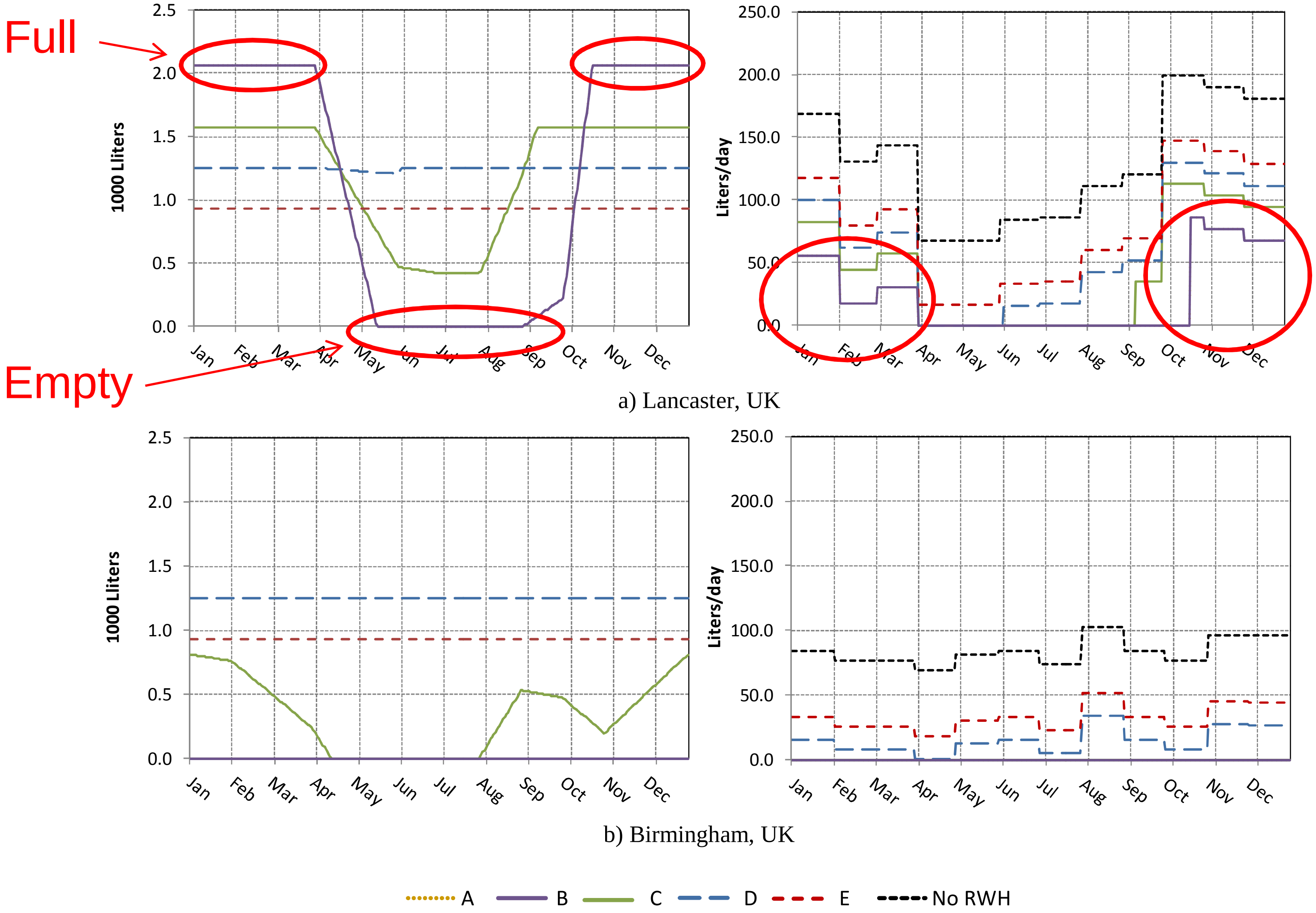
- Rainfall (mm/day)
- Irradiance (kW/m2/day)
- Wind speed (m/s - yearly average - 45m agl)
- Wind speed (m/s - yearly average - 25m agl)
- Wind speed (m/s - yearly average - 10m agl)
- Temperature (Degrees celsius)

Step 3: Necessary conditions (tank sizes)

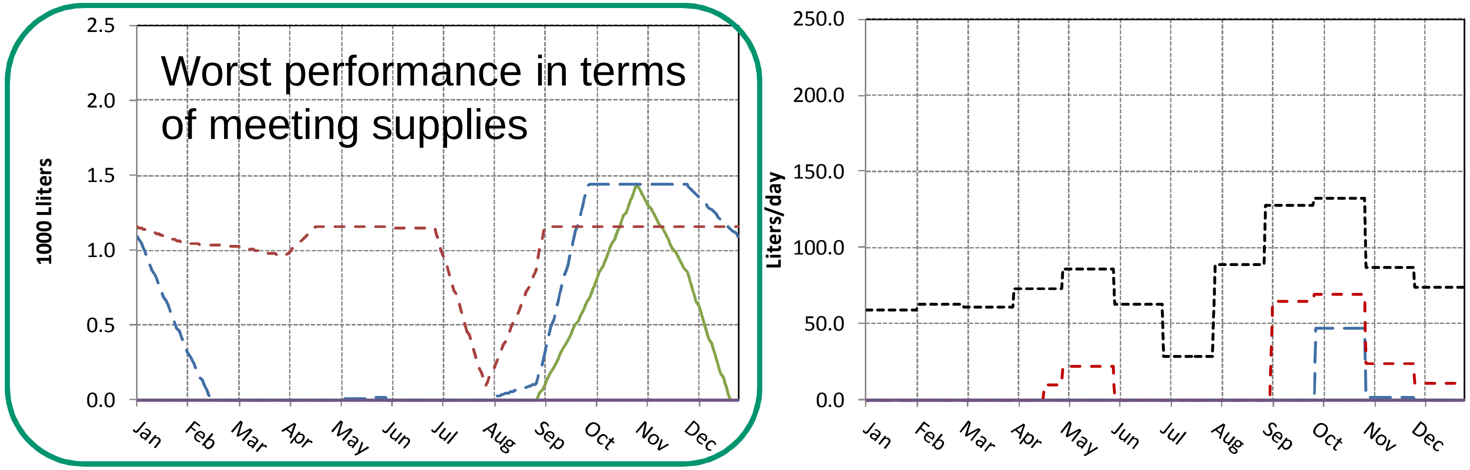
Location	Scenarios				
	A	B	C	D	E
Lancaster, UK	2063	2063	1567	1253	931
Birmingham, UK	1526	1526	1526	1253	931
Barcelona, Spain	1436	**1436**	1436	1436	1153
Malmö, Sweden	1359	1359	1359	1194	887

How big should tanks be in each location?

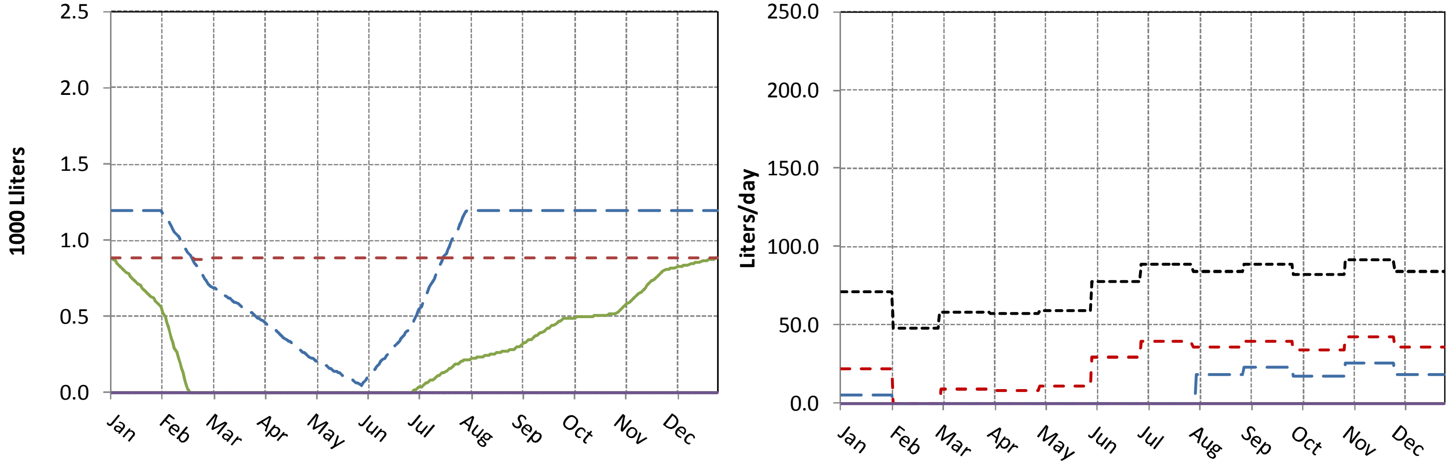
Stage 4: Risk of failure (RWH and Stormwater)



Stage 4: Risk of failure (RWH and Stormwater)



c) Barcelona, Spain



d) Malmö, Sweden

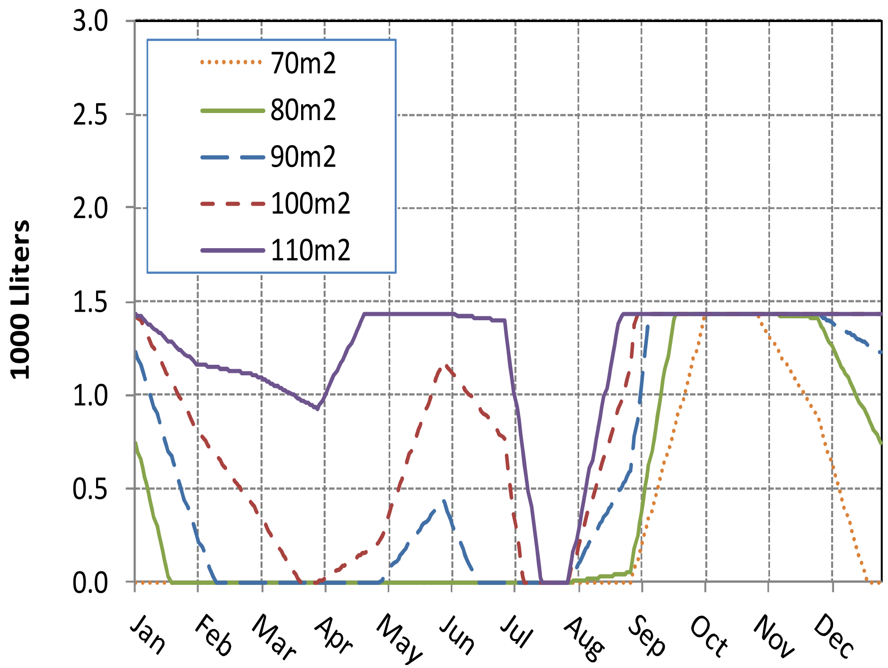
A B C D E No RWH

Step 5: Modifying solutions (Barcelona)

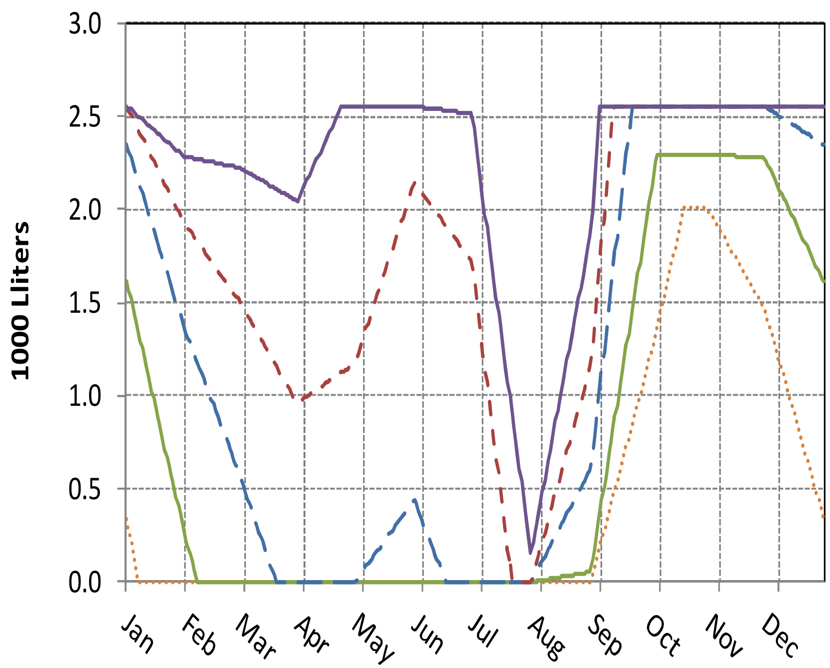
Location	Scenarios				
	A	B	C	D	E
Lancaster, UK	44	44	33	27	20
Birmingham, UK	68	68	51	41	31
Barcelona, Spain	89	**89**	68	54	40
Malmö, Sweden	72	72	55	44	33

How big should roofs be in order to meet yearly demands?

Step 5: Modifying solutions (Barcelona)



(a) Impact of roof size
(all tanks = 1496 l)



(b) Additional Impact of tanks
(sized for 5% rain collection)

Conclusions

- By changing technology, user behavior and location we can understand better ***future requirements*** (above and below ground).

- The UF methodology provides a framework for testing the and ***resilience*** of utility infrastructure provision adopted today in the name of ***sustainability***.

- The ***UF tool*** is necessary for quantitative ***futures analysis***.

- The UF methodology helps to ***raise questions*** that wouldn't normally be asked and ***enhances the solution*** that is put into place.

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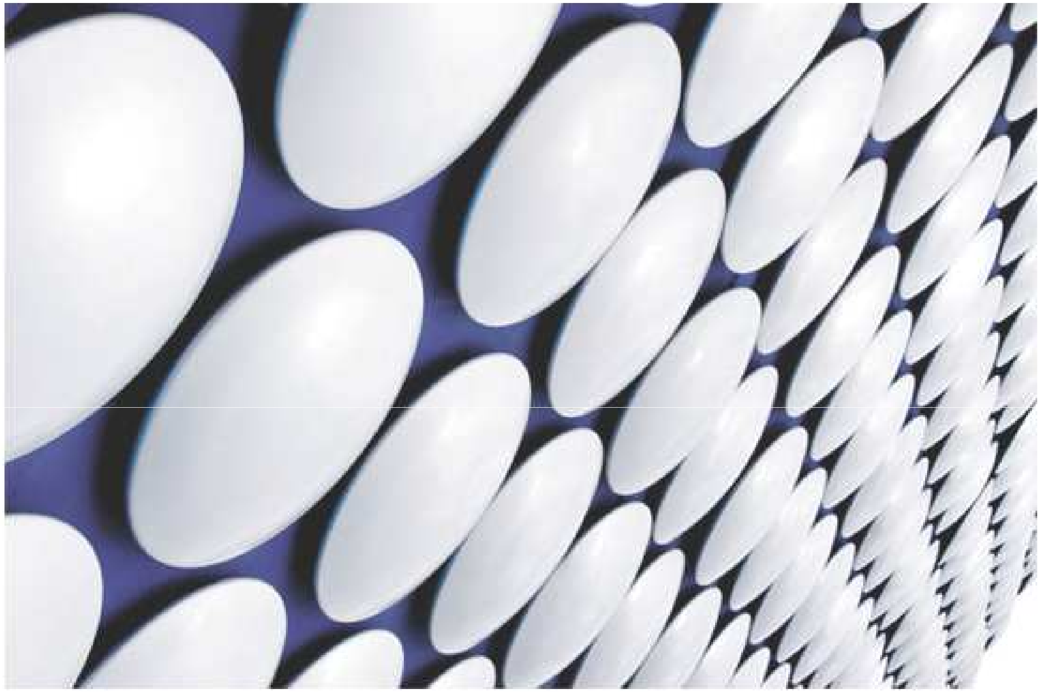
Thankyou



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