Urban Water Reuse

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Universitat de Girona

BCDS Broadband Communications and Distributed Systems

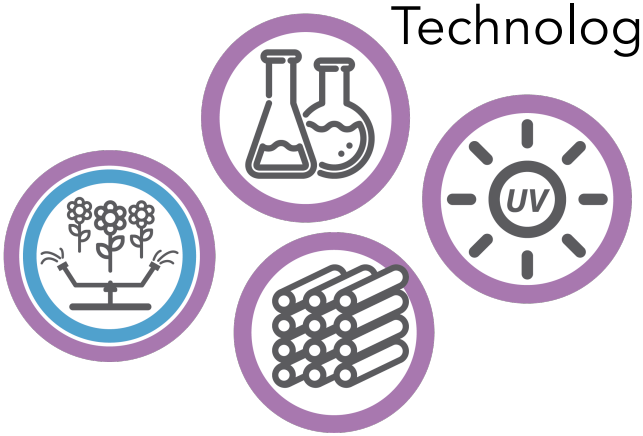
4th Delft - Girona Workshop on Robustness of Complex Network – July 7th 2021

Decision making in water reuse

Challenges

Criteria and Indicators

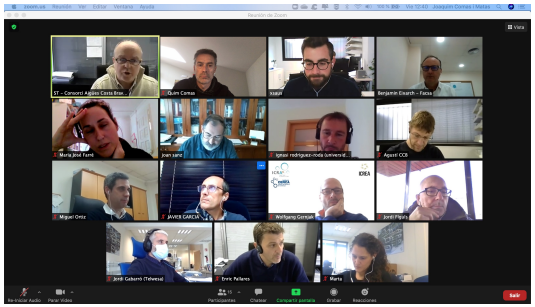
Technologies



Distribution and potential uses

Feasible water reuse projects

Experts, literature, case studies



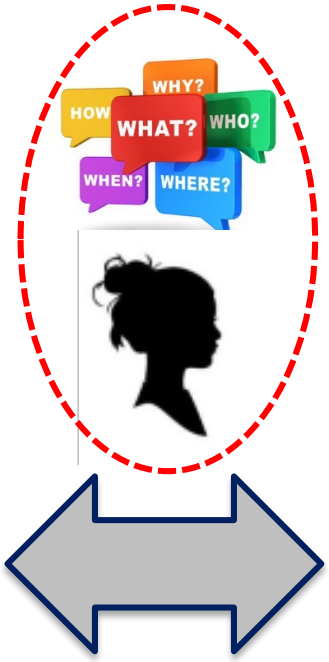
Created by Dmitry Baranovskiy from Noun Project

Water reuse and recycling in Australia — history, current situation and future perspectives

John C. Radcliffe, Declan Page

Chapter Two - California water reuse—Past, present and future perspectives

Adam W. Olivieri [a], Brian Pecson [b], James Crook [c], Robert Hultquist [d]



Decision Support Systems

- ✓ Water Reclamation Plants
- ✓ Reclaimed water distribution network

} CLEaN-TOUR DSS

CLEaN-TOUR project: objective

Circular Economy to facilitate urban water reuse in a touristic city

- Goal is to develop a tool to support planning of water reuse networks in cities, including collection of waste/greywater, treatment and re-distribution to the final users

Centralised o decentralised approach ?





CLEaN-TOUR DSS

INPUTS

- Target **city**
- **Automatic** (cloud) and **default** data collection
- Additional user information (uses or city districts to be considered or not, etc.)

OUTPUTS

- Administration
- Urban planners
- Eng./consulting companies
- etc.

CLEaN-TOUR DSS: Data collection

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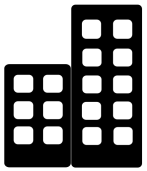
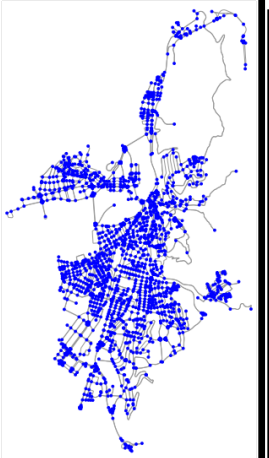
Automatic data from the cloud

Land use



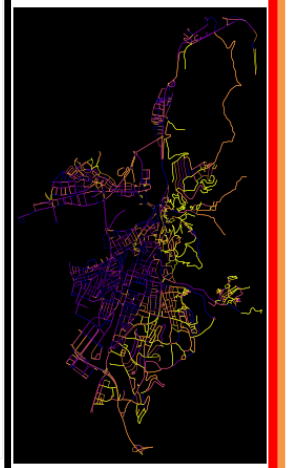
Sede Electrónica del Catastro

Street graphs



OpenStreetMap

Land elevation



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Default (customizable) values

Water origins (generation)

Water destination (consumption)

Costs

Literature, case studies, previous research & real data

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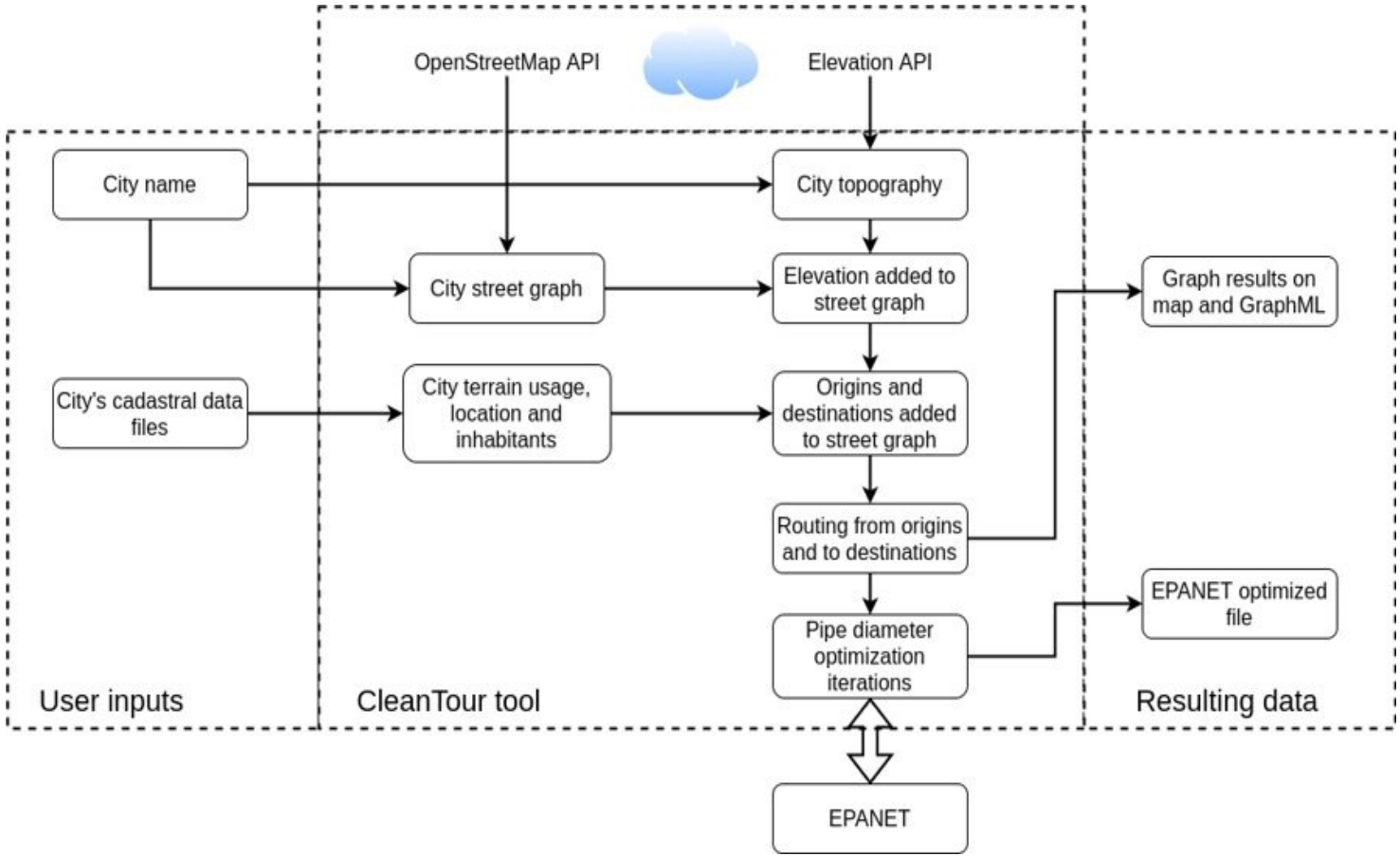
SewerLCA

CLEaN-TOUR DSS: Data collection

Canonada (mm)	Cost de material (€)	Cost de mà d'obra (€)	Cost total (€)	Canonada (mm)	Cost de material (€)	Cost de mà d'obra (€)	Cost total (€)
63	1.71	69.13	74.38	315	39.83	167.00	217.17
75	2.43	71.33	77.45	400	64.07	194.49	271.49
90	3.49	72.97	80.28	450	112.95	205.77	334.66
110	4.94	74.62	83.54	560	173.57	230.55	424.33
125	6.29	76.82	87.27	630	223.13	242.95	489.38
140	7.92	79.02	91.29	710	-	-	525.28 *
160	10.31	81.77	96.68	800	-	-	592.28 *
180	13.05	98.27	116.89	900	-	-	666.72 *
200	16.11	112.01	134.53	1000	-	-	741.15 *
225	20.43	125.76	153.50	1200	-	-	890.03 *
250	25.04	139.50	172.77	1400	-	-	1038.91 *

Cost de material (€) – inclou el preu de la canonada, Cost de mà d'obra (€) – inclou els preus dels treballadors i el d'obrir i tancar la rasa (57.04€), Cost total (€) – especifica el cost total de construcció per metre incloent els costos de material, de mà d'obra i un 5% addicional per costos indirectes.

CLEaN-TOUR DSS: the logics



CLEaN-TOUR DSS

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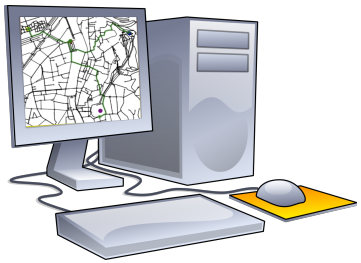
INPUTS

- Target **city**
- **Automatic** (cloud) and **default** data collection
- Additional information (carwash, firemen, etc.)



- Administration
- Urban planners
- Eng./consulting companies
- etc.

OUTPUTS

- Proposal of optimal water reuse network (on a **map**)
- **Water savings** quantification
- **Km.** of network
- **Investment** costs (pipes, pumps, treatment systems…)
- **Operation & maintenance** costs
- Validation and optimisation of pipe diameters with **EPANET**

CLEaN-TOUR DSS: calibration

WATER USES	Modelled consumption (m3/y)	Real consumption (m3/y)	ERROR (%)	Correction factor (%)
Private economic activities	534.680	540.802	1,15	-
Public use (municipal buildings + public gardening)	213.558	171.557	24,48	-
Domestic	9.112.783	1.594.749	471,42	18

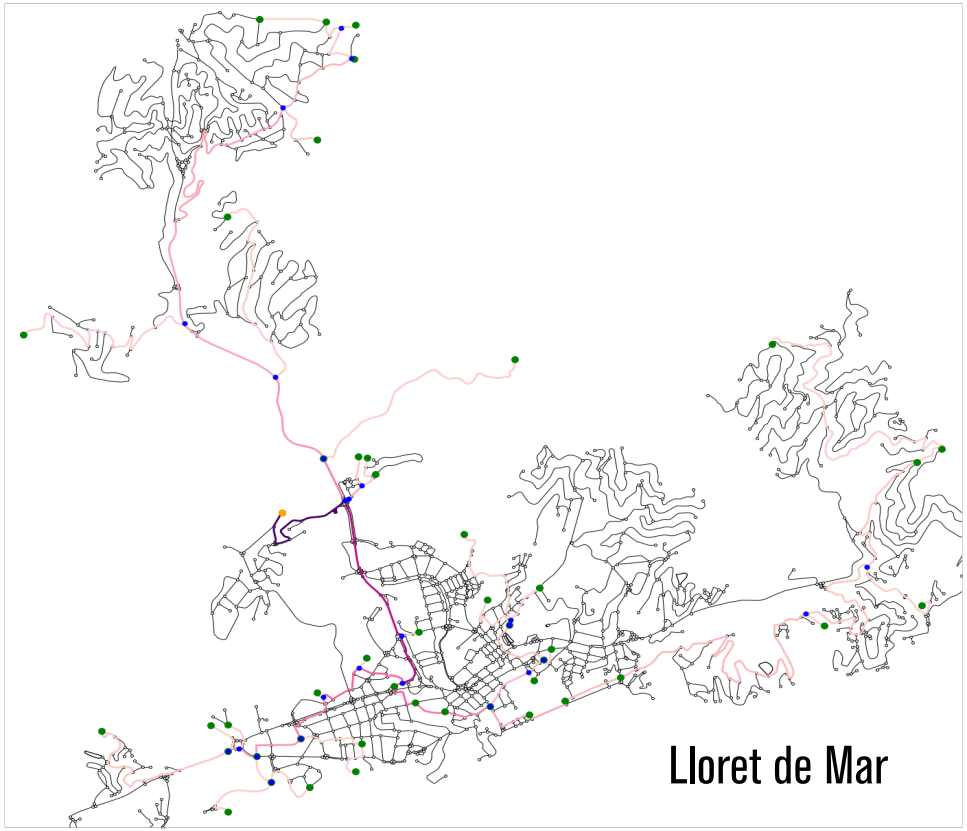
CLEaN-TOUR DSS: Results

- ✓ Automatic network generation/routing
- ✓ Automatic clustering of elevated areas (or for potential decentralisation)
- ✓ Optimization of network generation/routing

- ✓ First satisfactory results in Girona and Lloret de Mar
- ✓ (comparison between centralised and decentralised solutions)

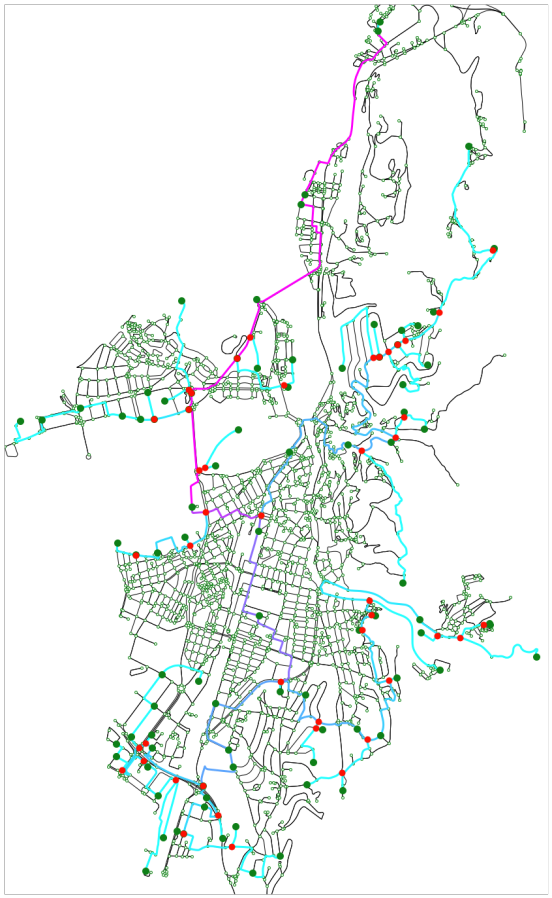
Routing: Steiner tree problem

- Design of a water network from WWTP to a set of points of use
- Should include all points of use
- As shortest/cheaper as possible



Example: Girona

Definition of points of use (destinations)



Pipe diameter and valves

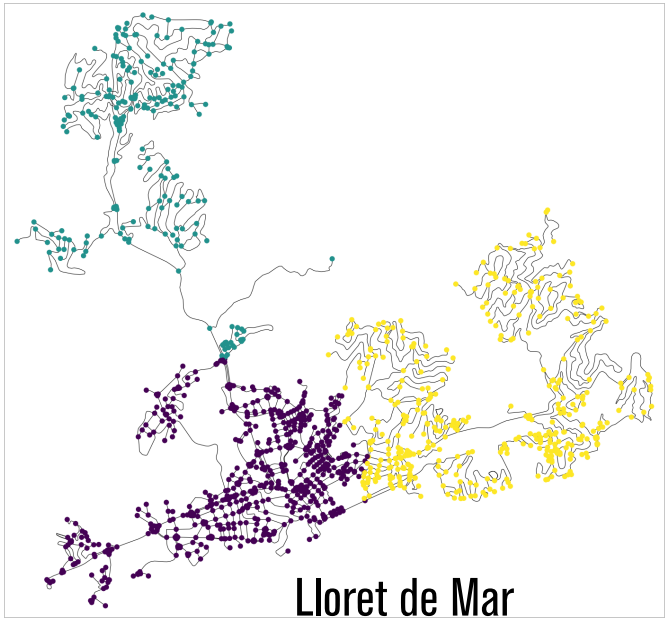
Example: Girona

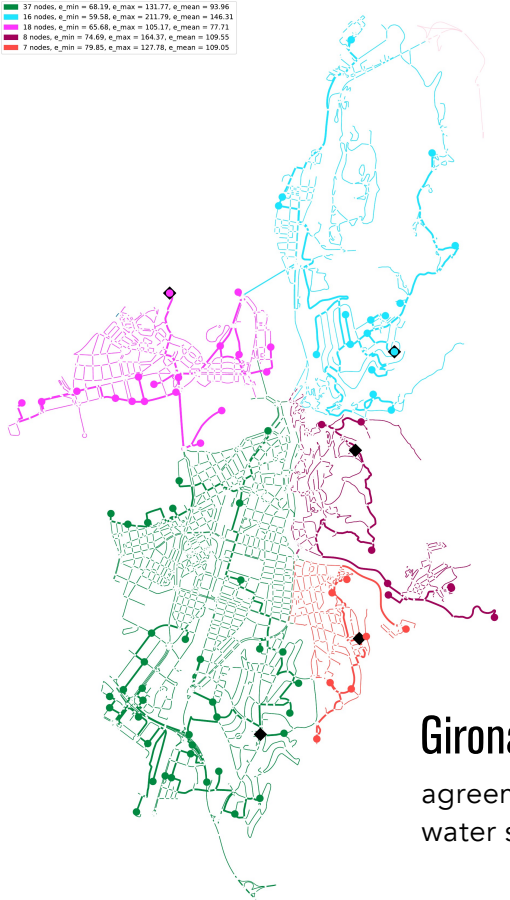
First algorithm: 61,3 km., 8873 m^3/d, 7.1M€

Second algorithm: 49,5 km., 8873 m^3/d, 5.8M€

Spectral Clustering

- Results of the spectral clustering of the Street graphs of Lloret de Mar with 3 clusters



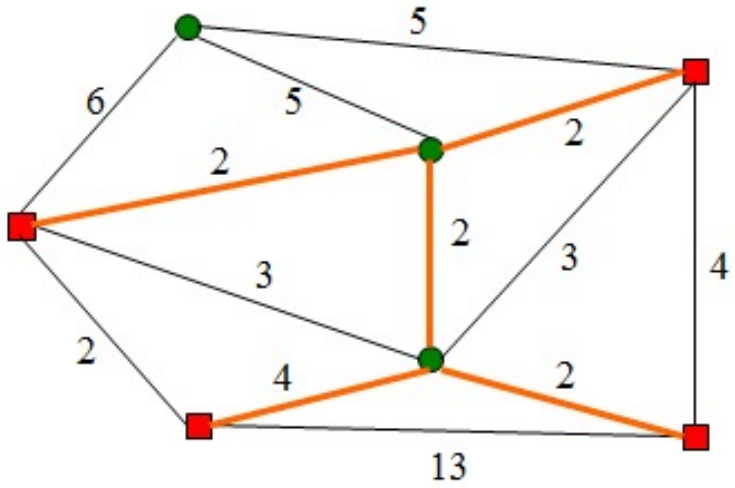


Girona

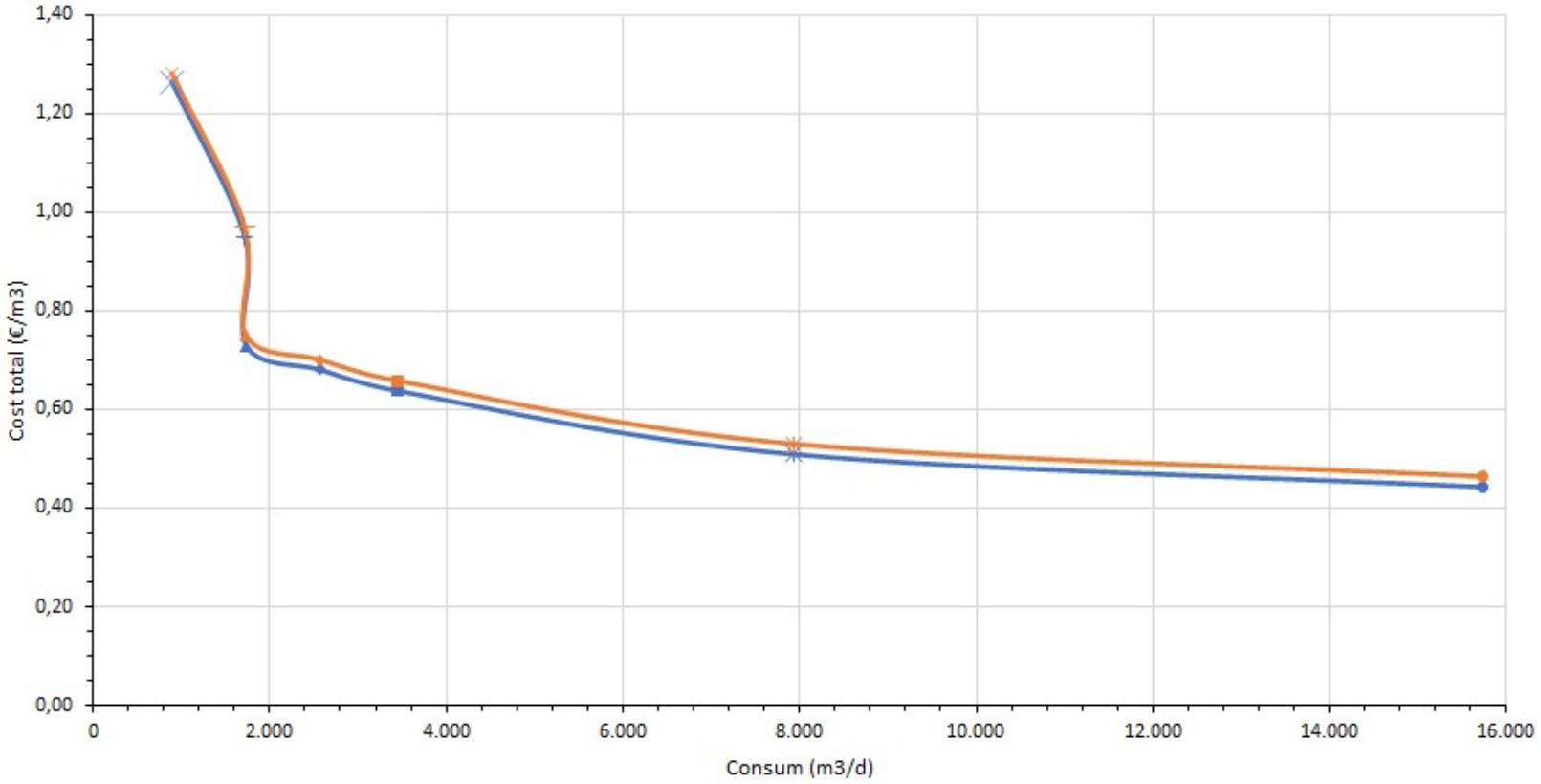
agreement with drinking water storage tanks

Optimization: Steiner tree

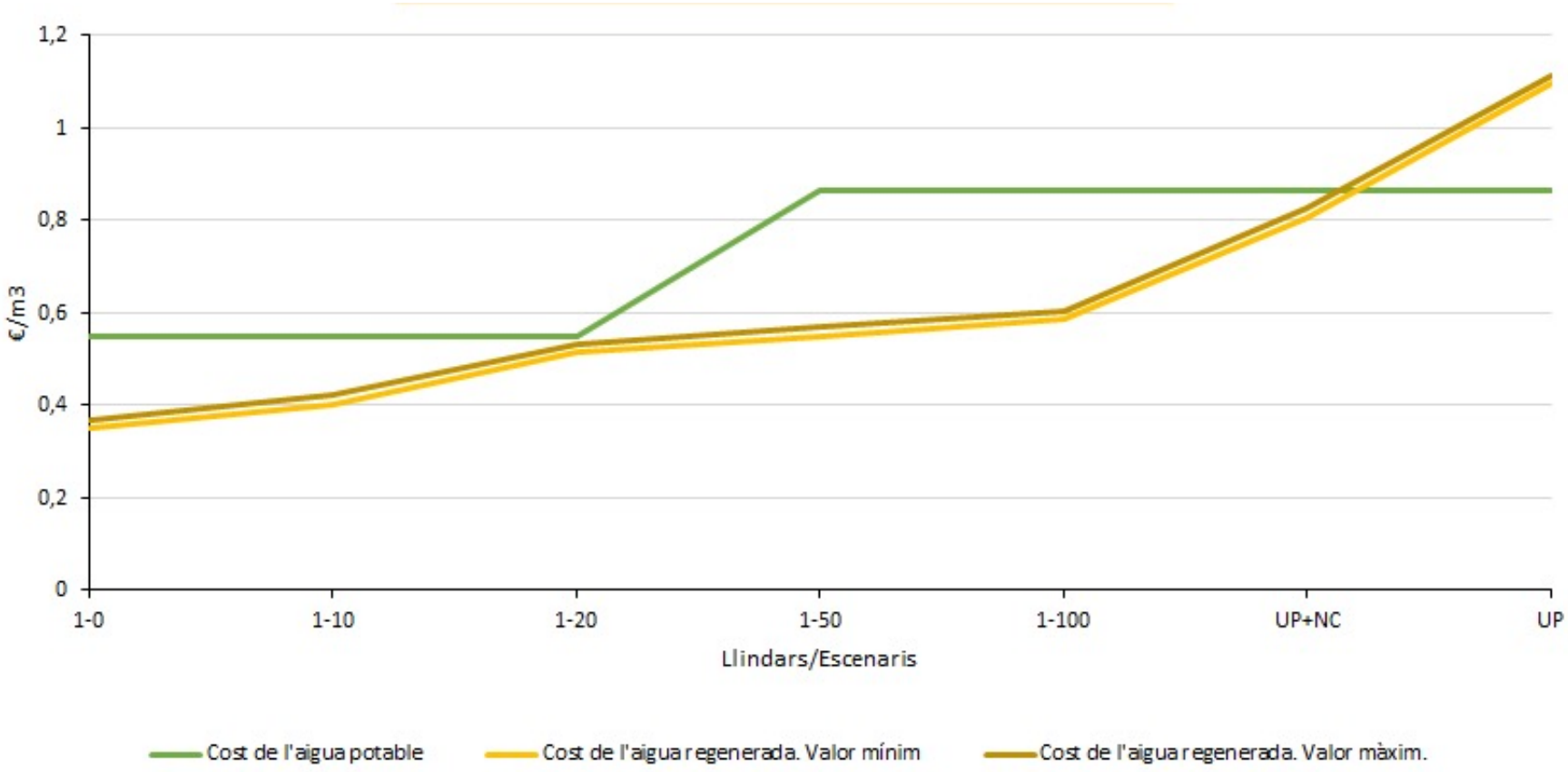
- For each cluster, finding Steiner tree
- Tree of minium cost conecting all terminals of a graf, using other nodes (Steiner vertices)
- Kou algorithm
- Takahashi algorithm
- Ant Colony Optimization
- Melhorn algorithm (best results)



Example: Girona, total costs



Drinking vs regenerated water



Next Steps

- ✓ Optimizing network generation based on a fixed budget.
- ✓ Automatic clustering for potential decentralisation.
- ✓ Comparison between centralised and decentralised solutions.

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Thanks a lot for your attention

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Girona, January 2020

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