spatial and temporal disaggregation of water demand and leakage of the water distribution network in Skiathos, Greece

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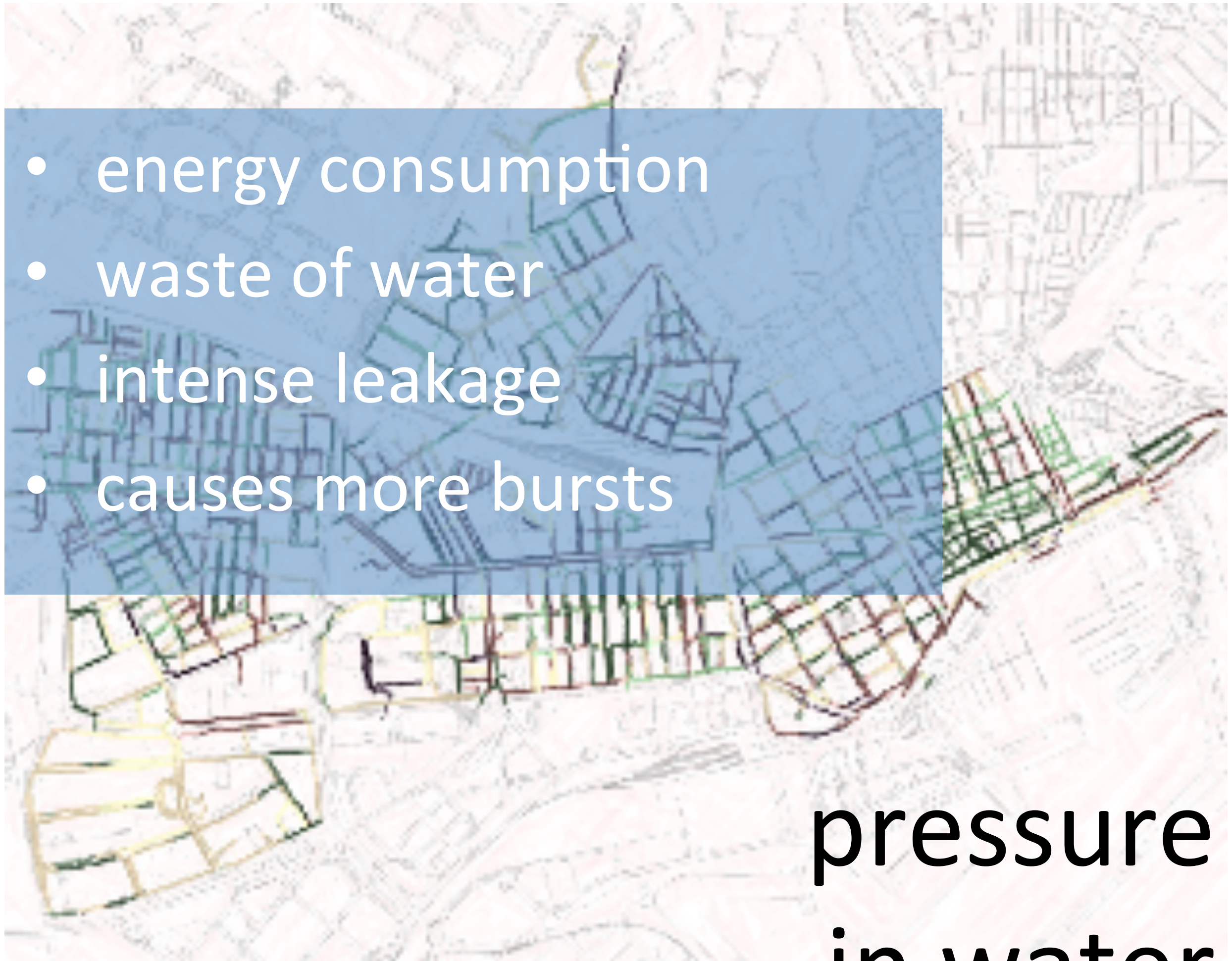

- energy consumption
- waste of water
- intense leakage
- causes more bursts

pressure in water distribution networks

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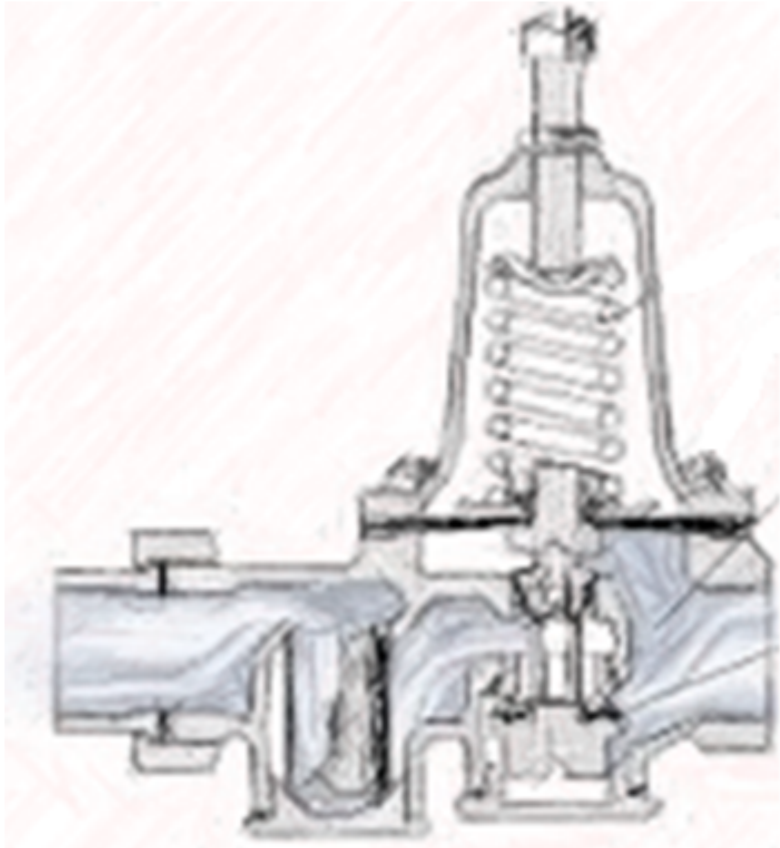
- PRVs: adjust diameter to water demand
- single-feed or multi-feed scheme
- DMAs, depending on the network variability



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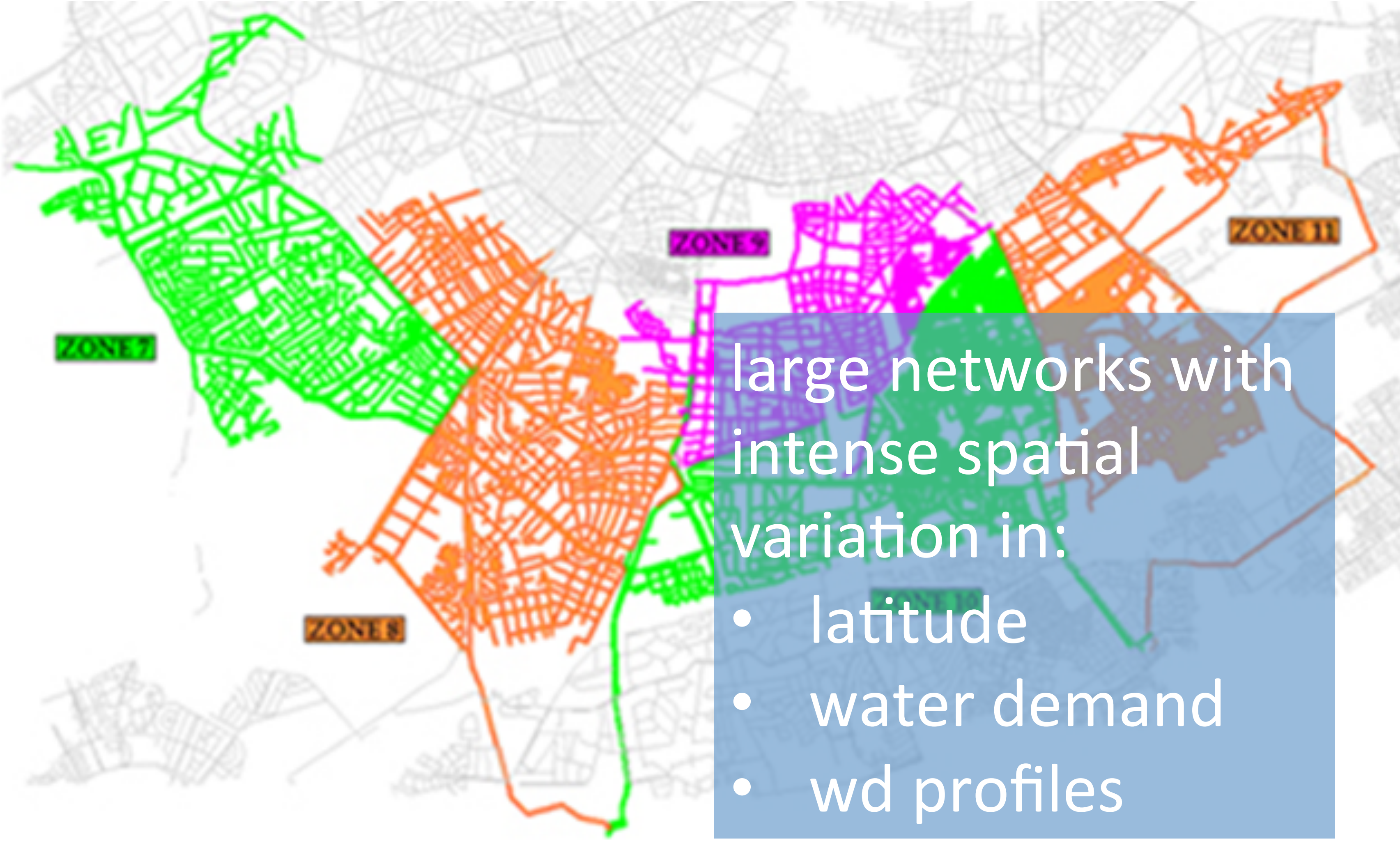
pressure control management

District Metered Areas

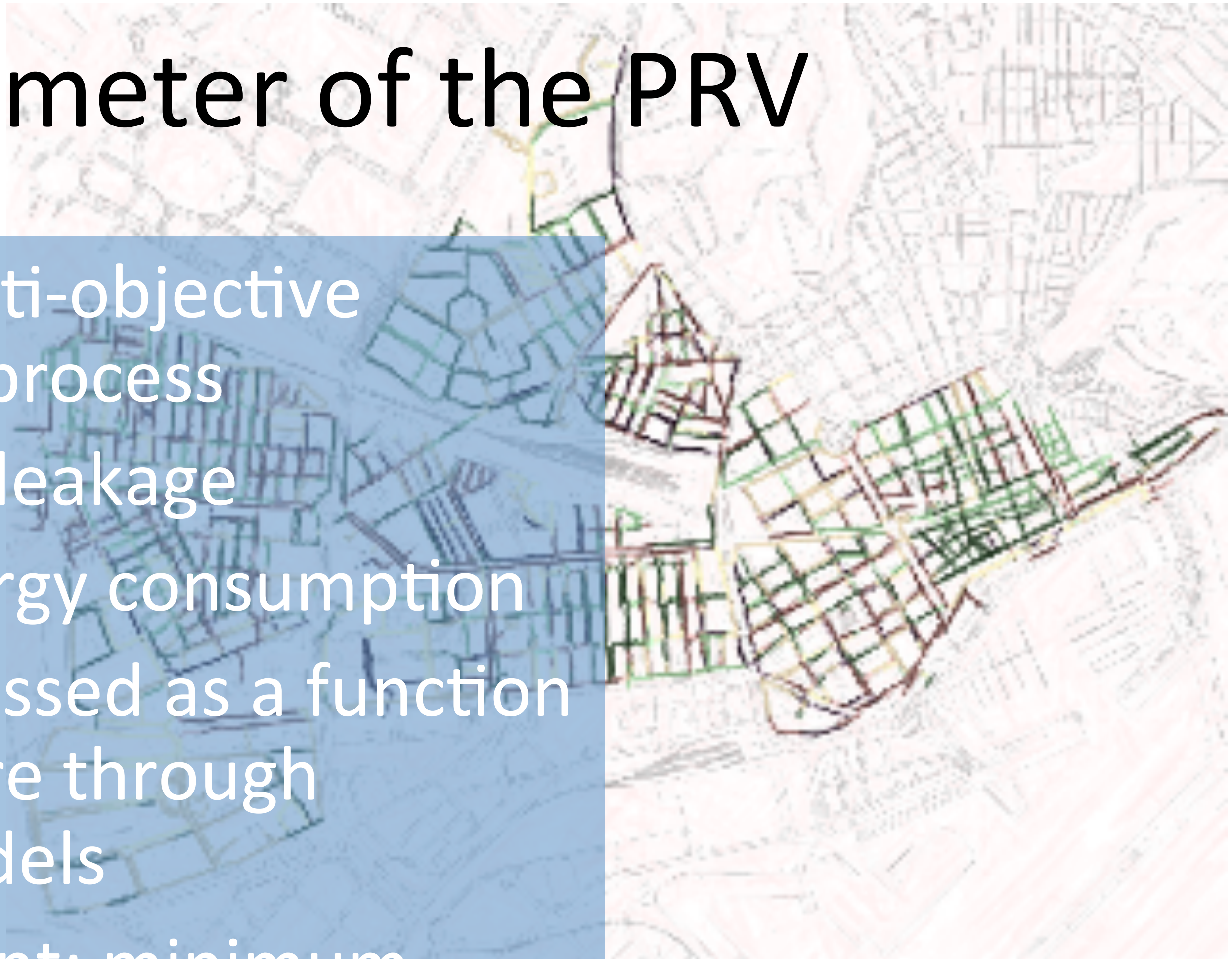


large networks with intense spatial variation in:

- latitude
- water demand
- wd profiles

diameter of the PRV

- output of multi-objective optimization process
- minimize the leakage
- minimize energy consumption
- leakage expressed as a function of the pressure through empirical models
- basic constraint: minimum pressure at critical point



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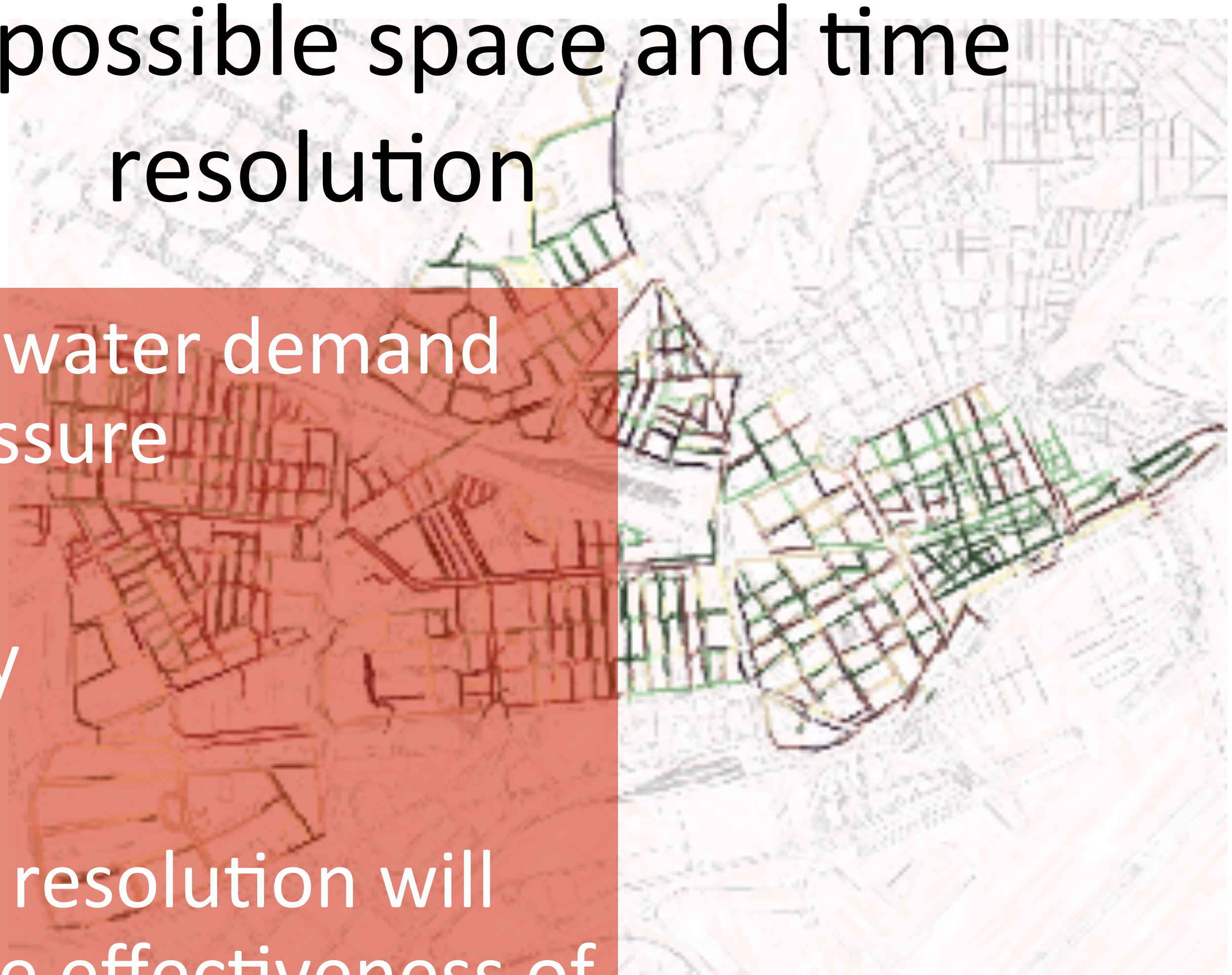
highest possible space and time resolution



need to map water demand and then pressure

- spatially
- temporarily

The resulting resolution will determine the effectiveness of the applied network pressure management.

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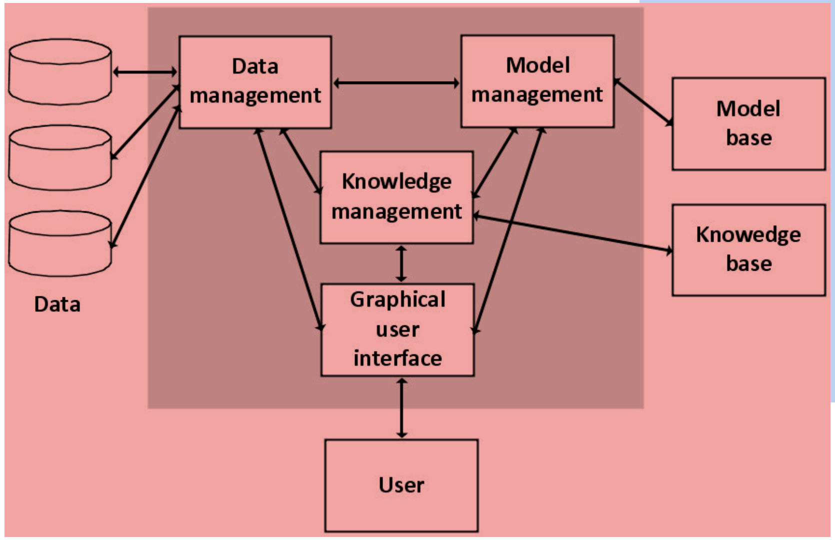
recent established technologies allow network operators to achieve real time management through a **Decision Support System** based on:

- algorithms
- leakage model
- forecast model of the consumption
- optimization sub-routine
- real-time monitoring of pressure, sensors at critical points



Skiathos Island, Greece

- aged network with significant leakage up to 50% levels of the whole water consumption
- network currently under reconstruction
- six-month high touristic activity, summer wd peaks up to a point six times multiple the average winter demand
- water uses through the town of Skiathos are almost uniformly distributed



- 3,500 water meters
- small extent of the network
- uniformity of uses
- a single groundwater drilling
- a single PRV installed downstream the tank

a booster pump might be added to the pressure control management scheme, cutting off the hilly area of the town into a second DMA

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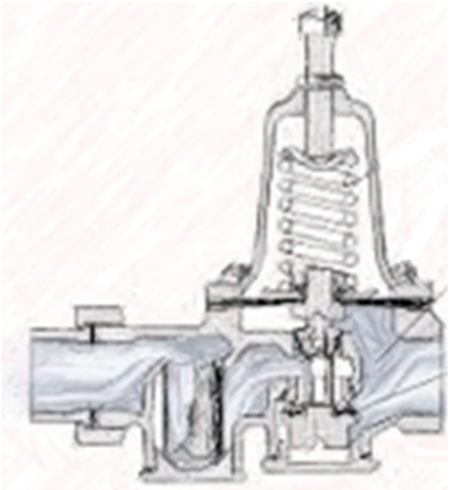

- one boundary valve
- one DMA
- closed at all other boundaries
- ease of control and minimizing infrastructure cost
- less secure in terms of supply than multi-feed

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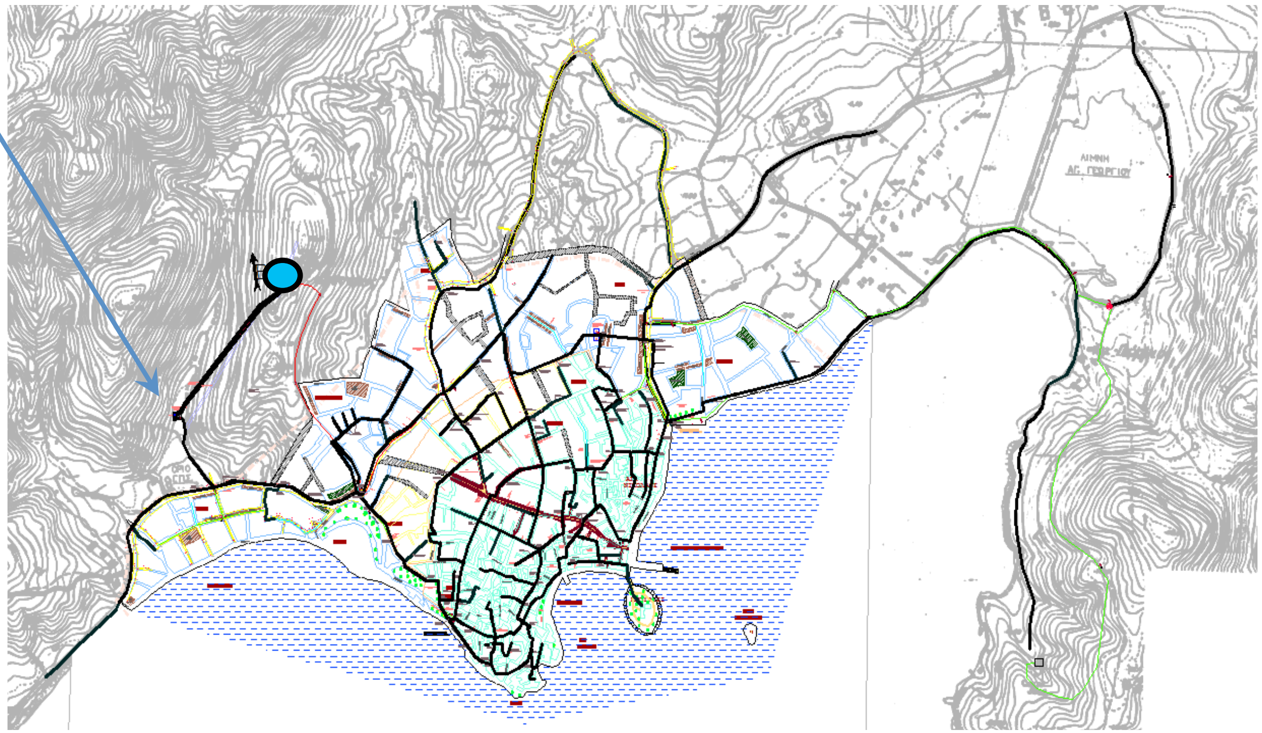
single-feed PRV scheme

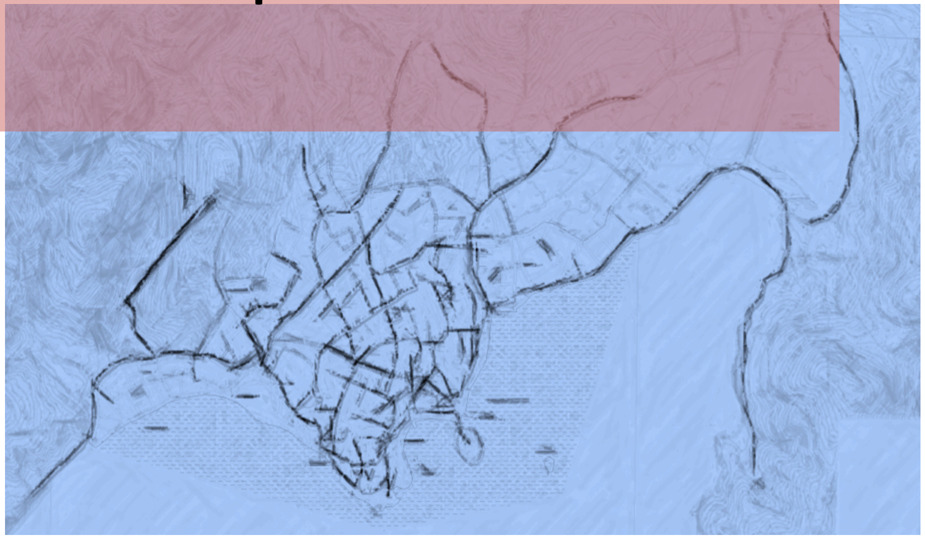


data

- daily pumped groundwater from a single drilling filling a single tank

equal to total daily water consumption of the whole town plus network leakage

- quarterly water consumption for each household



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the method

$$d_{k,t,tri} = w_{k,tri} * D_{t,tri}$$

$$w_{k,tri} = d_{k,tri} / \sum_{t} D_{t,tri}$$

$$d_{k,tri} = d_{kbilled,tri} * (1 + a_{tri})$$

$$a_{tri} = \sum_{t} D_{t,tri} - \sum_{k} d_{kbilled,tri} / \sum_{k} d_{kbilled,tri}$$

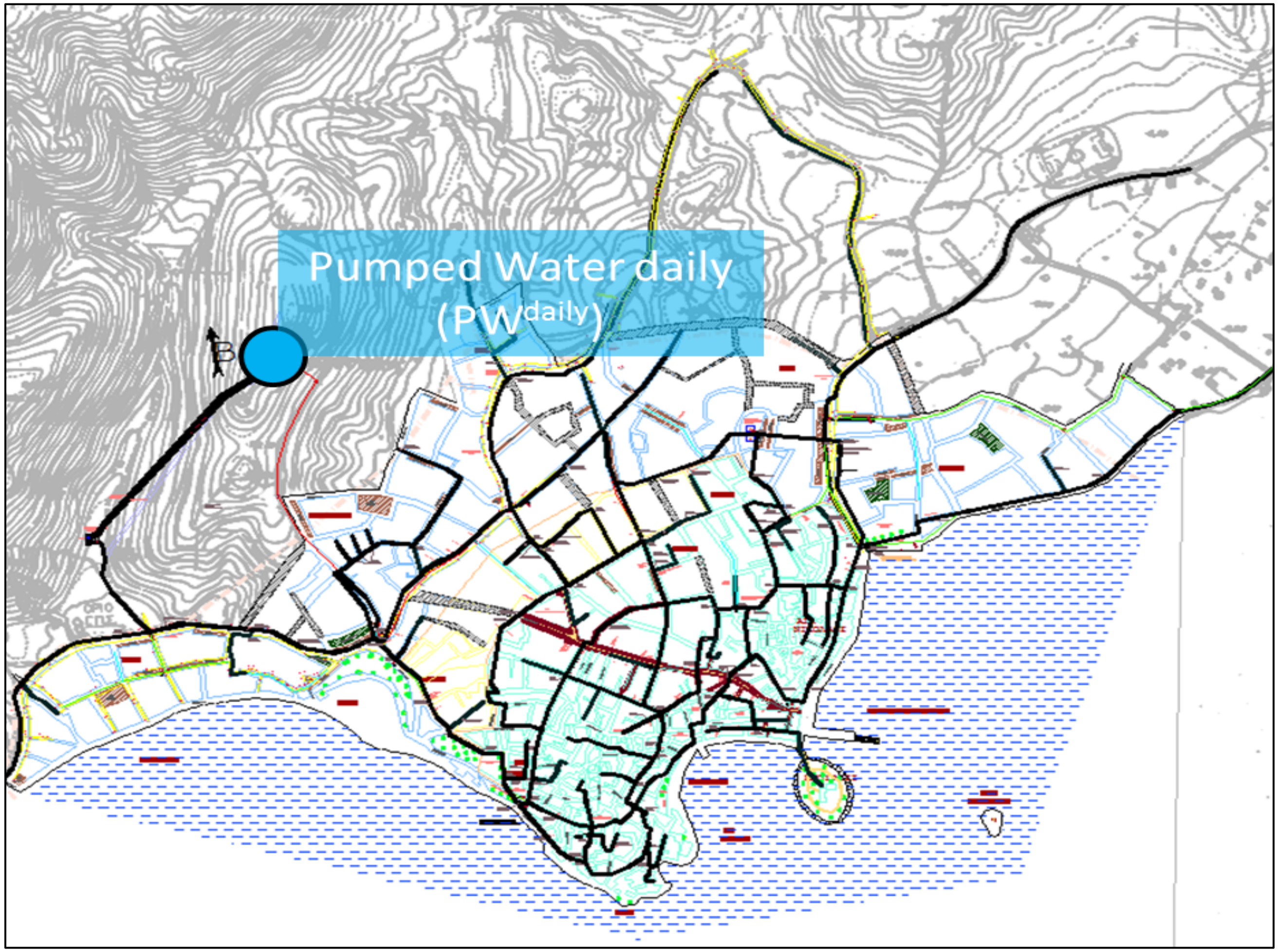
$D_{t,tri}$: water demand of whole town for day *d* of the trimester, or the daily pumped water

$w_{k,tri}$: specific weight of each water meter for trimester *tri*

$d_{k,tri}$: water demand of water meter *k* for the whole trimester *tri* , including the leakage that corresponds to that water meter. That is the trimester billing for water meter *k* with the theoretical leakage percentage added to it.

$d_{kbilled,tri}$ is the trimester *tri* water meter billing

$$Daily\ Water\ Losses = D_{t,tri} \sum_{t} D_{t,tri} - \sum_{k} d_{kbilled,tri} / \sum_{t} D_{t,tri}$$



Water distribution network of Skiathos Island supplied daily by a single drilling.

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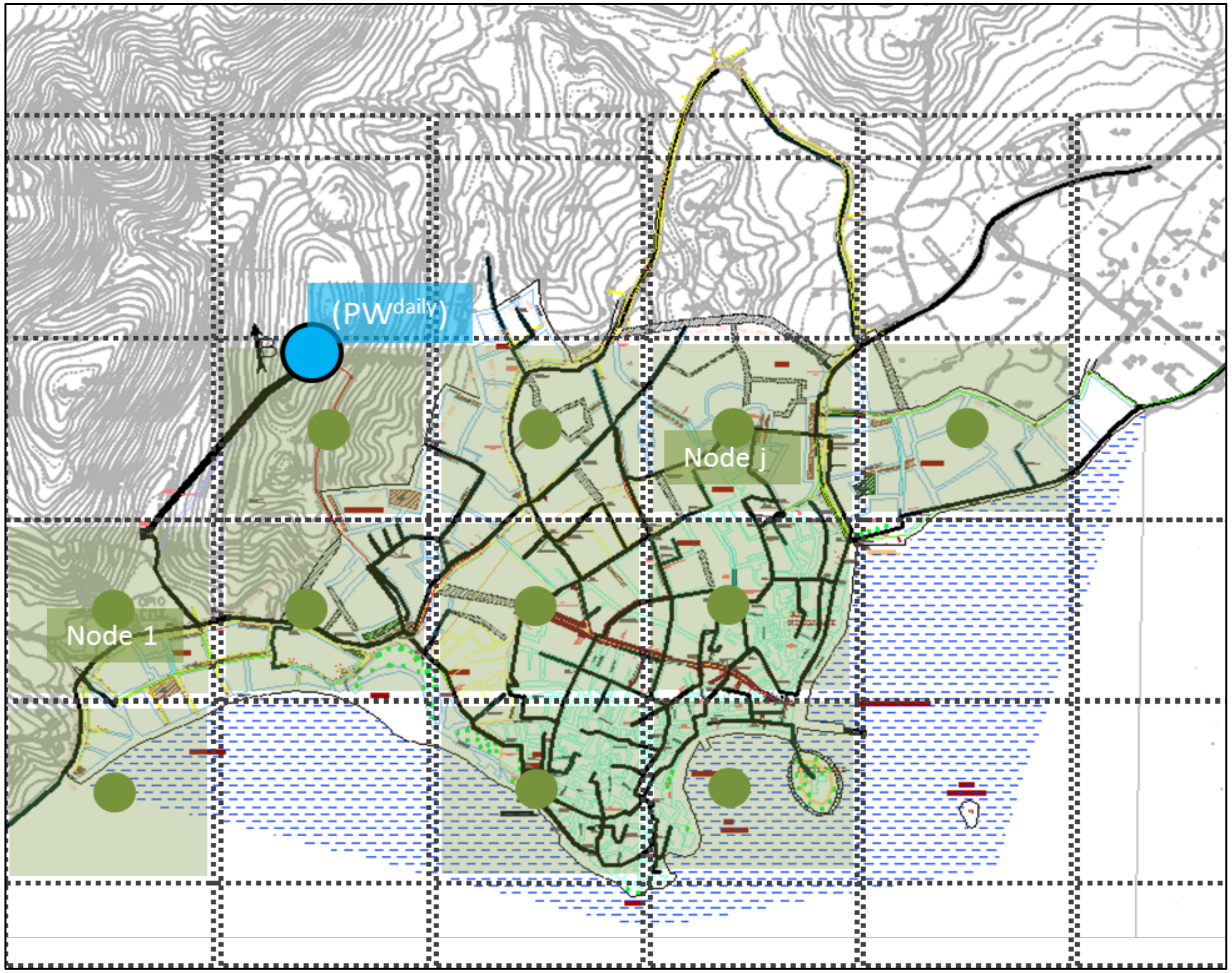

The network is divided into node areas.

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Each node will be a node of the hydraulic model that will be used to estimate the pressure map out of the water demand map.

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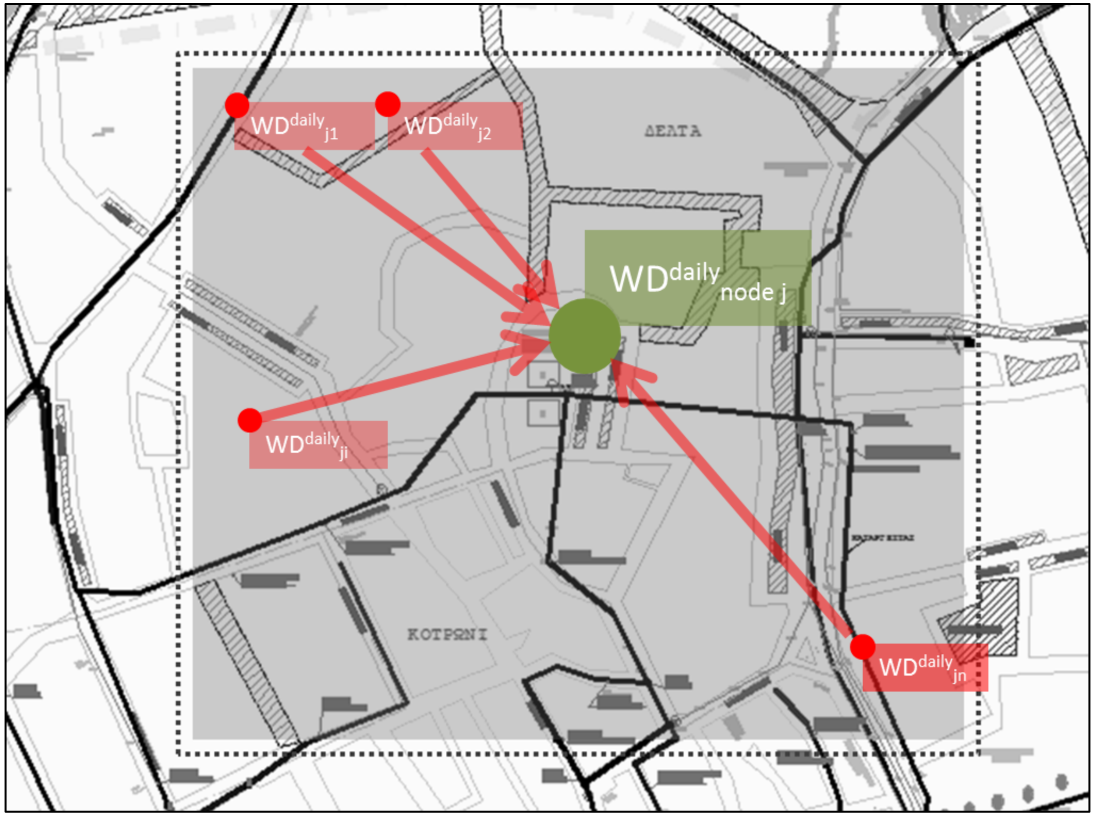
Each node corresponds to a water demand value that comes out by adding the household water demands that are supplied by the specific node of the network.



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Results

- the whole water demand of the town can be distributed to theoretical household demands including (or not) the leakages that "correspond" to the specific households with use of trimester household consumption weights.
- we do not expect this estimation to be accurate: since throughout a trimester the consumption profile of a household might change dramatically from one day to the next.

Results

- once the individual consumer daily demands are added at **a node level** the error becomes less significant, since a node will include multiple consumers
- potential to investigate the construction of a leakage model further than the literature suggested empirical leakage models.

Conclusions

limited data availability is a major obstacle in the implementation of any pressure management scheme in water distribution networks

in “low-tech” situations where **smart meters are not available** at the consumer level and customer billing is done manually with bills being issued once every three months or longer

we presented a methodology that can be useful in **disaggregating bulk town water supply data** to the level of individual consumer

The methodology, although not accurate, provides a way to deal with the lack of data and produces time series that can be refined later, as sensors and smart meters becomes more widely available

thank you for your attention

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