

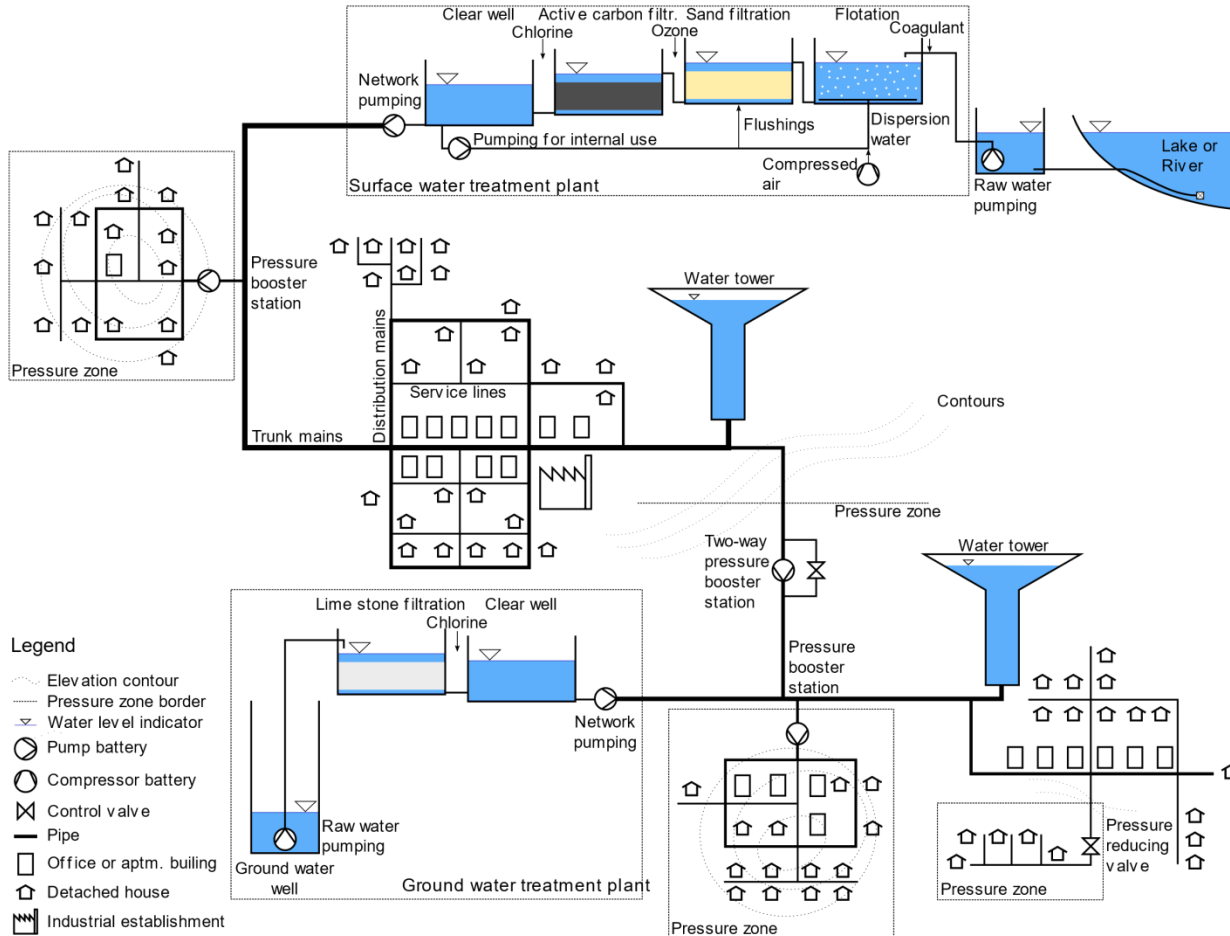


WATER DISTRIBUTION NETWORK RESILIENCE INDICES

5th Annual Seminar of the UNESCO Chair in Sustainable Water
Services
Tampere University of Technology 2017-08-25

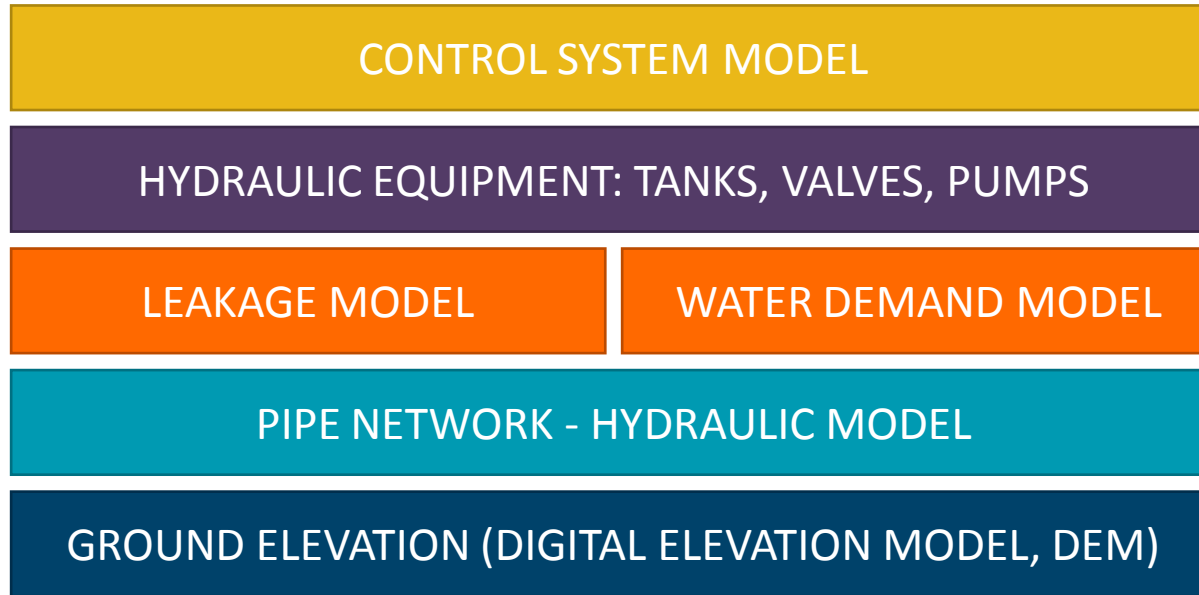
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WATER SUPPLY SYSTEM



WATER SUPPLY SYSTEM MODEL

MODEL AND PHYSICAL LAYERS

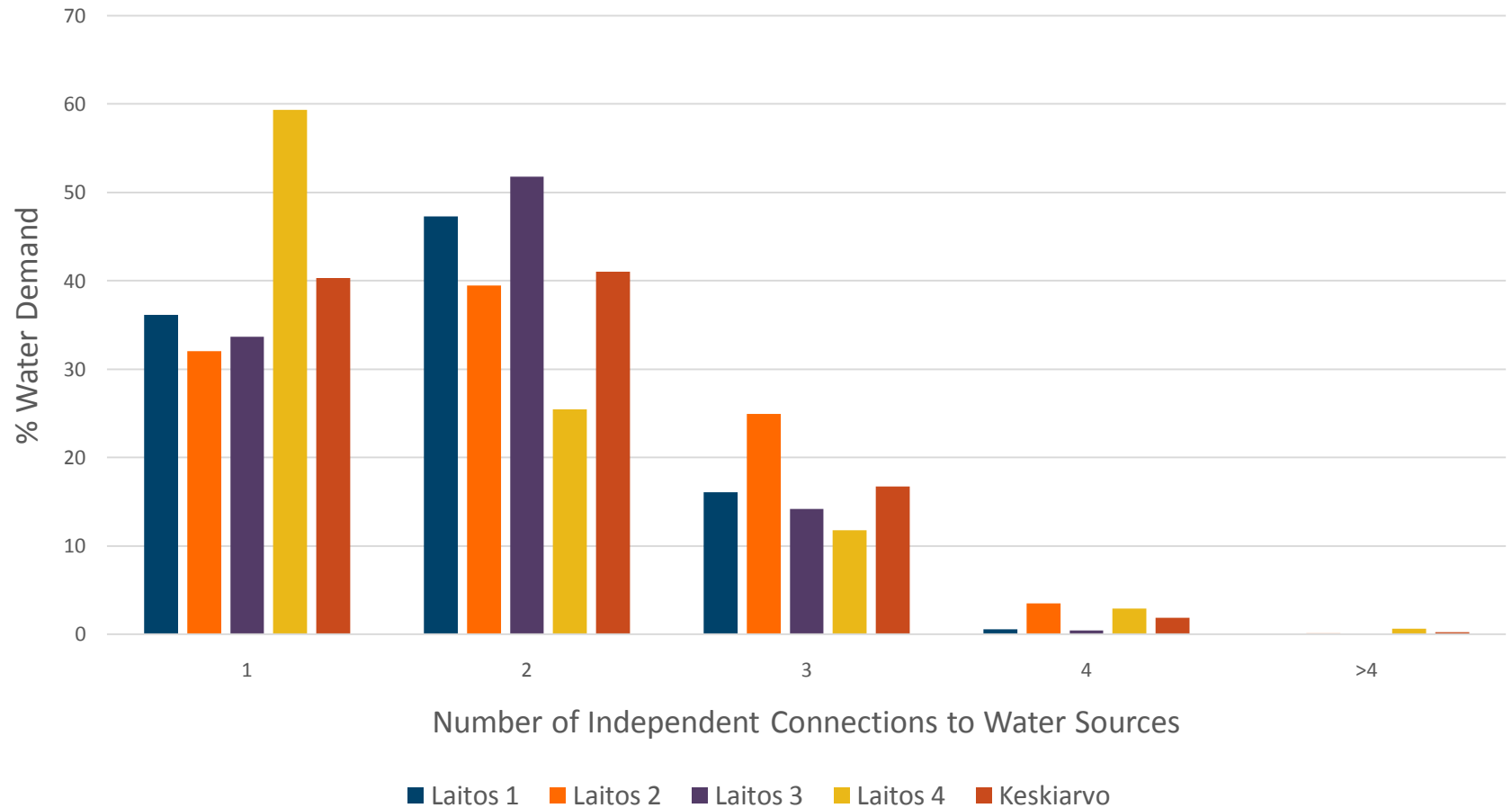


- Water distribution system is modelled as a graph of vertices (nodes) and edges (links)
- Model solves the state of the whole system as a function of time
- Using model, it is possible to get a lot of information that would be practically impossible to measure from the system – all pressures and flows are known and multitude of derivative variables can be calculated

SOME WATER DISTRIBUTION NETWORK RESILIENCE INDICES

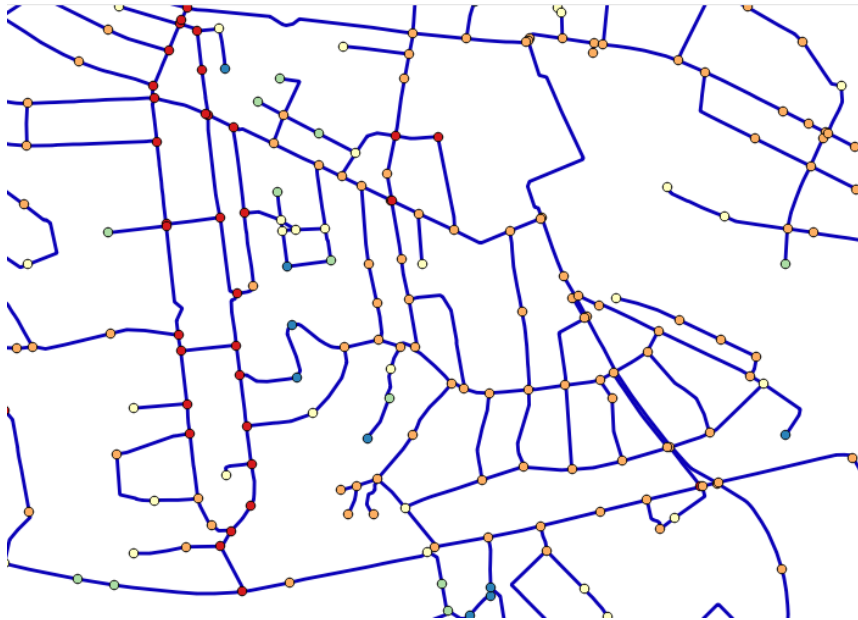
- Graph theoretical
 - Centrality
 - **Number of independent routes to water sources**
 - Reliable loops
 - Meshedness
 - Central-point dominance
 - Algebraic connectivity (spectral analysis)
- Hydraulic
 - Min. pressures
 - Network capacity
 - Pumping capacity
 - **Effects of closing pipes and pipe bursts**
 - Number of independent routes to water sources *w.r.t. route capacity*
 - Gross flow
- Quality
 - Water age
 - **Water source (mixing regions)**
 - Chlorine content
- Energetic
 - Pipe surplus factor
 - Todini res. index
 - Modified res. index
 - Network res. index
 - Transferred energy
 - Excess energy

NUMBER OF INDEPENDENT CONNECTIONS

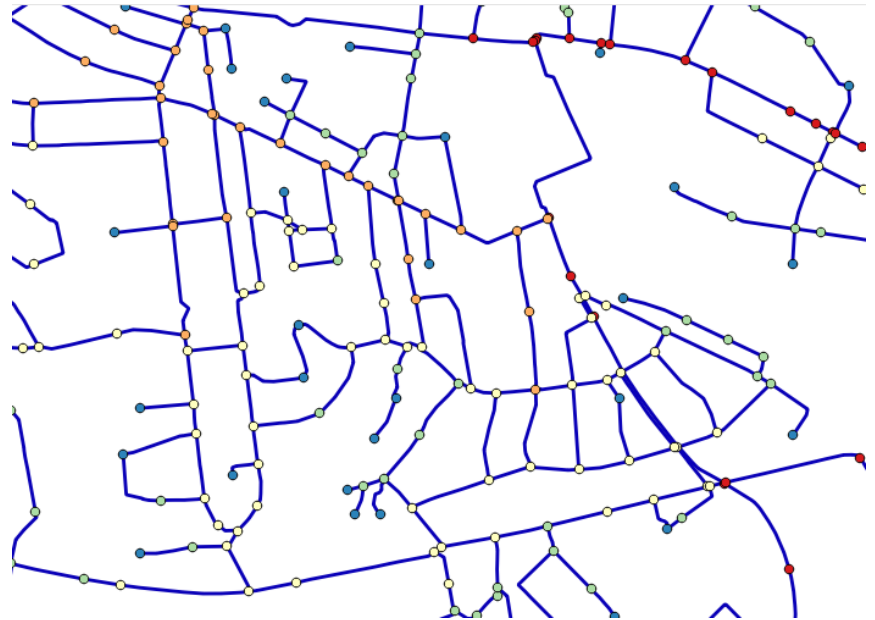


SENSITIVITY TO POLLUTE AND BE POLLUTED

Relative sensitivity to pollute network



Relative sensitivity to be polluted



EFFECTS OF PIPE BURSTS AND CLOSURES

Relative # of consumers affected by burst



Relative # of consumers affected by closure



LITERATURE

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