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Towards a comprehensive, general resilience assessment for intervention development in water distribution systems

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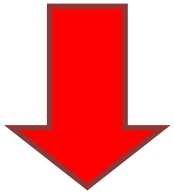
Safe&SuRe Water management

Outline

1. Background
2. General resilience concept
3. Case study
   - *Resilience assessment*
   - *Analysis*
   - *Intervention development and evaluation*
4. Conclusions

Background and aim

Specified resilience: "*the resilience of some particular part of the system… to one or more identified kinds of shocks*" *(Folke et al. 2010)*



What about trade-offs?

What about the unknowns?

General resilience: "*the resilience of any and all parts of a system to all kind of shocks including novel ones*" *(Folke et al. 2010)*

Assessment challenging

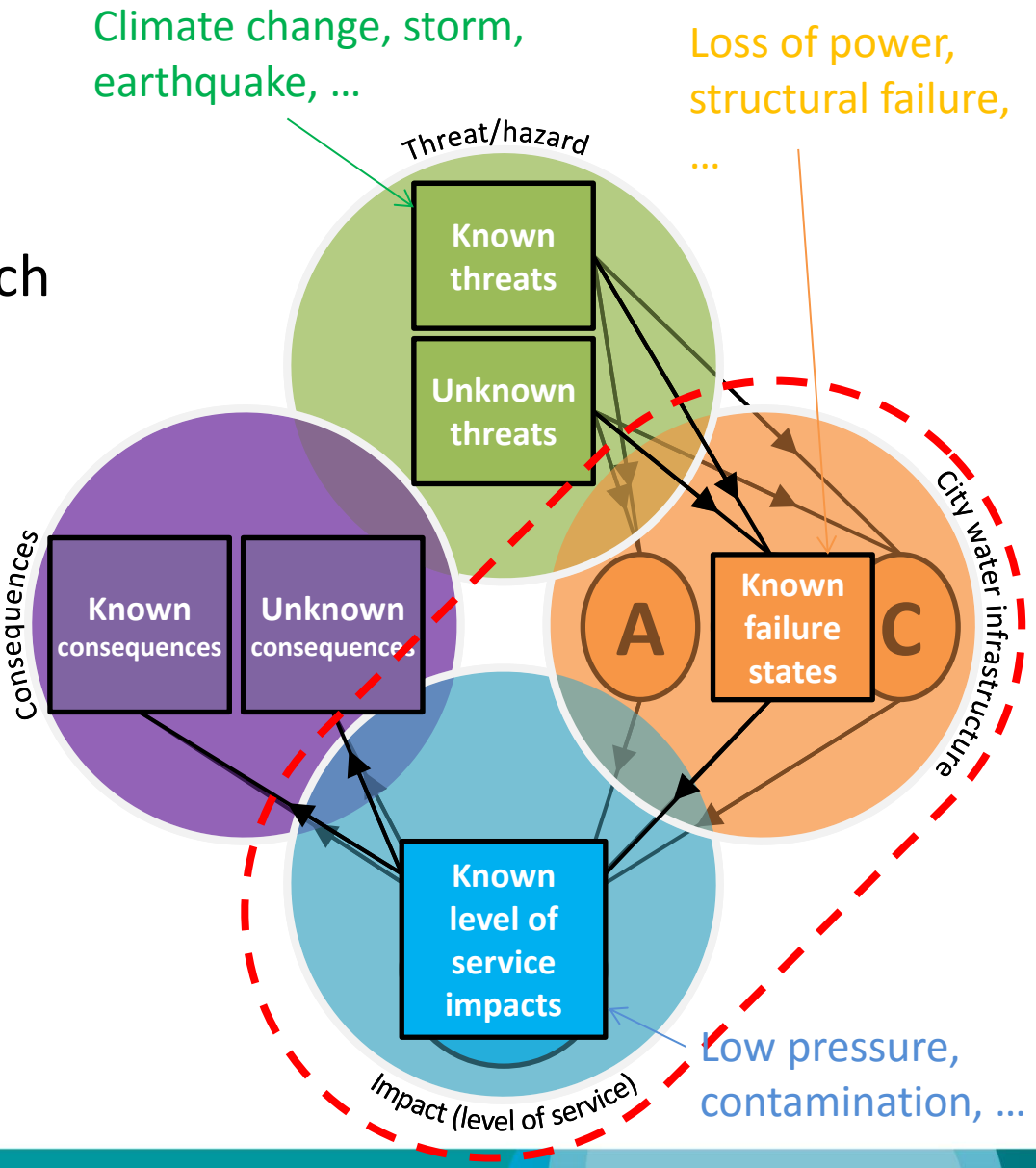
Typically qualitative or property-based

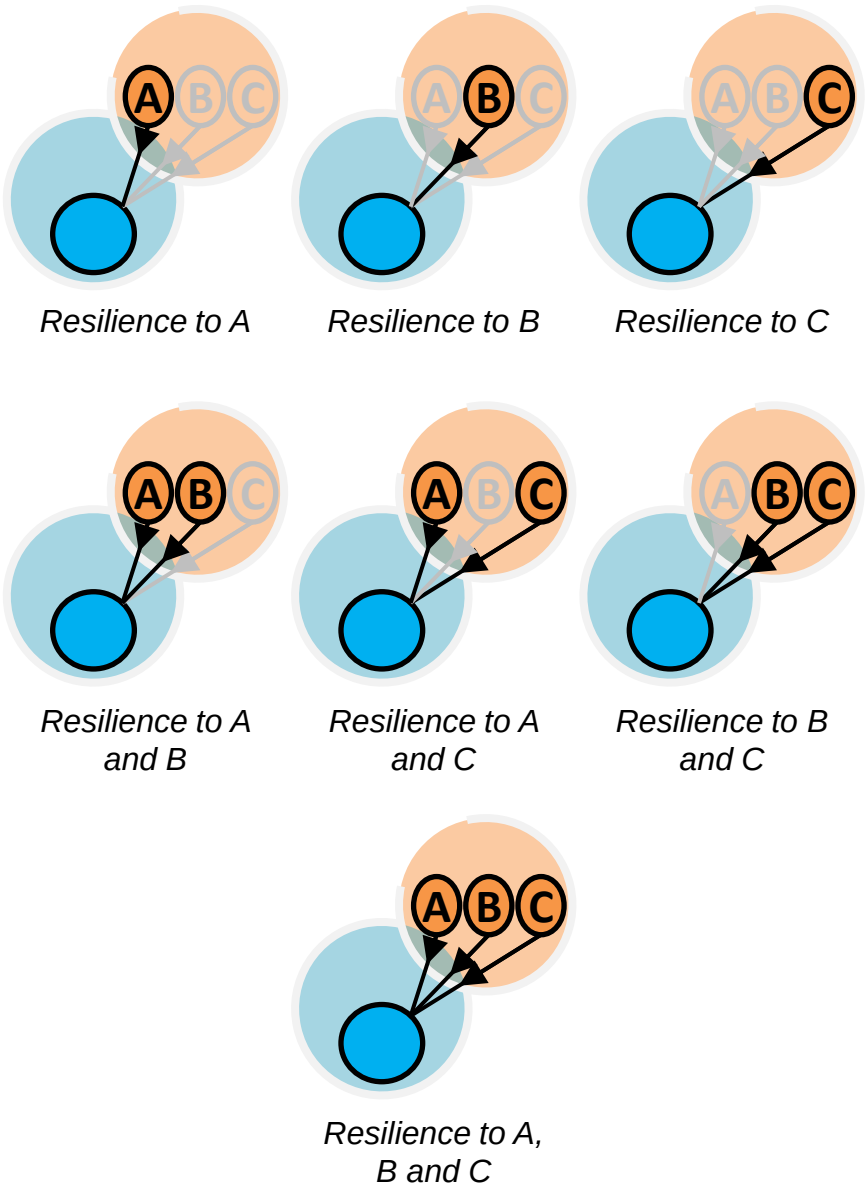
AIM: ***To provide a comprehensive, general resilience assessment for development of interventions water distribution systems***

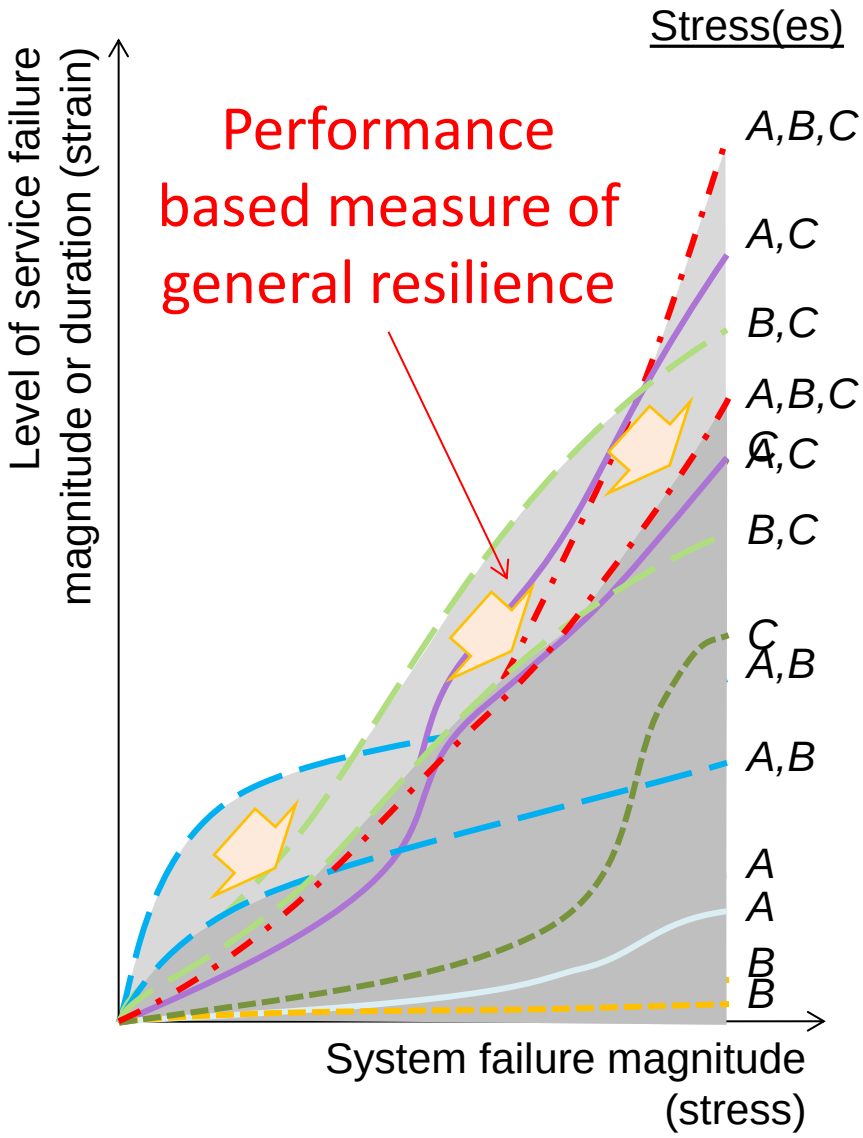
Concepts

1. A middle based approach allows all threats to be addressed

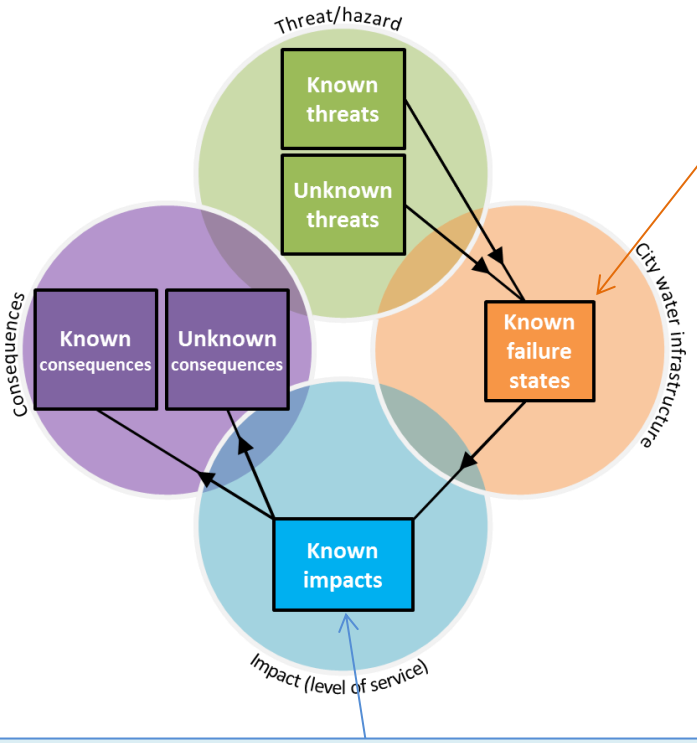
2. General resilience can be decomposed into multiple formulations of specified resilience




A
B
C
Resilience to A
Resilience to B
Resilience to C
A
B
C
Resilience to A and B
Resilience to A and C
Resilience to B and C
A
B
C
Resilience to A, B and C

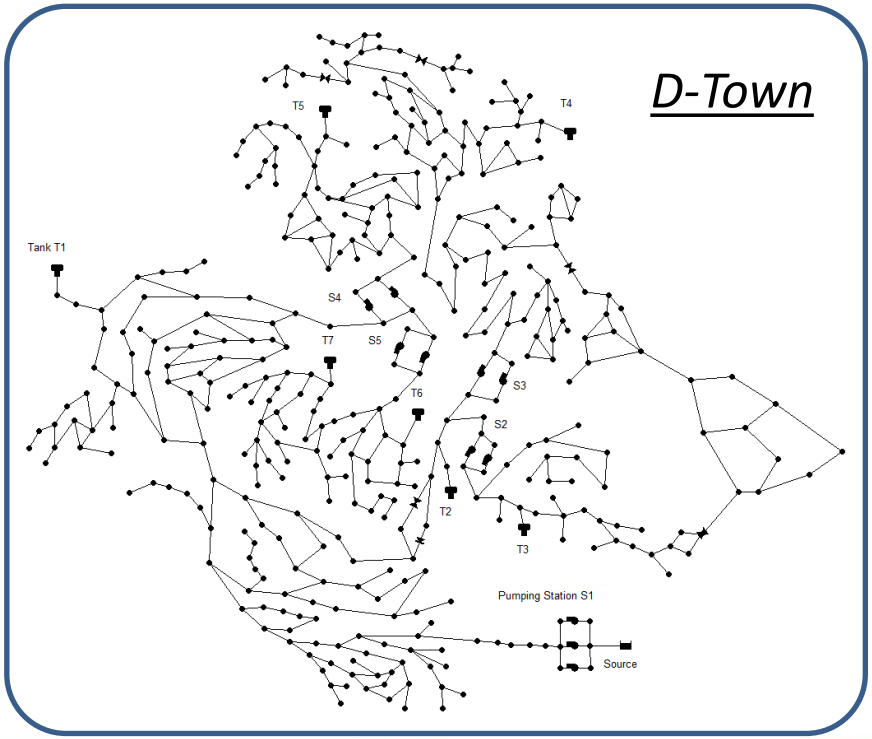

Stress(es)
Performance based measure of general resilience
Level of service failure magnitude or duration (strain)
A,B,C
A,C
B,C
A,B,C
A,C
B,C
C
A,B
A,B
A
A
B
B
System failure magnitude (stress)

Case study



System failure modes

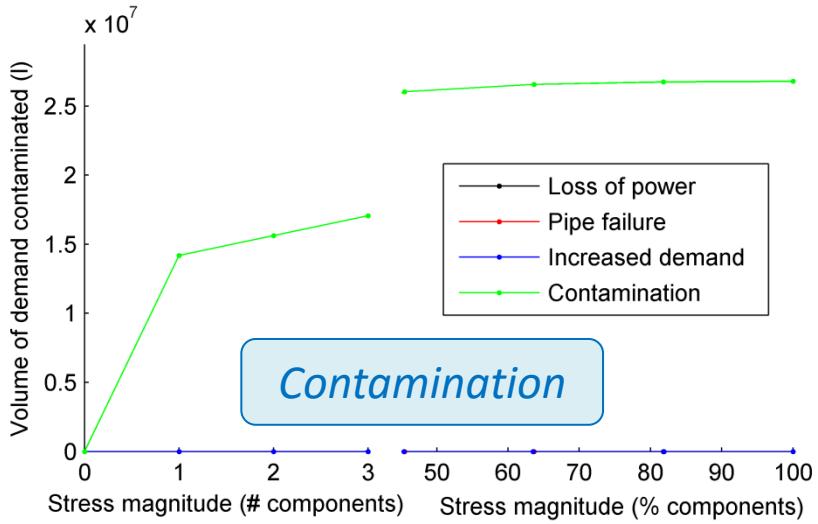
- Loss of power
- Pipe failure
- Contamination
- Increased demand

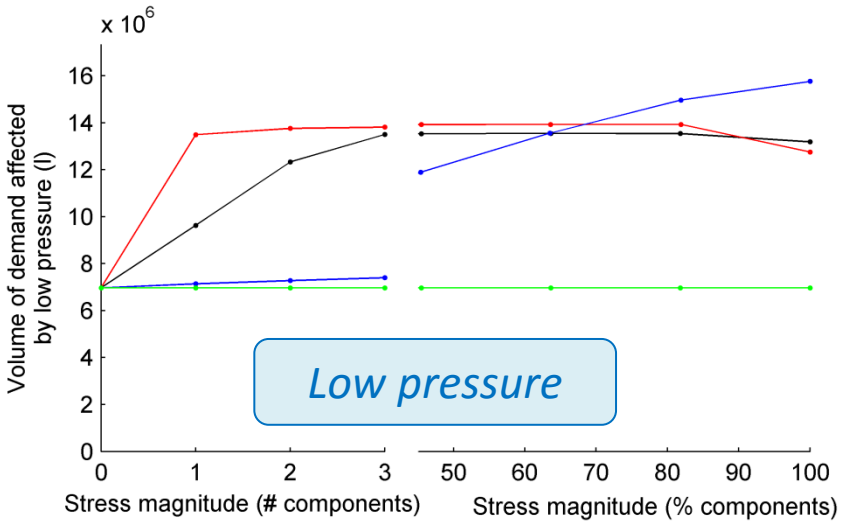


Level of service measures

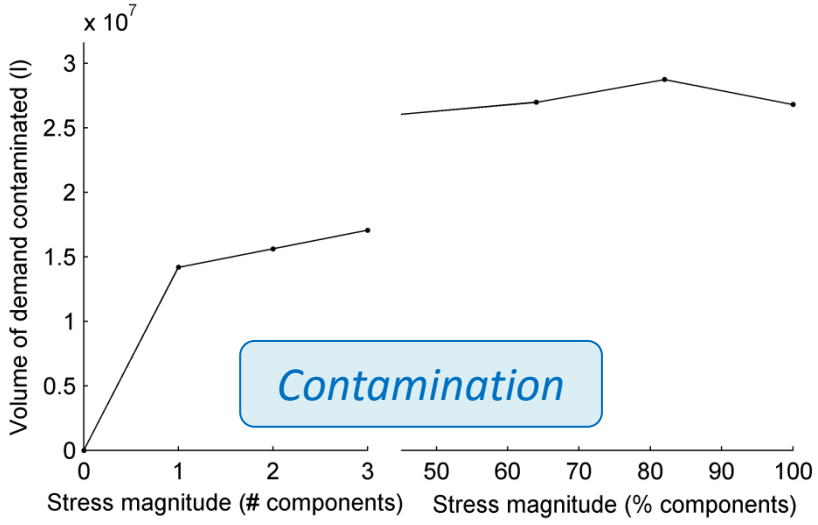
- Pressure
- Contaminant concentration

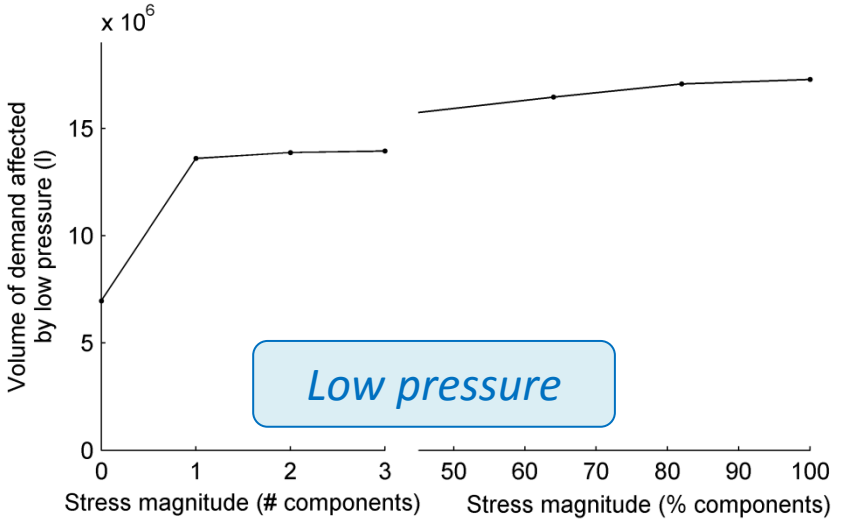
Maximum response to individual system failure modes





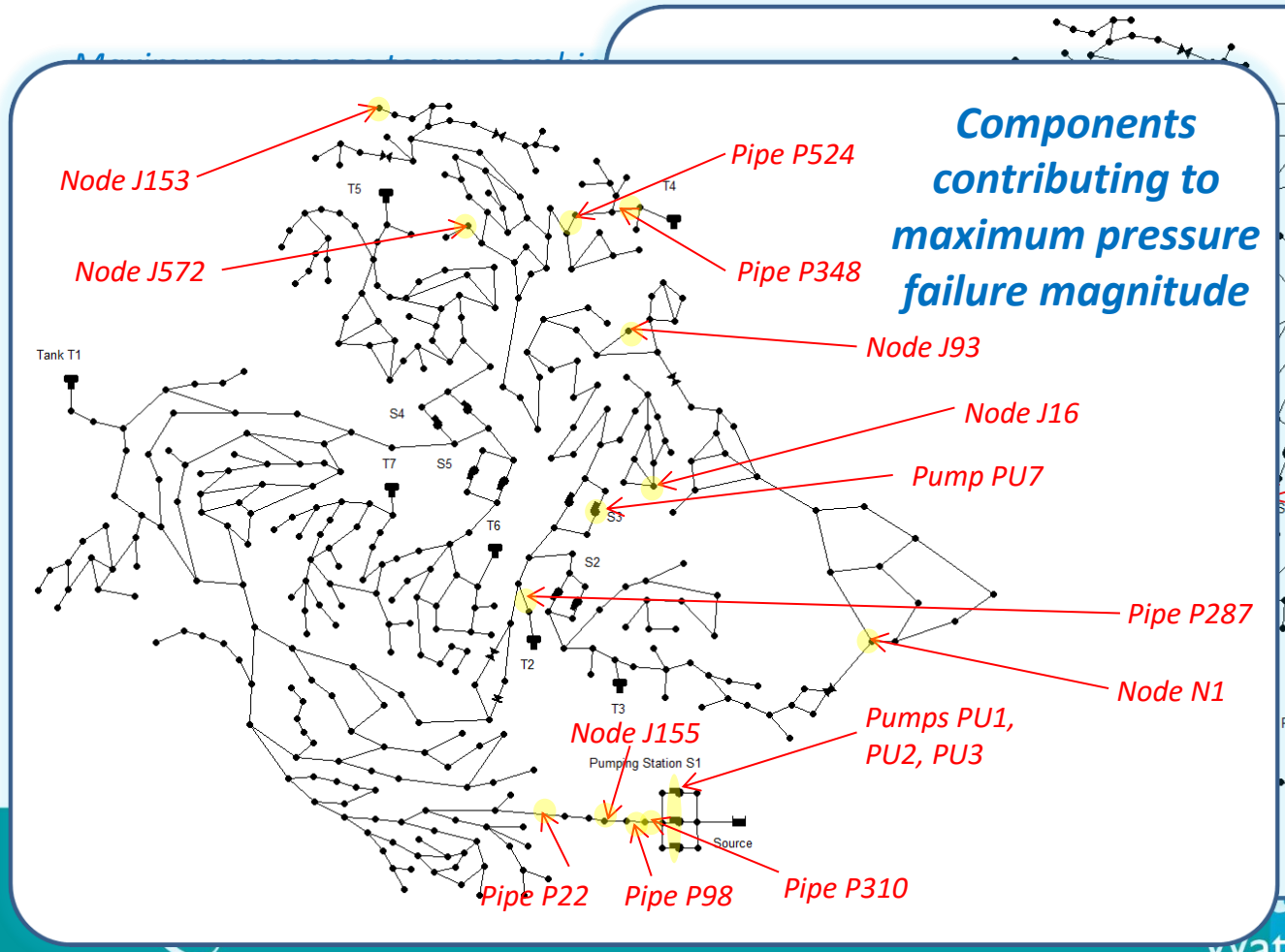
Maximum response to any combination of system failure modes

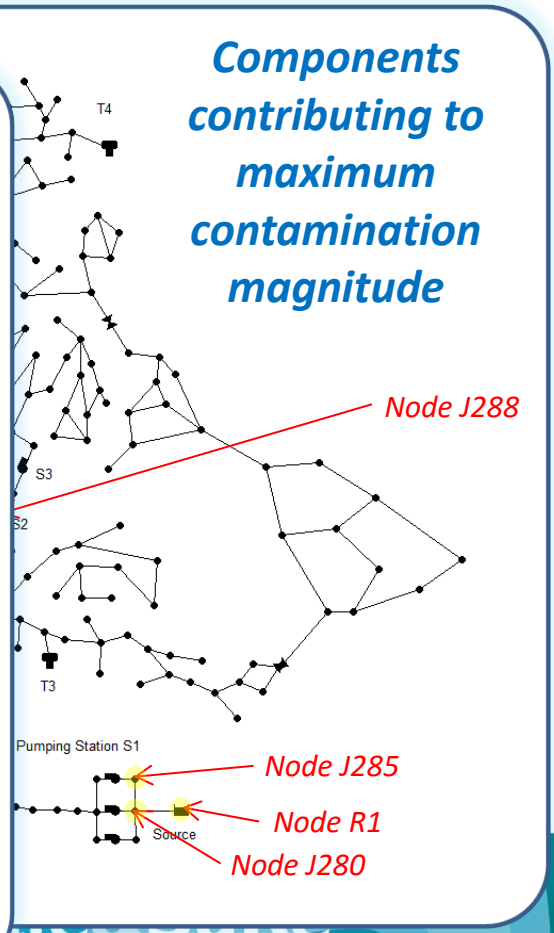




Intervention development

→ Identify components contributing to maximum pressure failure and contamination magnitudes

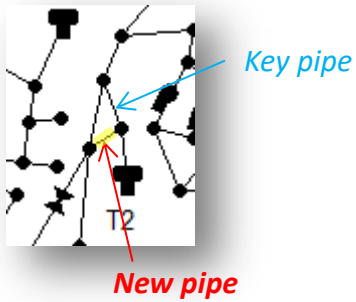




Water management

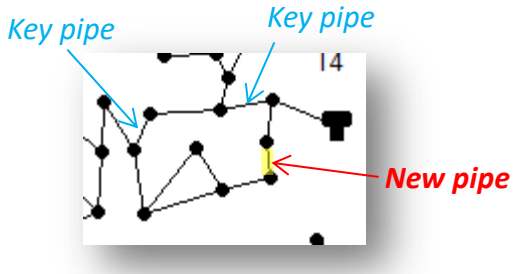
Intervention 1

Provide alternative route for key pipe *(flexibility)*



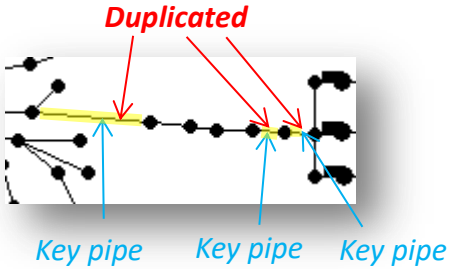
Intervention 2

Provide alternative route for key pipes *(flexibility)*



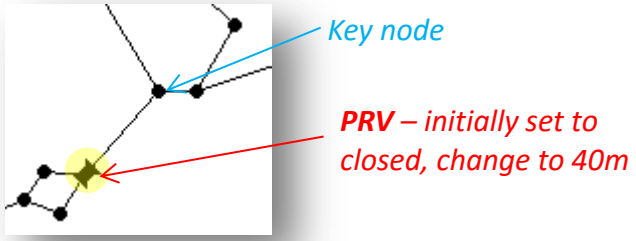
Intervention 3

Duplicate key pipes *(redundancy)*



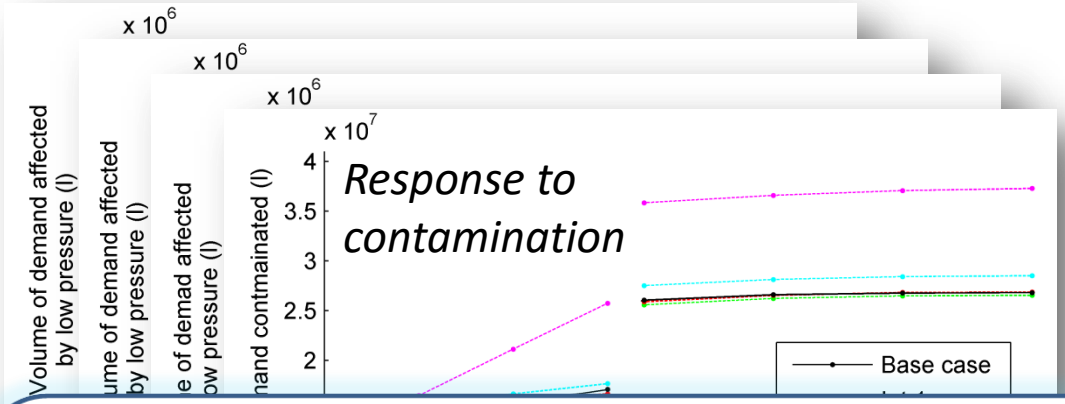
Intervention 4

Provide additional route to key demand node *(flexibility)*



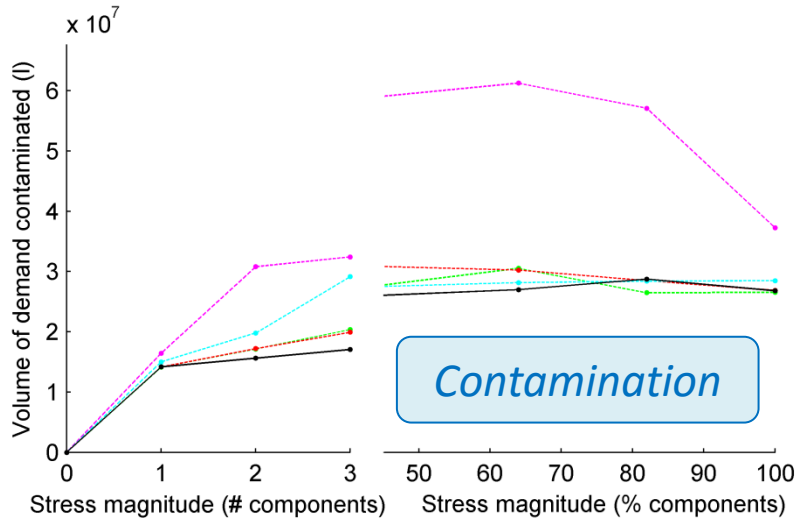
Intervention evaluation

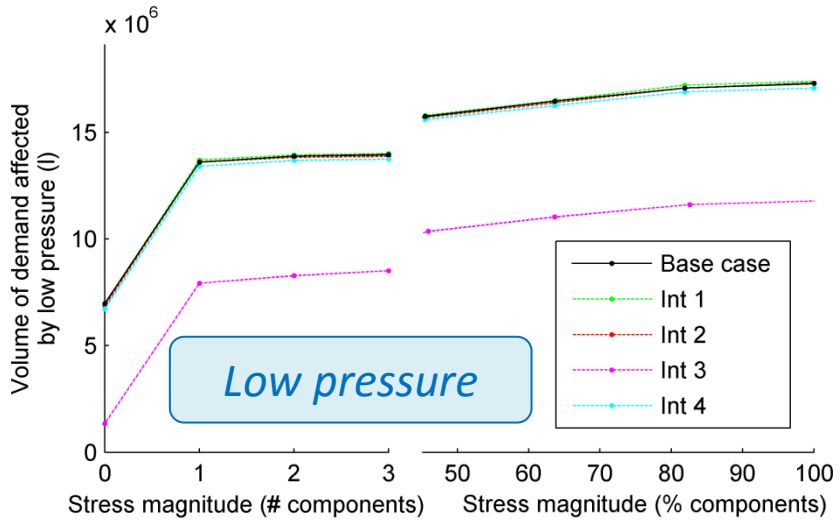
Maximum response to individual system failure modes:



- Resilience to loss of power, pipe failure and increased demand increased by intervention 4
- Resilience to contamination decreased by intervention 4

Maximum response to any combination of system failure modes (general resilience):





Conclusions

- General resilience assessment:
  - Ensures that a wide range of system failure modes, including those that occur simultaneously, are considered.
  - Incorporates the effects of potential failure in interdependent systems such as power distribution
  - Can inform the development of targeted interventions
  - Ensures knowledge of trade-offs and demonstrates challenges in intervention development

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