

WatefCon 2016

Water Frontiers: Strategies for 2020 and beyond

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Resilience: hype or hope?

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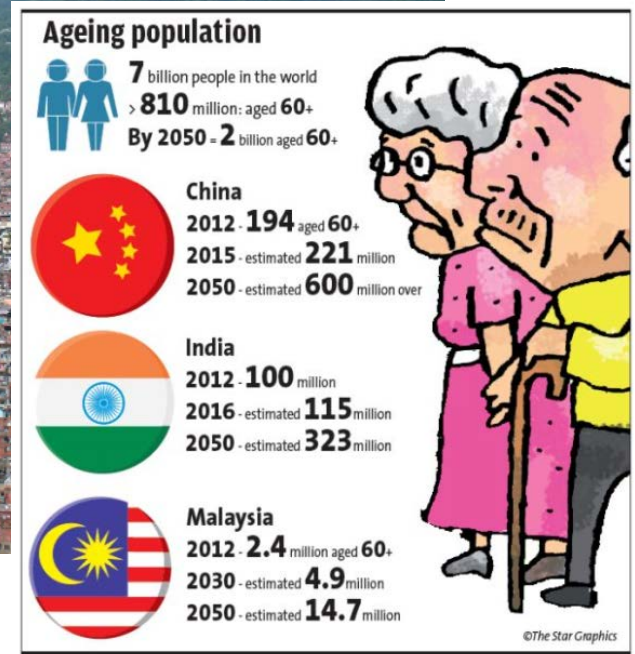
Outline

- Why?
- What?
- How?

Resilience: why?



Global threats



An era of unprecedented variability?



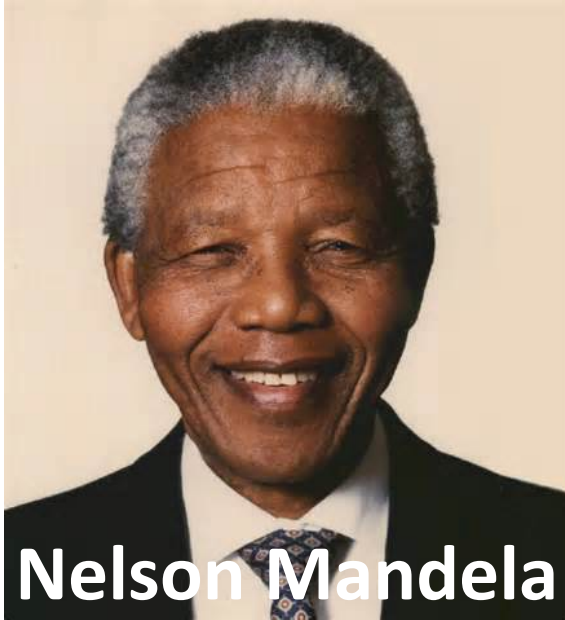
Ofwat's new resilience objective

- Secure the **long-term resilience** of water supply and sewerage systems;
- Promote action to respond effectively to **pressures** on the environment (including climate change), population growth and changes in behaviour;
- Ensure **long-term** planning and investment;
- Promote **measures** to manage water sustainably and reduce demand so as to reduce pressure on water resources.

Resilience: what?



Defining resilience



Nelson Mandela

“Do not judge me by my successes, judge me by how many times I fell down and got back up again.”



“It's not how you go down, but how you get up.”



Leicester City Football Club

News / Fixtures & Results / Tickets / Team / Stats / Fans / C

City Resilience Delights Morgan

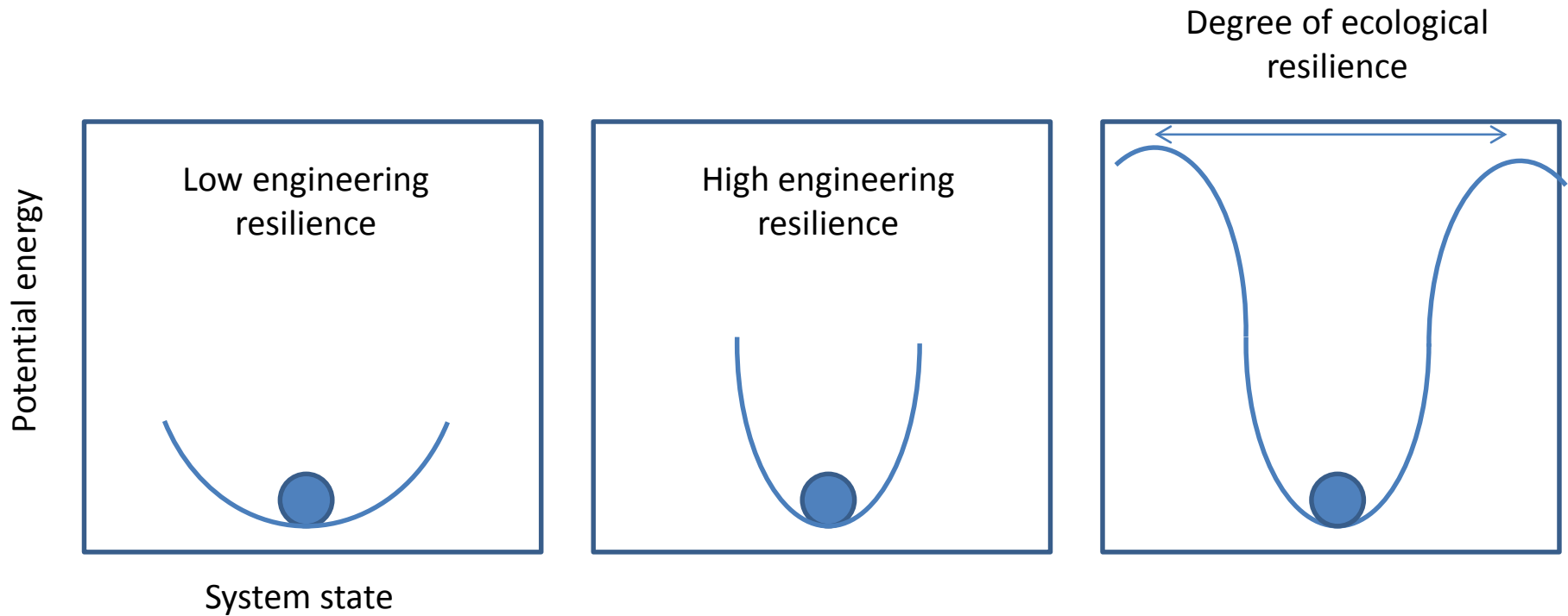
Posted: Mon 02 May 2016
Author: Leicester City



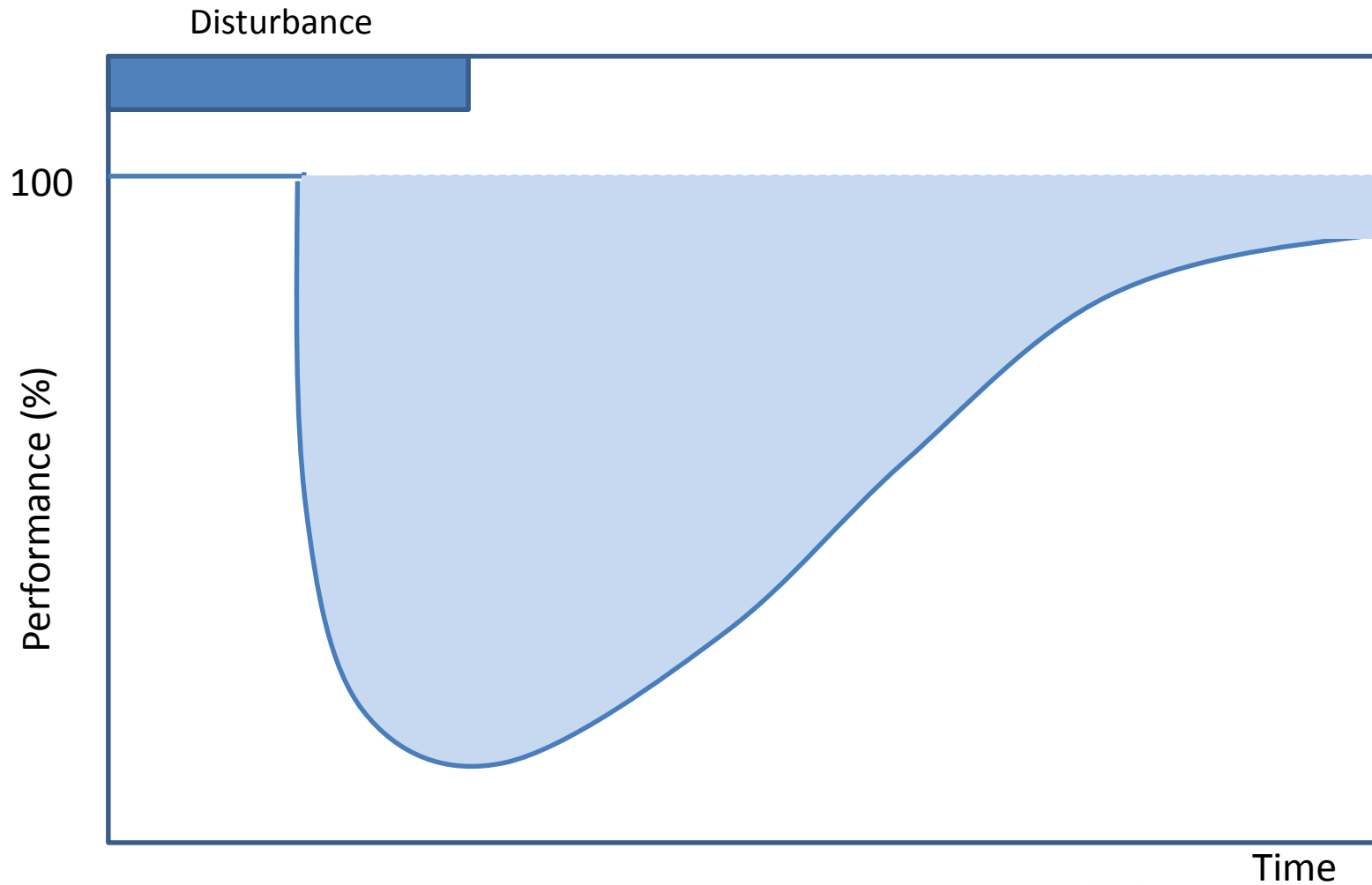
After recovering from an early setback to secure a 1-1 draw with Manchester United at Old Trafford on Sunday, Wes Morgan spoke of the resilience within the Leicester City squad.

“
We started to come into our own in the last 15

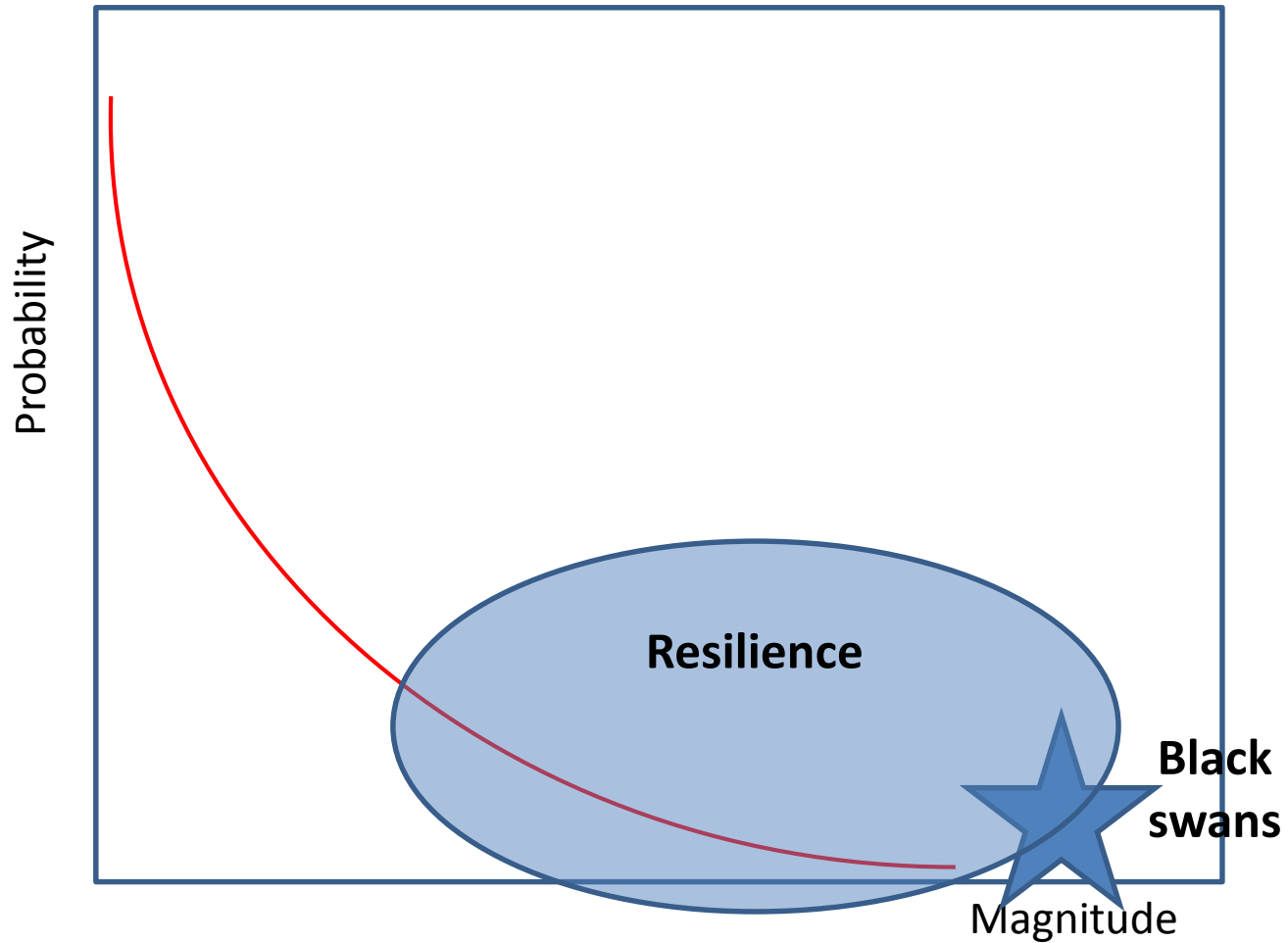
Basic concepts



System performance response curve



Response to extreme events



Resilience definition & dimensions

Dimensions

Properties

- State of the system
- Related to **design and operation** of system

Performance

- Function of system
- Related to **level of service**

Performance definition

*The degree to which the system minimises the level of service **failure magnitude and duration** under unexpected or exceptional loading conditions*

= min(failure: magnitude, duration)

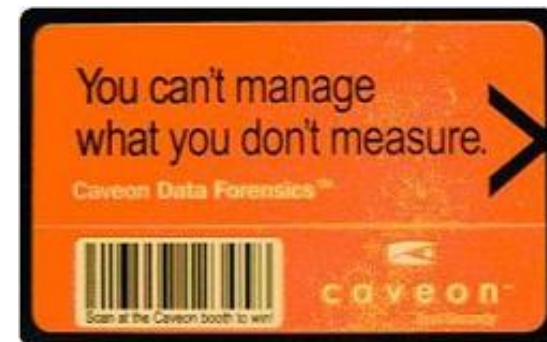
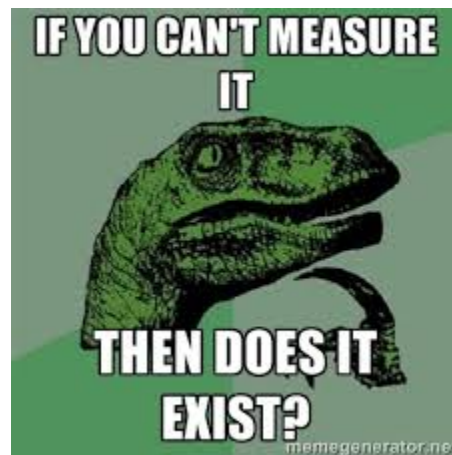
Bouncebackability

Fail safe → Safe to fail

Resilience: How?

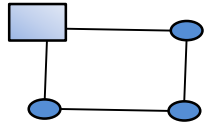


Measuring resilience



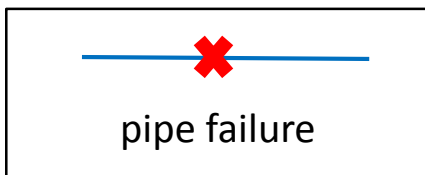
Global Resilience Analysis

Simple example



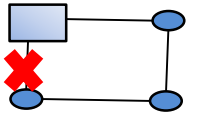
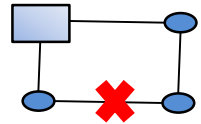
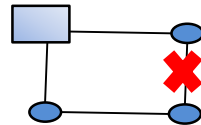
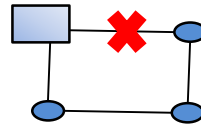
Failure state
e.g. Pipe failure state

Stress

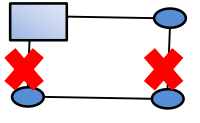
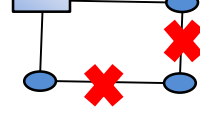
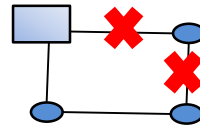
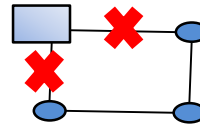


Failure scenarios

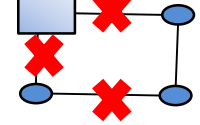
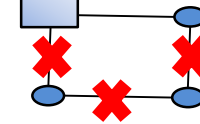
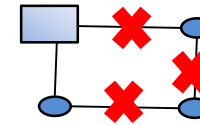
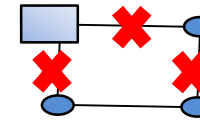
One pipe fails
(4 Scenarios)



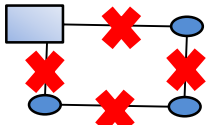
Two pipes fail
(12 Scenarios)



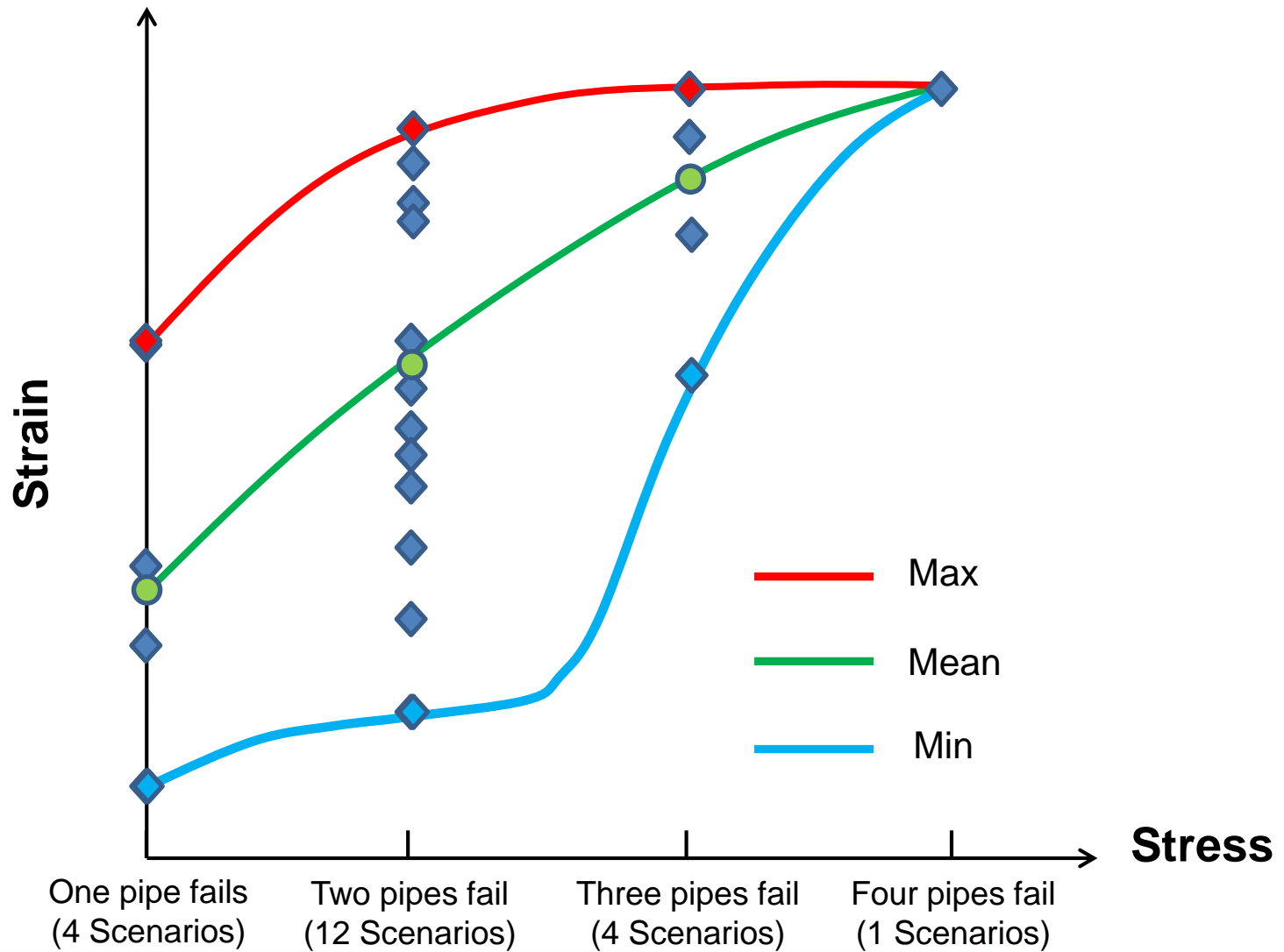
Three pipes fail
(4 Scenarios)



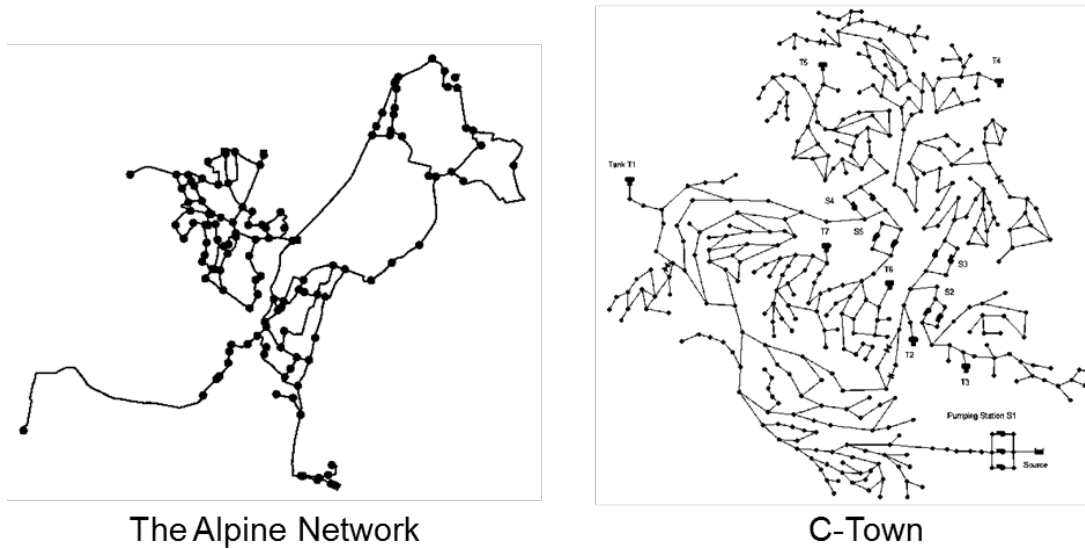
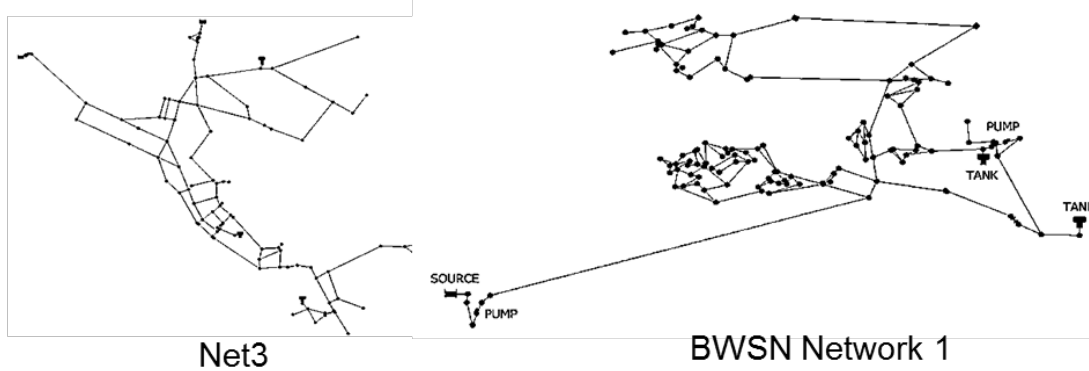
Four pipes fail
(1 Scenarios)



GRA Stress-Strain Plot

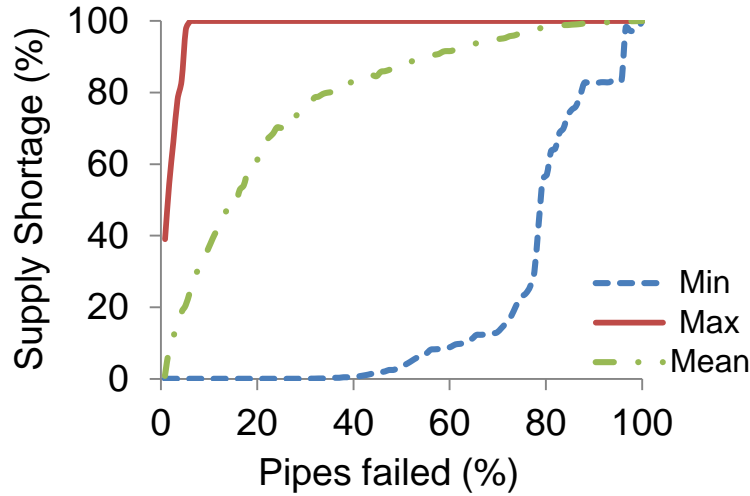


Case Study Systems

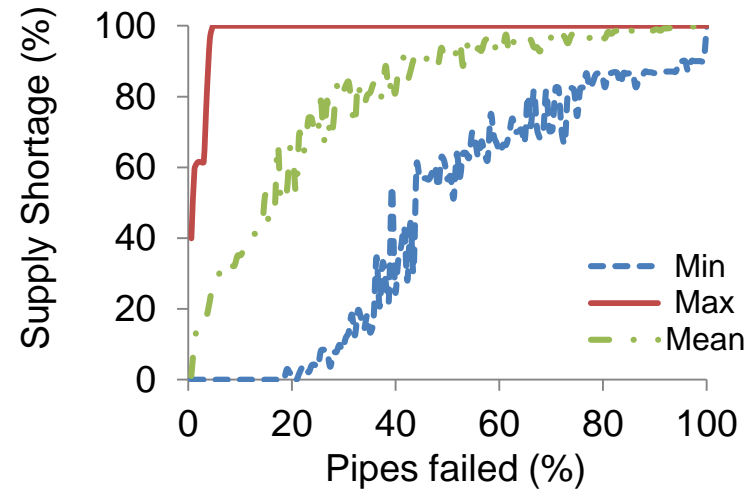


Pipe failure GRA curves

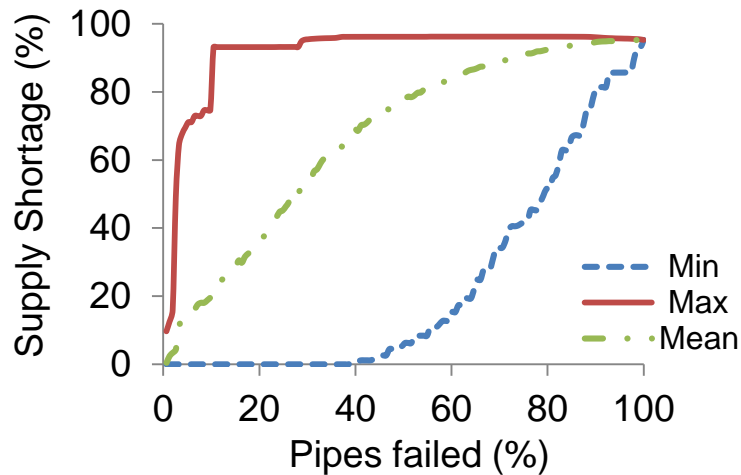
Net3



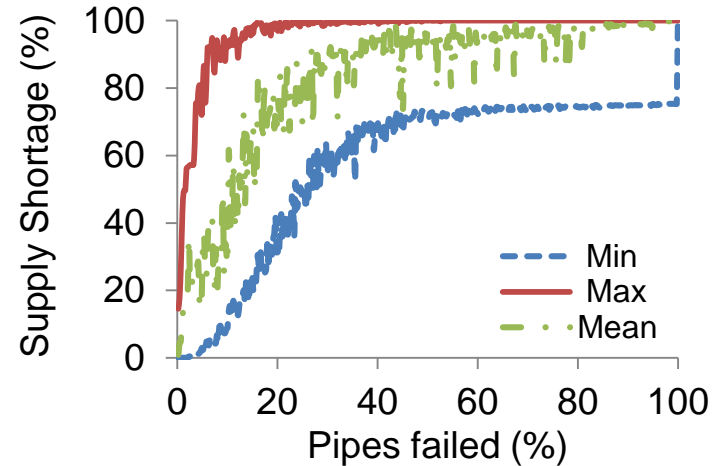
BWSN Network 1



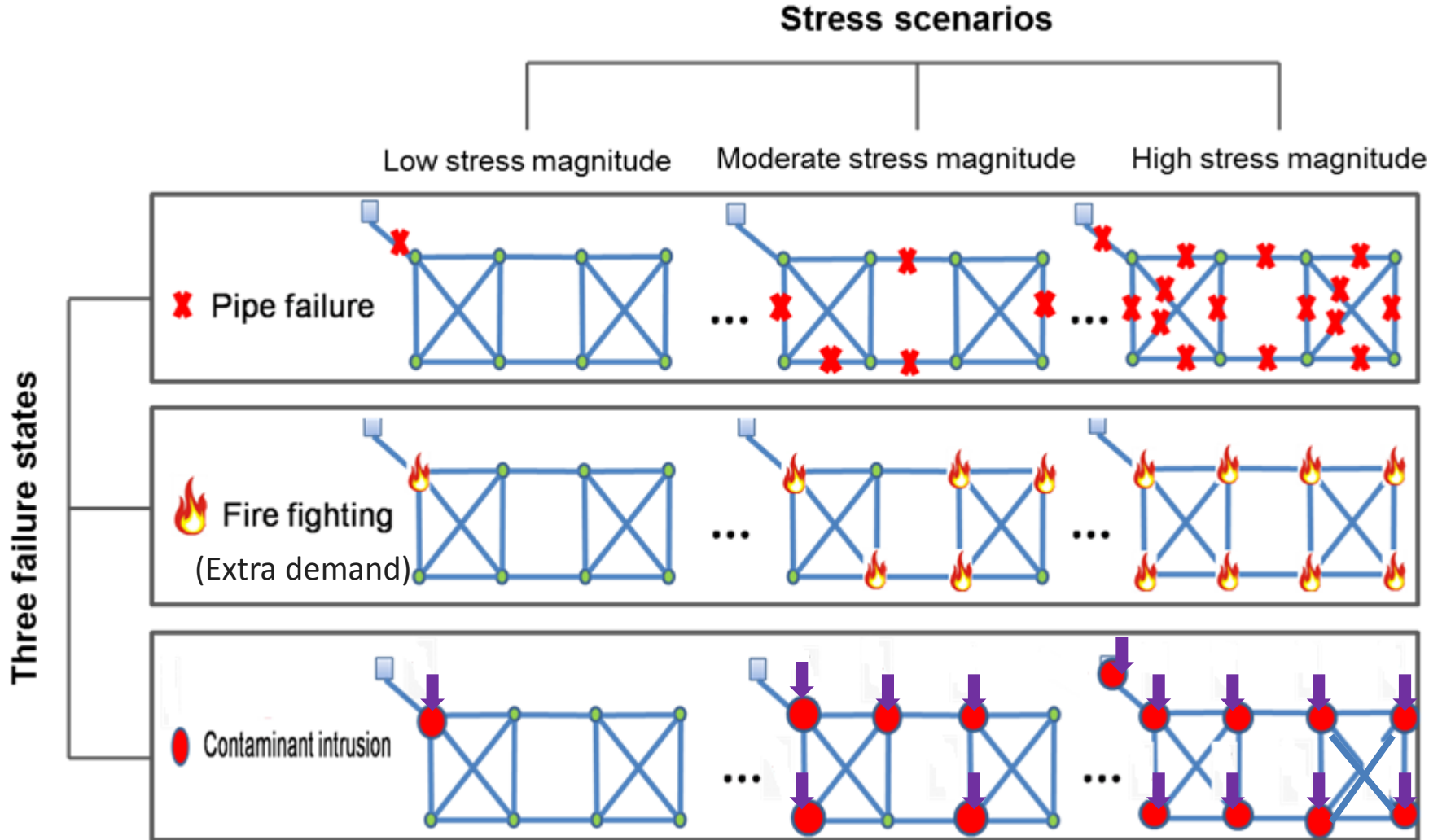
Alpine



C-Town

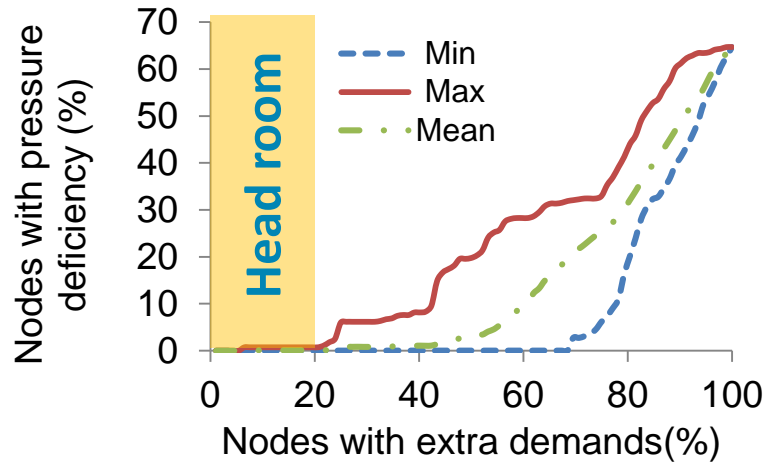


Three possible failure states

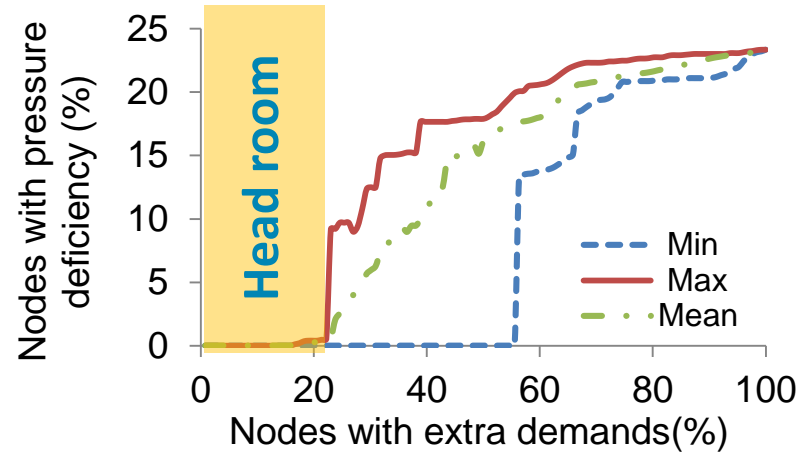


Firefighting GRA curves

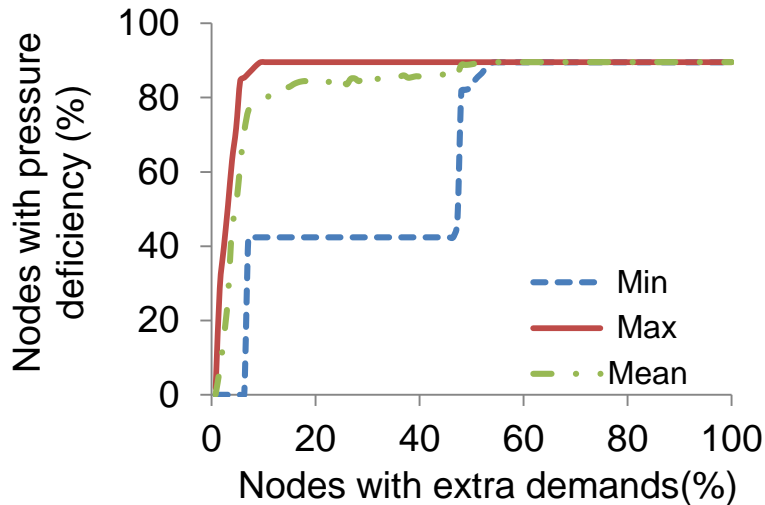
Net3



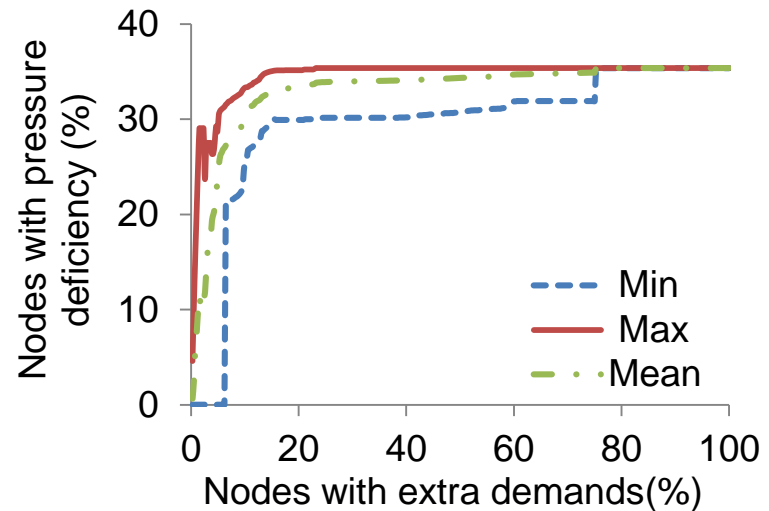
BWSN Network 1



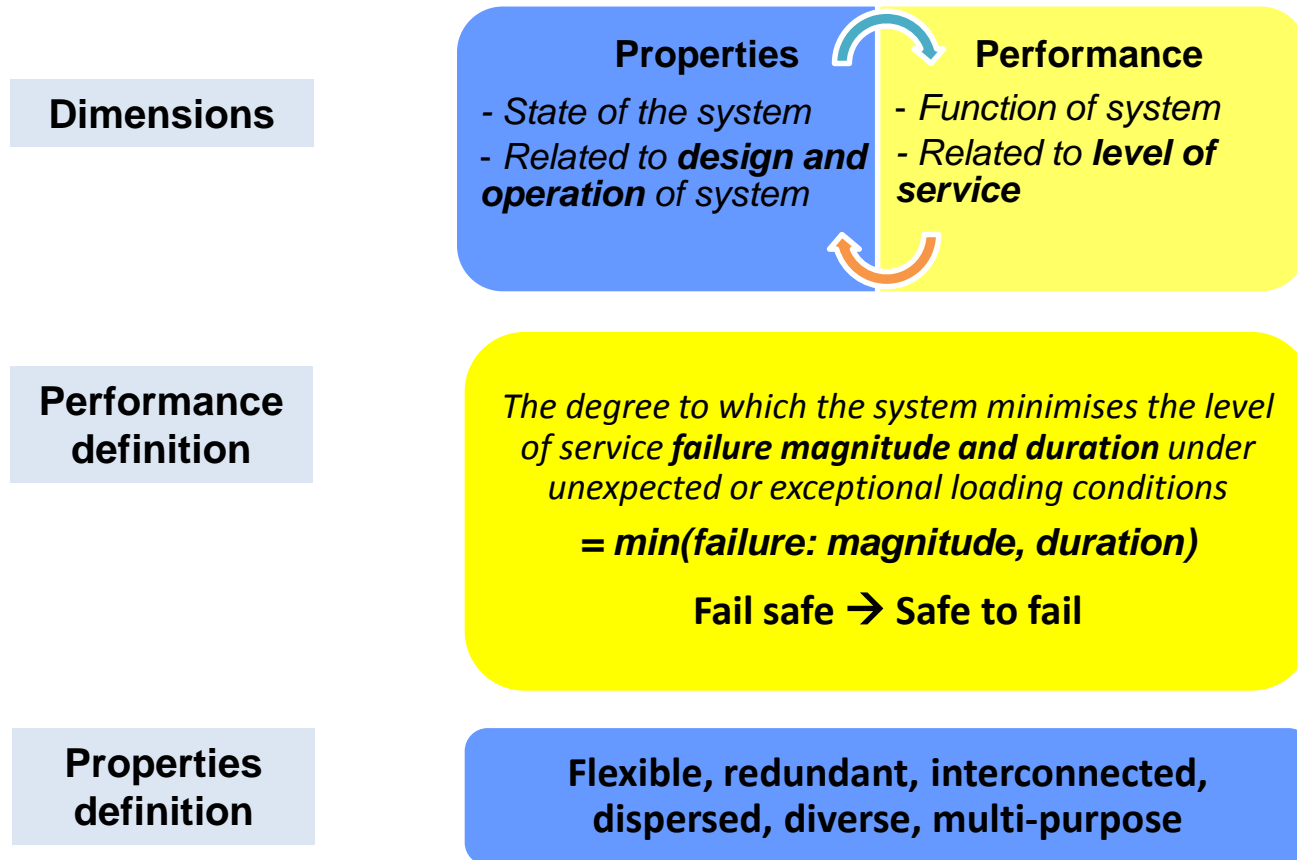
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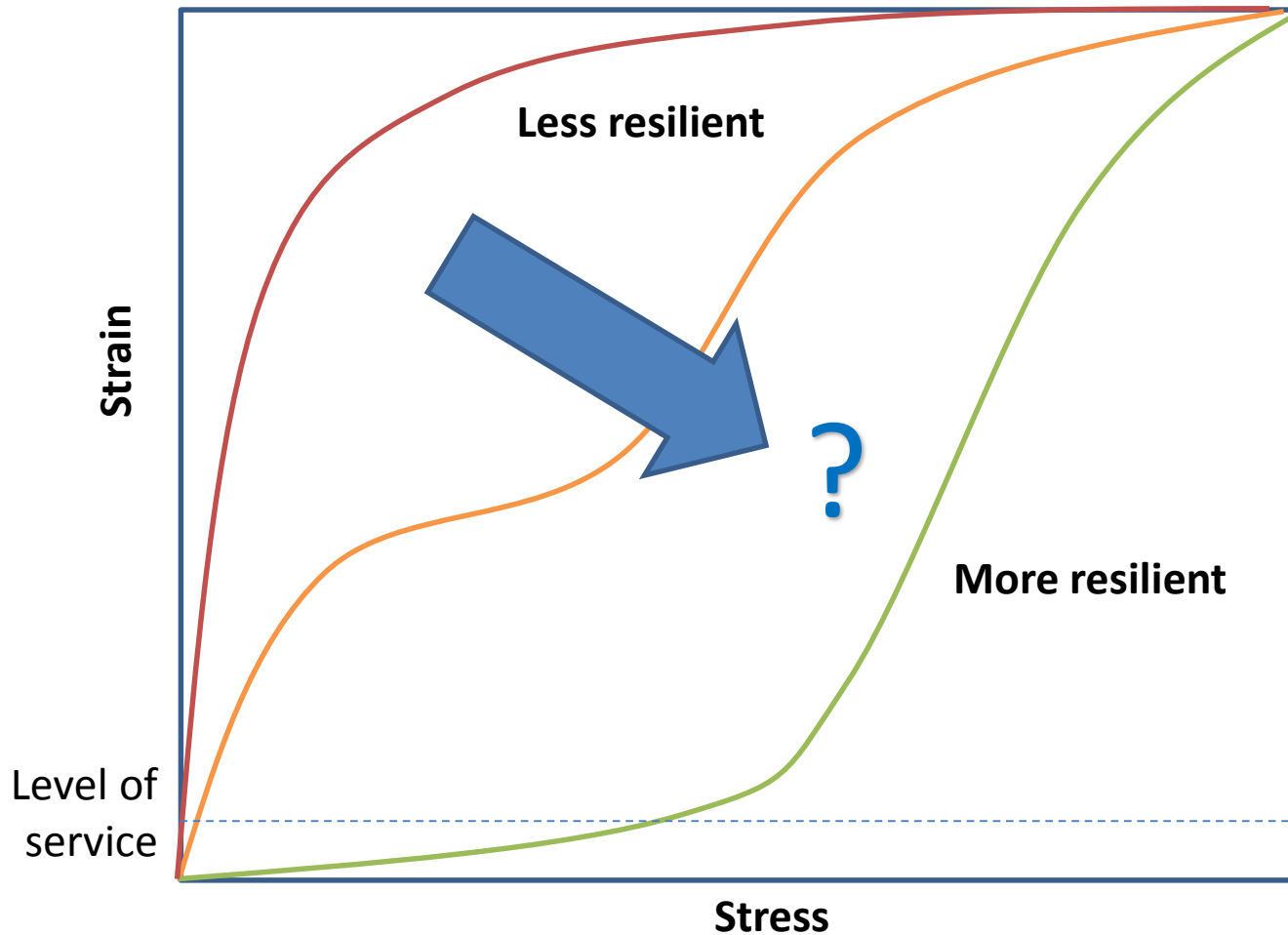
C-Town



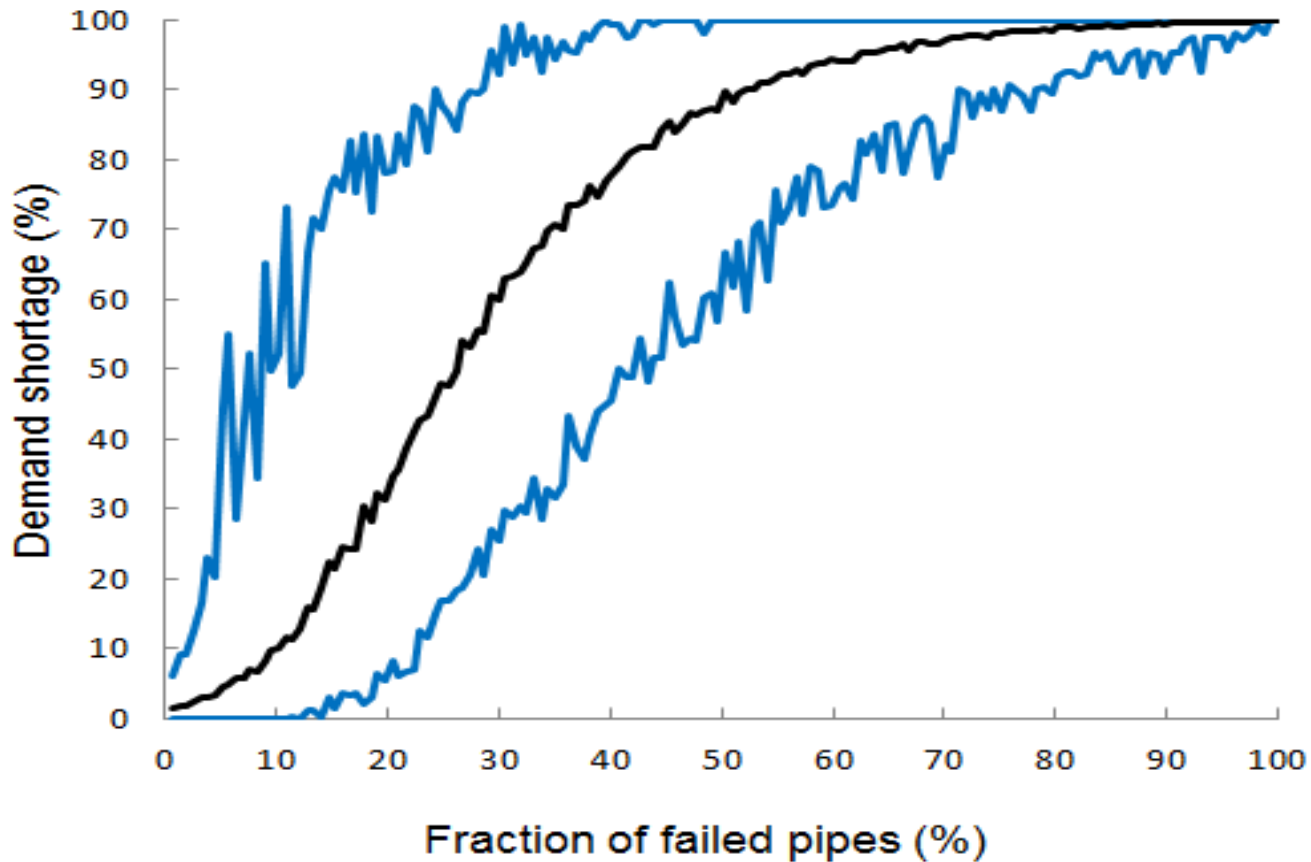
Resilience definition & dimensions



Global resilience analysis

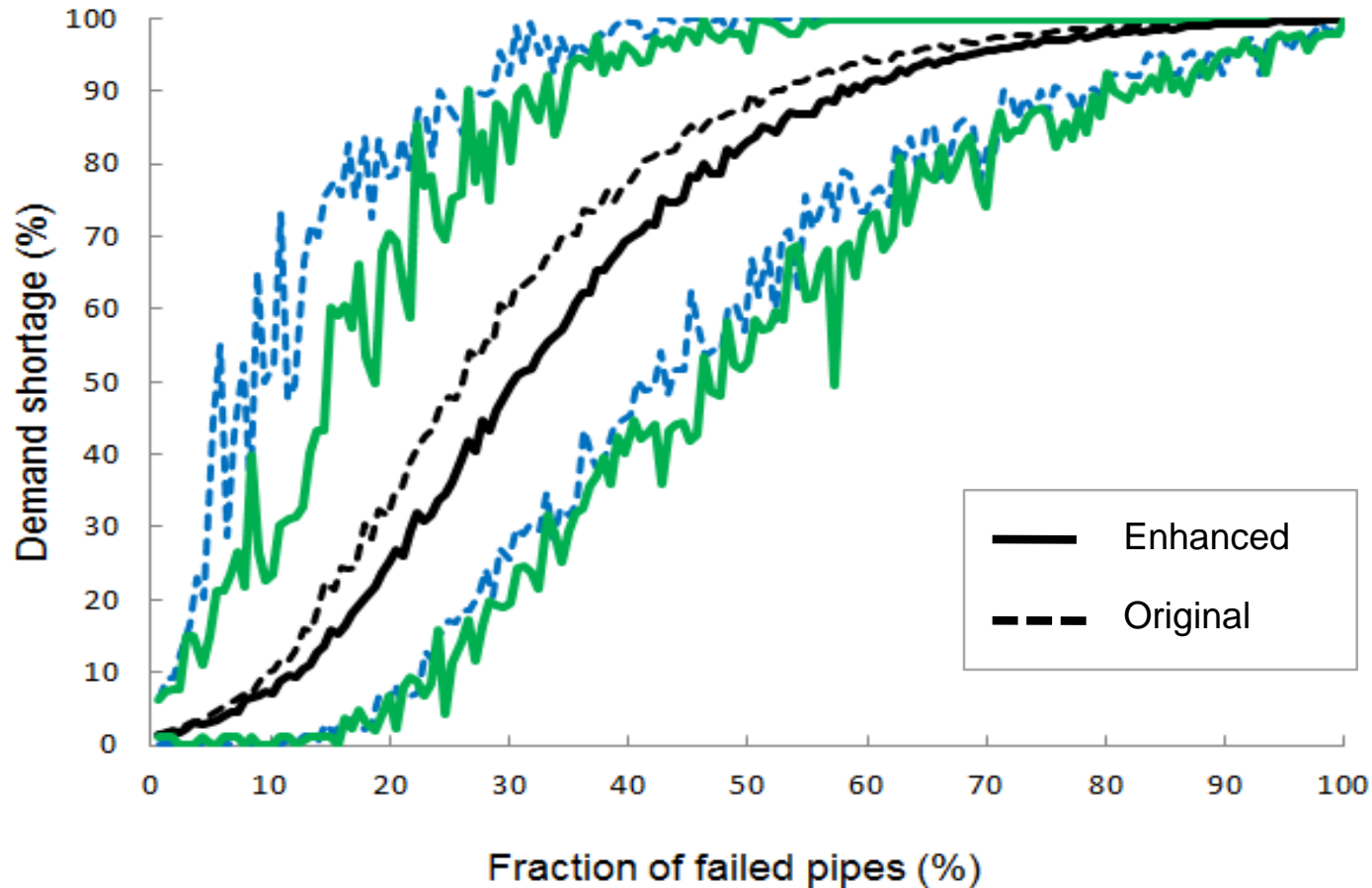


Pipe failure GRA curve



Global resilience analysis

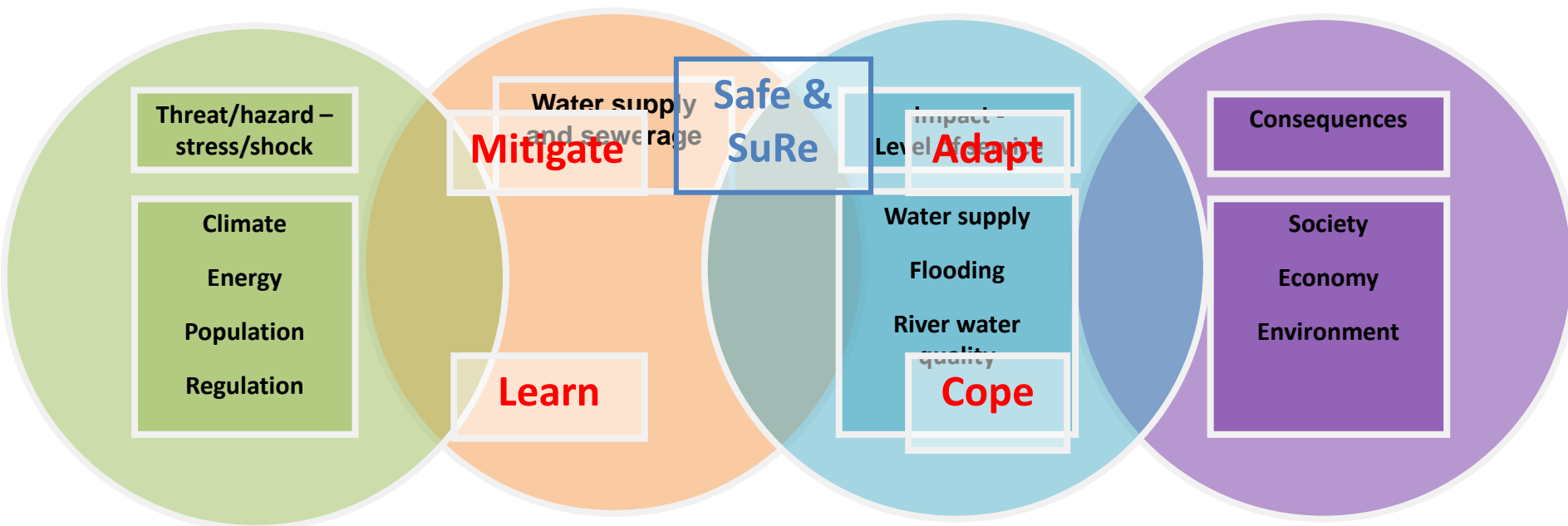
Duplicate critical pipes



Pulling it all together: Safe & SuRe



Safe & SuRe framework – emphasis on intervention



Conclusions

Why?

- Significant long-term pressures;
- Unprecedented variability;

What?

- Bouncebackability under extreme load;
- Management of failure magnitude and duration;

How?

- Problem diagnosis/masurment – being prepared;
- Solution evaluation – assessing the options;
- Recognition that no *‘one size fits all’*;
- Acceptance of *safe to fail* philosophy.

Resilience: hype or hope?



David Butler

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