

Modelling impacts of natural hazards on interconnected infrastructure networks

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What we set out to do

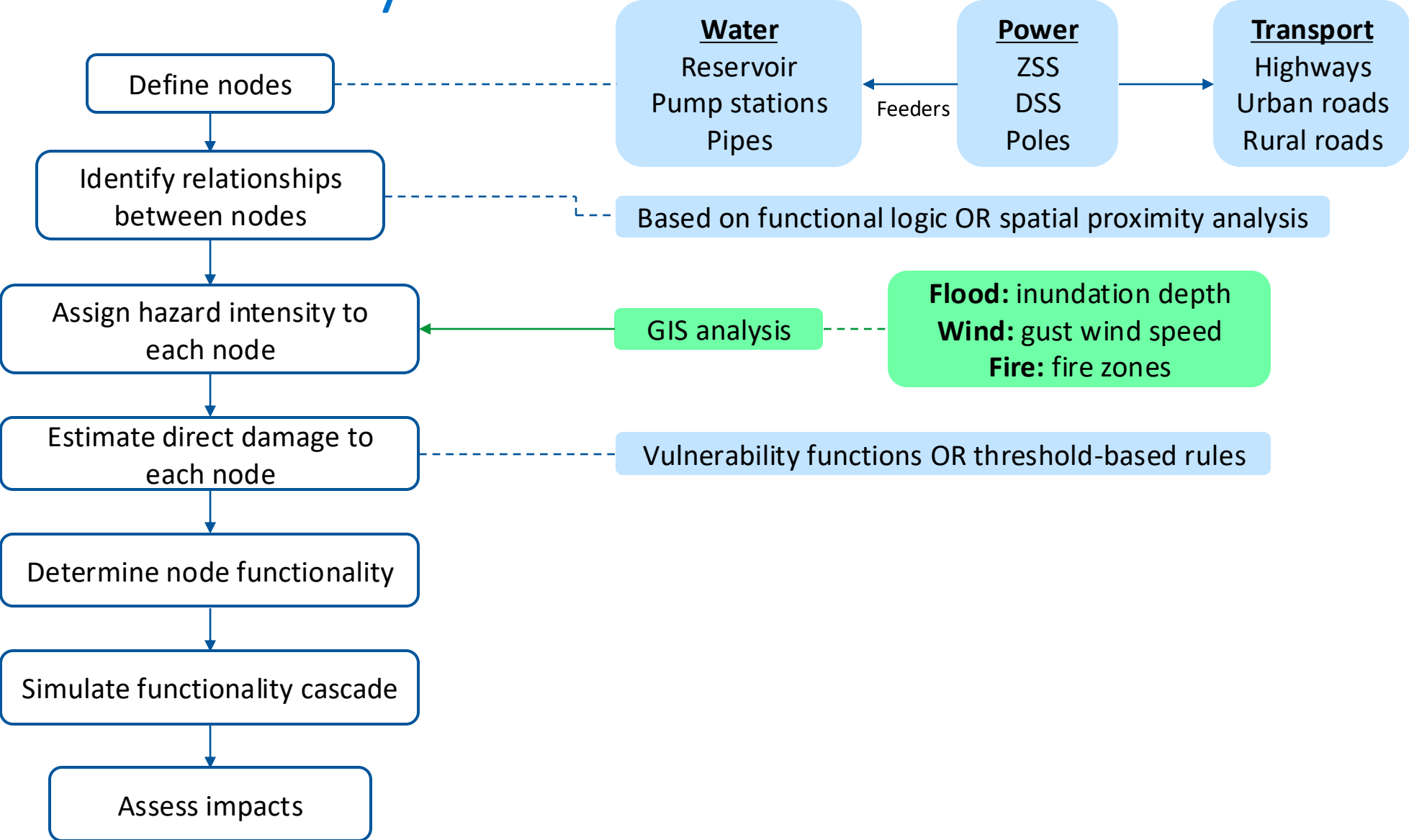
The Aim of this research project was to:

1. Understand the extent of direct and cascading impacts on infrastructure during natural hazards
2. Develop estimation methods to model the impact of natural hazards on interconnected infrastructure
3. Provide a framework to better understand the value of infrastructure resilience investments.

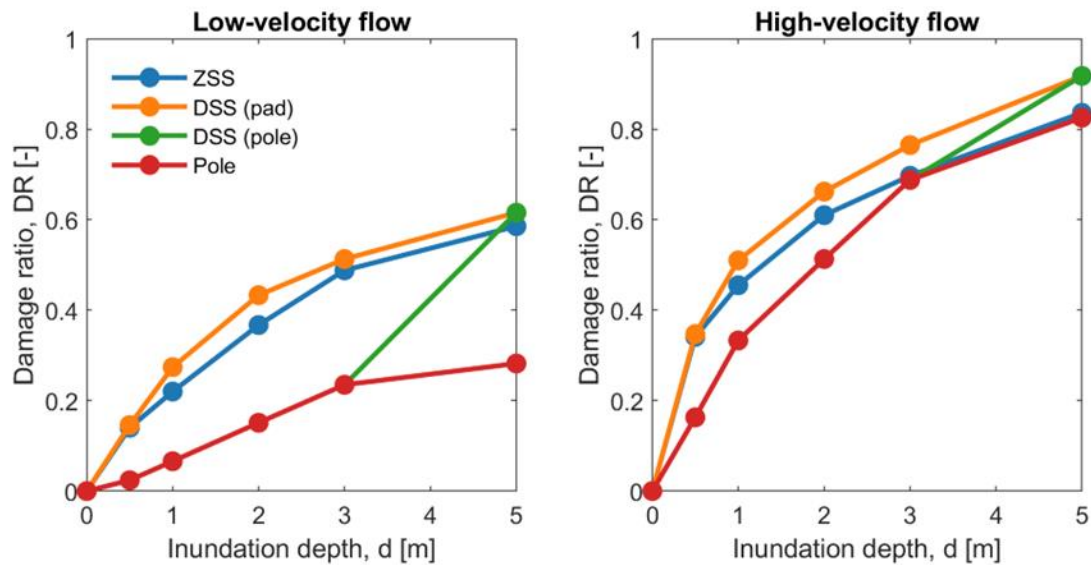
Primary research activities

1. Network (and interdependencies) mapping
 - Simplified road transport, electricity distribution, potable water
2. Damage model development
 - Direct damage, recovery time
 - Existing models, empirical development, expert judgement, end-user feedback
3. Develop functionality cascade model framework
 - Hierarchical Bayesian model
4. Utilisation case studies
 - Flood, tropical cyclone, bushfire

Model summary



Model summary



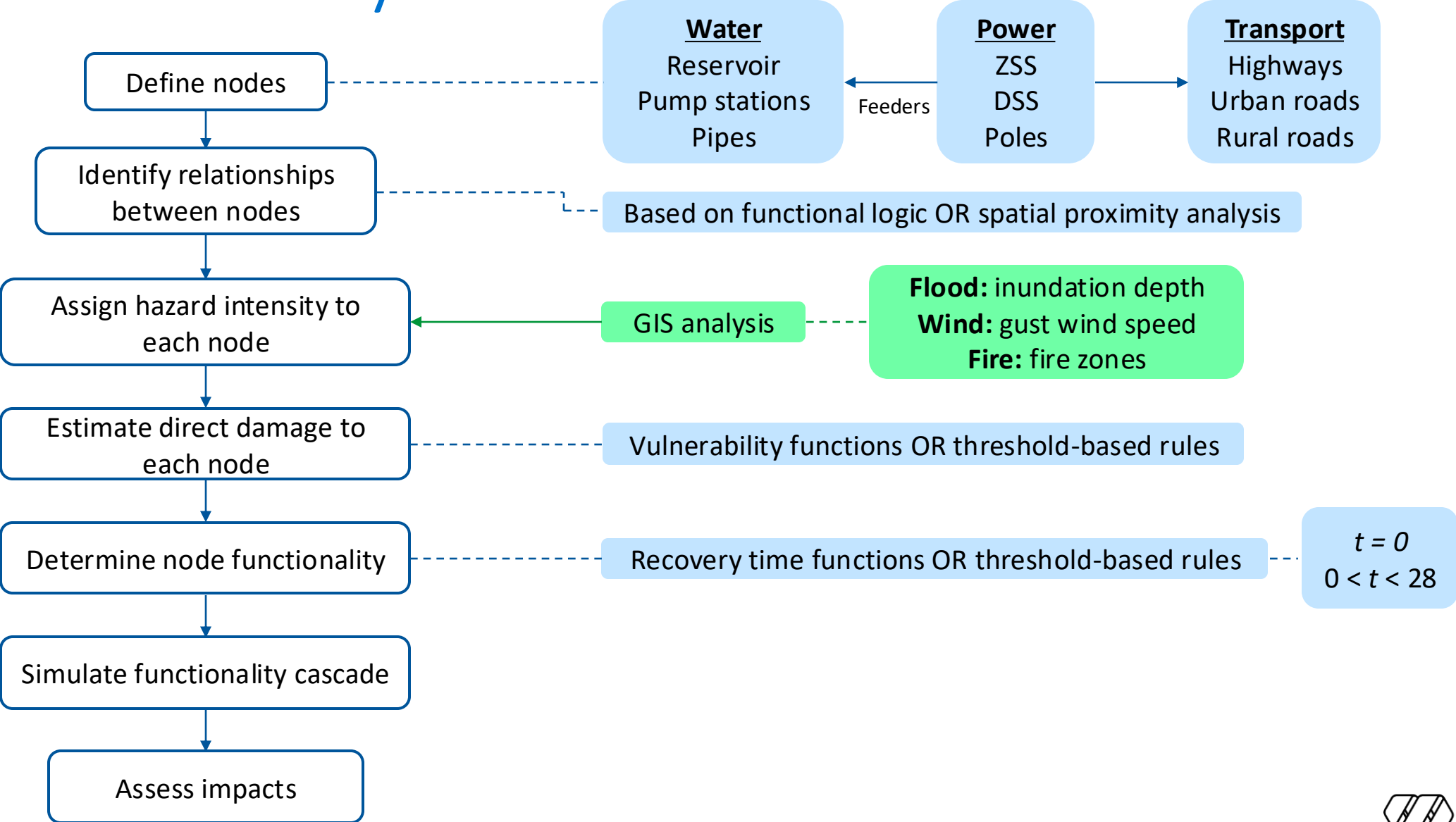
Vulnerability functions

Bushfire exposure	Damage state
Burnt zone	Moderate to extensive damage (expected damage ratio between 0.25 and 1)
Buffer zone	No to minor damage (expected damage ratio between 0 and 0.25)
Outside both zones	No damage

Threshold-based rules



Model summary



Model summary

Initial functionality

Logic-based

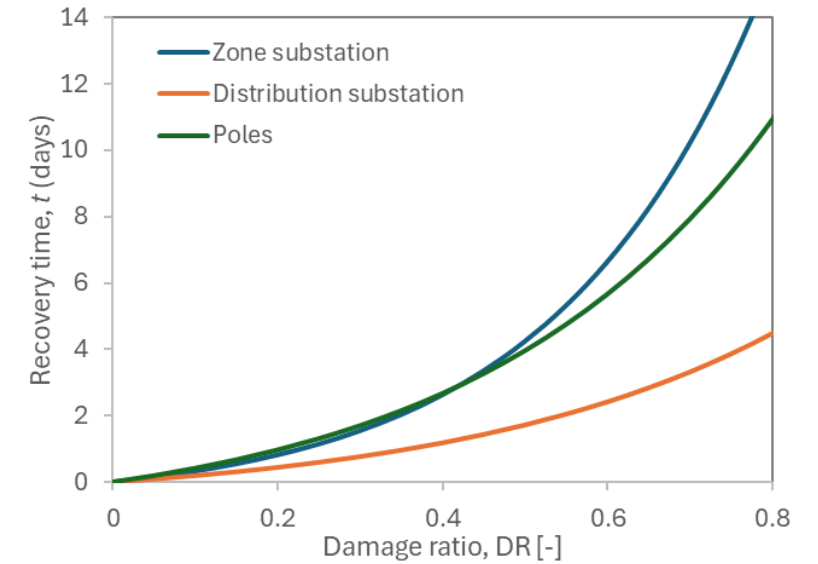
Asset type	Inundation depth	Functionality state
All	> 0 m	Interrupted
	0 m	Not interrupted

Asset	Wind speed (3-sec gust)	Functionality state
All roadways in highly vegetated areas	≥ 110 km/h	Interrupted (roadways become inaccessible due to tree and/or distribution line collapse)
	< 110 km/h	Not interrupted
All roadways in urban or rural areas	≥ 150 km/h	Interrupted (roadways become inaccessible due to building debris and/or distribution line collapse)
	< 150 km/h	Not interrupted

Threshold-based rules

damage-based (DR \approx 5%)

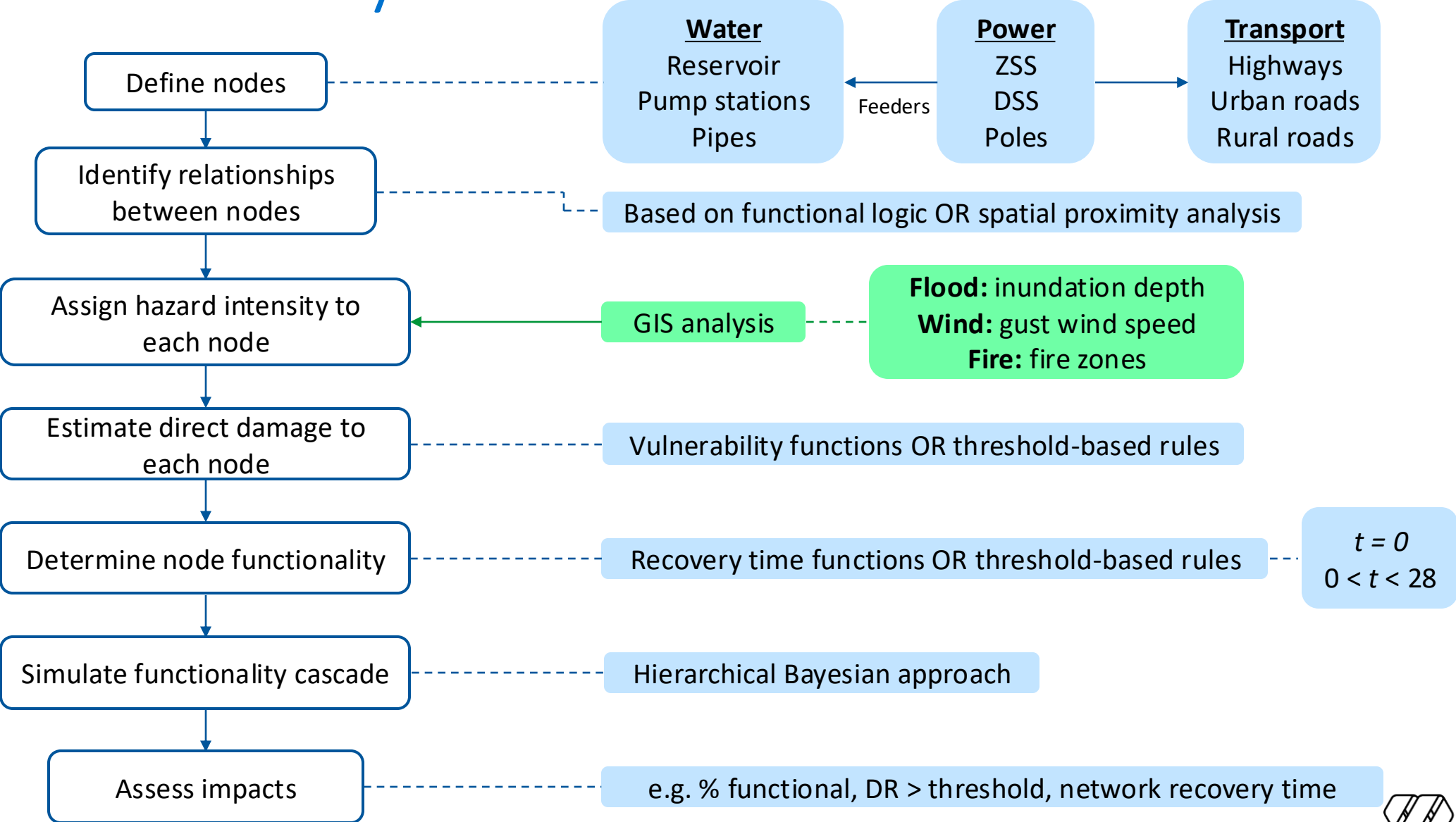
Functional recovery



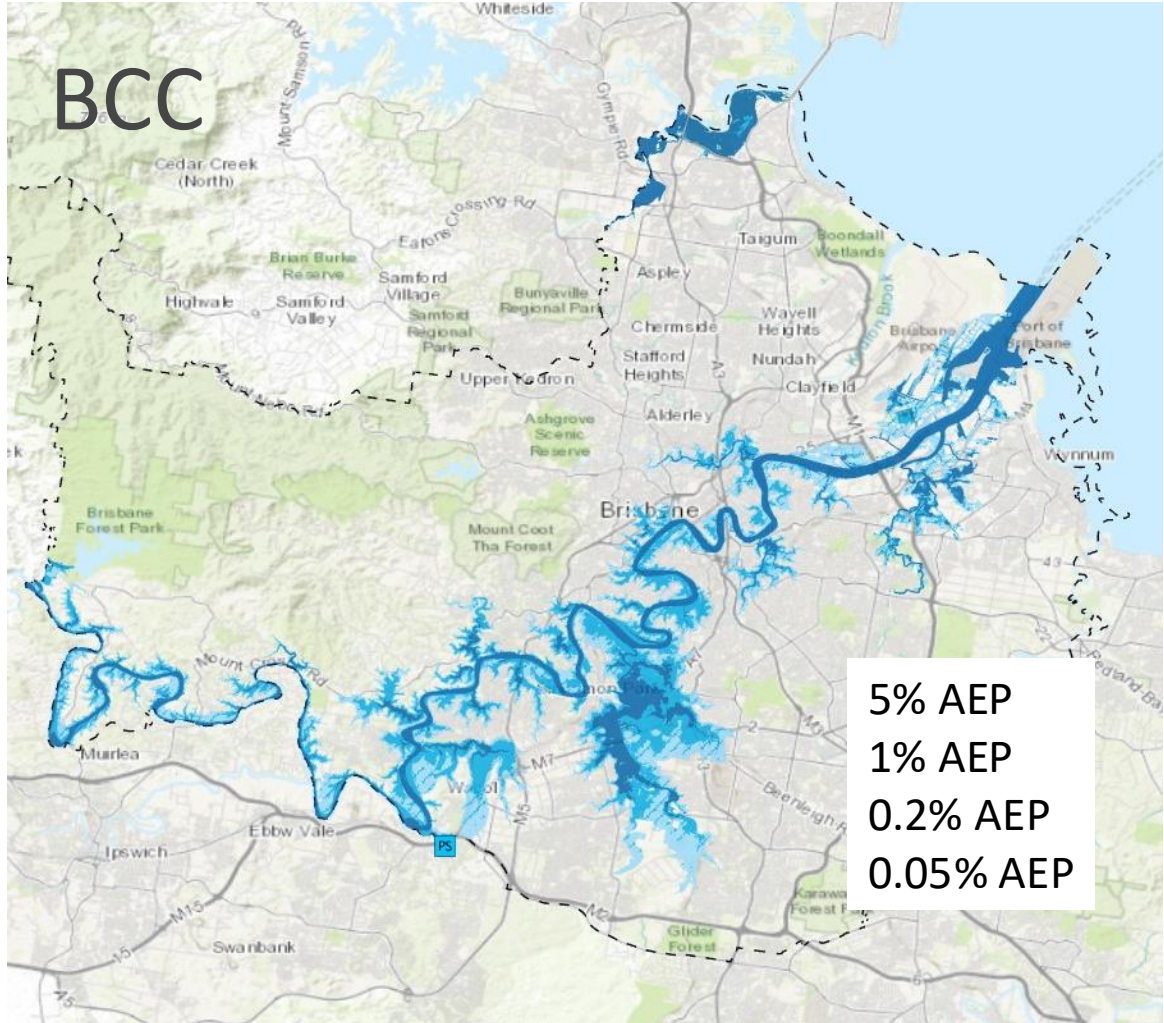
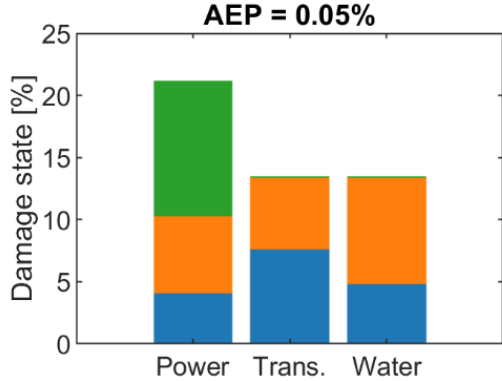
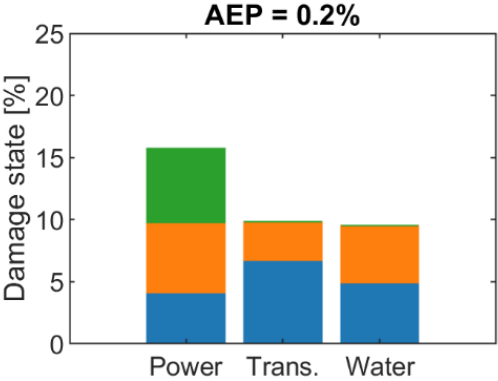
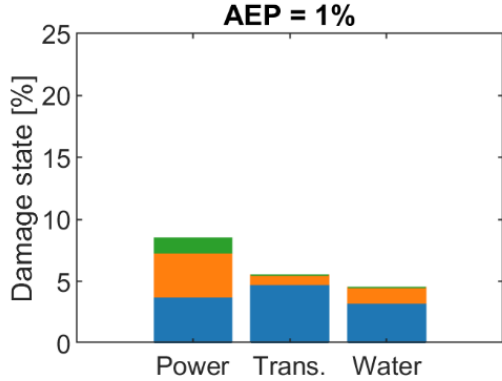
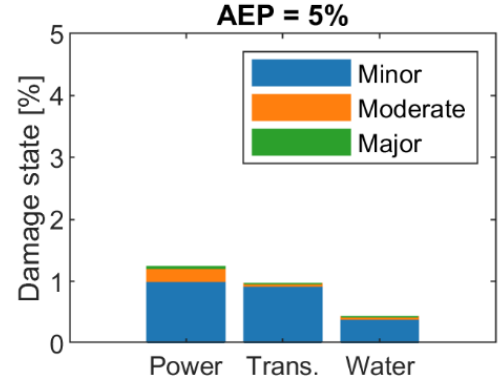
Recovery time function



Model summary



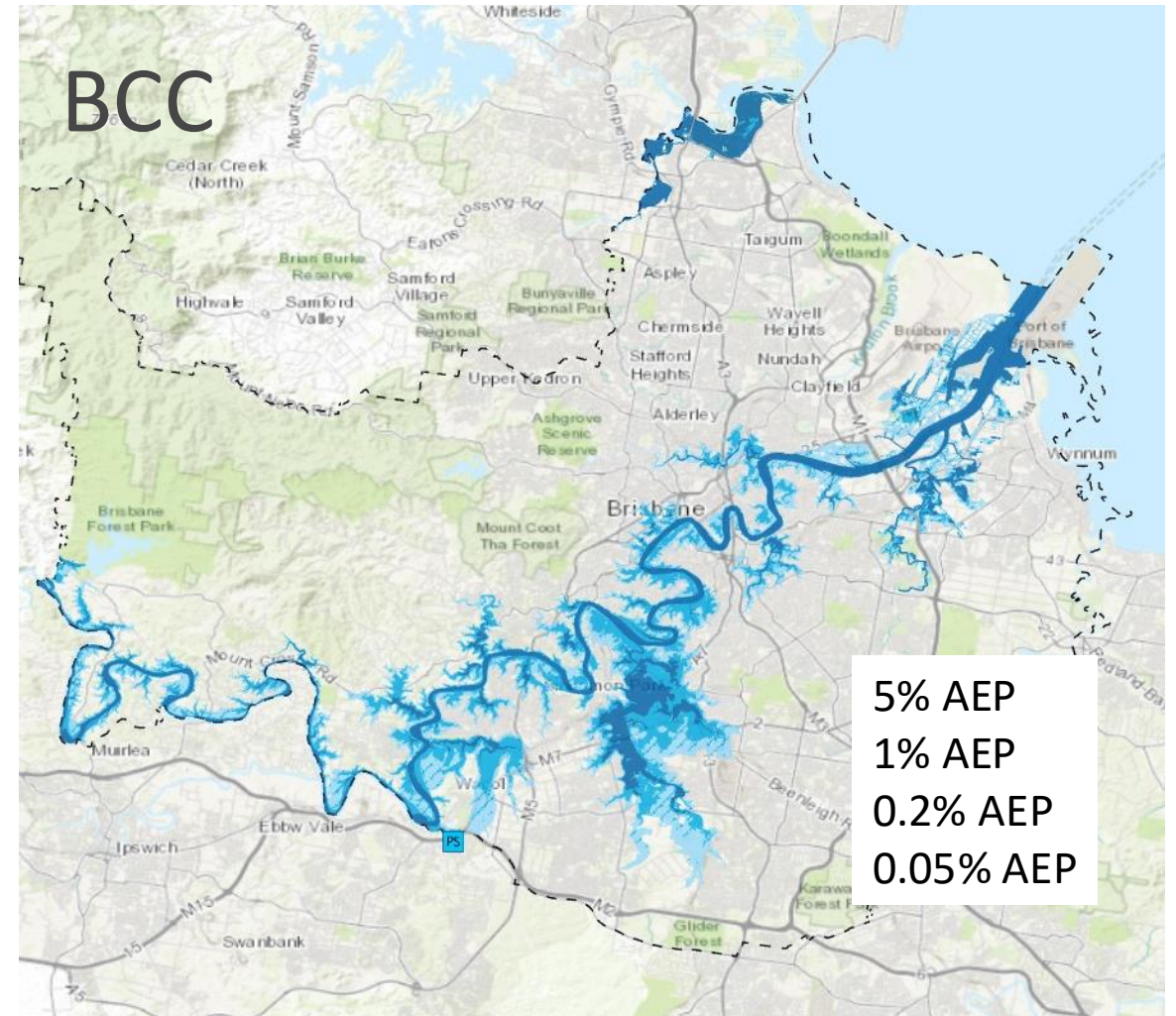
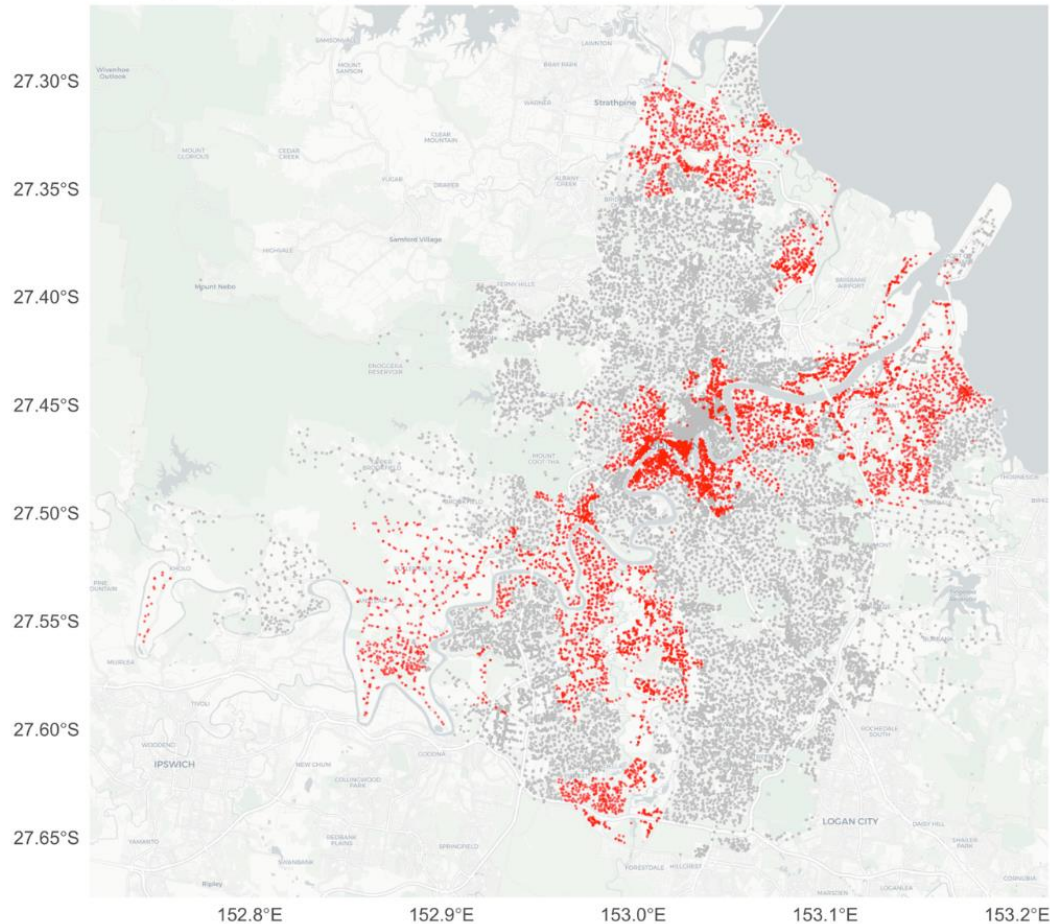
Case study – Brisbane flood



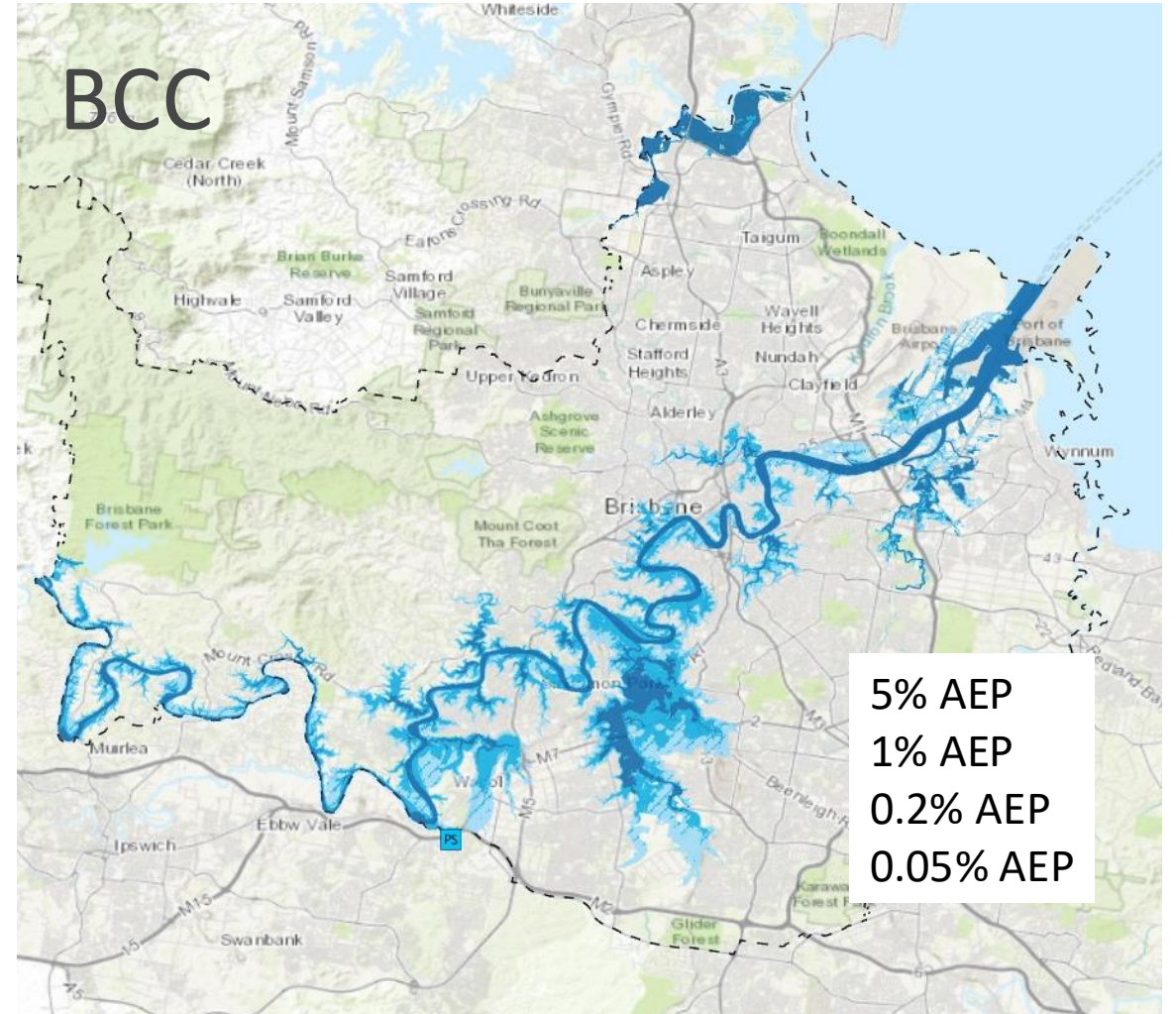
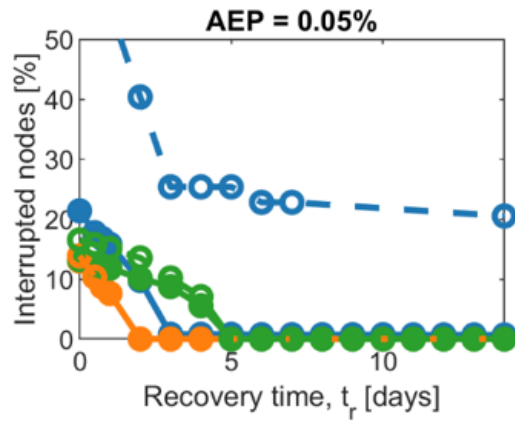
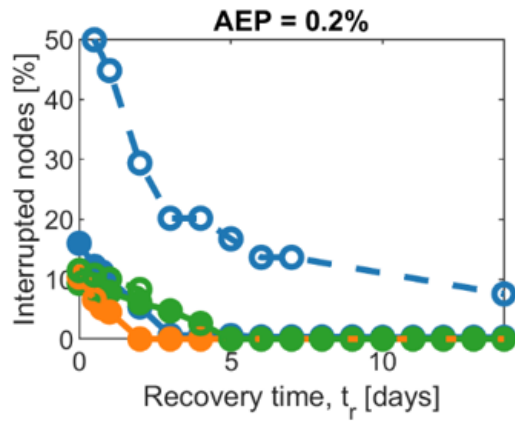
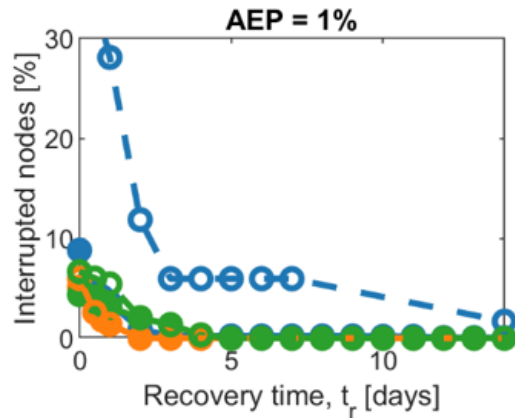
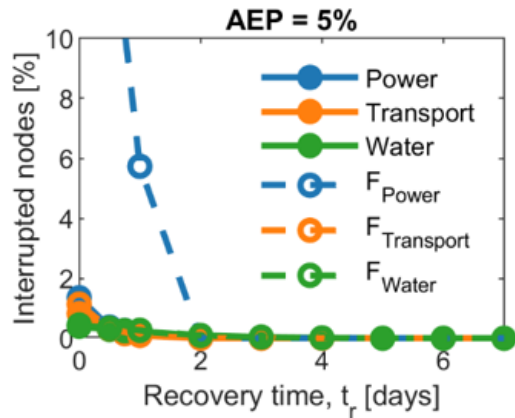
Direct impacts

Case study – Brisbane flood

Interrupted power assets (direct & intra-network cascading impacts)
Flooding, 20-year return period



Case study – Brisbane flood



Findings and recommendations

Key findings

- Access to data limited damage and recovery model development.
- Cascading impacts are important!
- Model is an effective tool for identifying network (and inter-network) vulnerabilities.

Recommendations

- Expert elicitation workshops to be run to build damage models.
- Network and cascade models to be extended to include more nodes and redundancy (intra- and inter-).
- Inclusion of service providers in model development is critical.