



# Modelling impacts of natural hazards on interconnected infrastructure networks



# The project

## → The Aim of this research project is to:

1. Understand the extent of direct and indirect impacts/losses relevant to infrastructure
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.

The primary focus of this project is on public infrastructure.

## → Primary Tasks

1. Review existing literature, models and data relating to damage estimation (direct and indirect) as it relates to public infrastructure and Australian natural hazards.
2. Develop (or implement) methods to estimate direct and indirect damage to three types of infrastructure and three hazard types.
3. Undertake 'proof-of-concept' case studies to demonstrate any models developed.
4. Develop a conceptual framework for dealing with cascading or compounding events (test through case studies).
5. Outline future research needs in this space.



# The project

## → We have 3 streams of research

1. Network mapping
2. Damage estimation
3. Utilisation case studies

## → Hazards & networks

- Flood, wind/storm, fire
- Power (transmission & distribution), water, roads

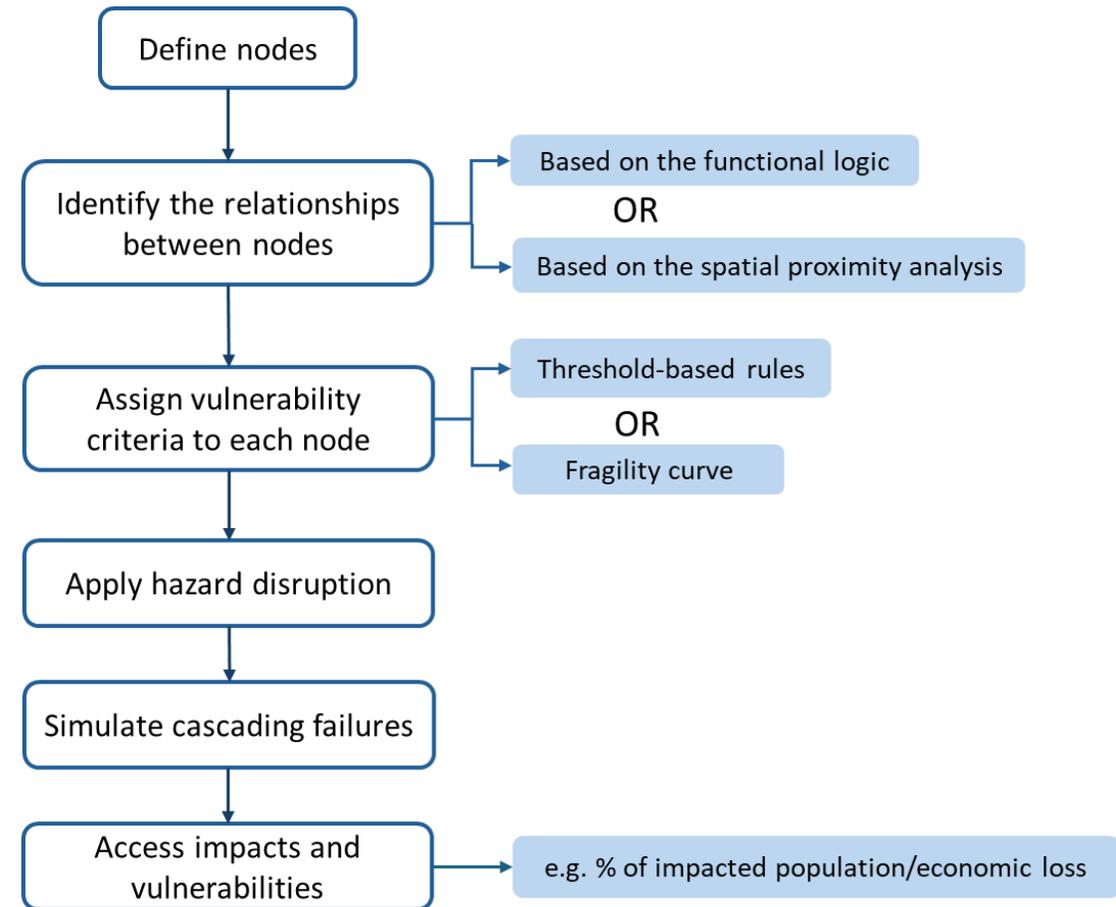
## → Study region (our sandbox)

- Develop models/frameworks using SE Queensland networks and data
- Frameworks (and where possible, models) will be region agnostic



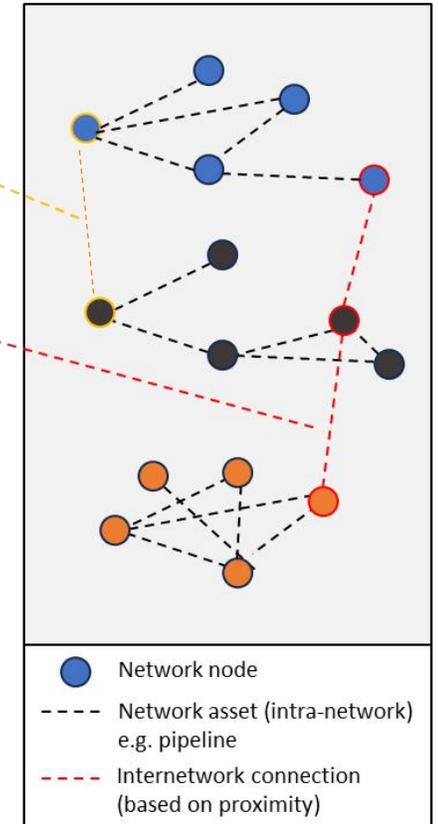
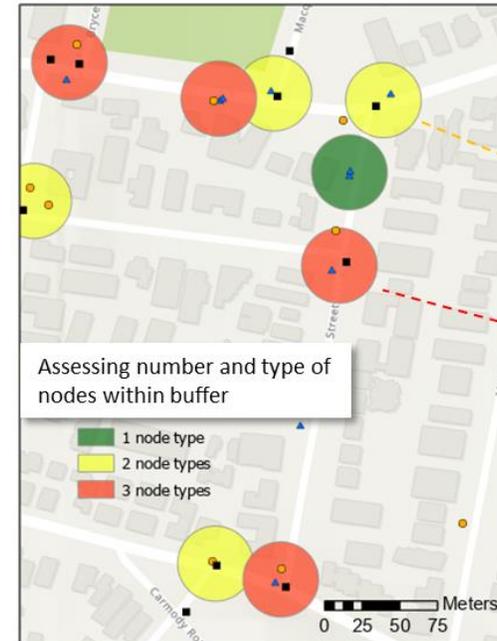
# Literature review

- Systematic literature review
- Methods for network interaction
  1. Network/Graph theory
  2. Network flow models
  3. Probabilistic & statistical models
  4. Spatial Overlay & Clustering Models
  5. Qualitative & Systems-Thinking Models
  6. Input-Output & Inoperability I-O Models



# Network mapping

- Network mapping and data extraction
  - Automated network data and attribute extraction with St Lucia as a case study
  - Network linkage initially through proximity
  - GIS platform developed for interaction with infrastructure operators
  - Ready for damage data case studies to build damage models



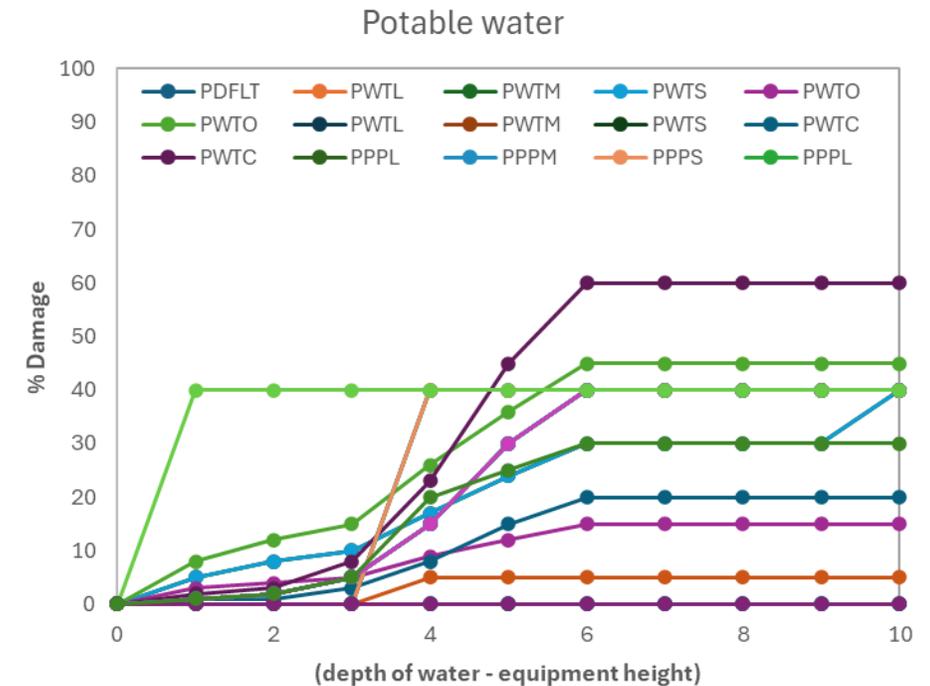
# Damage estimation

- Consultation meetings/workshops
  - Energy Queensland
  - Powerlink
  - Qld Urban Utilities
  - Optus
  - Transport & Main Roads
- Primary questions:
  - *What assets on your network are most vulnerable to natural hazards?*
  - *What methods do you employ to manage natural hazard risk?*
  - *What network and impact/interruption data is available?*
  - *What is your understanding of upstream/downstream relationships with other networks?*

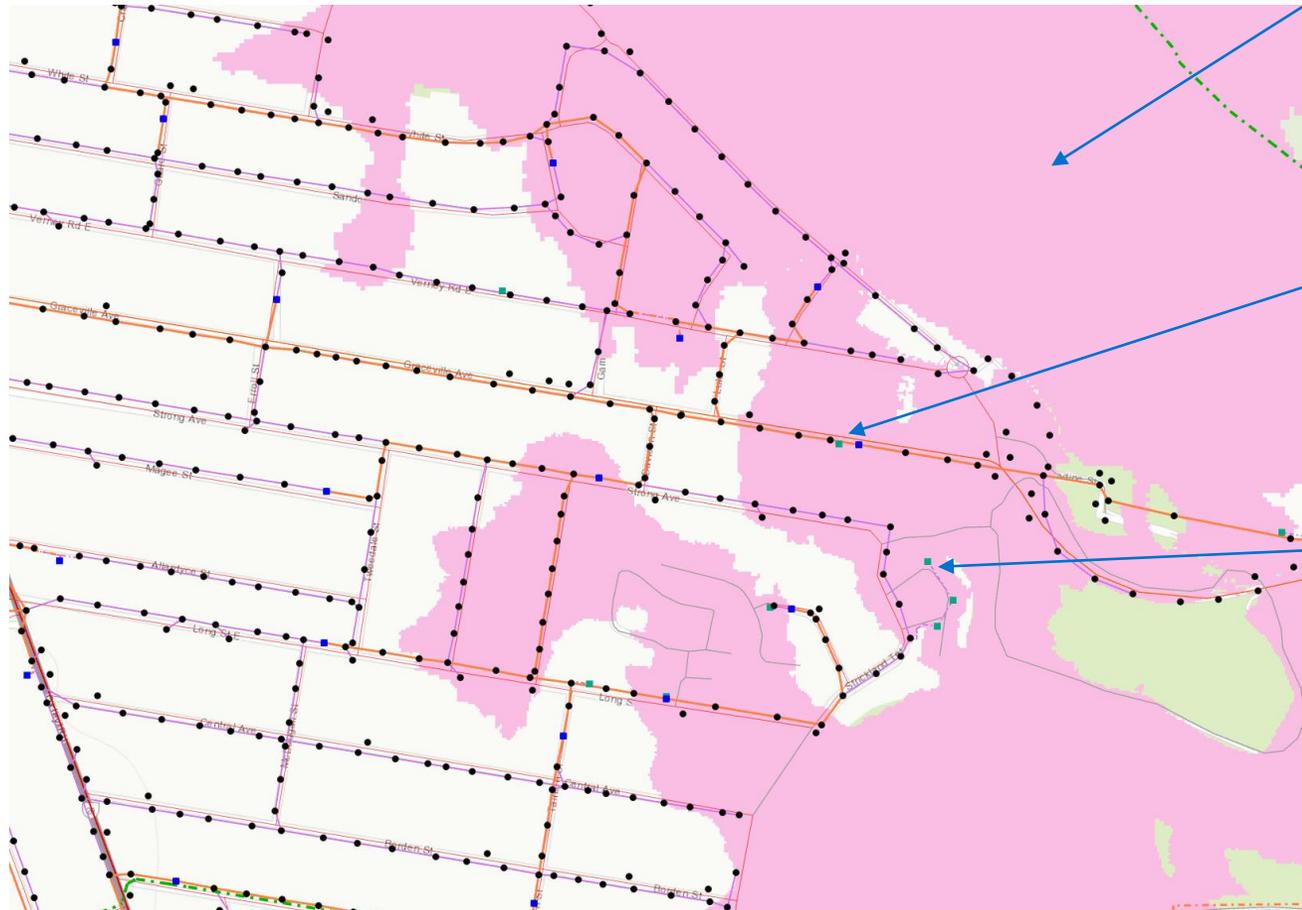


# Damage estimation

- Damage estimation models
  - Review and extraction of existing damage models used by Hazus
    - Flood, cyclone
    - Power systems, potable water, wastewater, transport (bridges), telecommunication
  - Other models turning up in literature review
  - Building damage functions
    - Data driven event-based approach
    - Case-study event identification
    - Linking damage/interruption data with GIS layers



# Damage estimation



Hazard extent (flood/fire/**storm**)

- Intensity metric (e.g. depth)

Impacted road

- Open or closed
- Duration of closure

Impacted distribution feeder

- Operational/non-operational
- Interruption period
- Network asset failure



# Next steps

- Continue compiling and building damage estimation models (empirical, heuristic, modified existing)
- Couple damage estimation models with network model to take to further consultation meetings
- Case studies – extend Severe Wind Hazard Assessment SEQ case studies to infrastructure

