# Increasing the resilience of Transport Networks

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# Problems

Increasing frequency & intensity of natural disasters

Significant disruption on **transport networks** with major social & economic impacts

*Flash floods from high intensity rainfall are already Australia's most expensive disasters, averaging $8.8 billion per year and this is set to increase (UN, IPCC 2022, WGII Reports)*

# Impact of Disasters on Road Networks

# Royal Commission into Natural Disaster Arrangements (2020)

"Achieving an effective national approach to natural disasters requires a clear, robust and accountable system capable of both providing a comprehensive understanding of, & responding to, the aggregated risks associated with **mitigation, preparation for, response to & recovery** from natural disasters. "

23.6 Focused investment in research is required to improve knowledge and understanding of natural hazards and disaster risk. This will drive the development of expertise, **tools, systems & technology** to deal with natural disasters.

# Royal Commission into Natural Disaster Arrangements

**Provide decision makers with timely, consistent and accurate information;** be structured for decisions to be made at most appropriate level; allow decision makers to understand & **mitigate** all risks so far as reasonably practicable; enable stakeholders to understand residual risk & inform others so that they may take appropriate actions; & it must be **resourced** to fulfil these functions.

# National Disaster Risk Reduction Framework (NDRRF, 2018)

PRIORITY 2: Accountable decisions

Identify highest priority disaster risks & **mitigation** opportunities

Build the capability and capacity of decision-makers to actively address disaster risk in policy, program and **investment decisions**
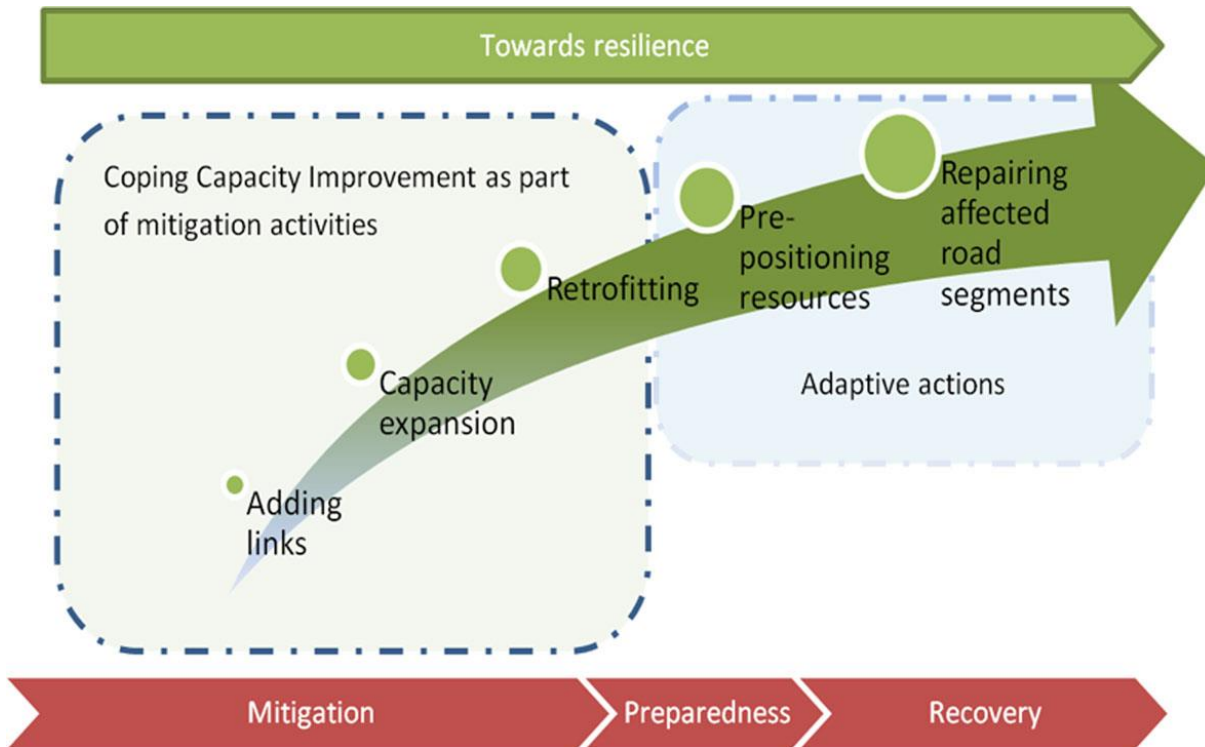
# Need for Research

Huge expenditure in recovery, but lack of investment in **mitigation**

**Lack of decision support tools** for determining

- Mitigation schedules for road networks

- Traffic management plans for diversions

- Recovery work schedules

Need improved tools for investigating the *optimal* network protection investment in transport infrastructure
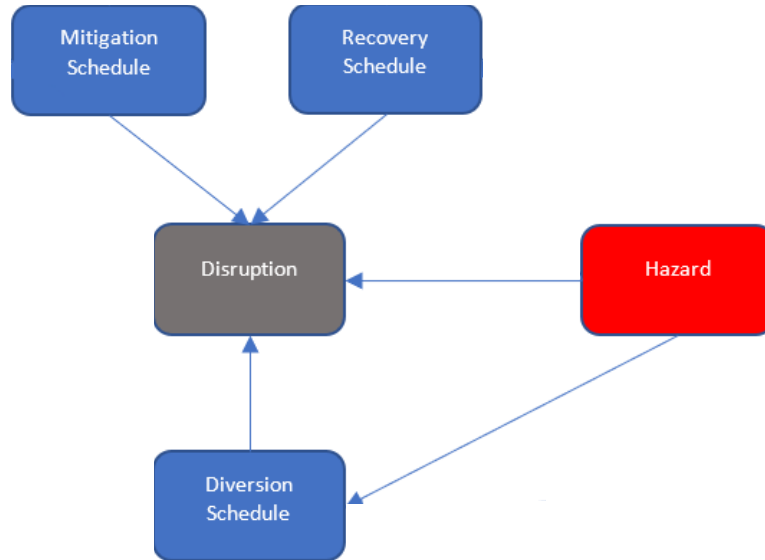
Towards resilience

Coping Capacity Improvement as part of mitigation activities

Retrofitting

Capacity expansion

Adding links

Pre-positioning resources

Repairing affected road segments

Adaptive actions
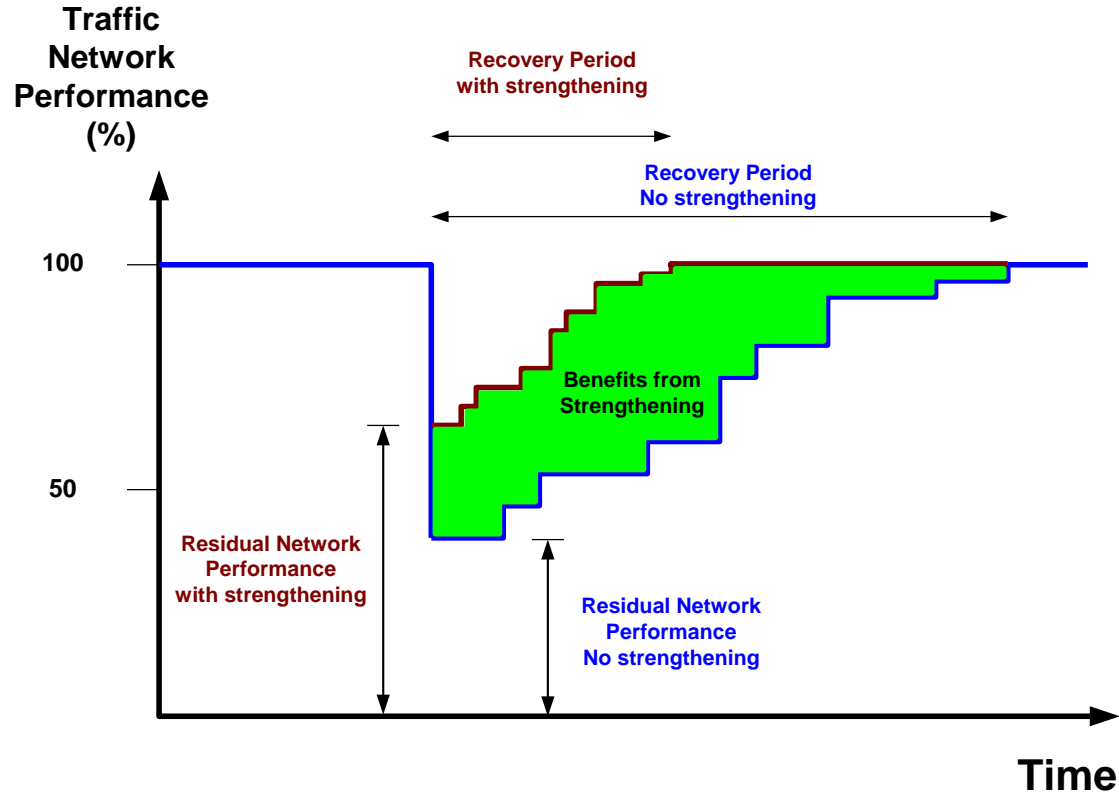
Mitigation — Preparedness — Recovery

Disruption

**Factors influencing disruption to transport networks**

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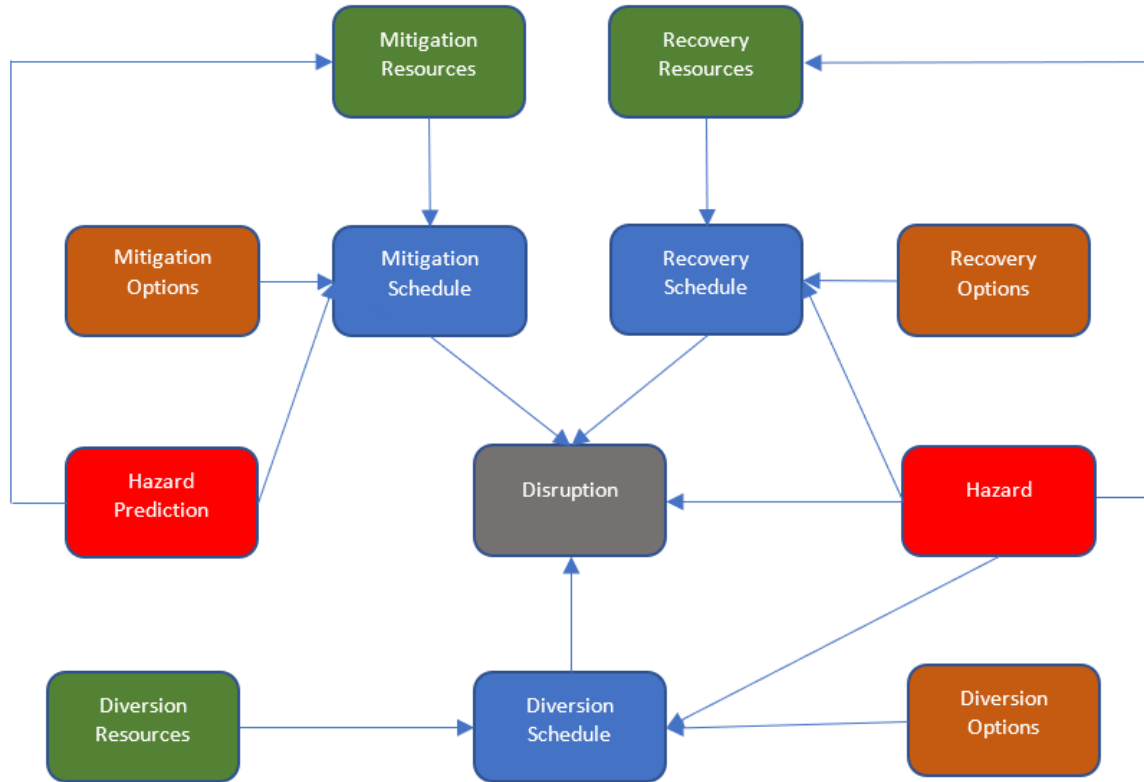
**Factors influencing disruption to transport networks**
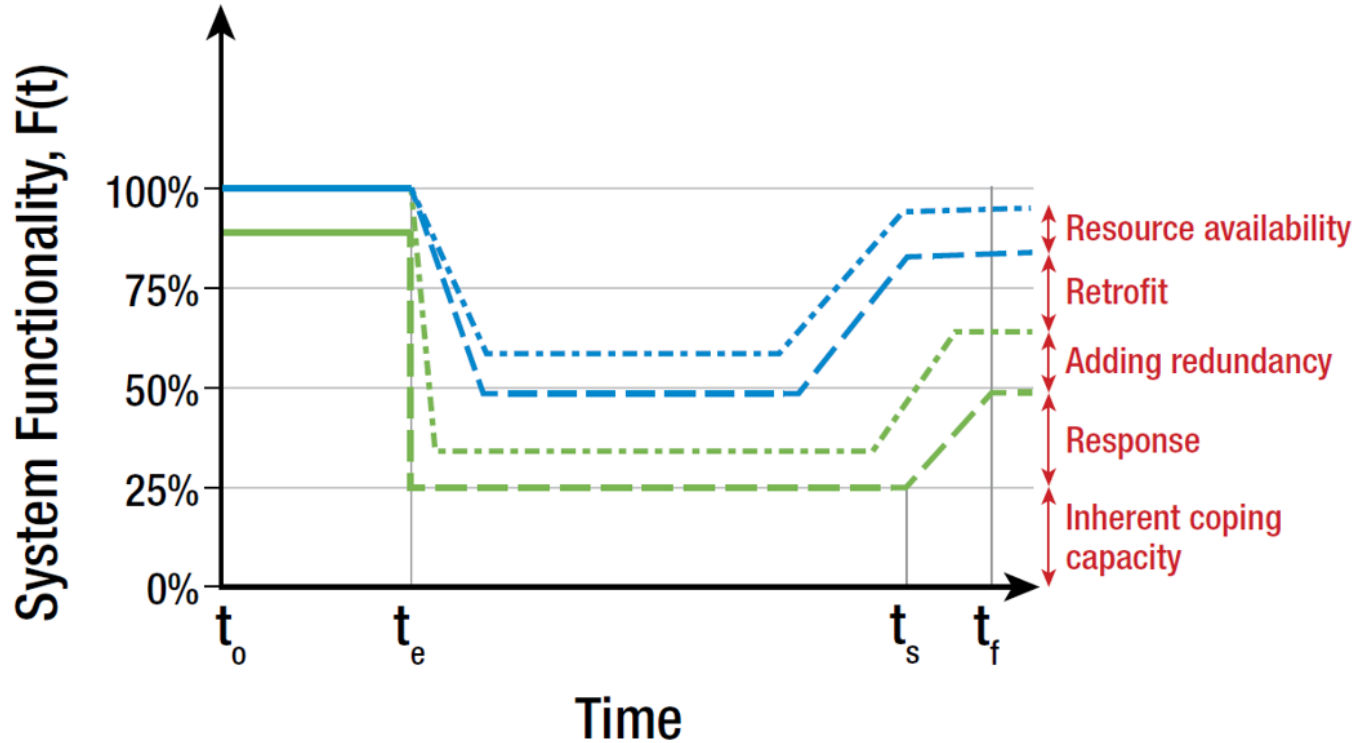
**Resilience curves (NASEM 2021)**

**Resilience curves**

**Base Case**

Costs ($)

Time

Disaster

Strengthening Costs

Traffic Disruption Costs

Reconstruction Costs

# Strengthening Facilities Case



**Costs ($)**

Time

Disaster

Strengthening Costs

Traffic Disruption Costs

Reconstruction Costs
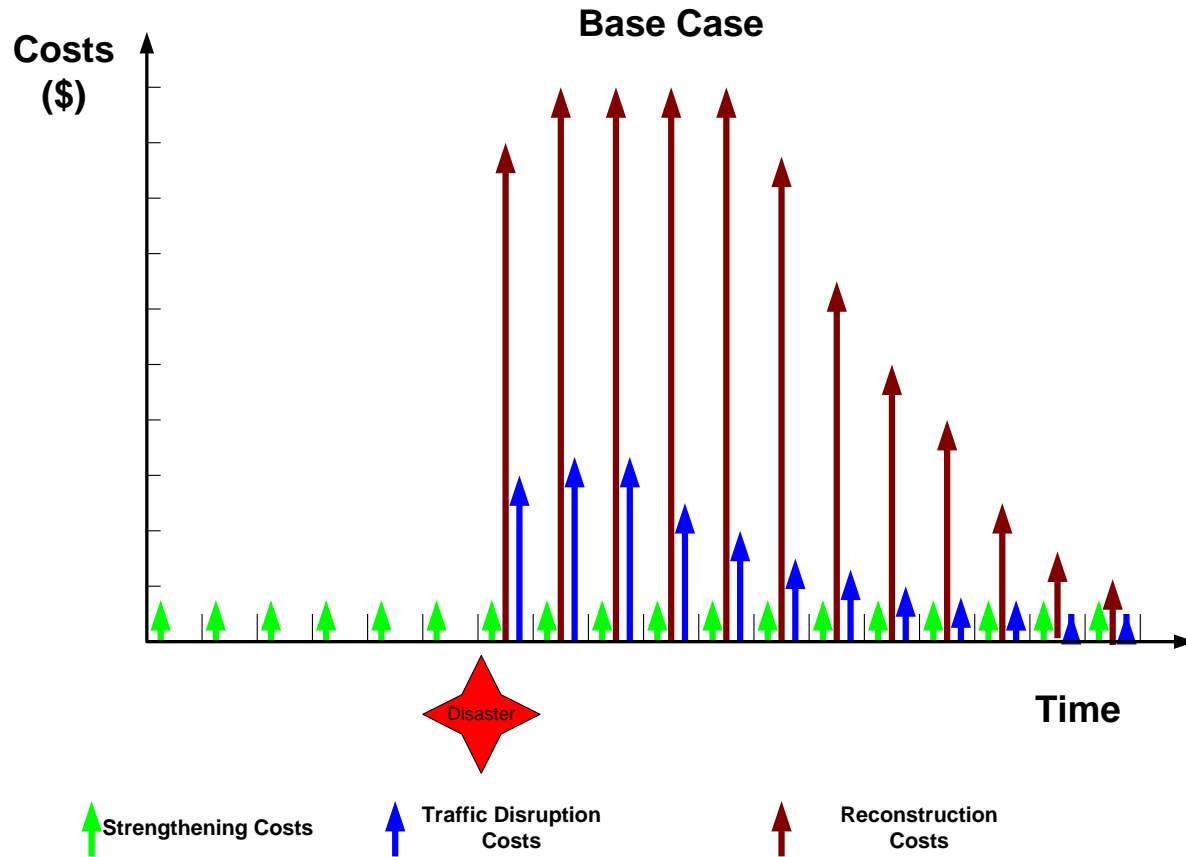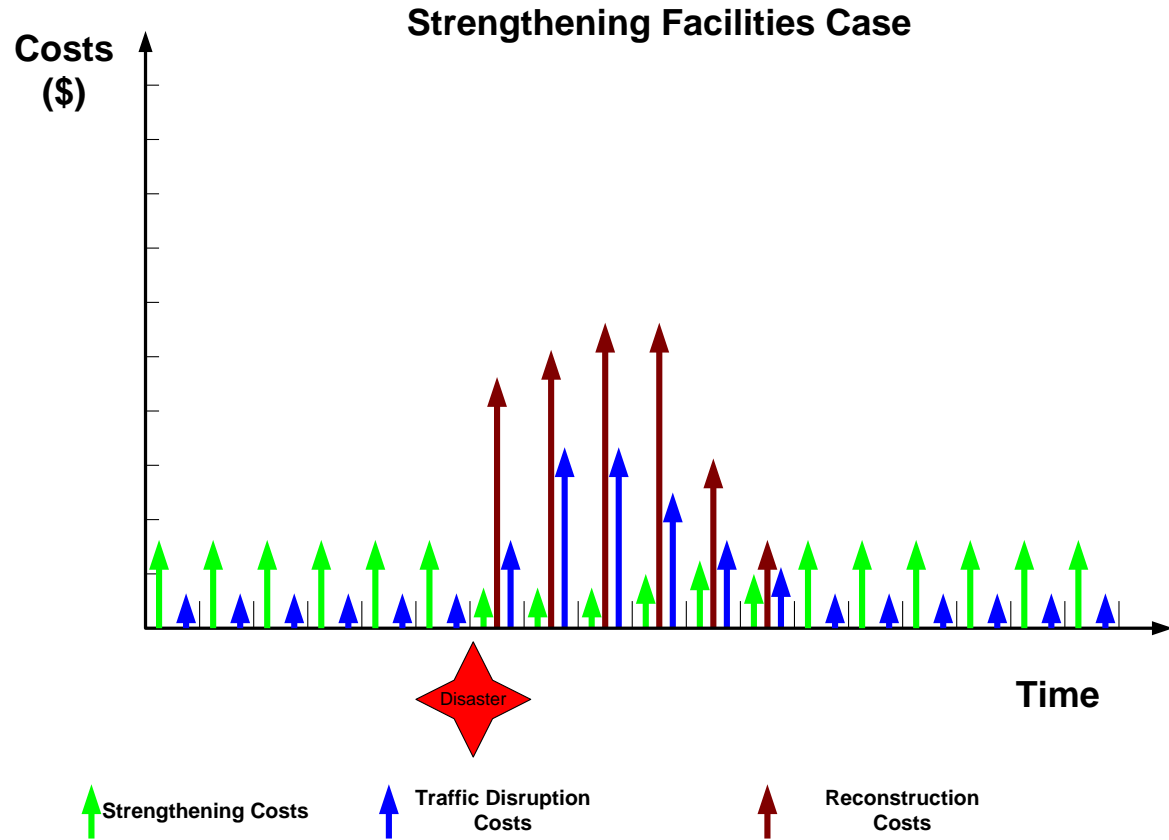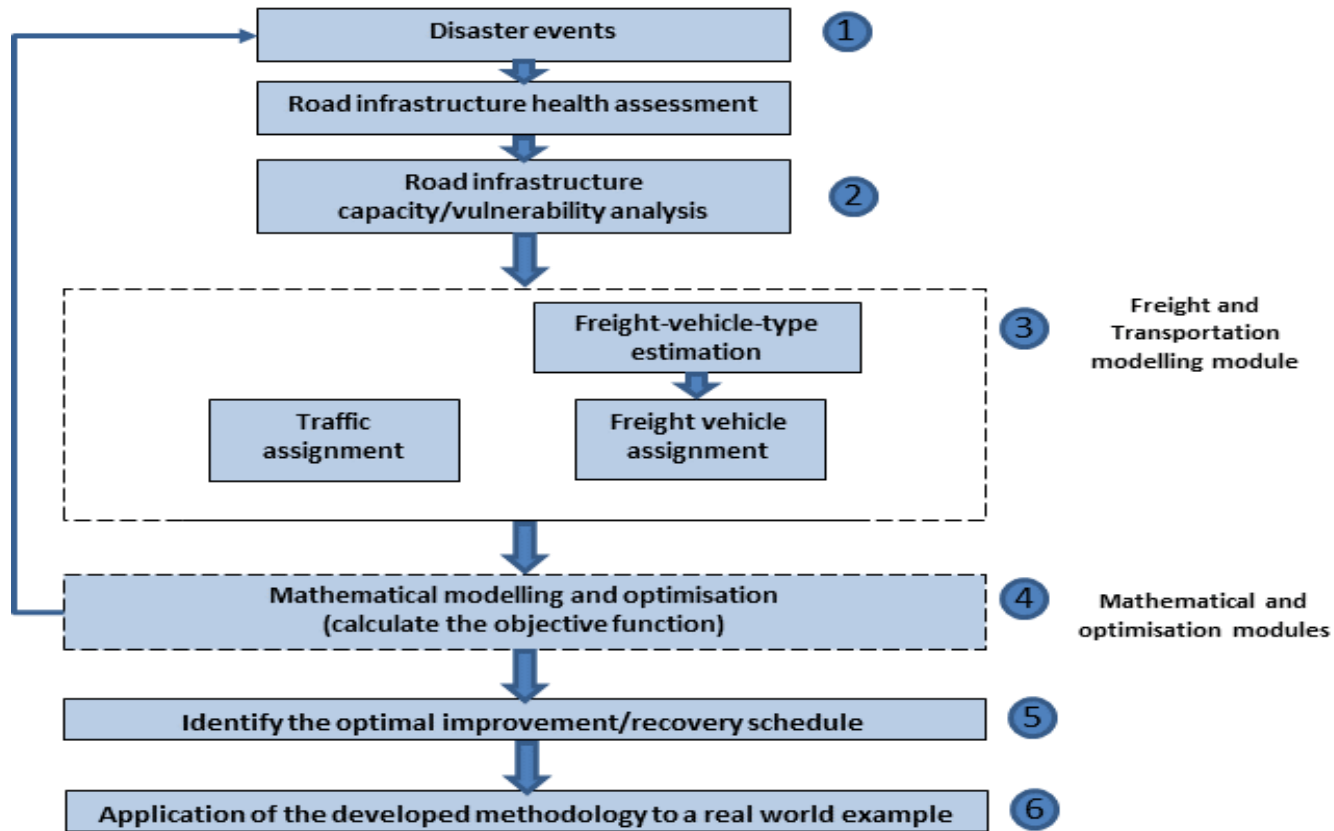
Conceptual flowchart of Decision Support System

# Transport Modelling

**Vulnerability Assessment**: identification of most vulnerable links in network

**Road Network Protection** : minimize disruption to road network through protection projects

**Optimal  Location for Traffic Guidance**: minimize total network travel time with deployment of roadside guidance devices during recovery

**Road Network Recovery Scheduling**: consider multi-classes of vehicles & disruption
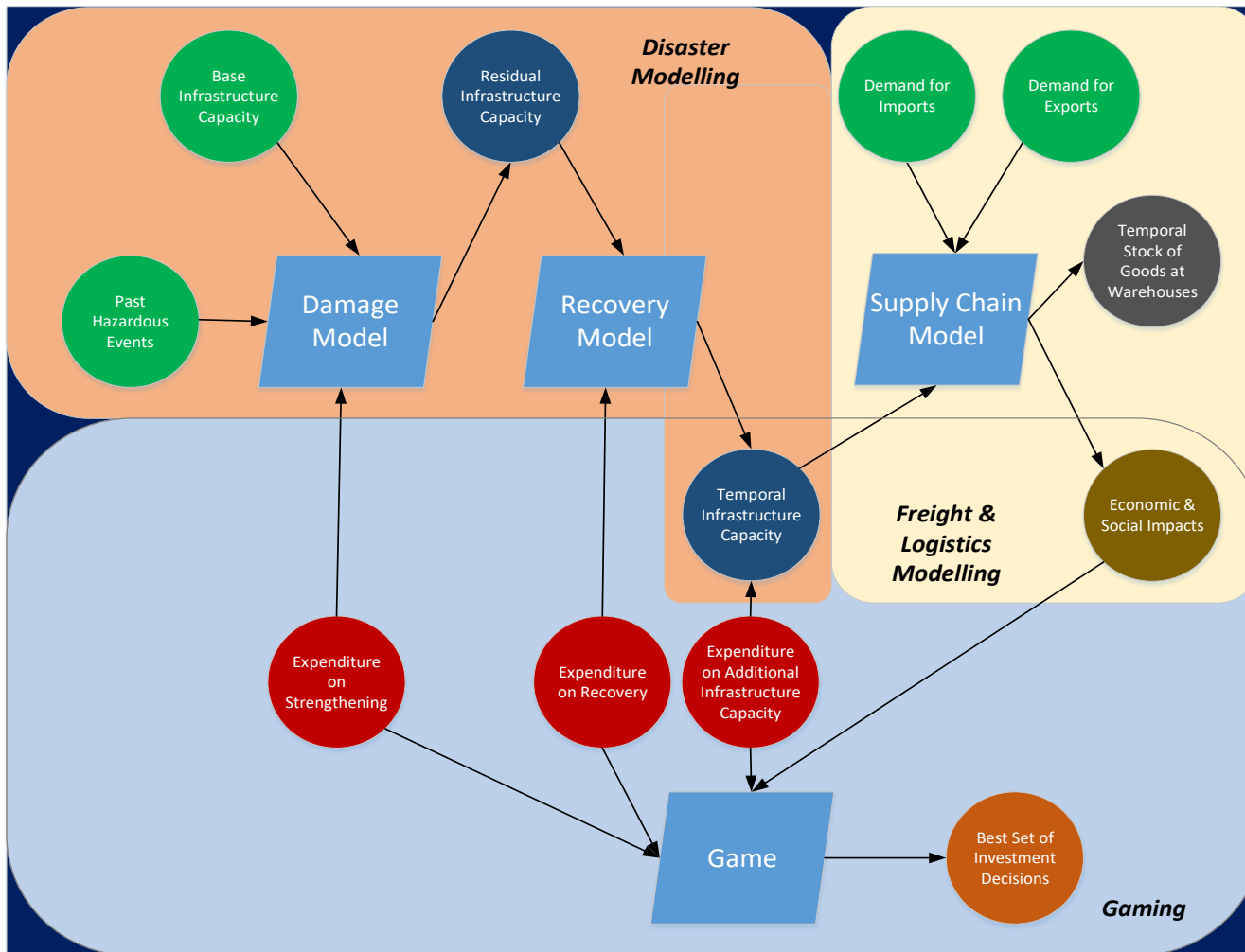
# Vulnerability Analysis

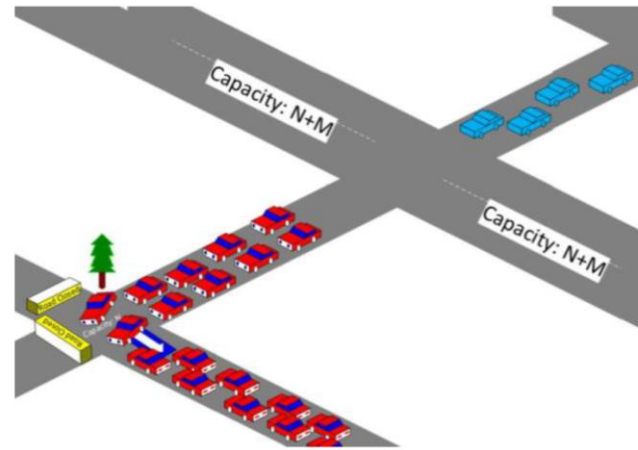Infrastructure Health Assessment (status of drainage & transport facilities)
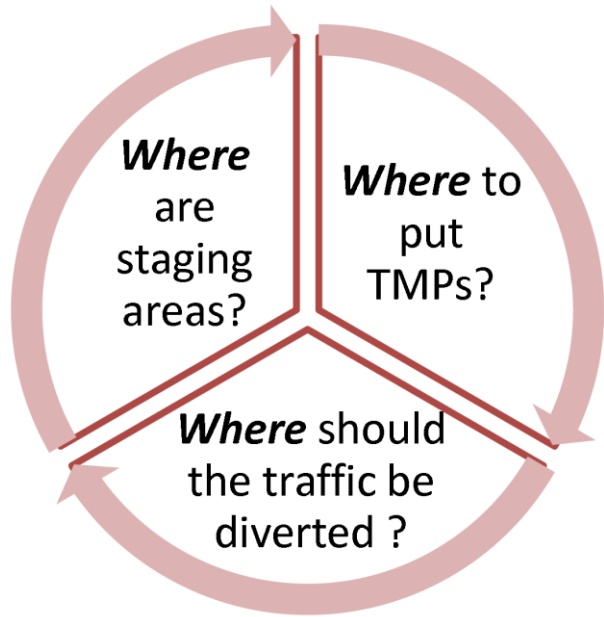
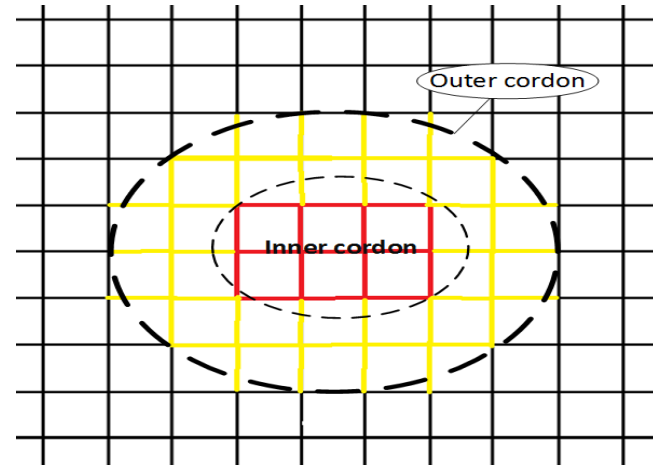Hazard Prediction (scenario based)

Transport Network Modelling

- Demand analysis (origins & destinations)

- Persons & Freight

**Modelling Framework**

**(World Bank)**

**Traffic Management Points (TMPs)**

# Digital Twins

Predictive (AI & optimisation based) Models
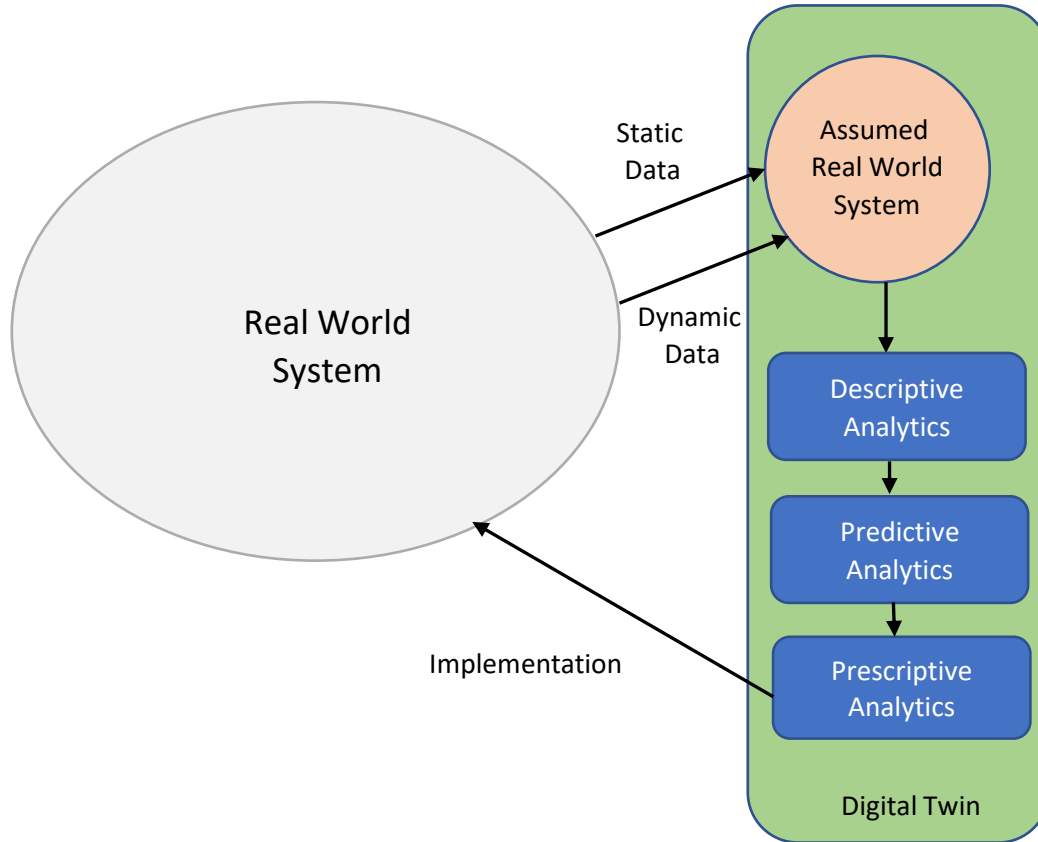
- Integrating climate, flood & traffic models

- Agent based modelling for mitigation, response & recovery

Assessment of post disaster impacts

- Condition of roads (IoT: sensors & drones)
- Link closures:  capacity reduction information

Real time monitoring of transport infrastructure

- Status of recovery works
- Diversion management

Modelling with a Digital Twin

# References

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For more information:

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