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Resilience of resource movements to disruptive events

International Symposium for Next Generation Infrastructure, October 2013

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Disruption to resource movement

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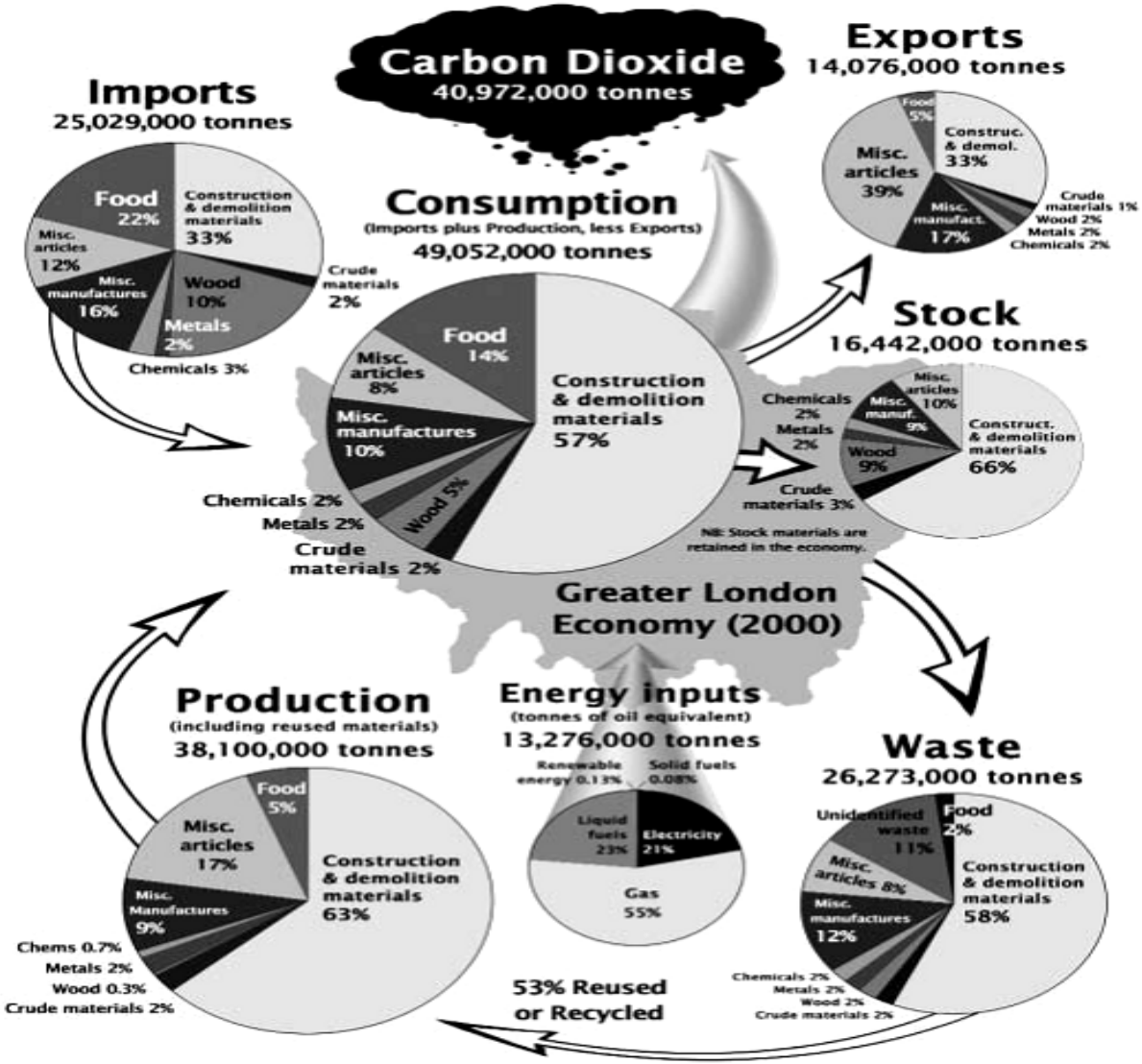
Material Flow Analysis



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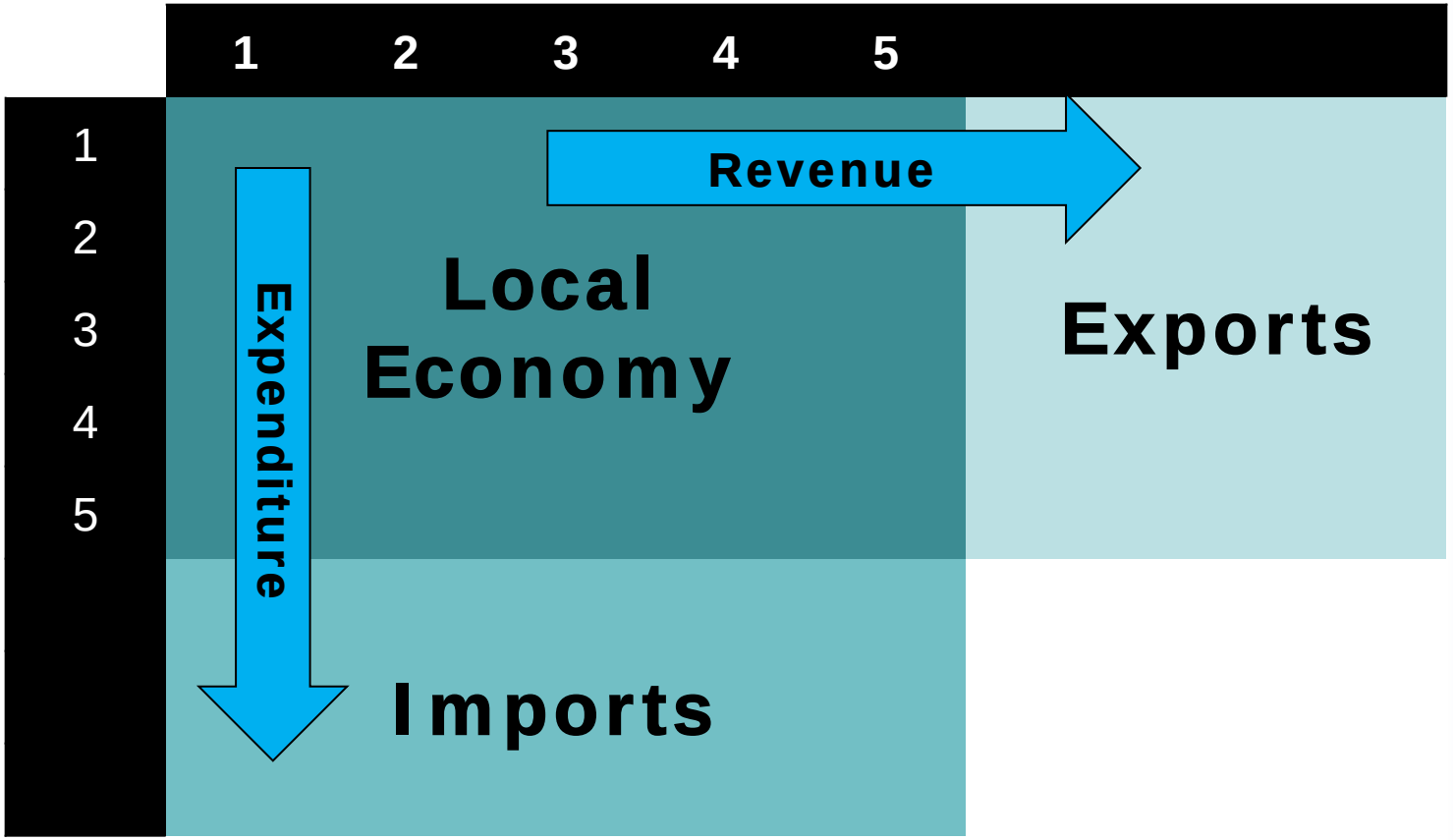
Input Output Table



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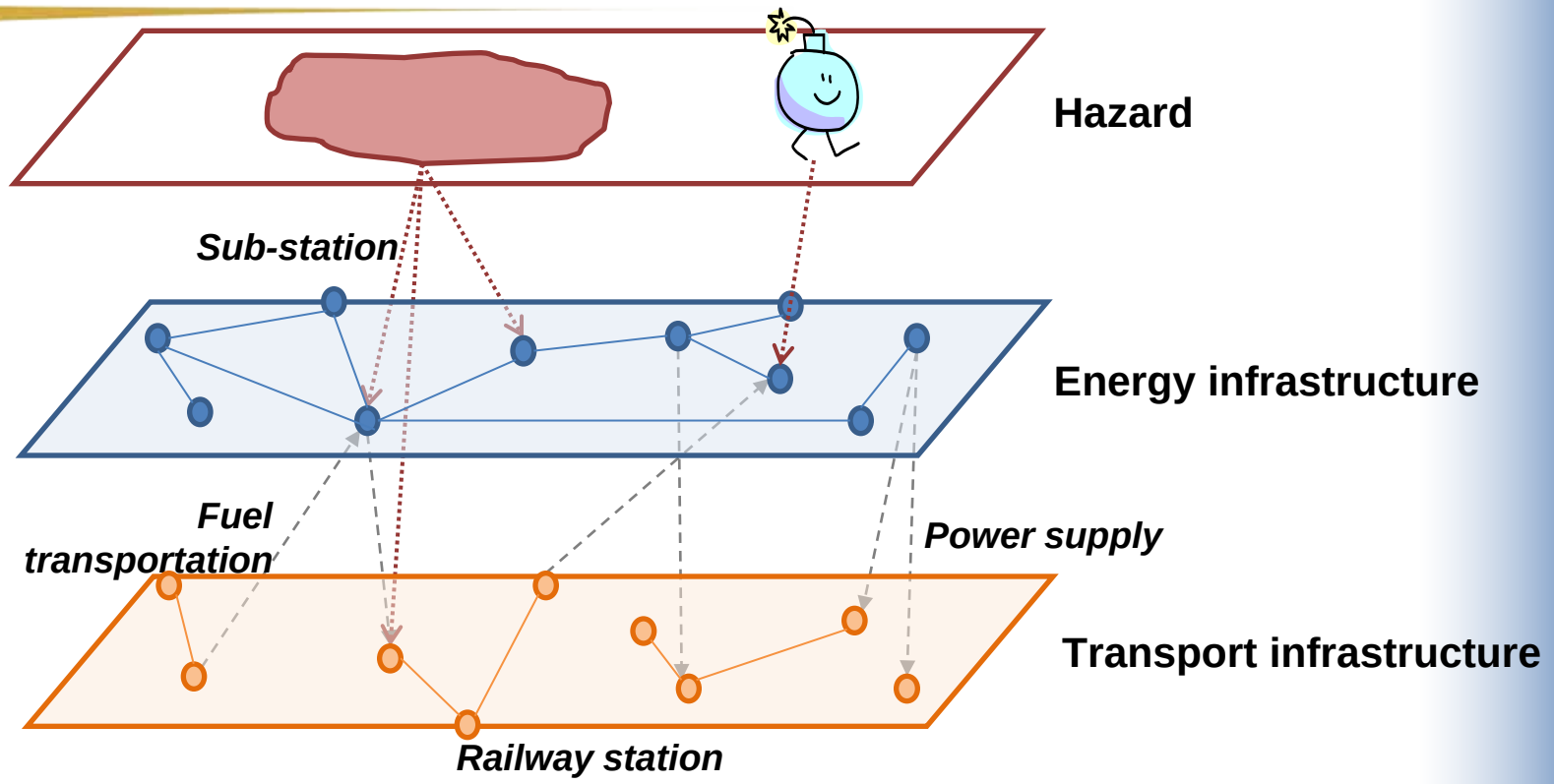
Methodology



Input-Output (as used by economists) can be used to model supply and use of resources – highlighting these interactions

Spatial network analysis to capture interactions with each other in space and with the environment

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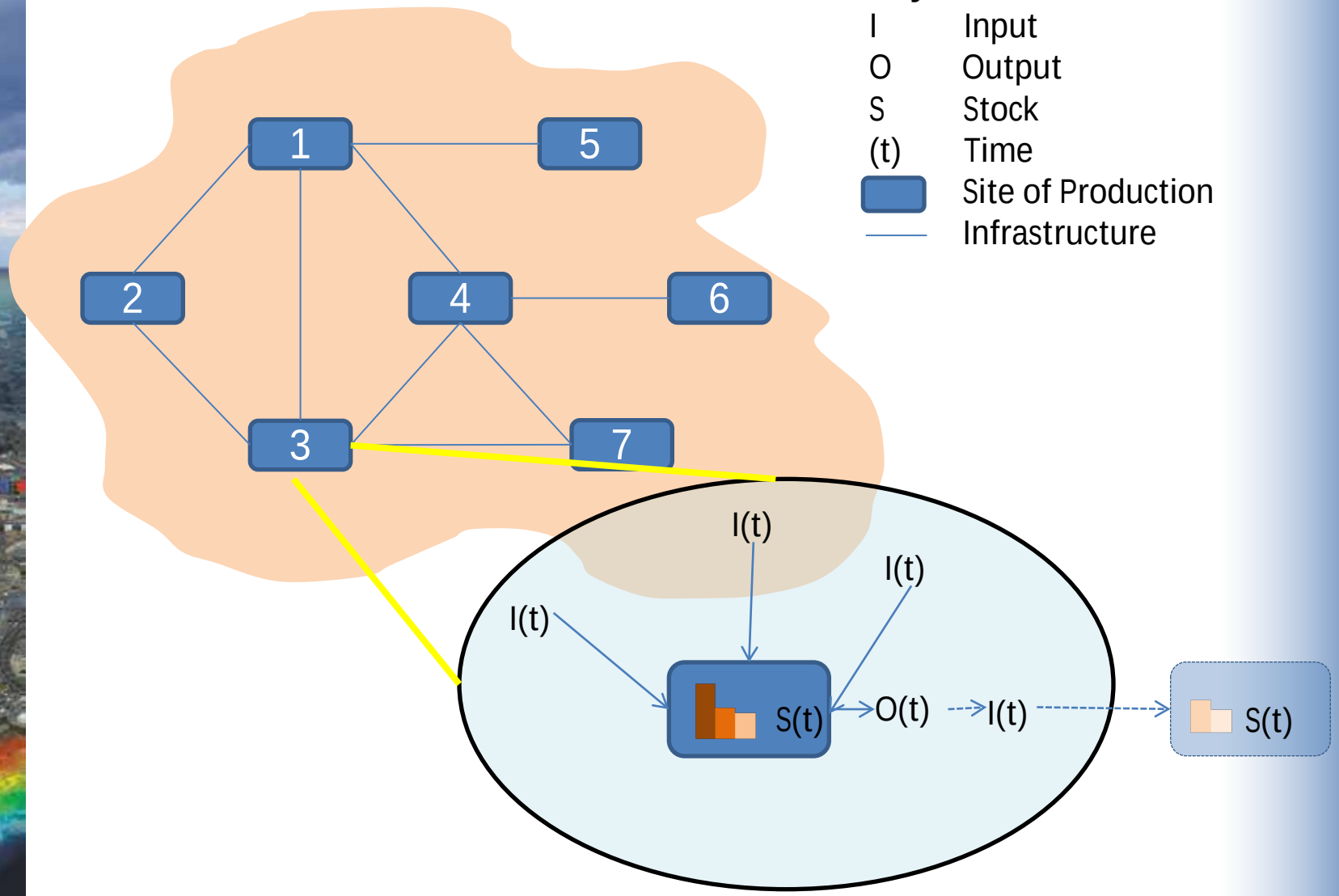
Modelling system



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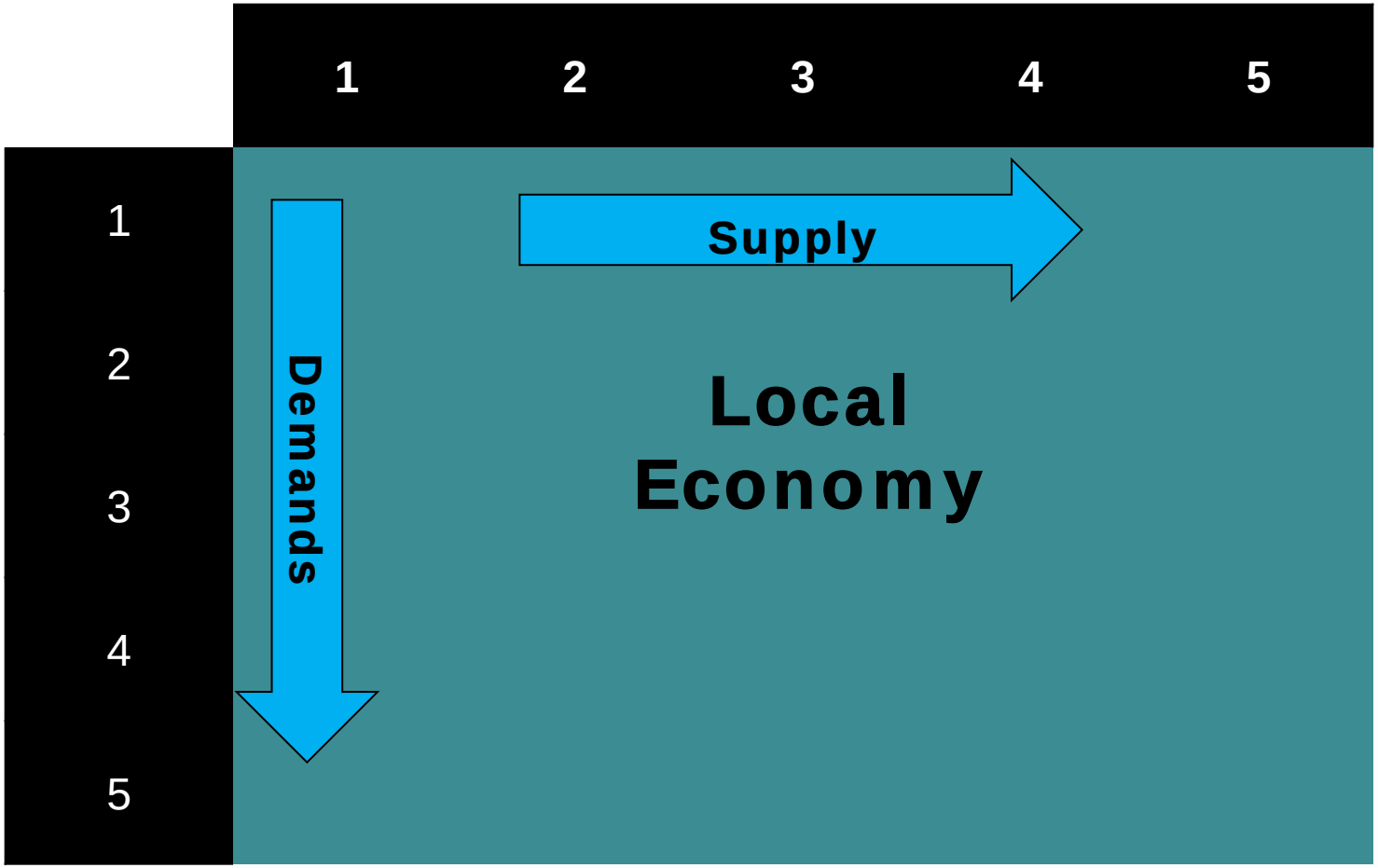
Methodology



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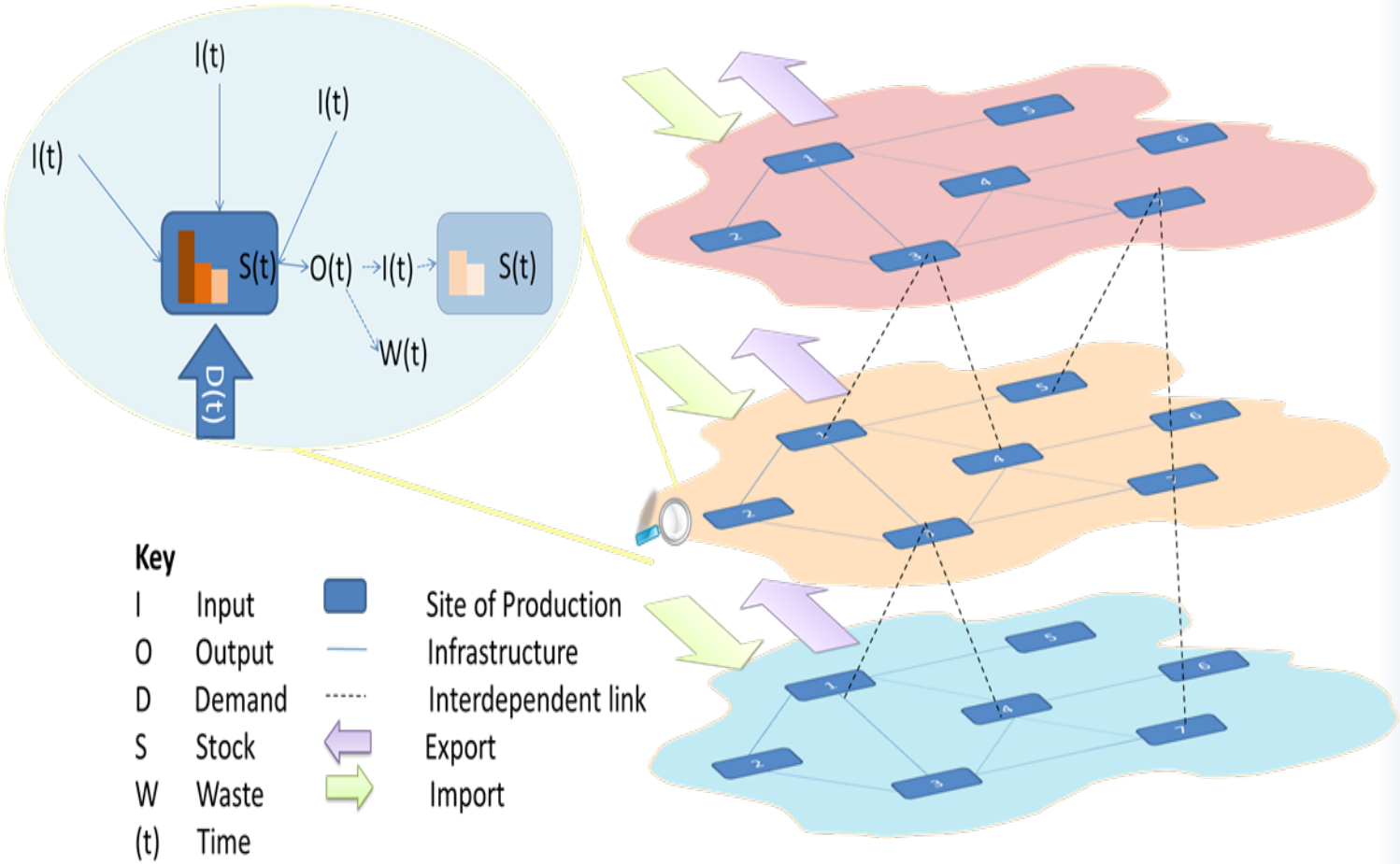
Modelling system



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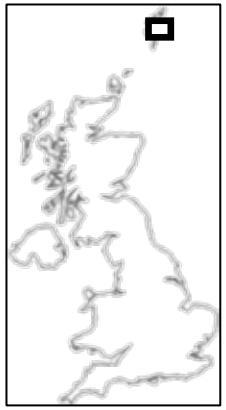
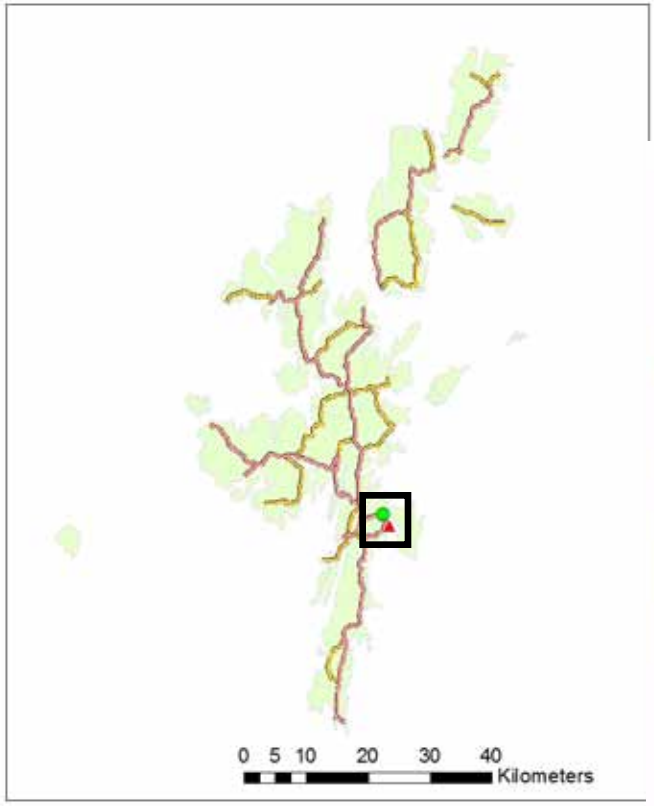
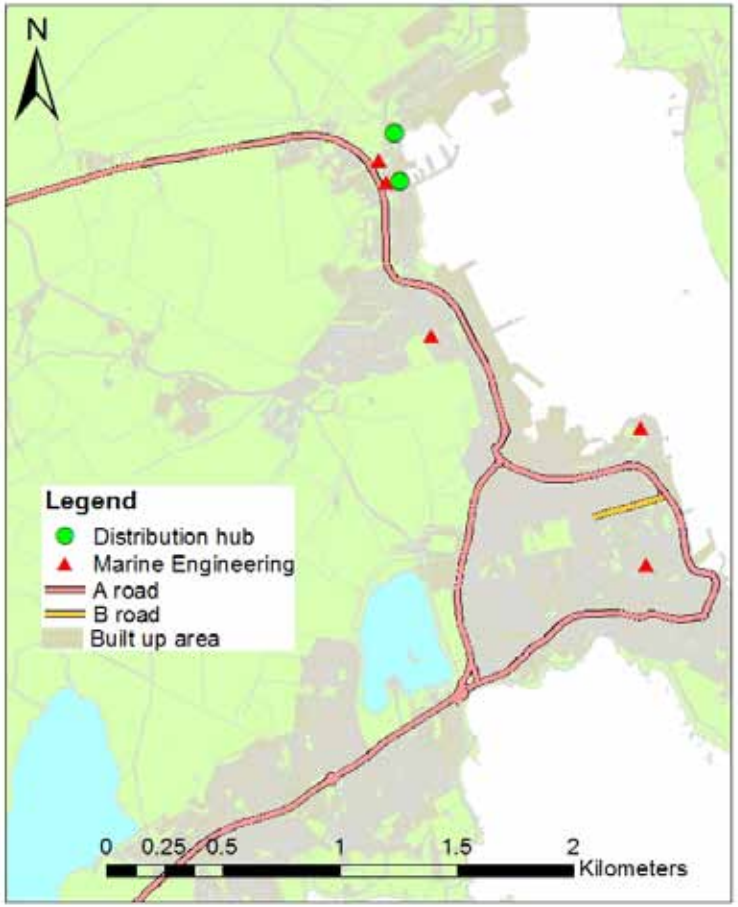
Case study: Shetland







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Case study implementation

- Flood occurs in Lewick
- On nodes [residential/industrial zones]
  - Halts production associated with relevant industry
  - Intermediate demand (e.g. for industrial processes) removed, but end user demand (e.g. food for people) remains
  - Destroys existing surplus stock
- On links [infrastructure networks]
  - Severs connection and any associated resource flows
  - Alternative routing sought if possible

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Analyses of resource movement resilience

Strategies (S)	Metrics
Deliveries of a single unit of stock at each time step.	The number of time steps after the initial disruptive event before each site is disrupted
As above plus additional reserve stock of three units.	The proportion of sectors operating
‘Batch deliveries’ plus additional reserve stock of three units	The number of remaining active I-O connections

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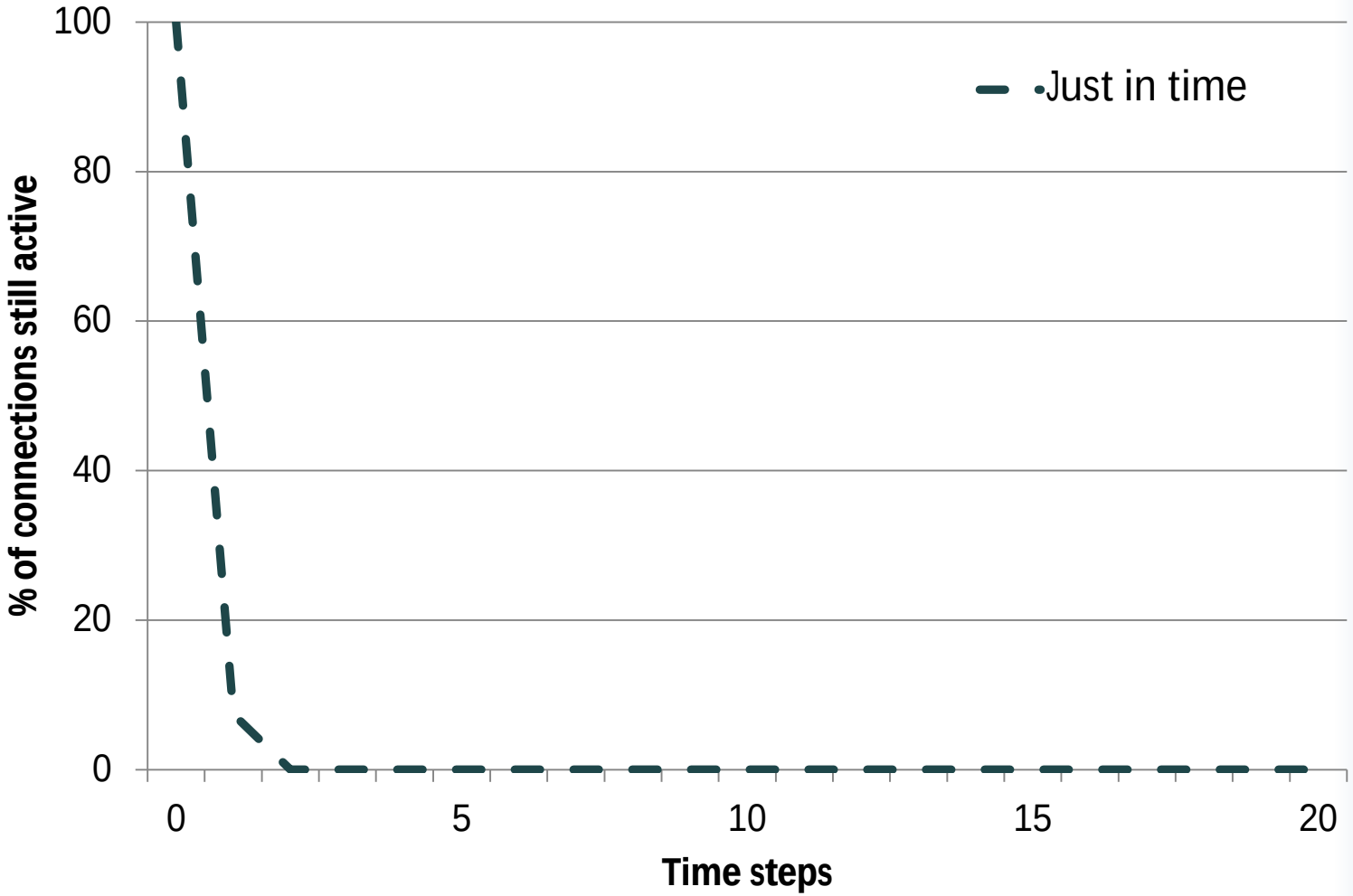
Disruption of distribution hub



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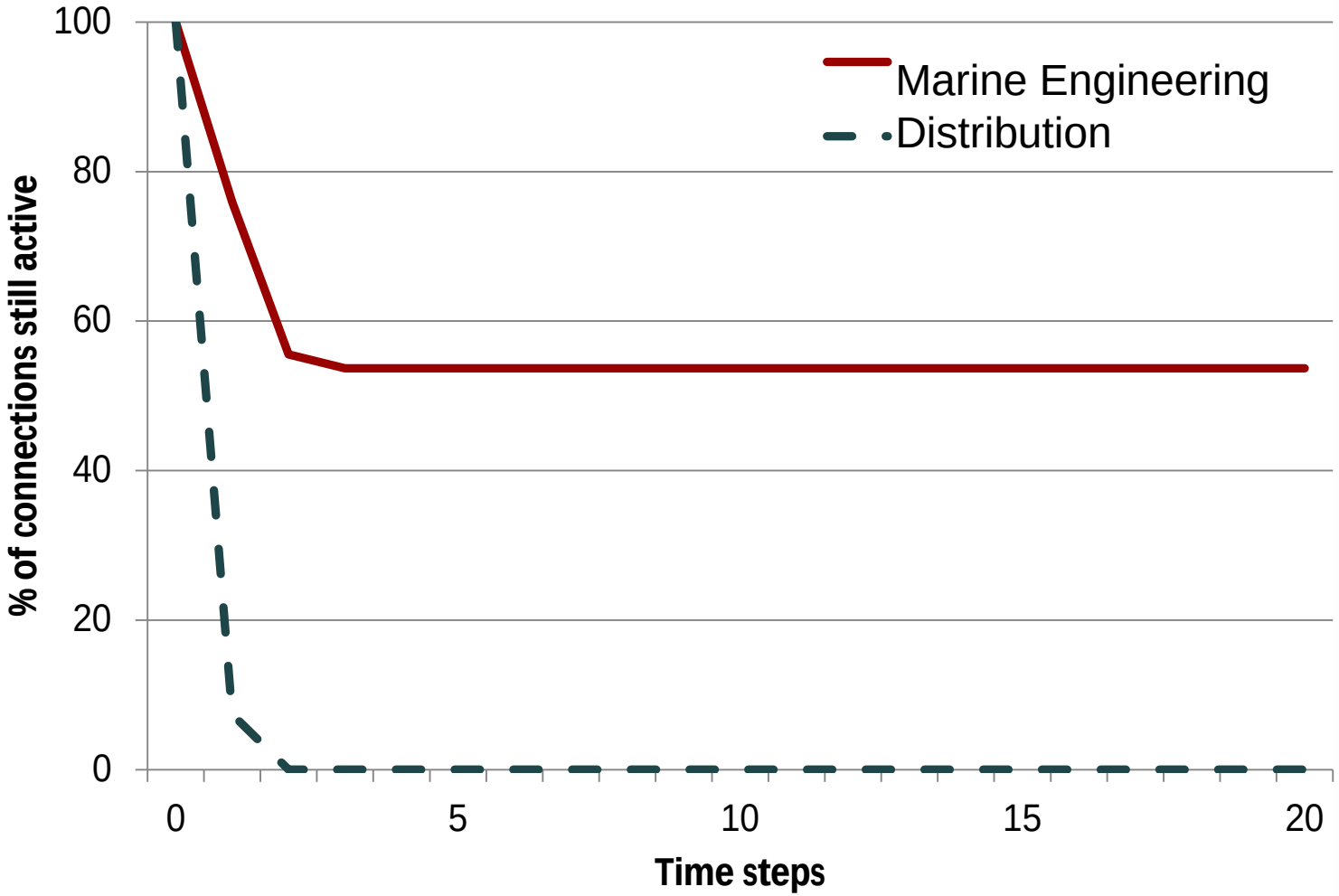
Marine Engineering



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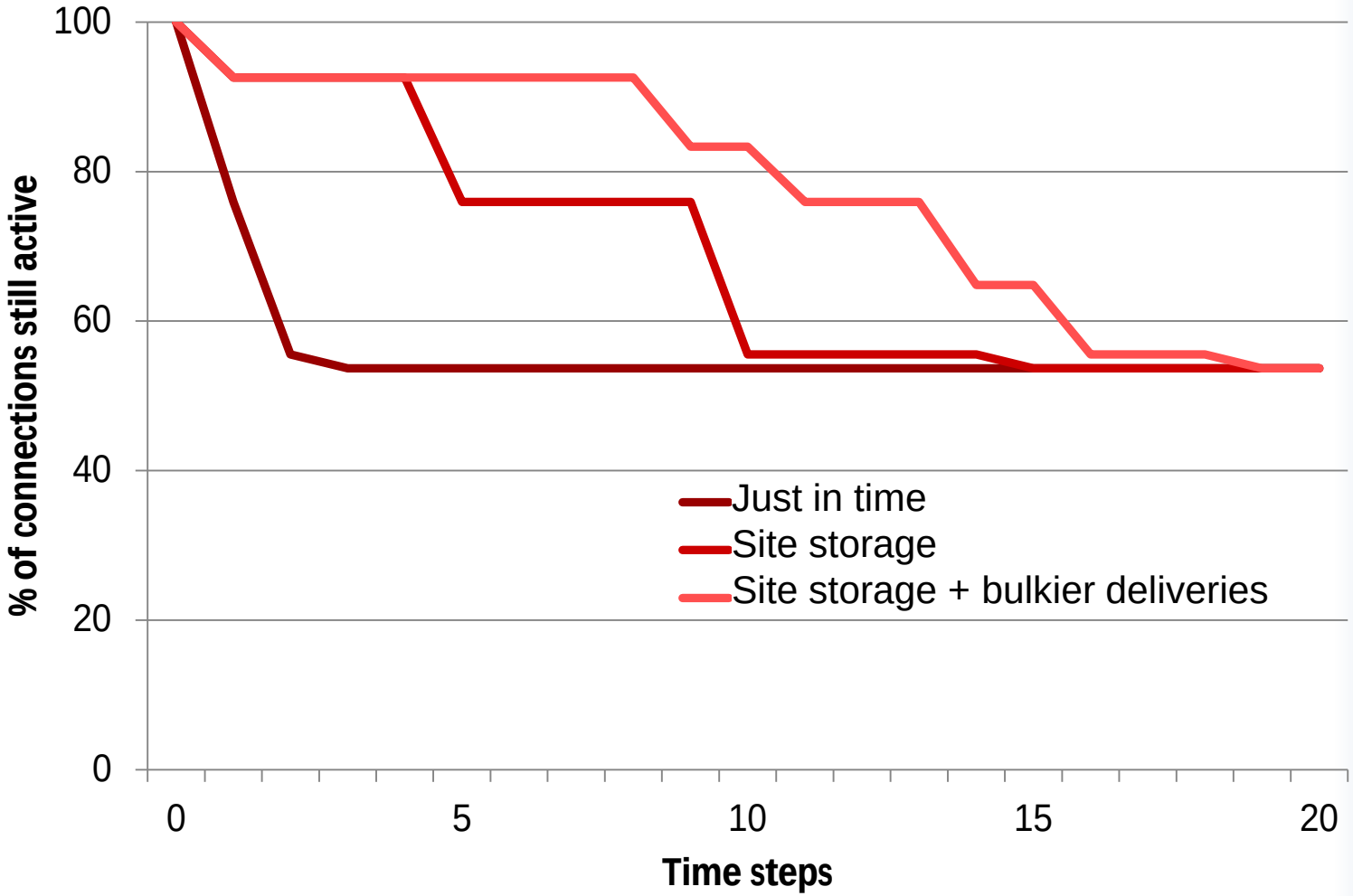
Alternative resource management strategies



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Conclusions

Disruption of the distribution industry led to far greater resource disruption overall and a more rapid cascading failure of the wider resource system because of its high levels of connectivity.

'Just in time' resource production and movement strategy led to the fastest system collapse.

On-site storage of stocks provided greater resilience with bulk deliveries providing further stability

Provides potential 'breathing room' for stakeholders to identify alternative mechanisms for ensuring the supply of critical resources, repairing facilities and infrastructure.

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Next steps

Maintaining the flow of food, materials, water and other resources before, during and after a flood event is vital for community resilience

Introduced a new resource model that couples information on consumption and demand for resources, with a spatial network model

Preliminary case study demonstrated proof of concept – ongoing work to:

- Prepare a more detailed case study – implement disagregation algorithm
- Better characterisation of failure
- Alternative metrics of ‘resilience’ – including impact of disruptions
- Develop and test wider range of adaptation strategies – including opportunities/risks associated with infrastructure interdependency
- Explore ‘recovery’ strategies

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