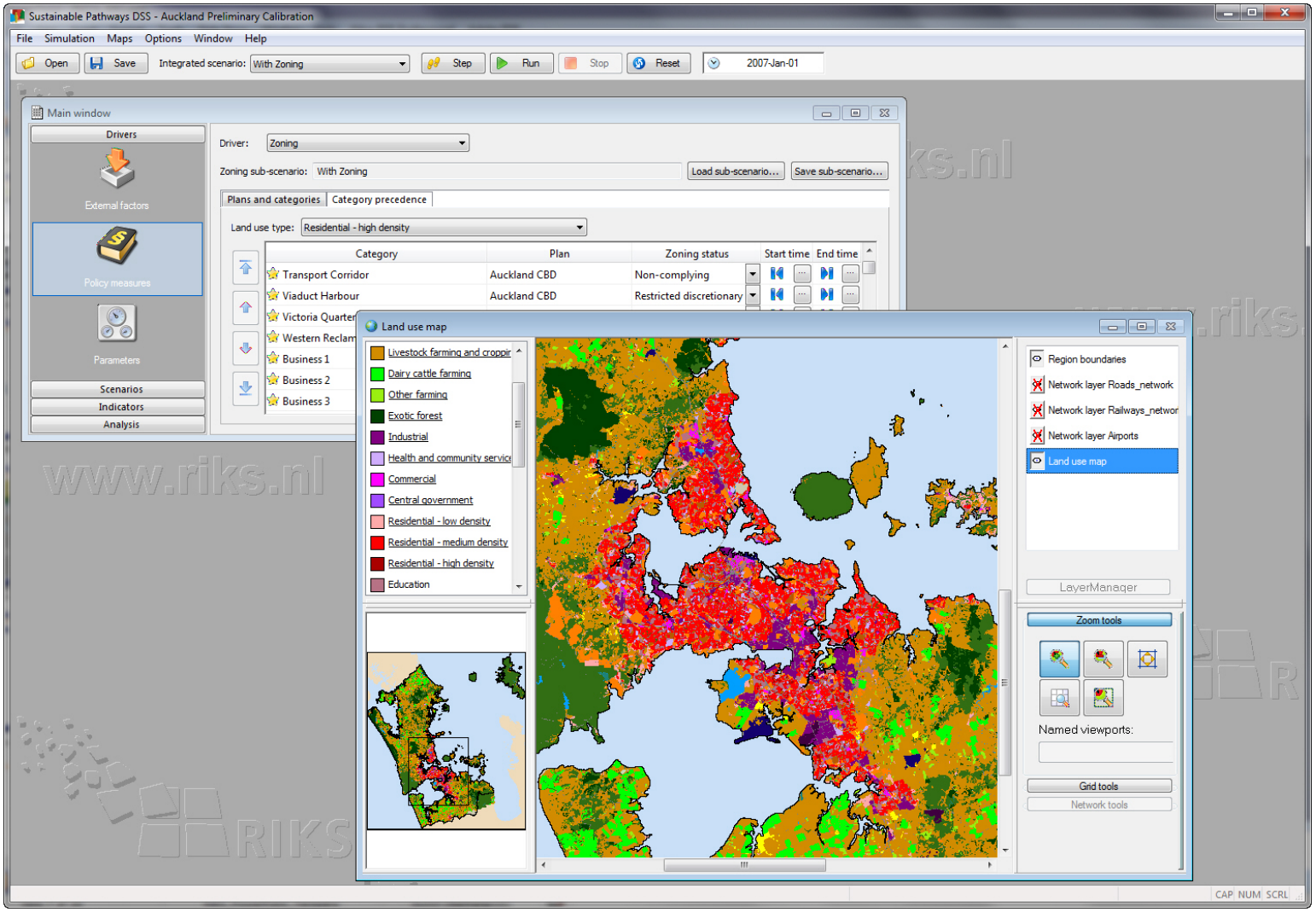
Spatial-MERIT

- **A spatially explicit and dynamic decision support system for assessing the economic impacts of hazards and infrastructure failure**
- **Runs in two different modes:**
  - Normal: baseline calculation of the spatially-explicit socio-economic developments
  - Shock time: impacts of an outage on transport and the economy
- **Allows for assessing impact of hazard and infrastructure failure now and into the future**

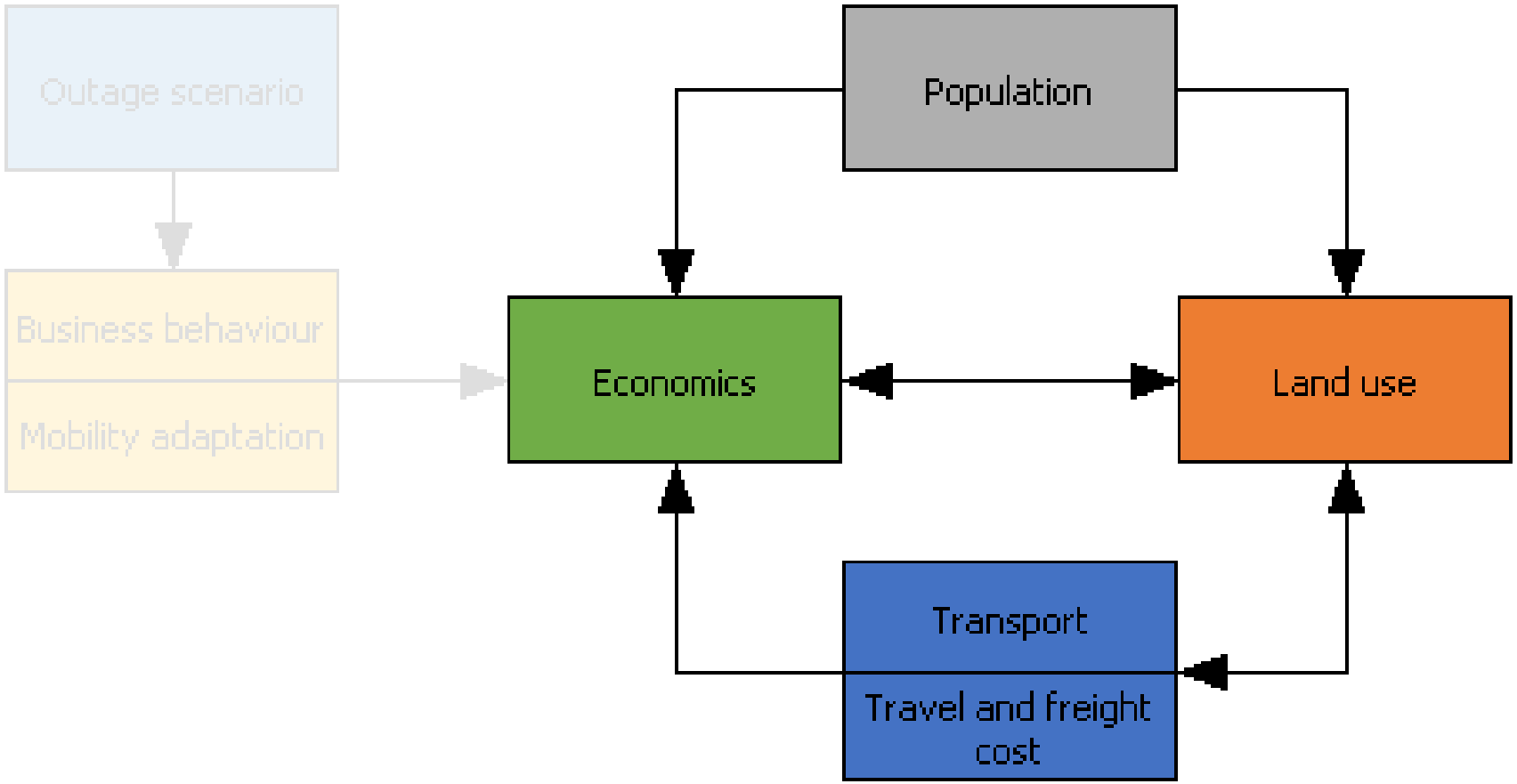
Characteristics of Spatial-MERIT

- Incorporates a spatially explicit integrated model including economics, demographics, land use and activities and transport
- Includes external drivers and policy options affecting on impacts of outages
  - Different regional socio-economic developments
  - Different spatial planning and infrastructure options
- Time horizon 2050
- Spatial extent Auckland, spatial resolution 100 m

Model Interface



The model in ‘normal’ mode



Population

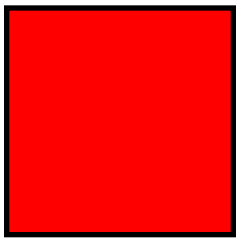
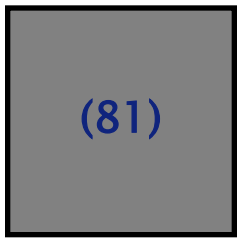
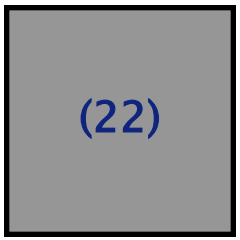
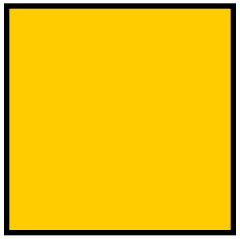
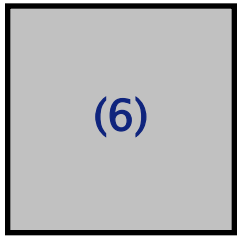
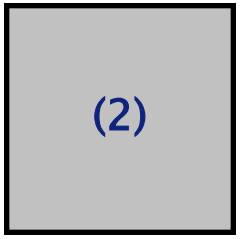
- Age cohort model
- Calculation of the population per age cohort based on birth, mortality and migration rates
- Annual time step

- Provides input for
  - Economic model: labour force
  - Land use: total population

What is ‘the’ land use?

Activity based approach

- Cells have an activity and a land use:

LU		Activity 1		Activity 2	Explanation
	&	 (81)	&	 (22)	Residential area with 81 inhabitants and 22 jobs
	&	 (6)	&	 (2)	Agriculture with 6 inhabitants and 2 jobs

Activity based land use model

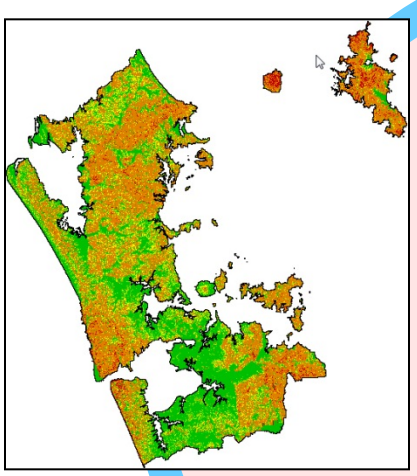
- **Activity based cellular automata model**
- **Calculates land use map and maps with activity levels per cell (density maps)**
  - Population
  - Employment (business and personal services, education, retail and hospitality, manufacturing)

- **Provides input for**
  - Economic model: unallocated economic demands
  - Transport model: location of activities and land uses

Land u

Suitability

&



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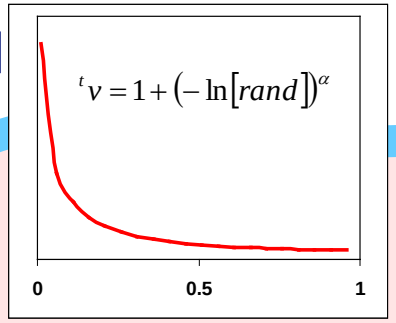
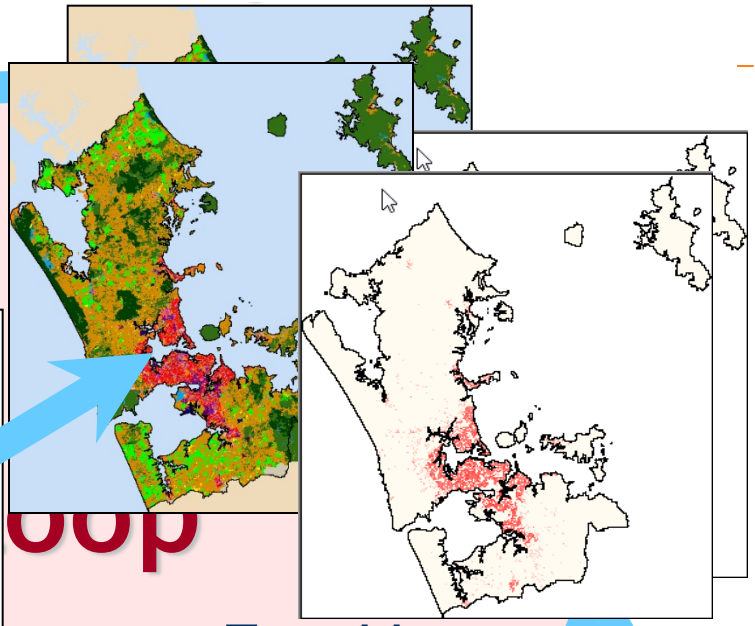
Stochastic perturbation



Land use and activity at time T+1



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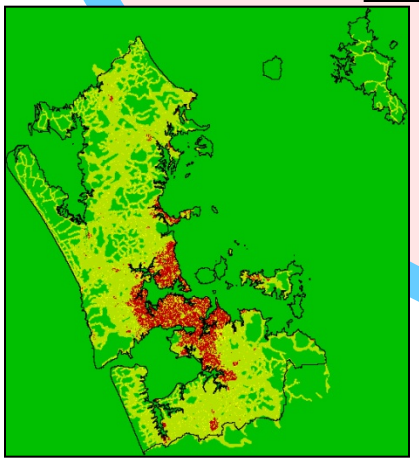
Transition Rule

Change cells to the land use for which they have the highest transition potential *until regional demands are met*

Accessibility



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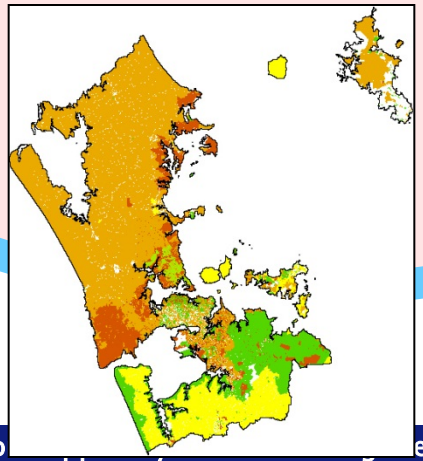
Zoning



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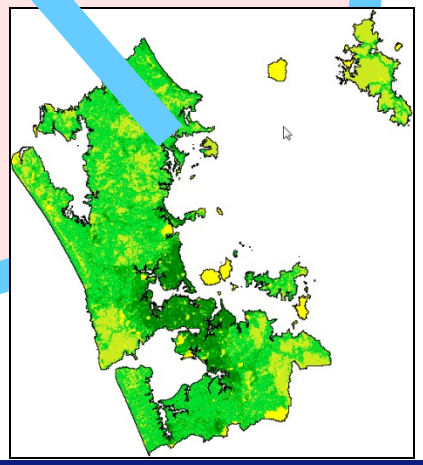
Transition potentials



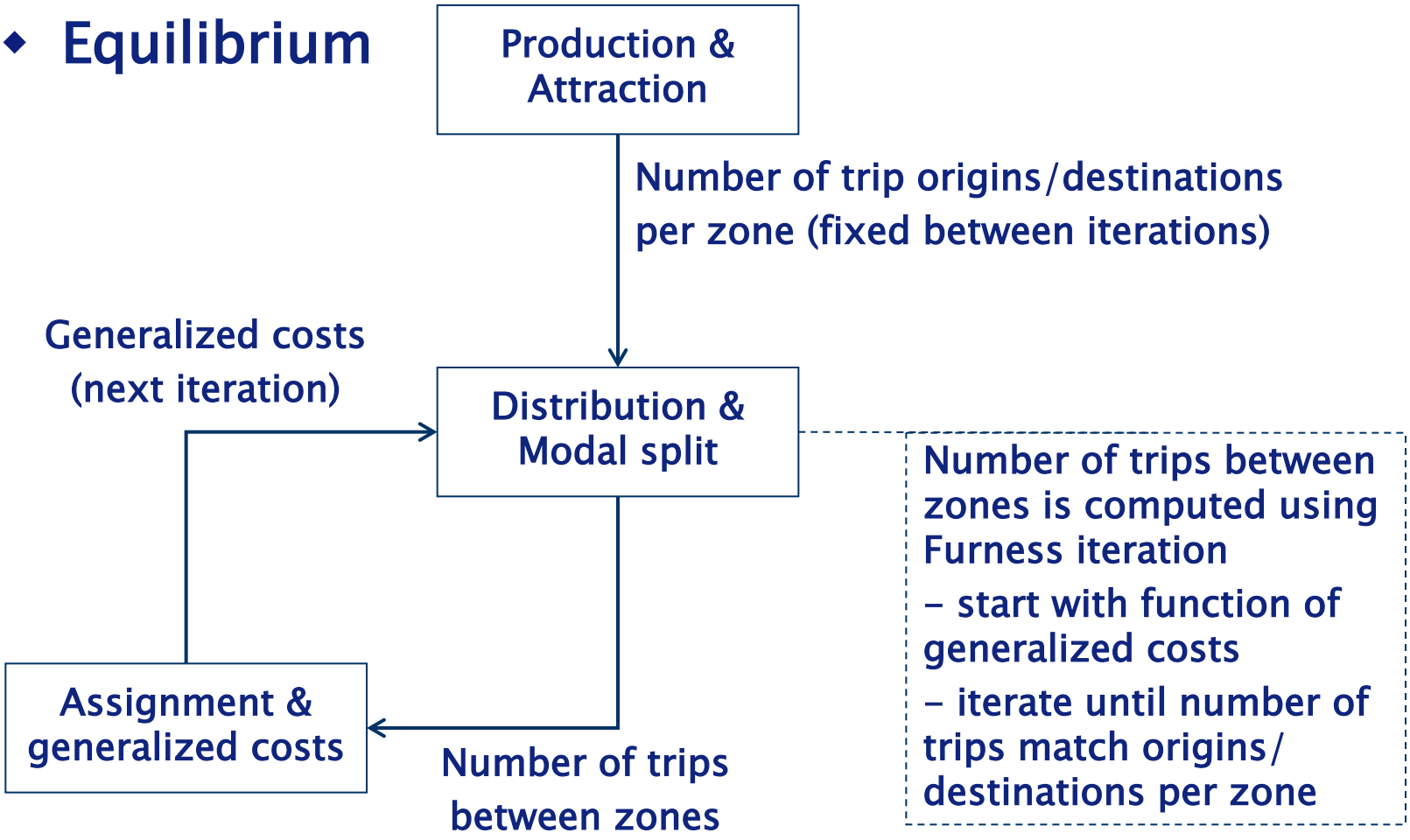
Transport

- **Four-step transport model**
- **Calculates traffic flows from each transport zone to each other transport zone**
  - Time, distance (per zone)
  - Intensity and congestion (on the road network)

- **Provides input for:**
  - Land use model: accessibility for allocation of businesses, residents and other activities
  - Economic model: transport costs for businesses, households and freight

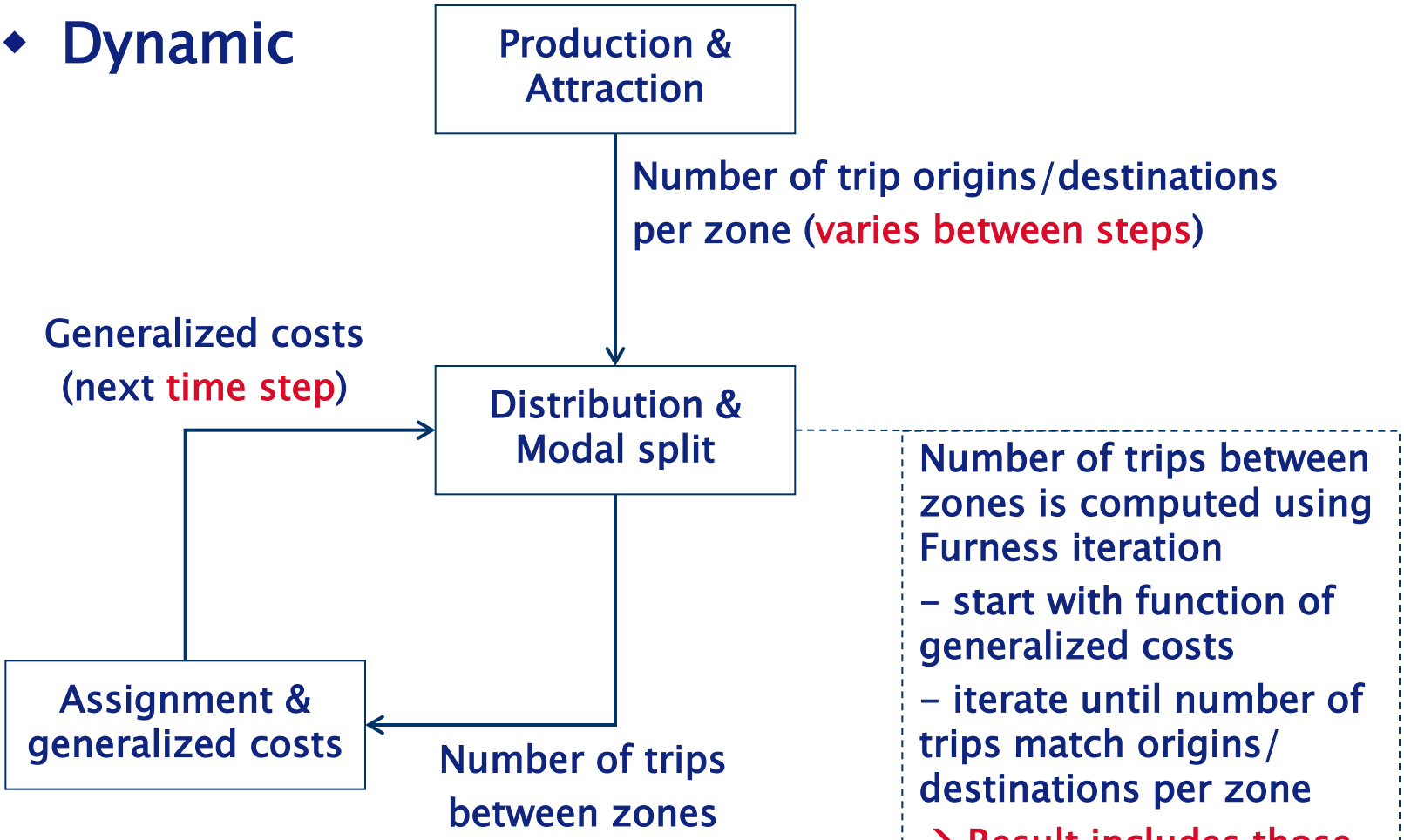
From classic 4-stage to dynamic

- Equilibrium

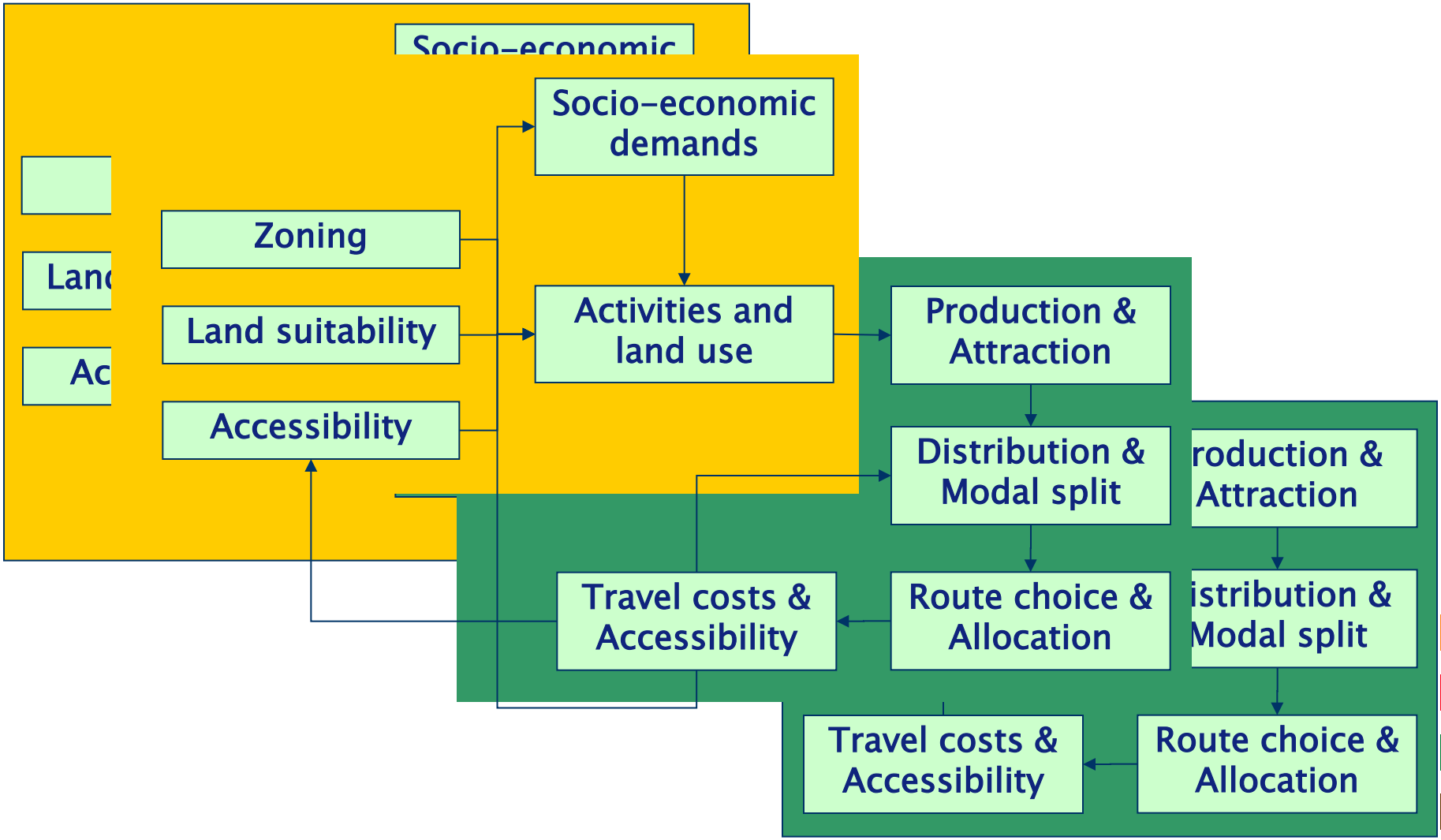


From classic 4-stage to dynamic

- Dynamic



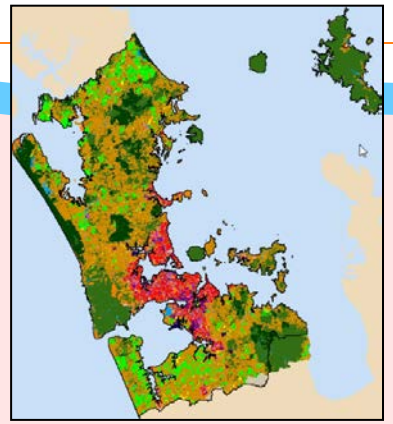
Integration land use and transport



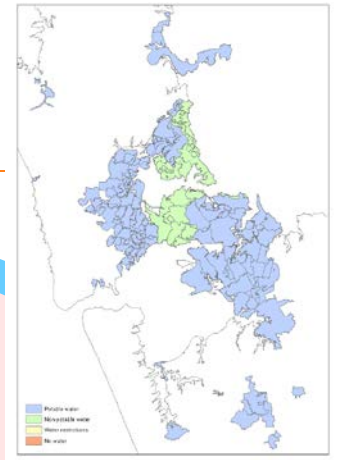
Measuring the Economic Resilience of Infrastructure Tool (MERIT)

- Dynamic economic model (CGE) assessing economic impacts of infrastructure outages
  - Economic interdependencies, cascading effects, feedbacks and lags
  - Business resilience adaptations and response options
- *Resolution*: multi-regional (all regions), temporal (daily time-steps, 20yr horizon), multi-sectoral (80+ industries)
- *Reports:* Changes in GDP, employment, income, labour/capital markets etc

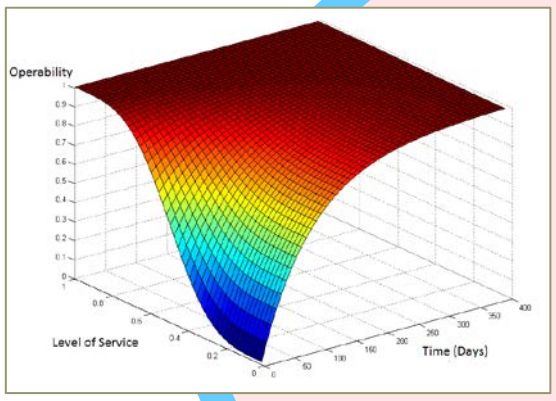
How is MERIT applied?



Directly Impacted Business

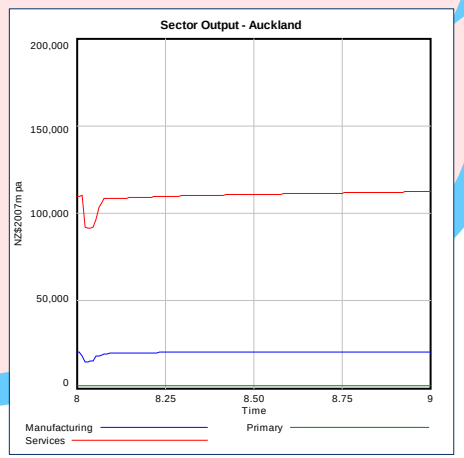


Infrastructure Outage Maps

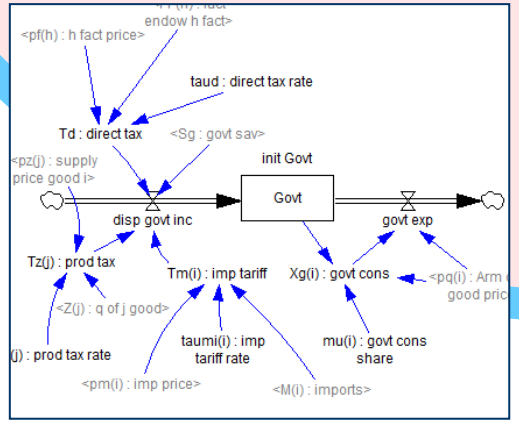


Business Operation Impacts

Report Economic Impacts



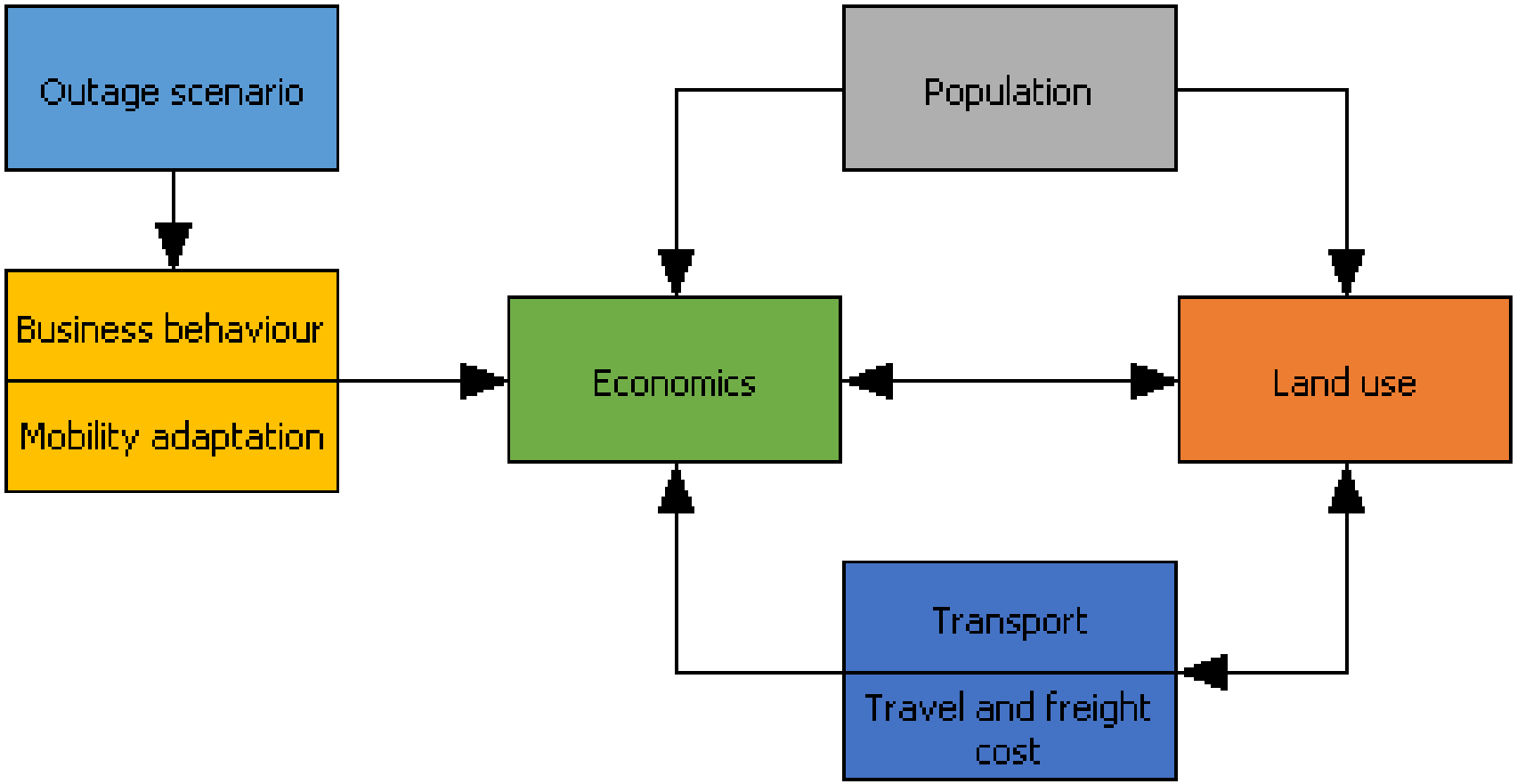
Run MERIT



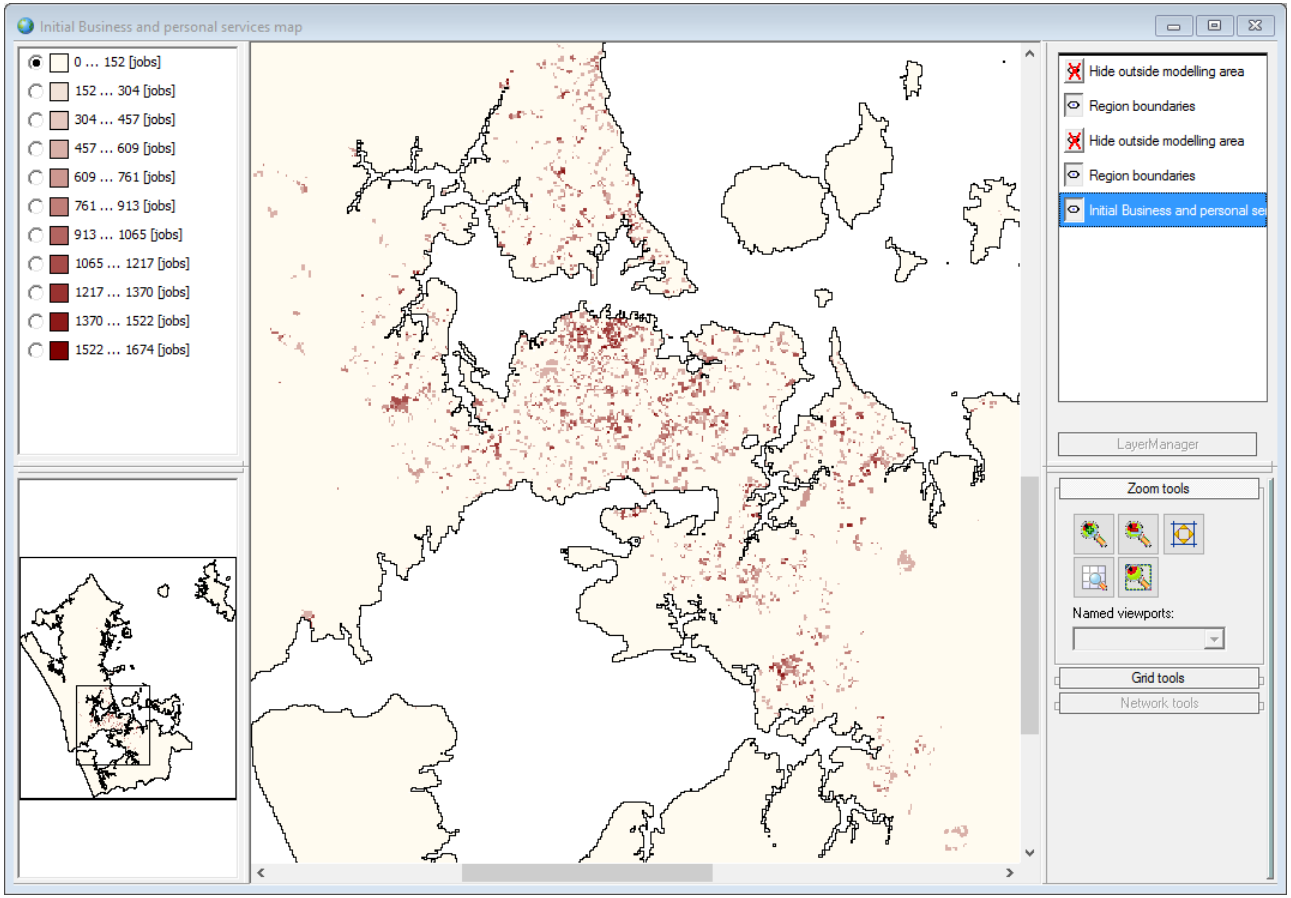
Where has MERIT been used?

- **Transport**
  - NZTA (Manawatu Gorge, SH2, online tool), MoT SH4 outage
  - Lyttelton Port, Ports of Auckland
- **Electricity**
  - Vector/Transpower
- **Water/Sewerage**
  - Watercare Services, Wellington Water
- **Multi-infrastructure outage events**
  - Alpine Fault, Auckland Volcanic Eruption, Wellington Resilience Business Case, *Kaikoura Quake*

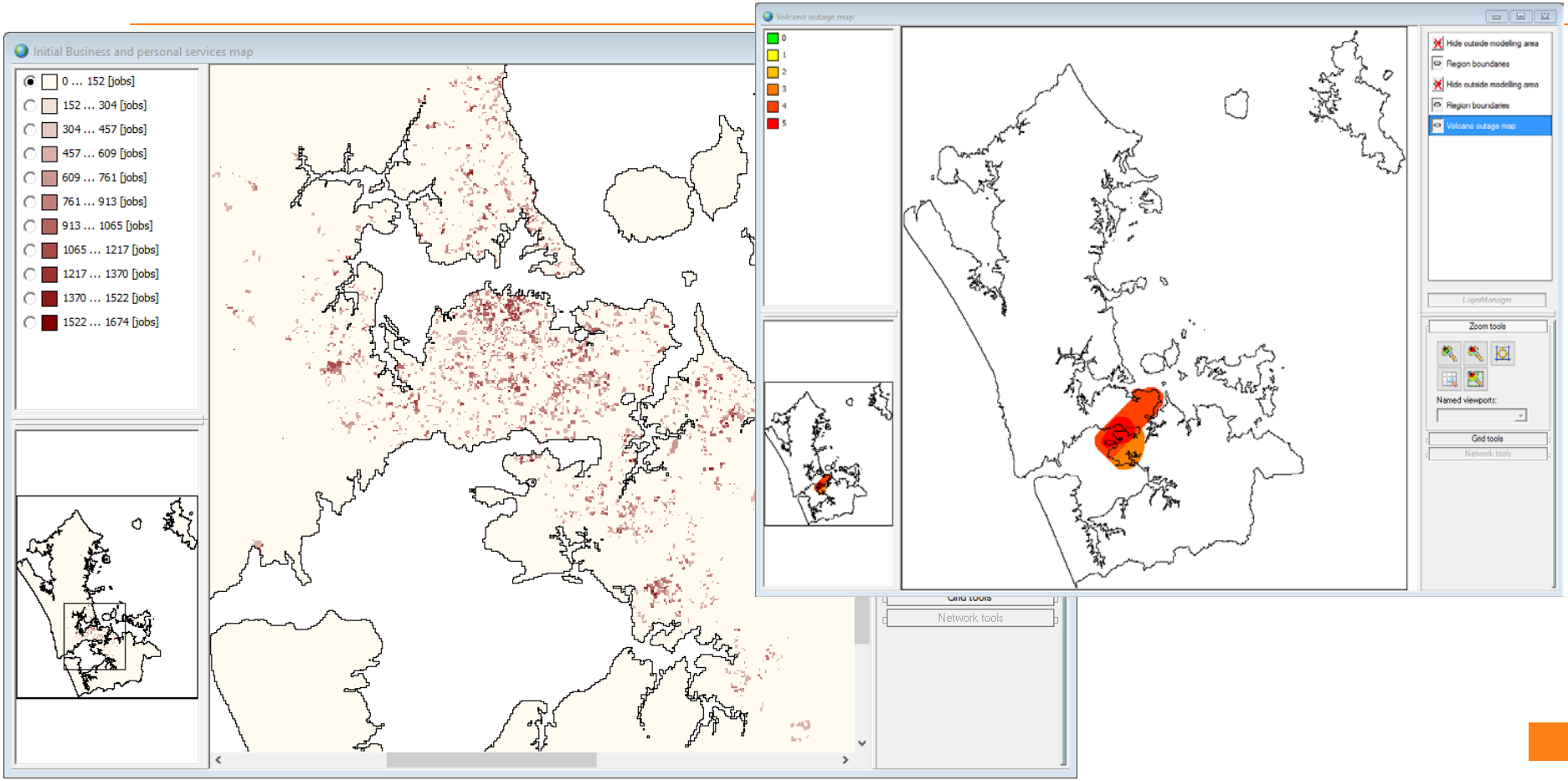
The model in ‘shock’ mode



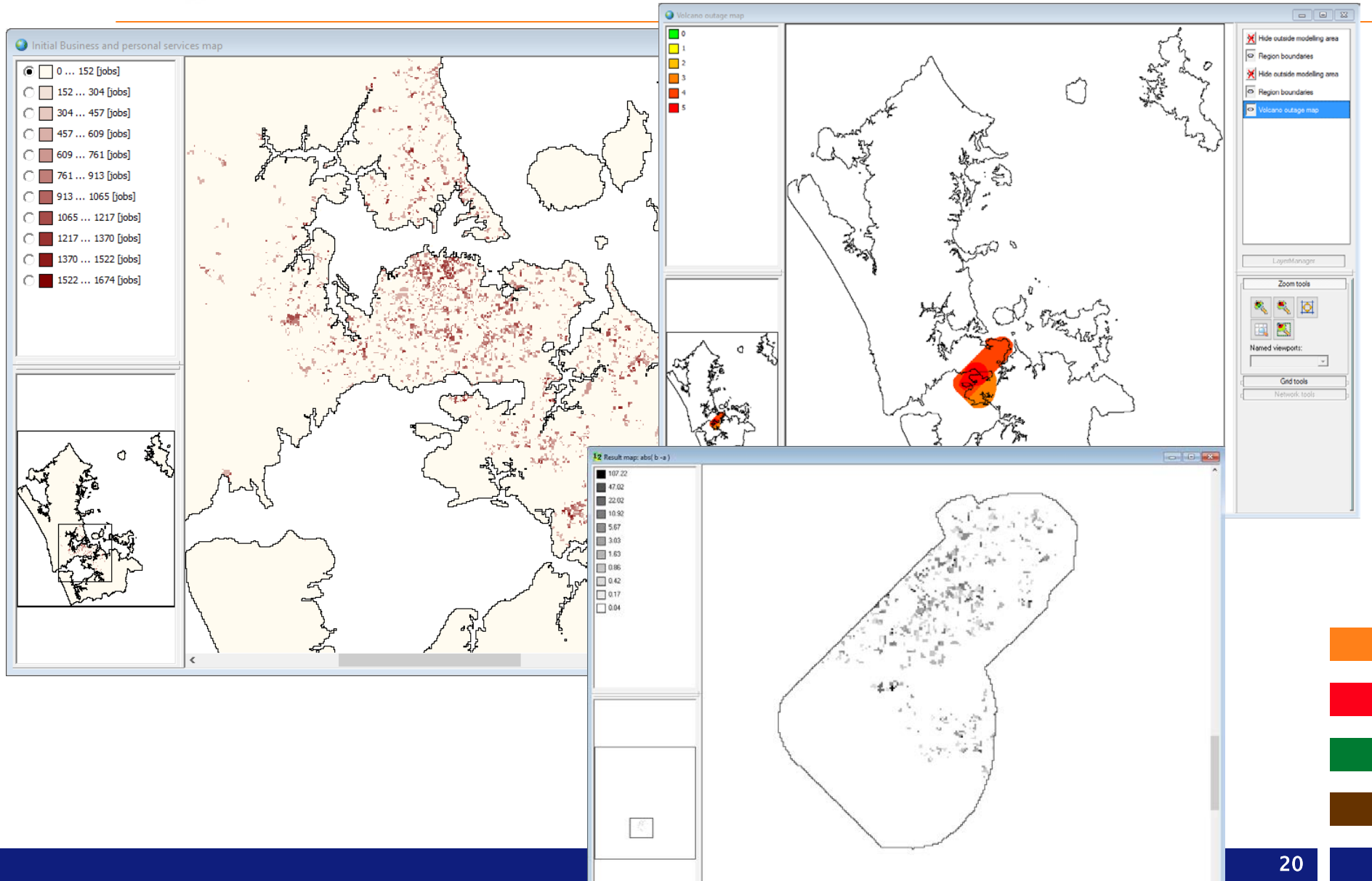
Employment in business and personal services



Volcano outage



Impact on local employment



Conclusions

- **Model integration allows to explore feedback between various processes**
- **Being able to couple models technically doesn't mean the coupling makes sense!**
- **Recommendations for future research**
  - Enhanced calibration and validation
  - Testing on more case studies to assess how generic the approach is
  - Improvements to the simulation run time
  - Enhanced incorporation of interaction of infrastructure outages
  - Incorporation of impacts on population