



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

Sustainable Pathways DSS - Auckland Preliminary Calibration

File Simulation Maps Options Window Help

Open Save Integrated scenario: With Zoning Step Run Stop Reset 2007-Jan-01

Main window

Drivers

External factors

Policy measures

Parameters

Scenarios

Indicators

Analysis

Driver: Zoning

Zoning sub-scenario: With Zoning Load sub-scenario... Save sub-scenario...

Plans and categories Category precedence

Land use type: Residential - high density

Category	Plan	Zoning status	Start time	End time
Transport Corridor	Auckland CBD	Non-complying		
Viaduct Harbour	Auckland CBD	Restricted discretionary		
Victoria Quarter				
Western Reclamation				
Business 1				
Business 2				
Business 3				

Land use map

- Livestock farming and cropping
- Dairy cattle farming
- Other farming
- Exotic forest
- Industrial
- Health and community services
- Commercial
- Central government
- Residential - low density
- Residential - medium density
- Residential - high density
- Education

Region boundaries

- Network layer Roads_network
- Network layer Railways_network
- Network layer Airports
- Land use map

LayerManager

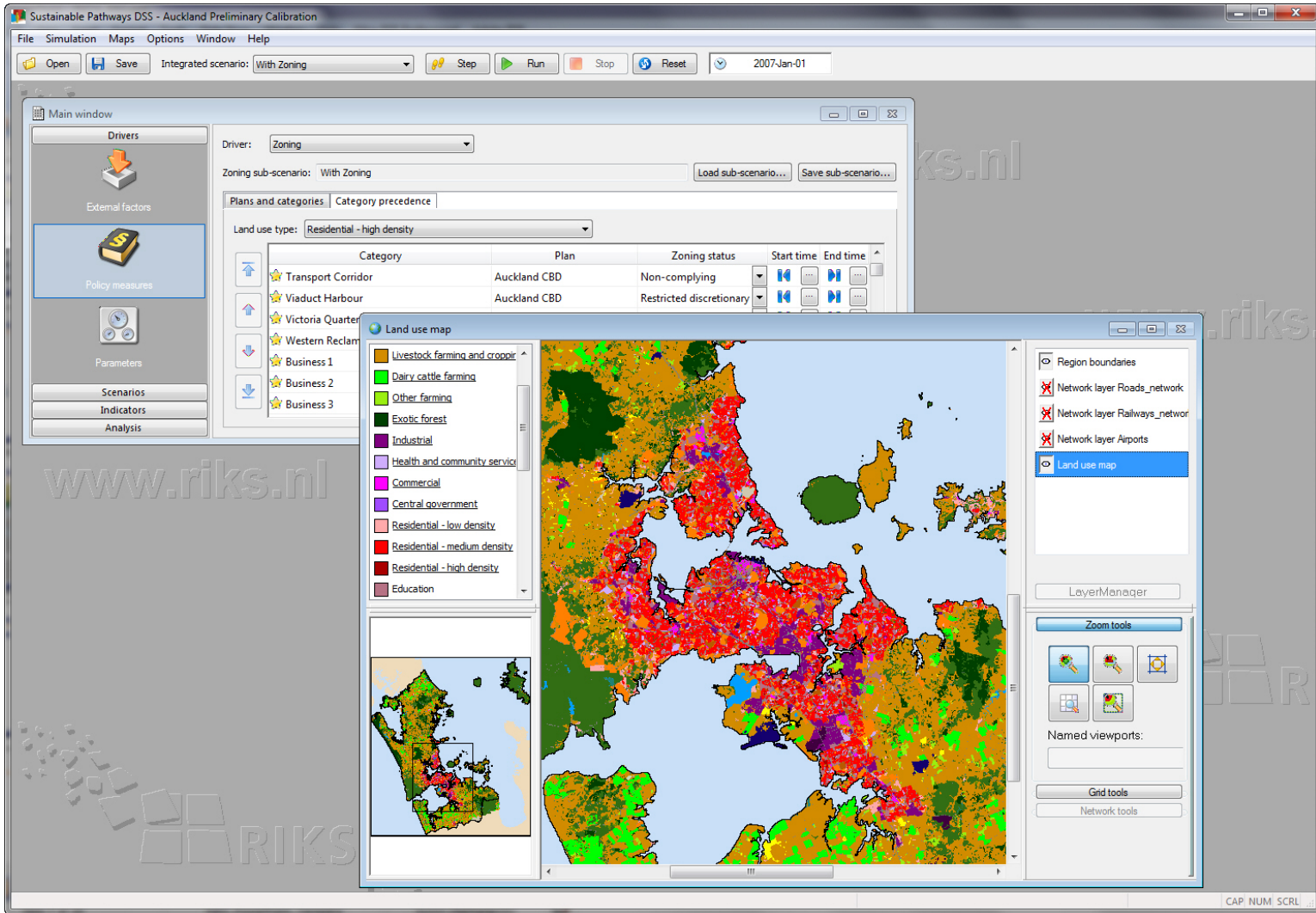
Zoom tools

Named viewports:

Grid tools

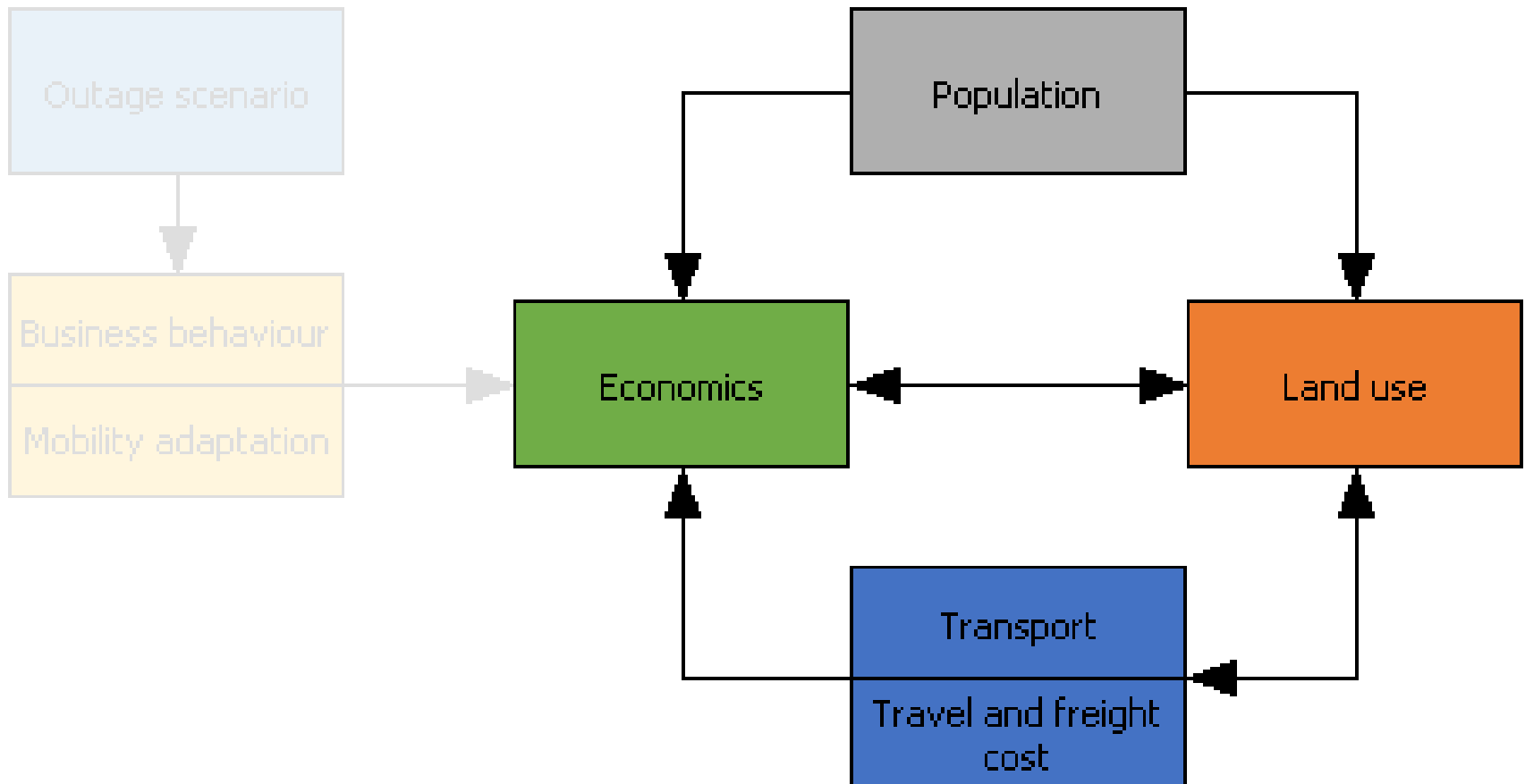
Network tools

CAP NUM SCRL





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



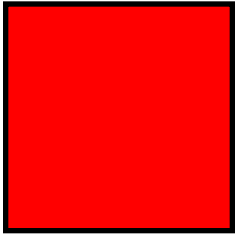
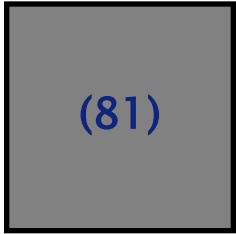
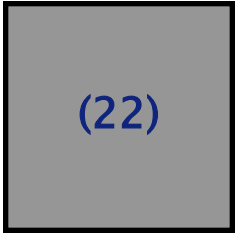
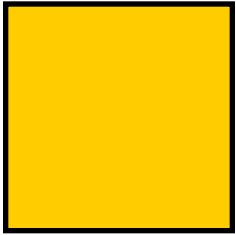
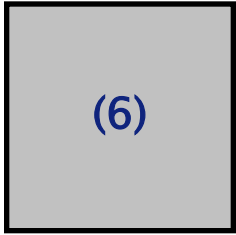
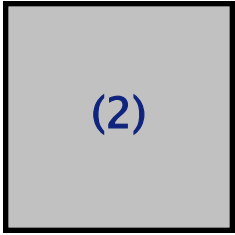
What is 'the' land use?





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





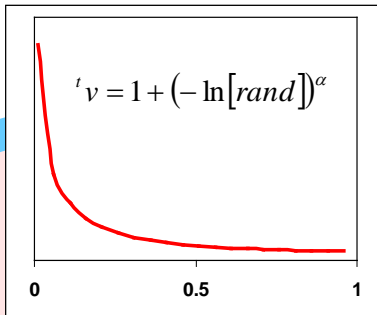
Stochastic perturbation

Land use and activity at time T+1

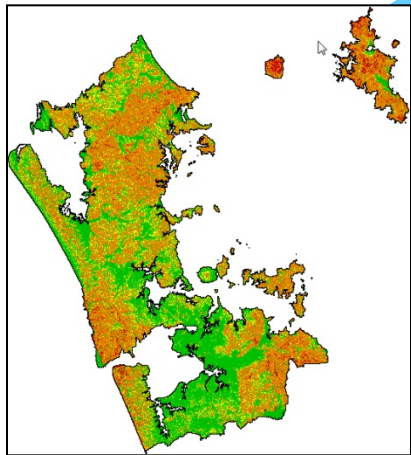
Land use

Suitability

&

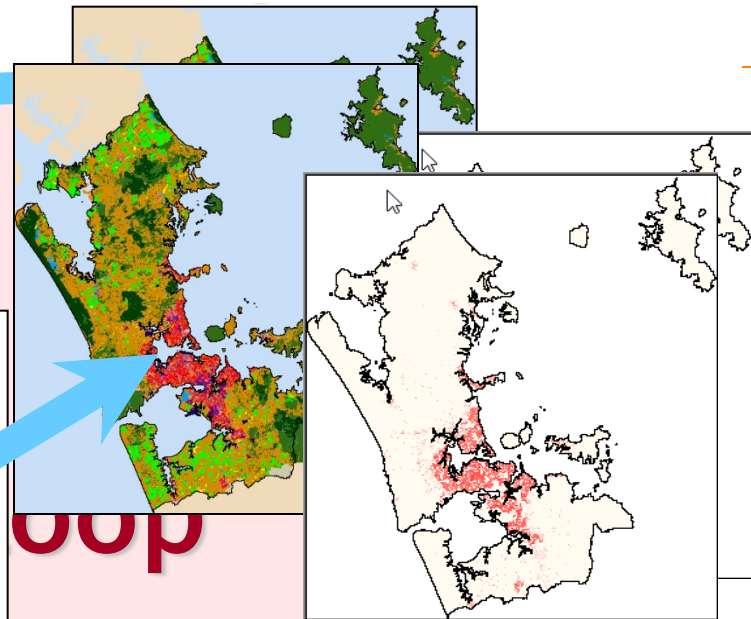


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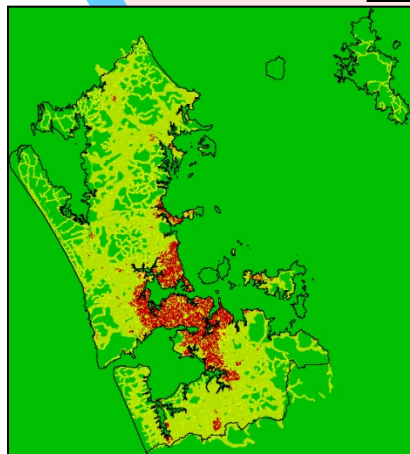


Accessibility

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

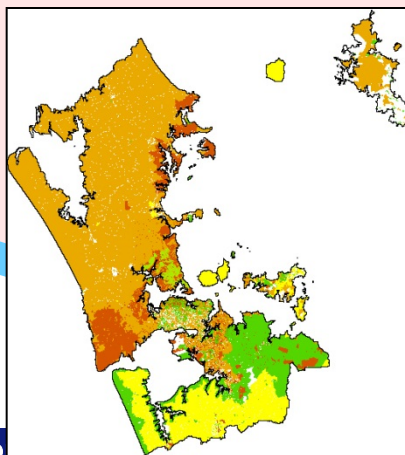


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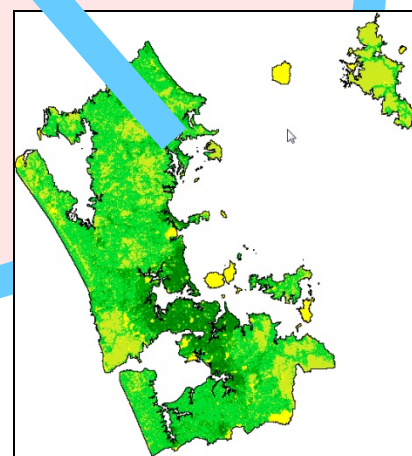
Zoning

&



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Transition Potentials

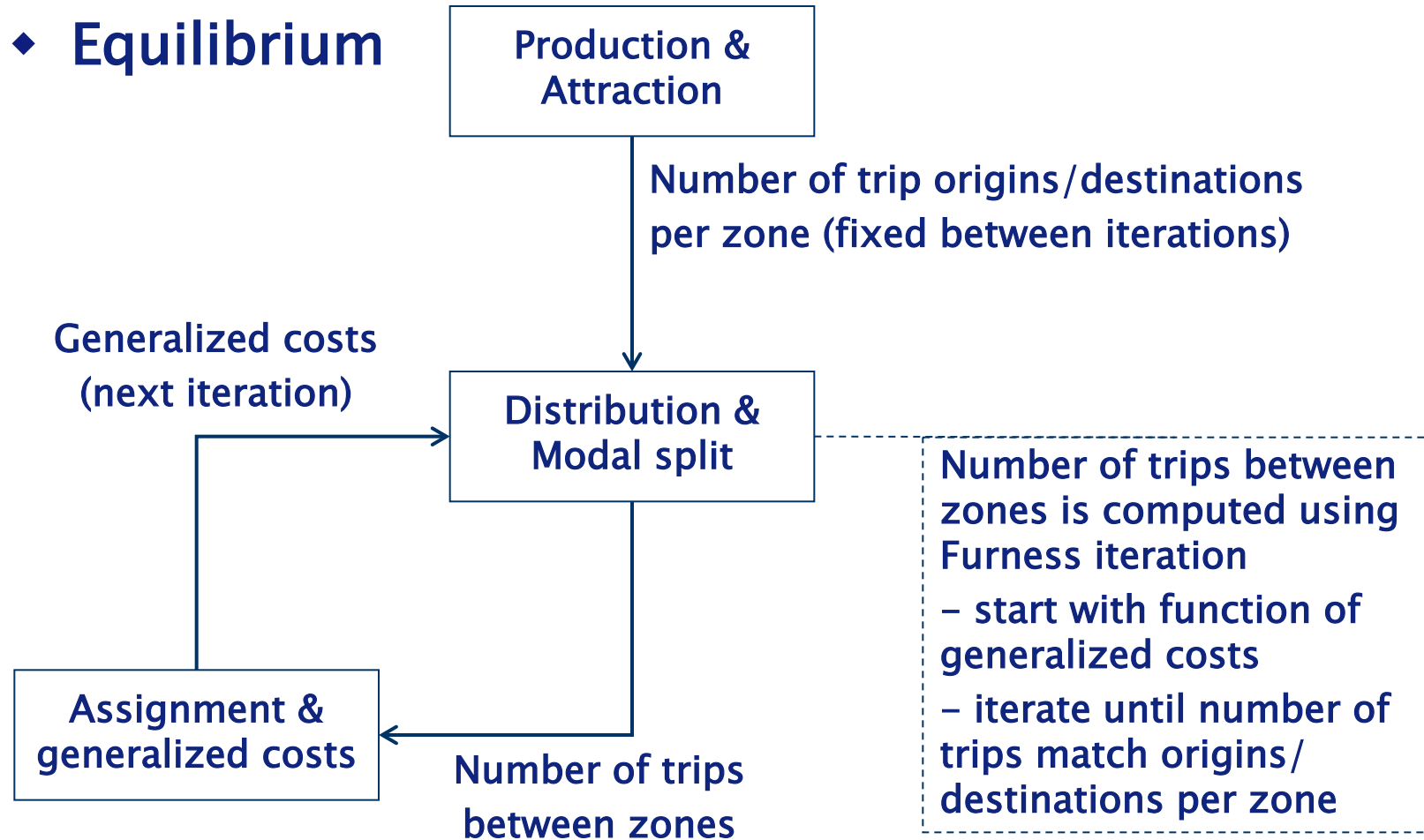


- ◆ **Four–step transport model**
- ◆ **Calculates traffic flows from each transport zone to each other transport zone**
 - Time, distance (per zone)
 - Intensity and congestion (on the road network)
- ◆ **Provides input for:**
 - Land use model: accessibility for allocation of businesses, residents and other activities
 - Economic model: transport costs for businesses, households and freight



From classic 4-stage to dynamic

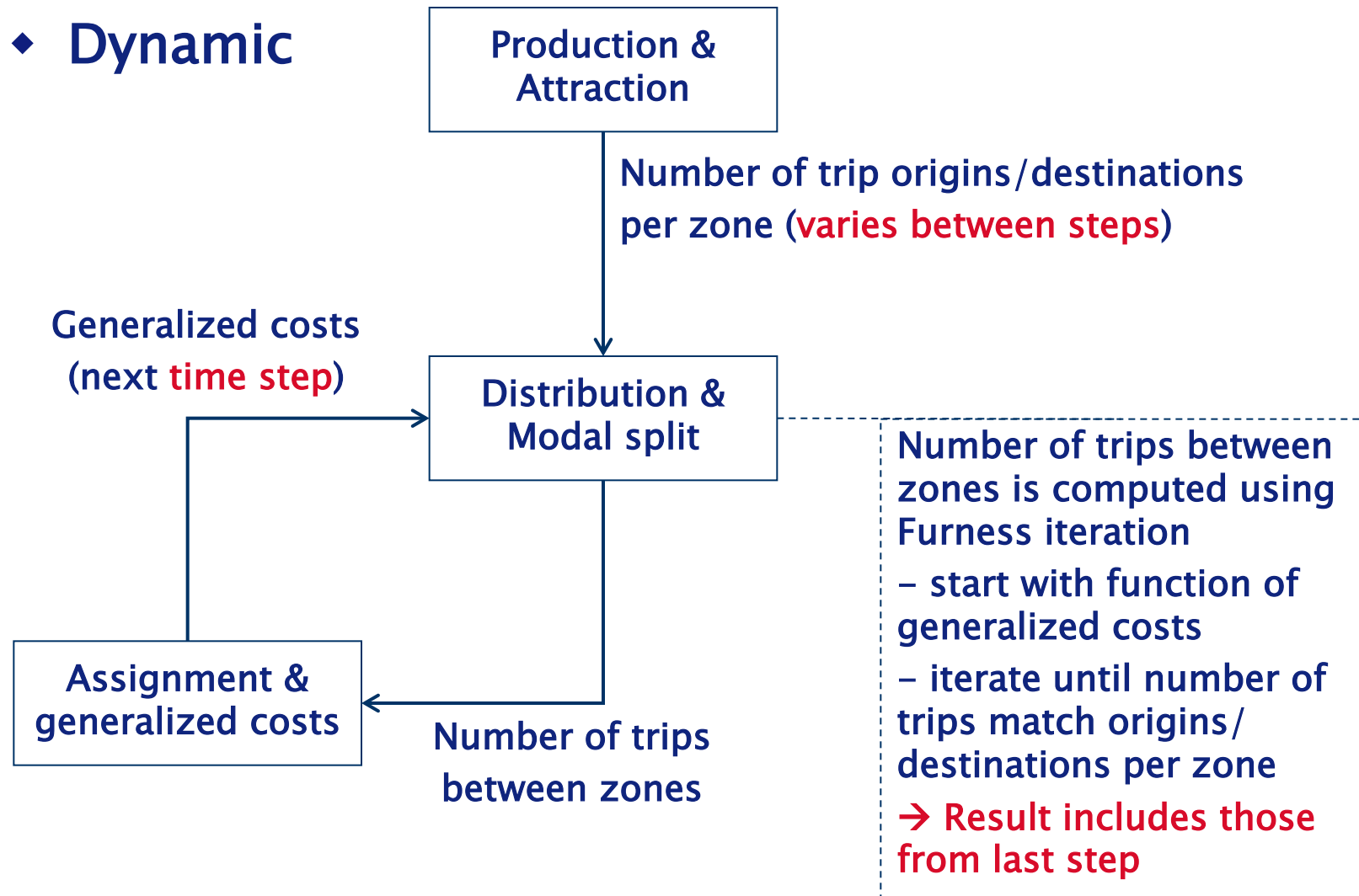
◆ Equilibrium





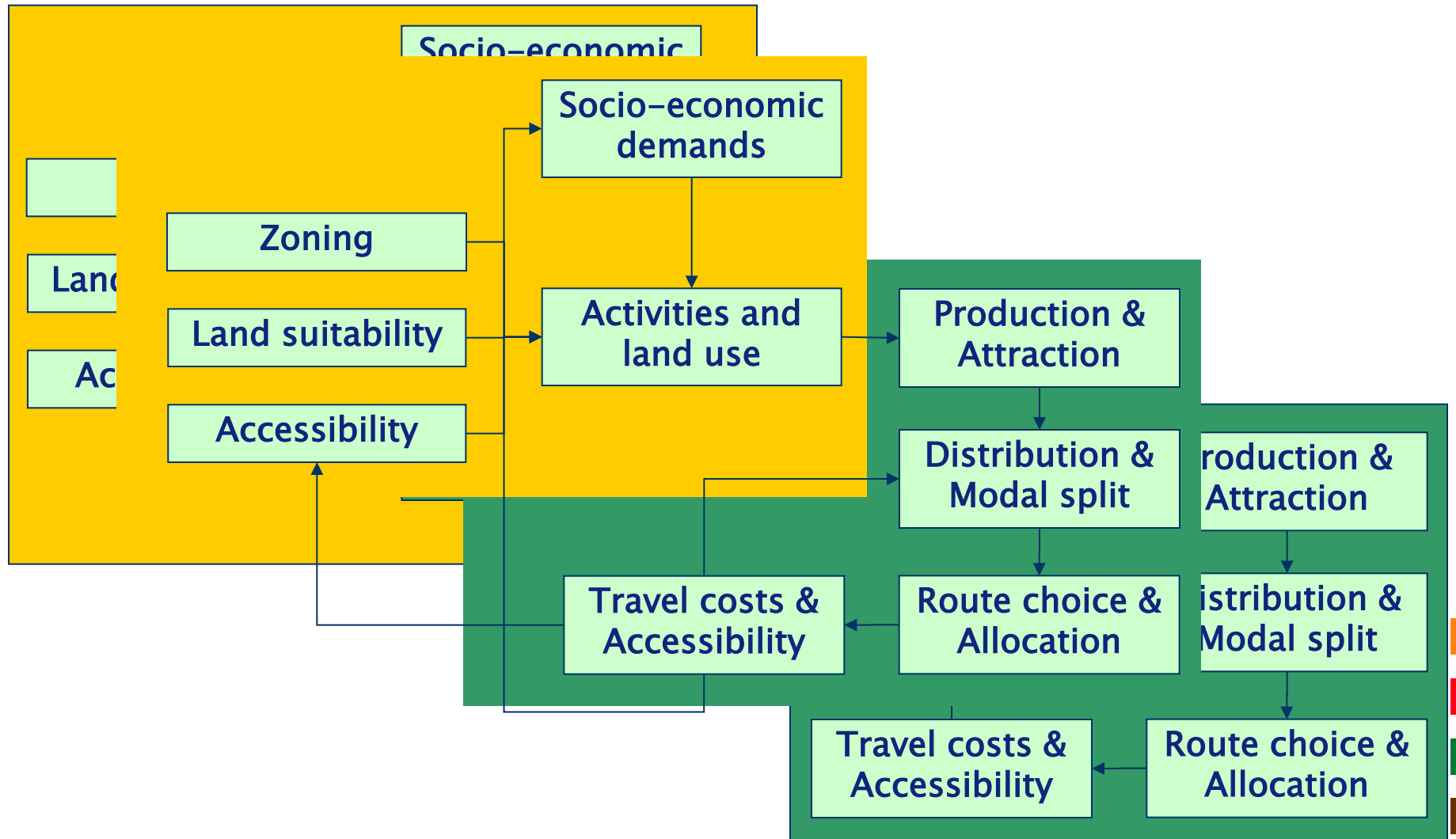
From classic 4-stage to dynamic

◆ Dynamic





Integration land use and transport



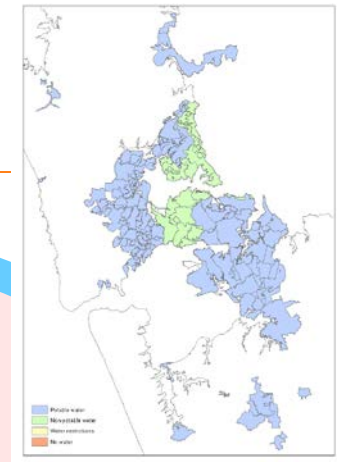


Measuring the Economic Resilience of Infrastructure Tool (MERIT)

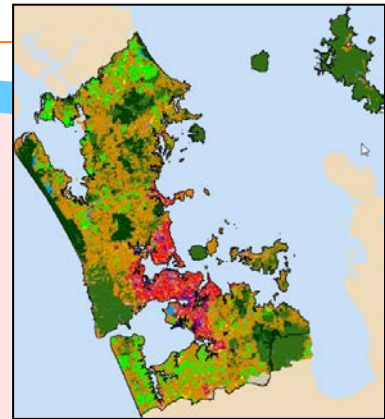
- ◆ Dynamic economic model (CGE) assessing economic impacts of infrastructure outages
 - Economic interdependencies, cascading effects, feedbacks and lags
 - Business resilience adaptations and response options
- ◆ *Resolution:* multi-regional (all regions), temporal (daily time-steps, 20yr horizon),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



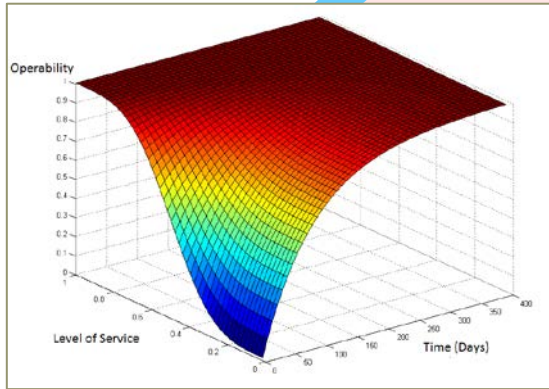
How is MERIT applied?



Infrastructure Outage Maps

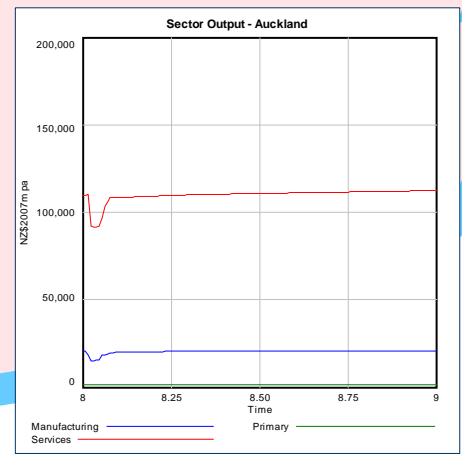


Directly Impacted Business

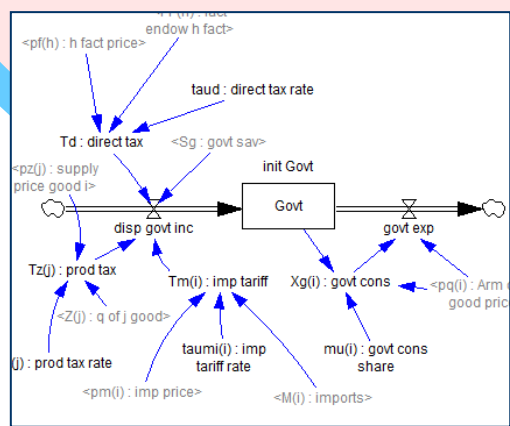


Business Operation Impacts

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

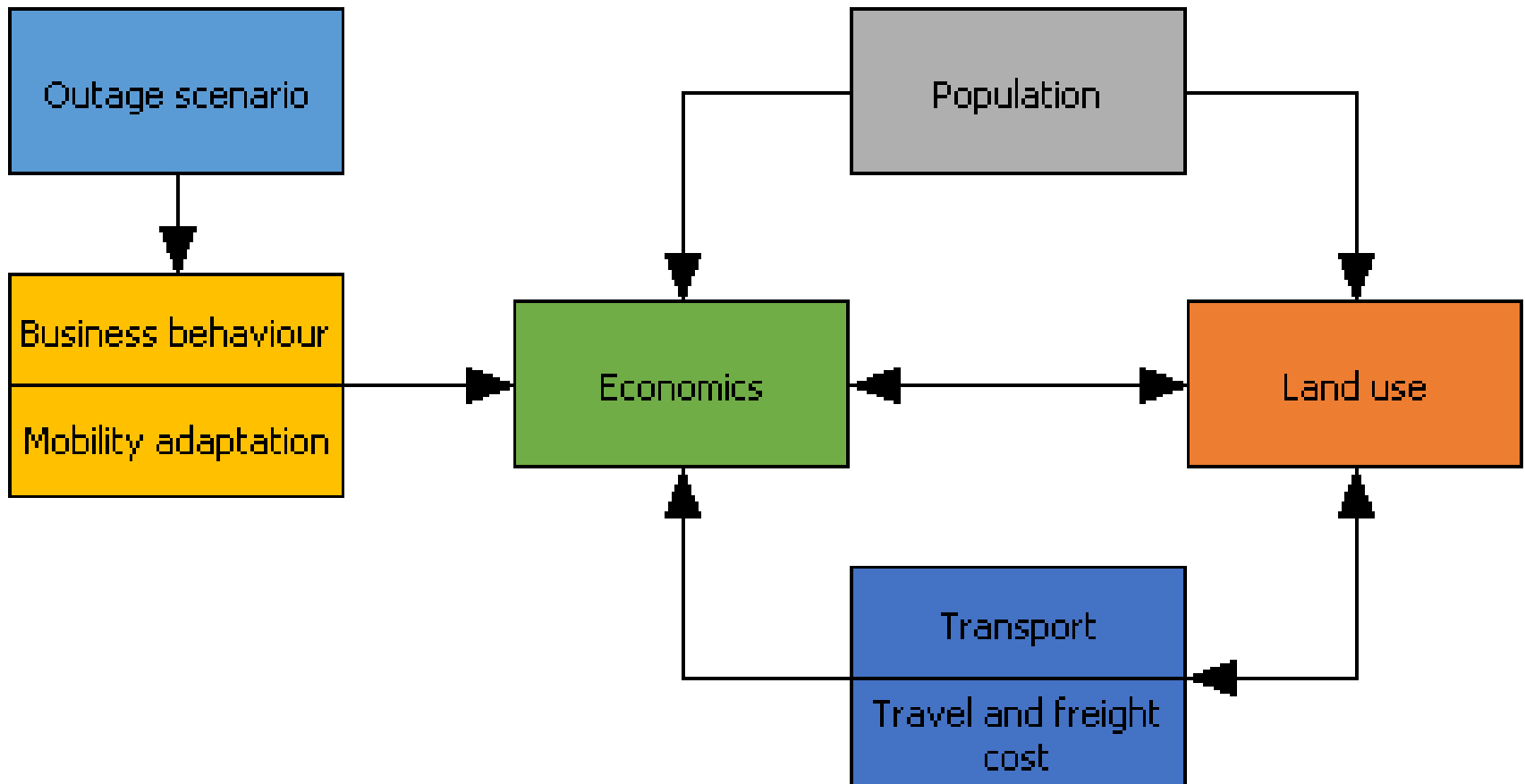
- Watercare Services, Wellington Water

◆ Multi-infrastructure outage events

- Alpine Fault, Auckland Volcanic Eruption, Wellington Resilience Business Case, *Kaikoura Quake*

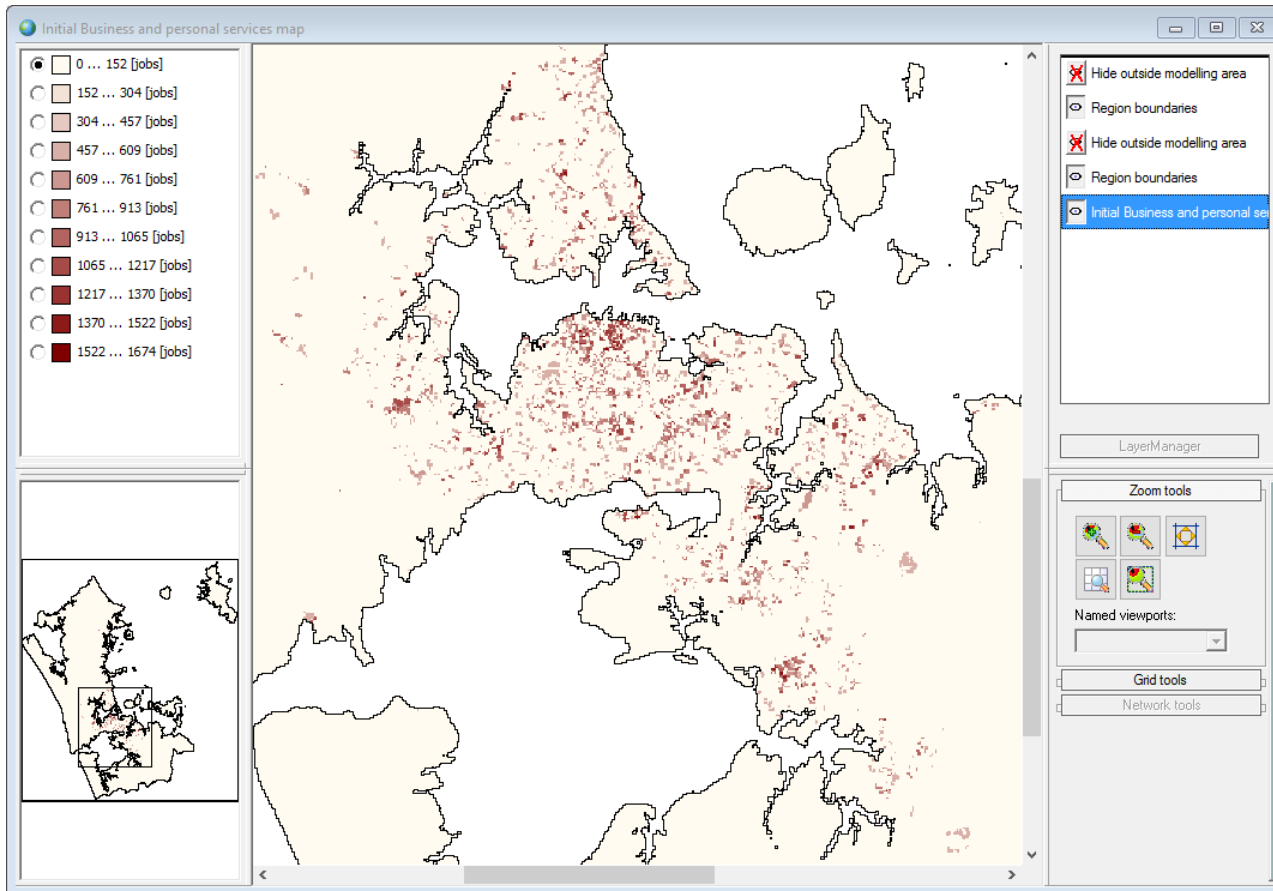


The model in 'shock' mode



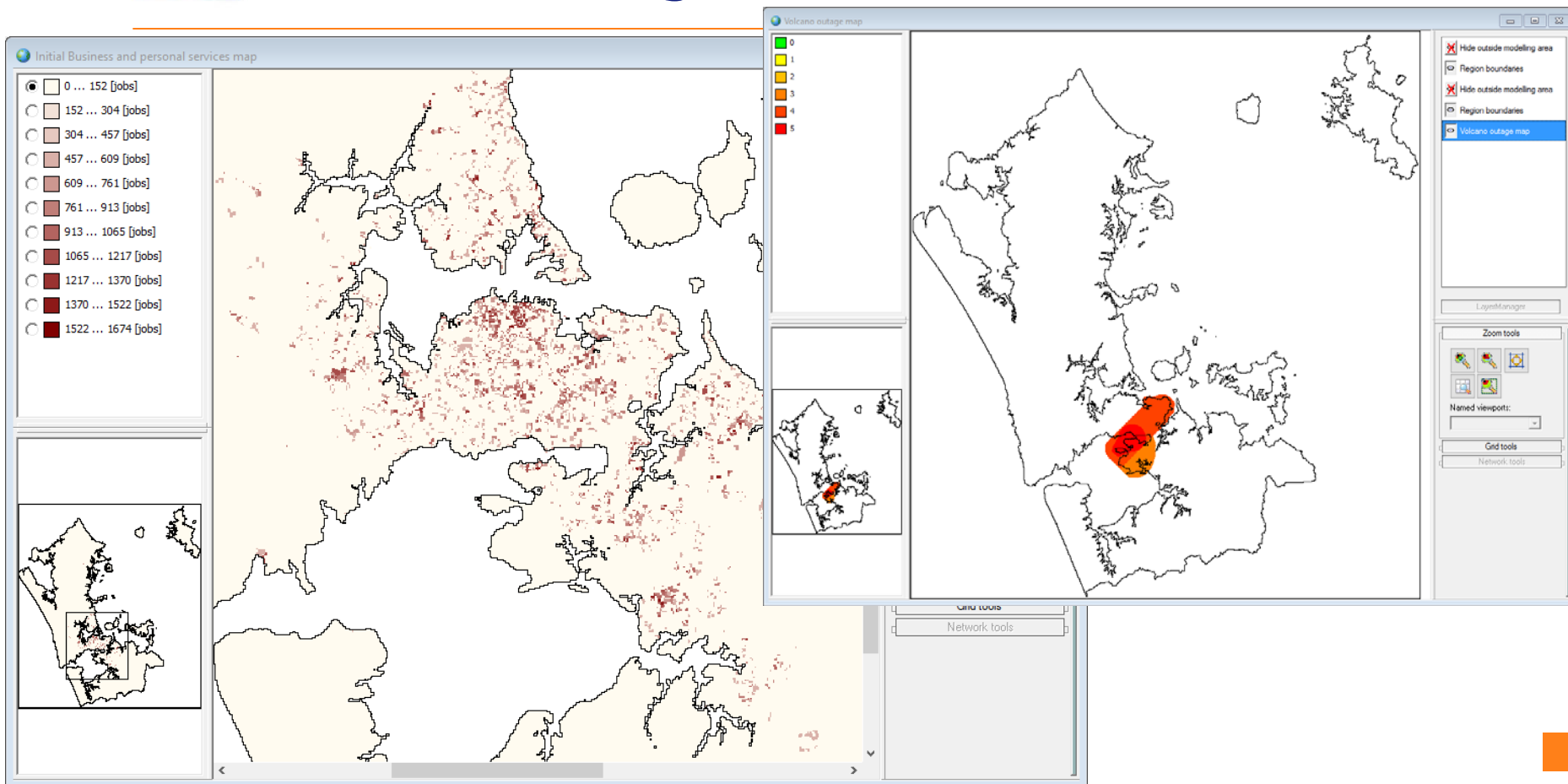


Employment in business and personal services



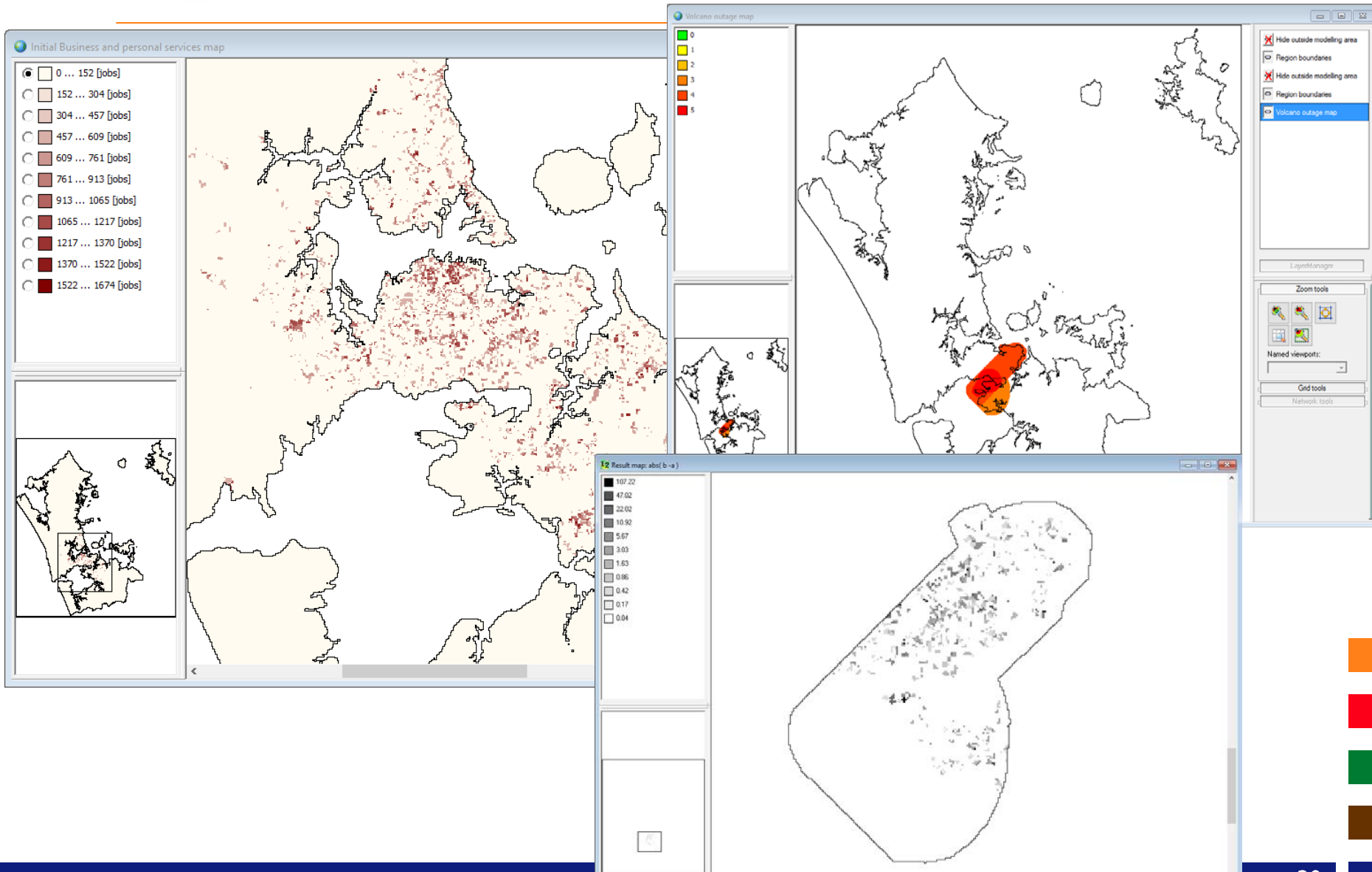


Volcano outage





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