A Spatio-Temporal Decision Support System for Natural Hazard Risk Reduction Policy Assessment and Planning

Holger R. Maier, Graeme A. Riddell, Hedwig van Delden, Jeffrey P. Newman, Aaron C. Zecchin, Roel vanHout, James Daniell, Andreas Schäfer, Graeme C. Dandy, Charles P. Newland

Acknowledgements: Molly O'Callaghan, Evangeline Moore, Philippa Radford, Yasmin Zhar

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RIKS research institute for knowledge systems

risklayer analysing and managing catastrophe risk

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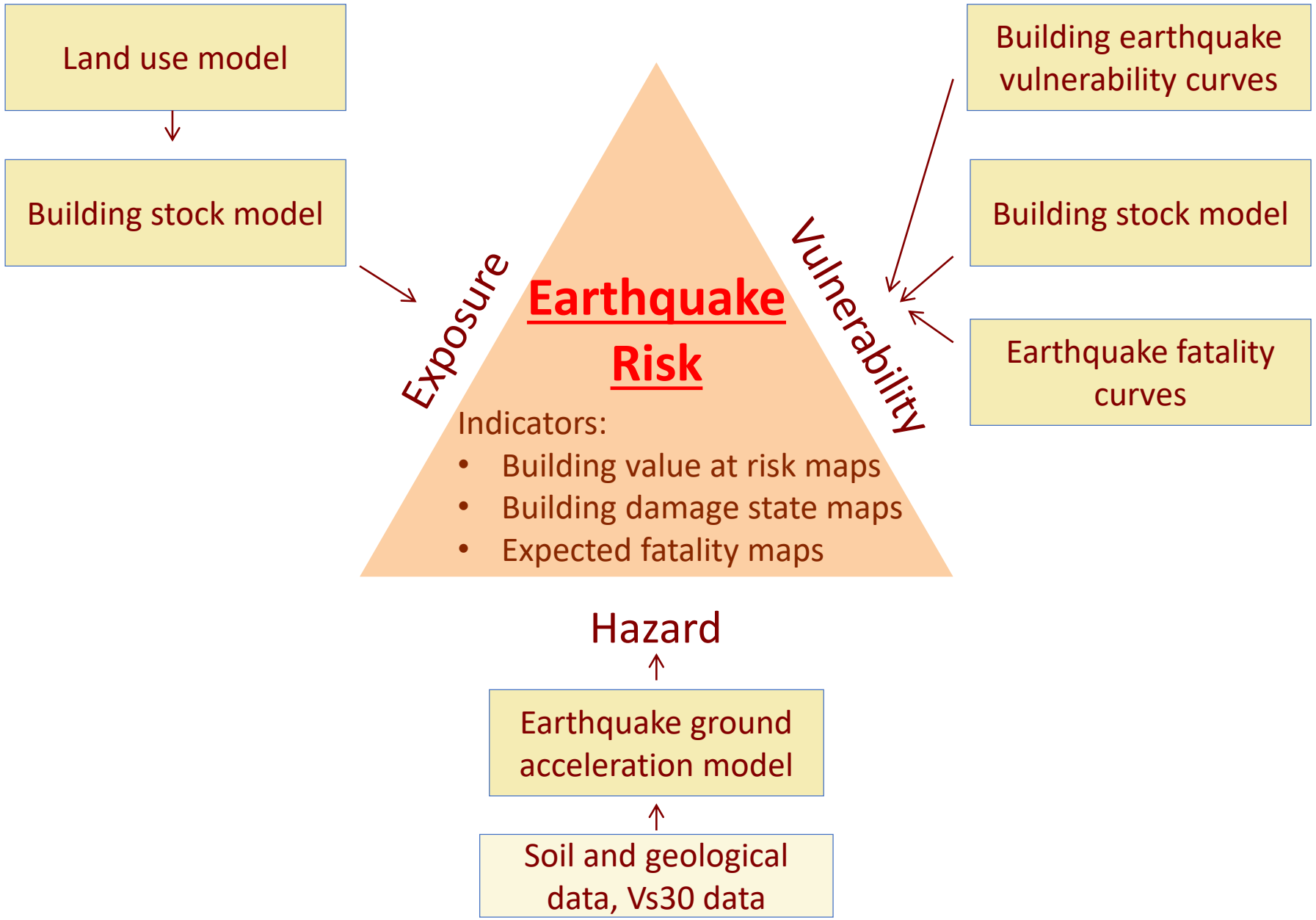
EARTHQUAKE


Land use model
Building stock model
Exposure
Earthquake Risk
Indicators:
• Building value at risk maps
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• Expected fatality maps
Vulnerability
Building earthquake vulnerability curves
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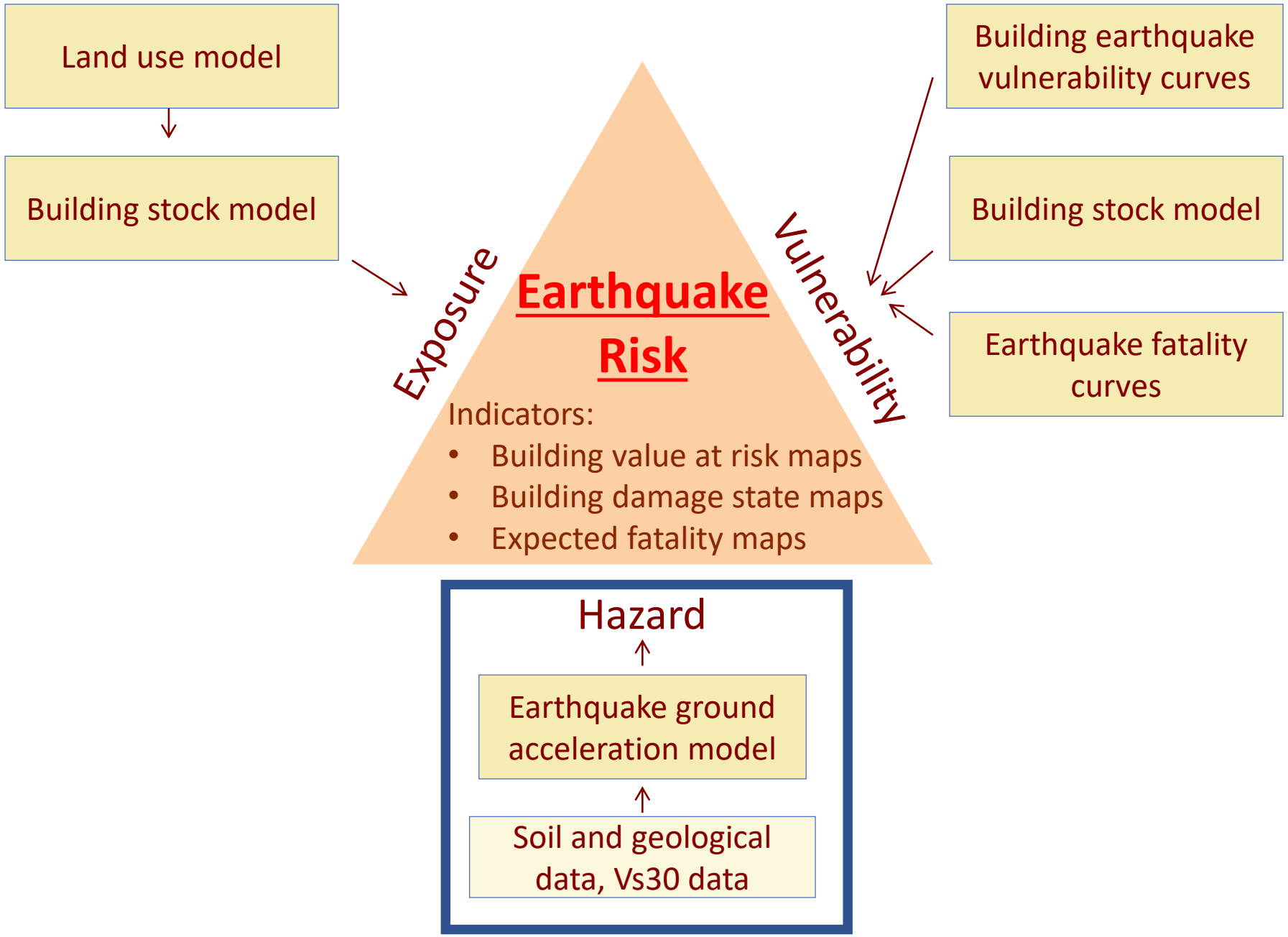
Hazard
Earthquake ground acceleration model
Soil and geological data, Vs30 data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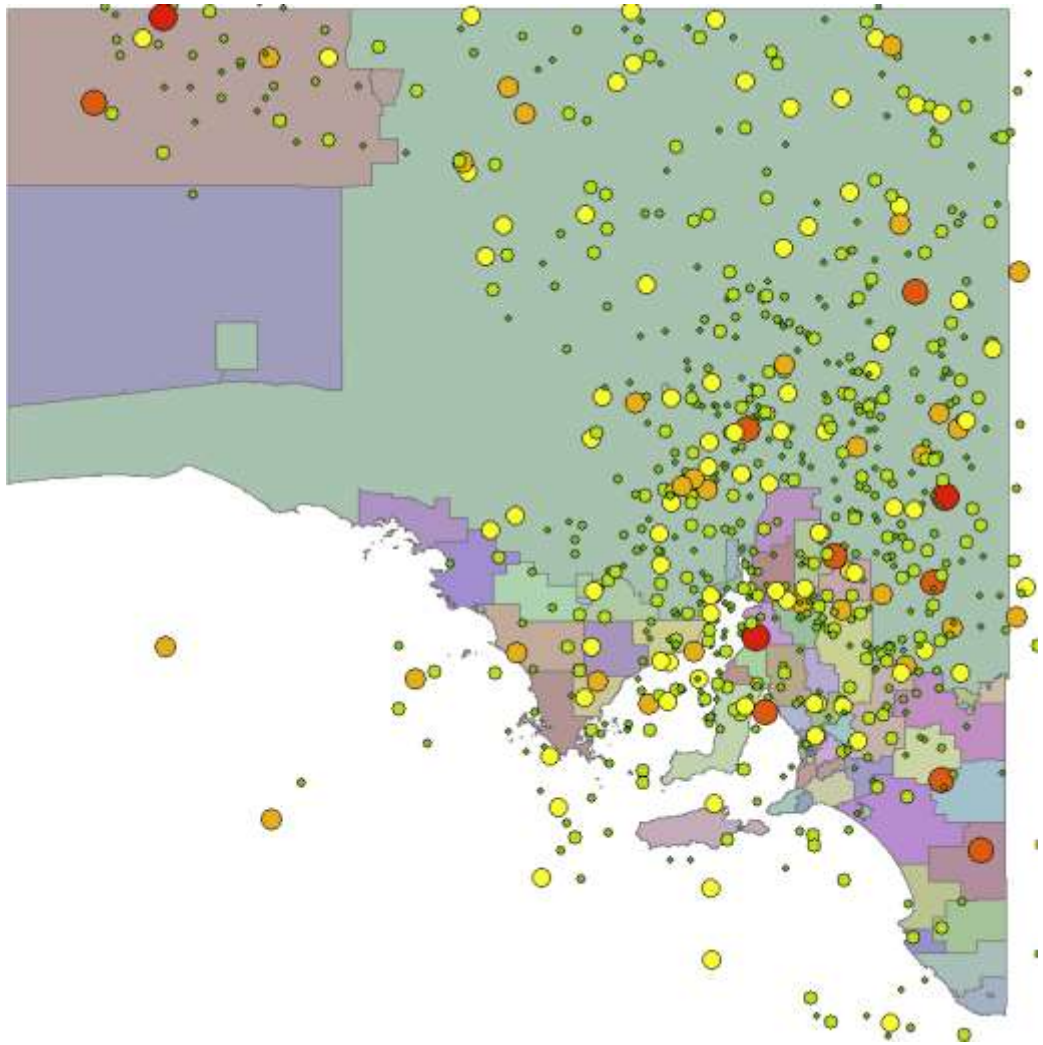
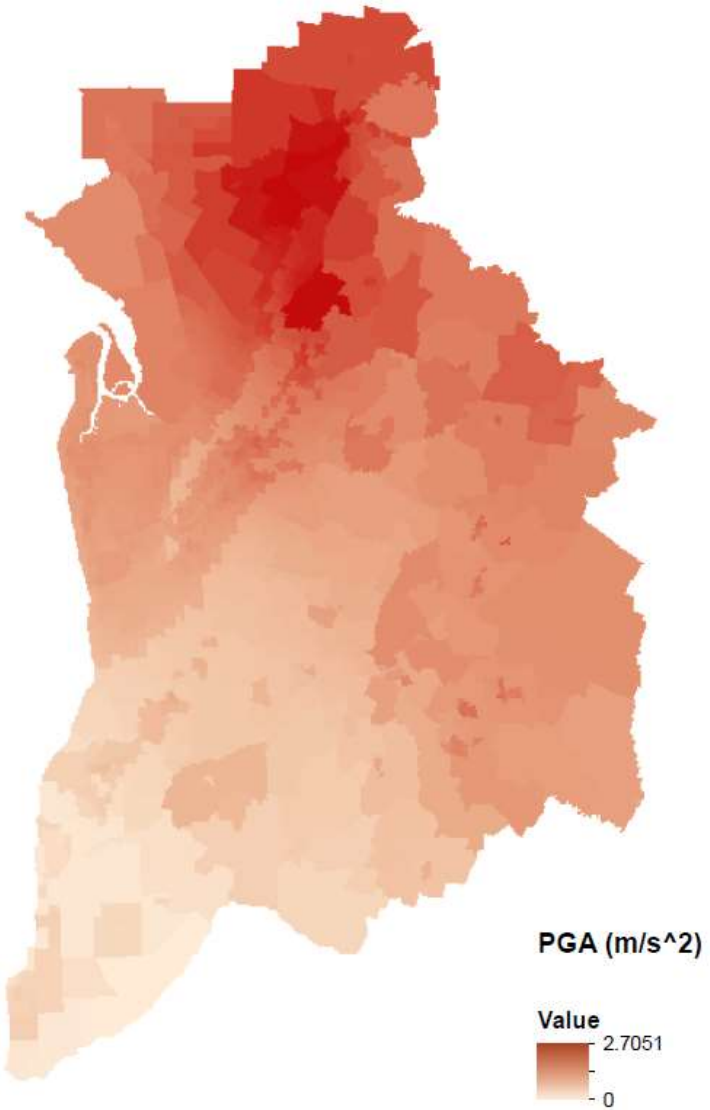
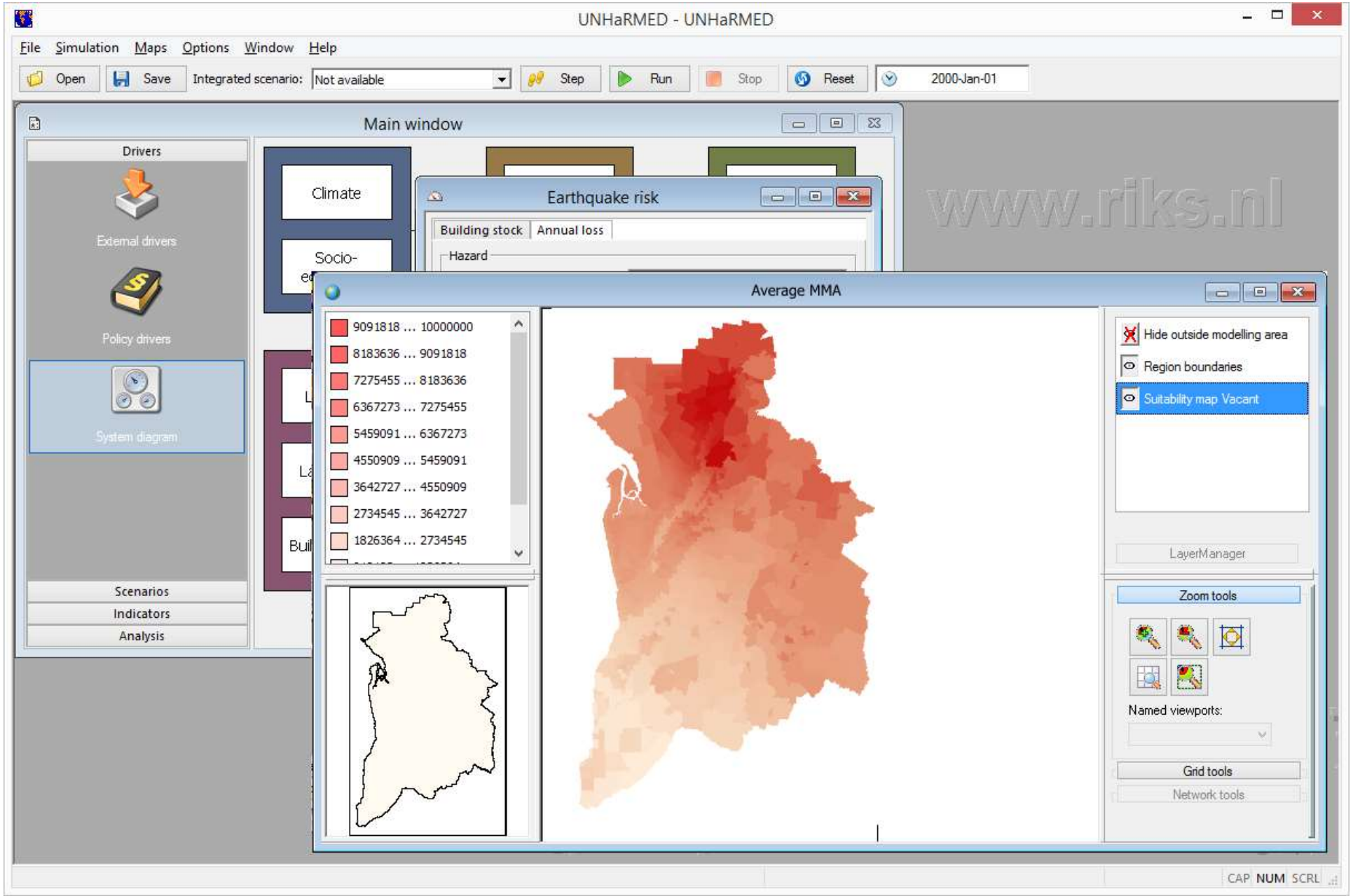
Stochastically Generated Earthquakes



Average PGA

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Main window
Drivers
External drivers
Policy drivers
System diagram
Scenarios
Indicators
Analysis
Climate
Socio-
Earthquake risk
Building stock
Annual loss
Hazard
www.riks.nl
Average MMA
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8183636 ... 9091818
7275455 ... 8183636
6367273 ... 7275455
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1826364 ... 2734545
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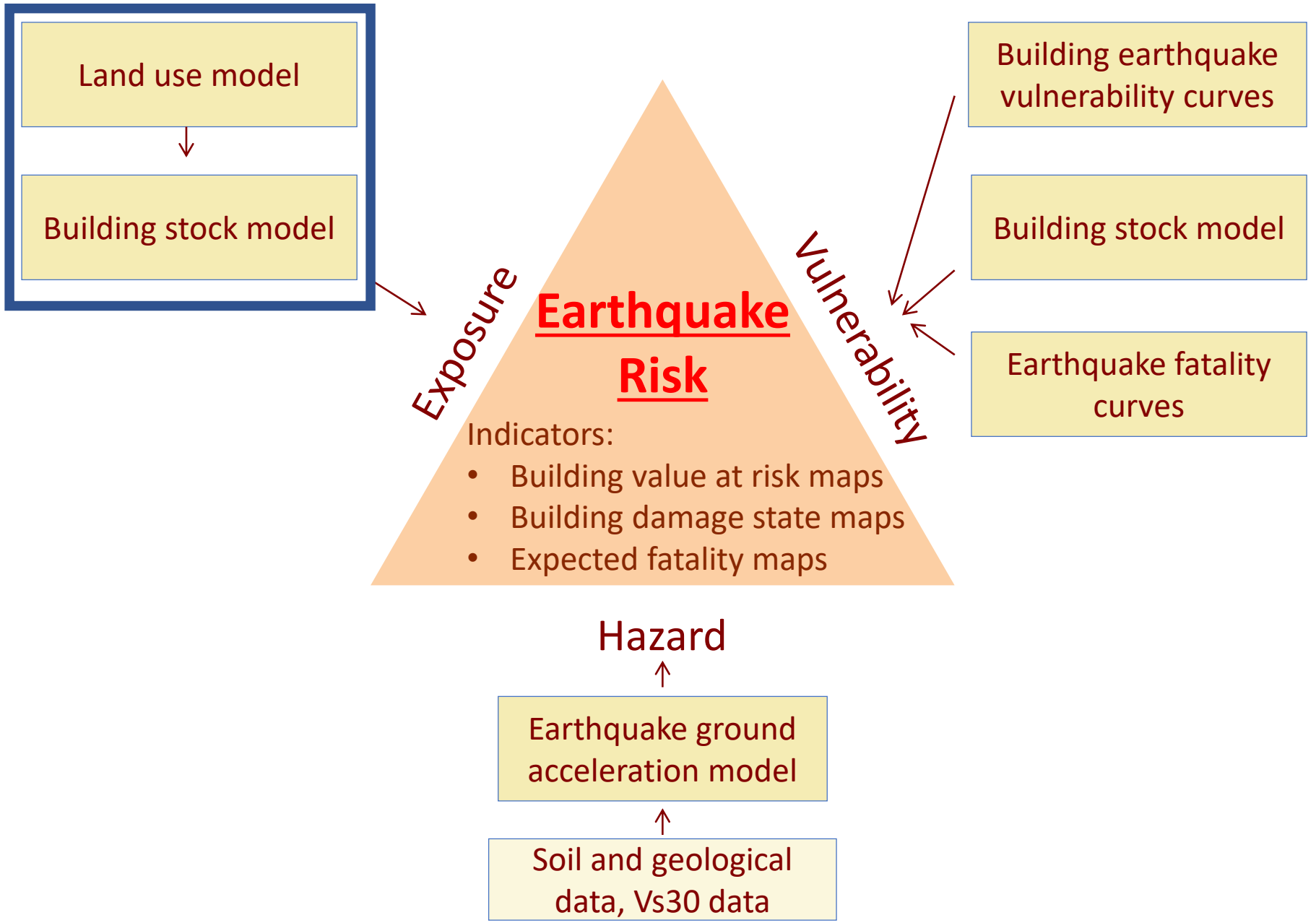
Region boundaries
Suitability map Vacant
LayerManager
Zoom tools
Named viewports:
Grid tools
Network tools
CAP NUM SCRL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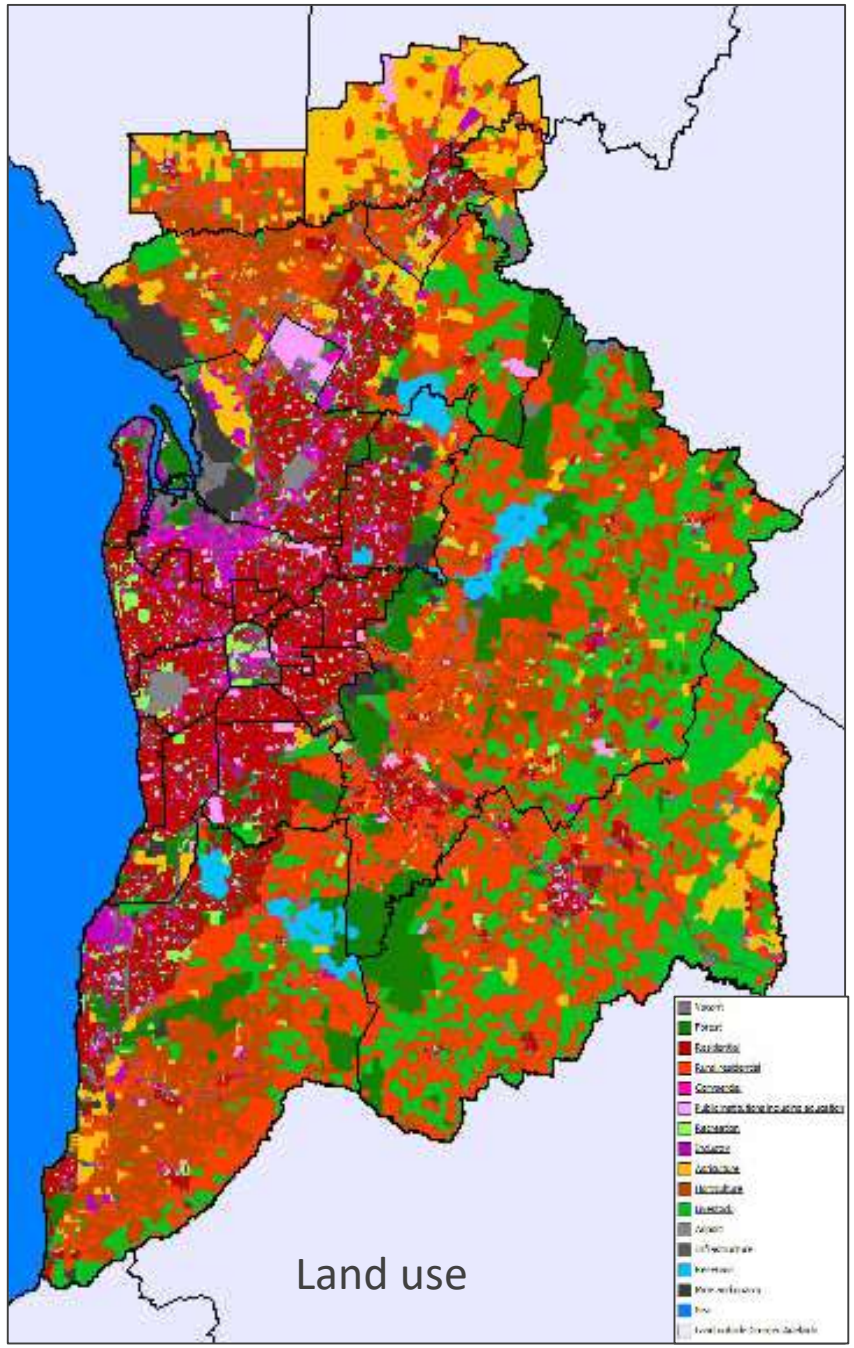
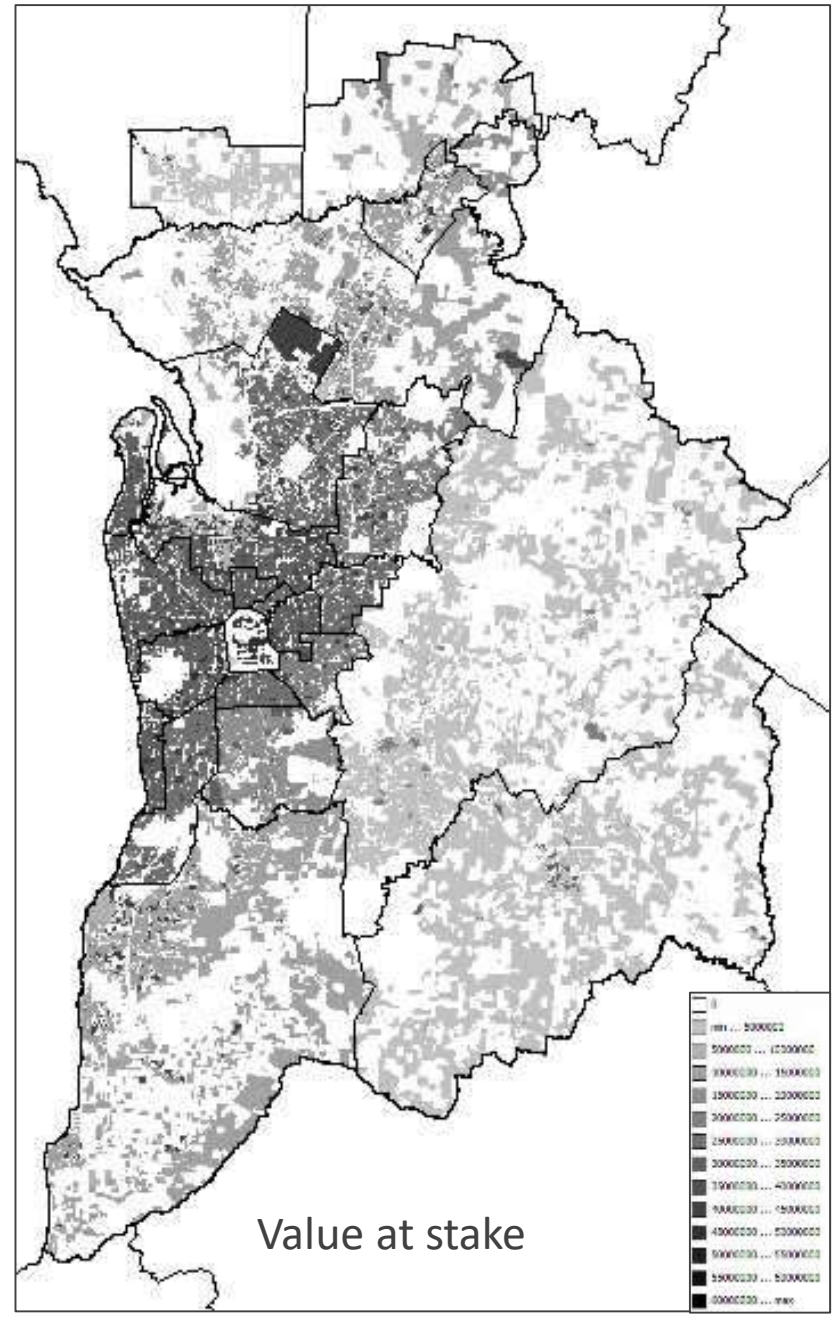
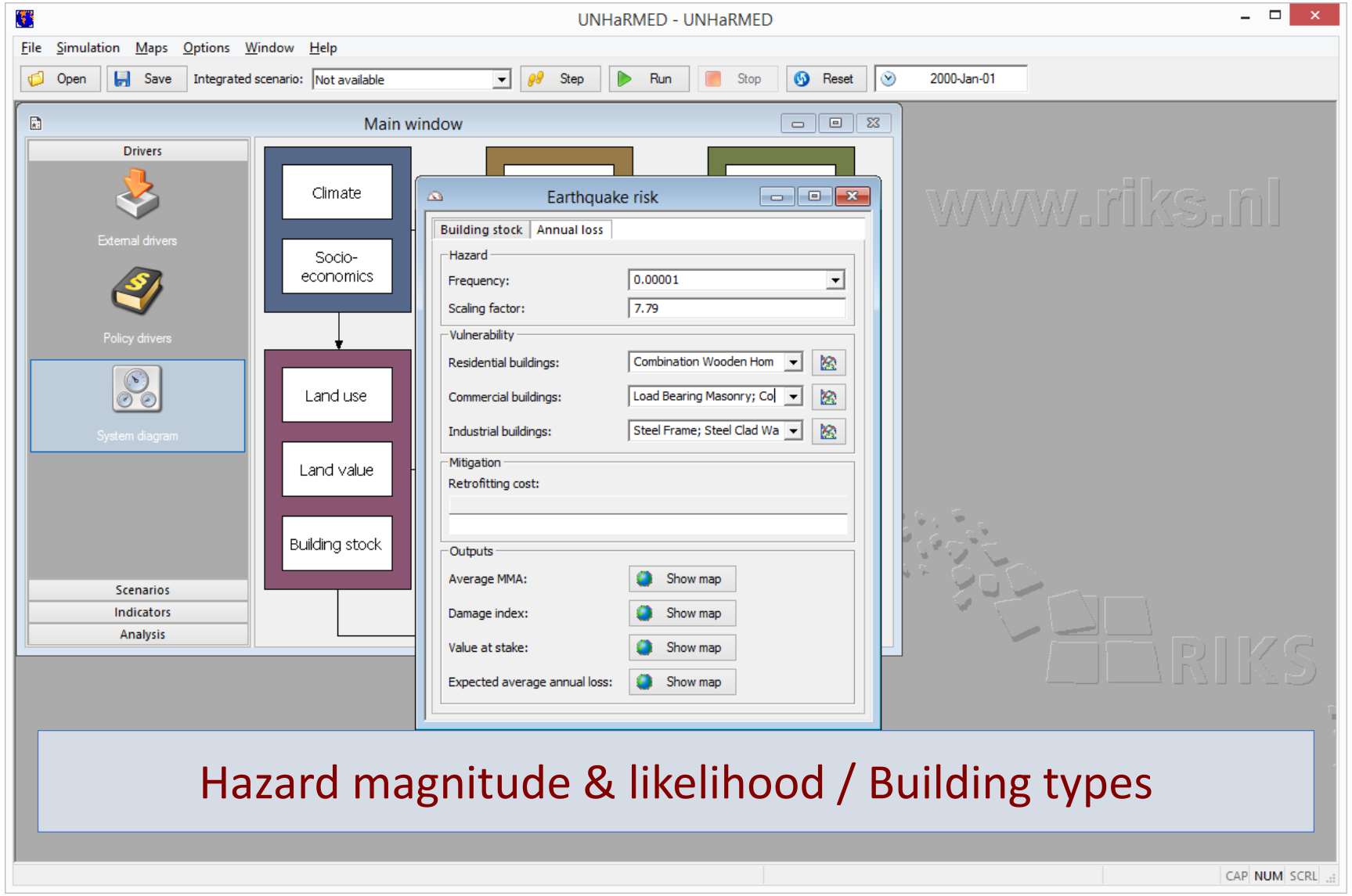
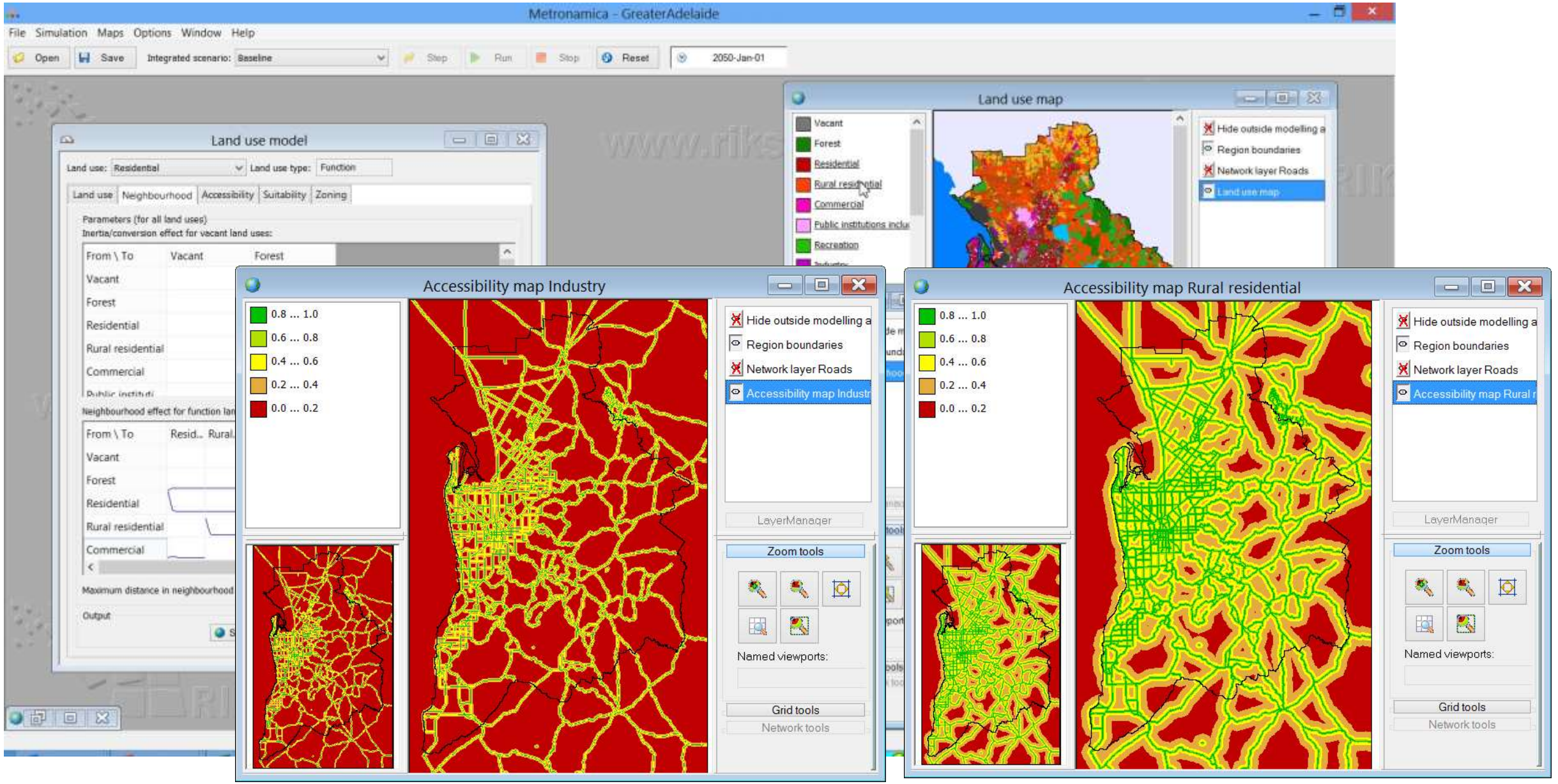

Land use


Value at stake

Modeller interface Earthquake



Land use model



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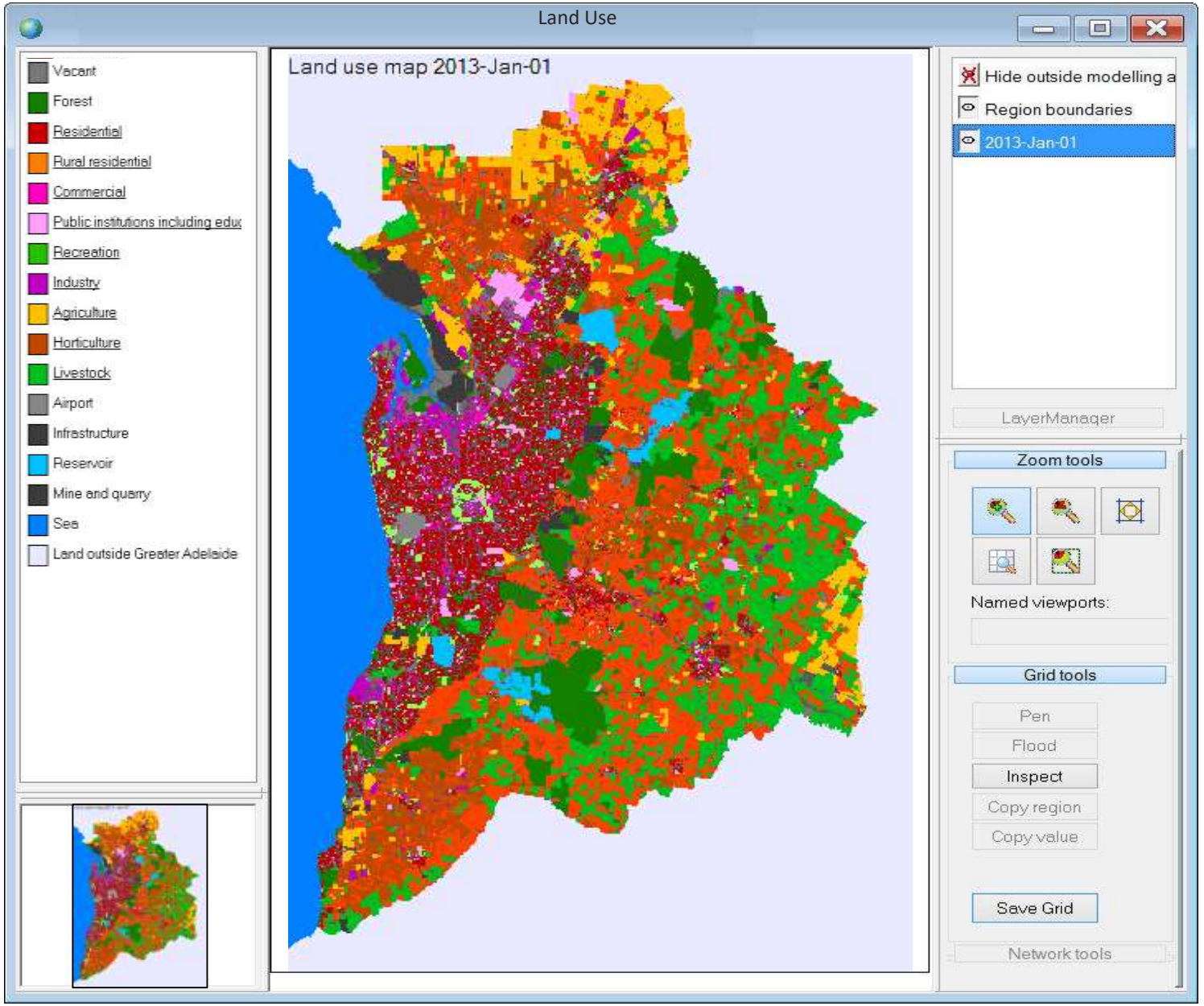
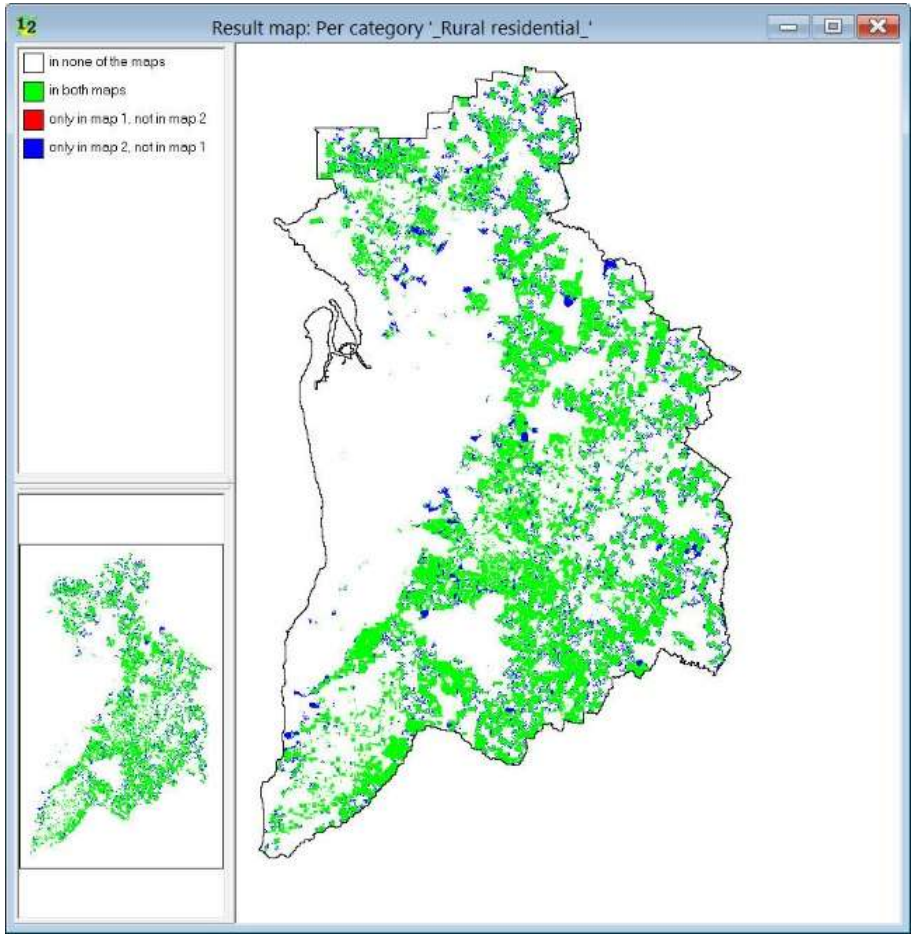


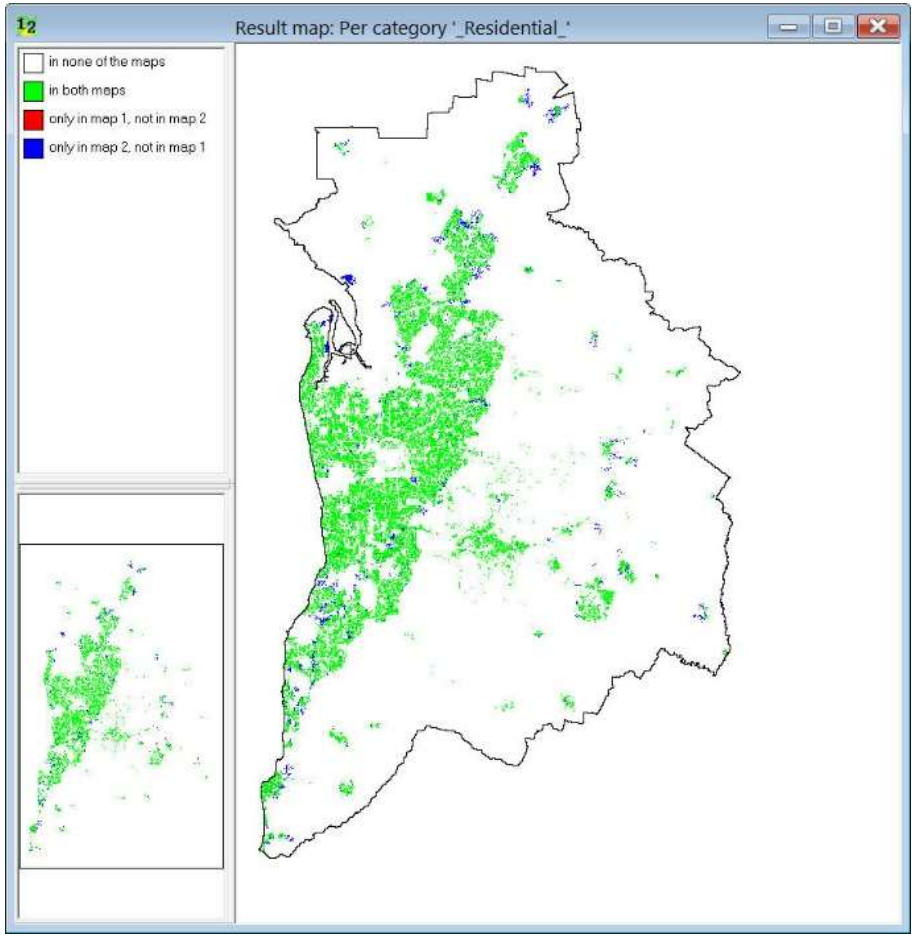
Dynamically changing land use (on an annual time step) under a particular socio-economic scenario – see video

Corresponding changes in building stock / values at stake (not shown here)

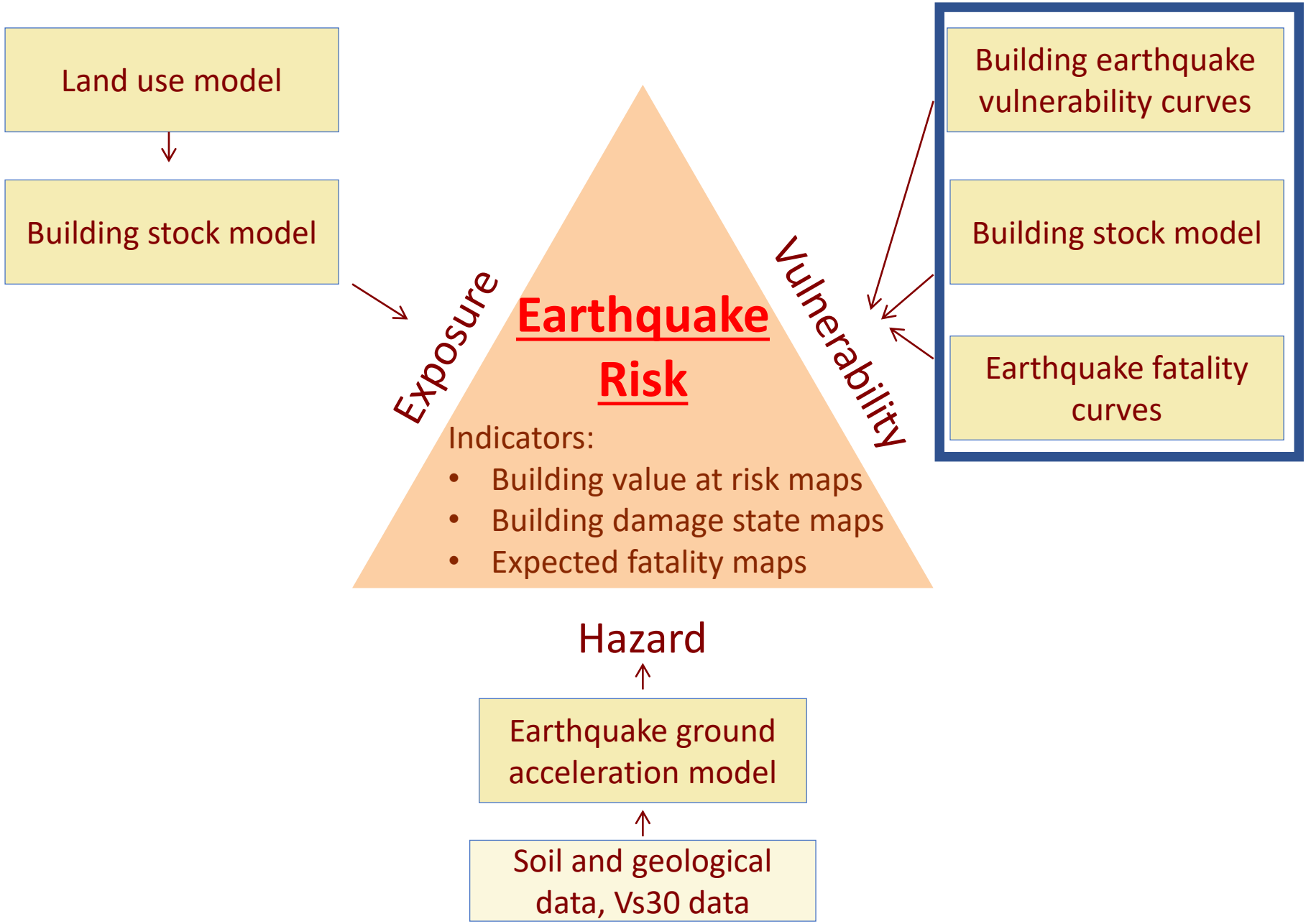
Land use model



Change Map – Rural Residential



Change Map – Residential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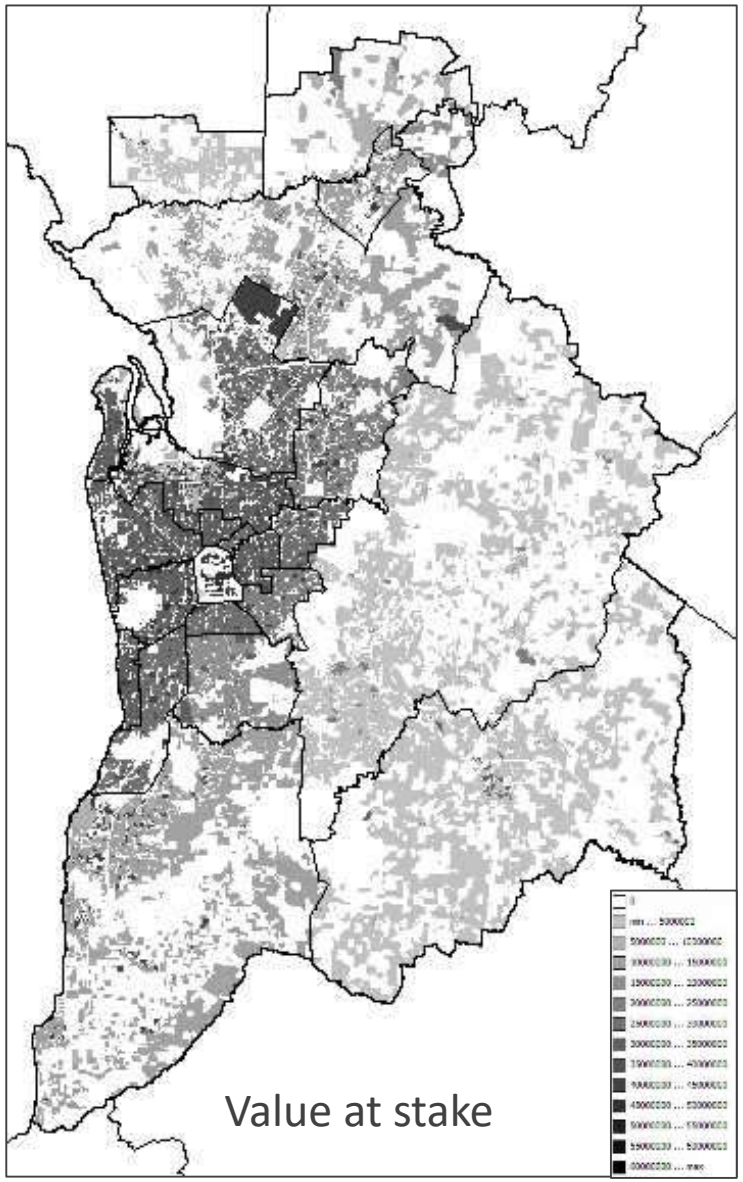
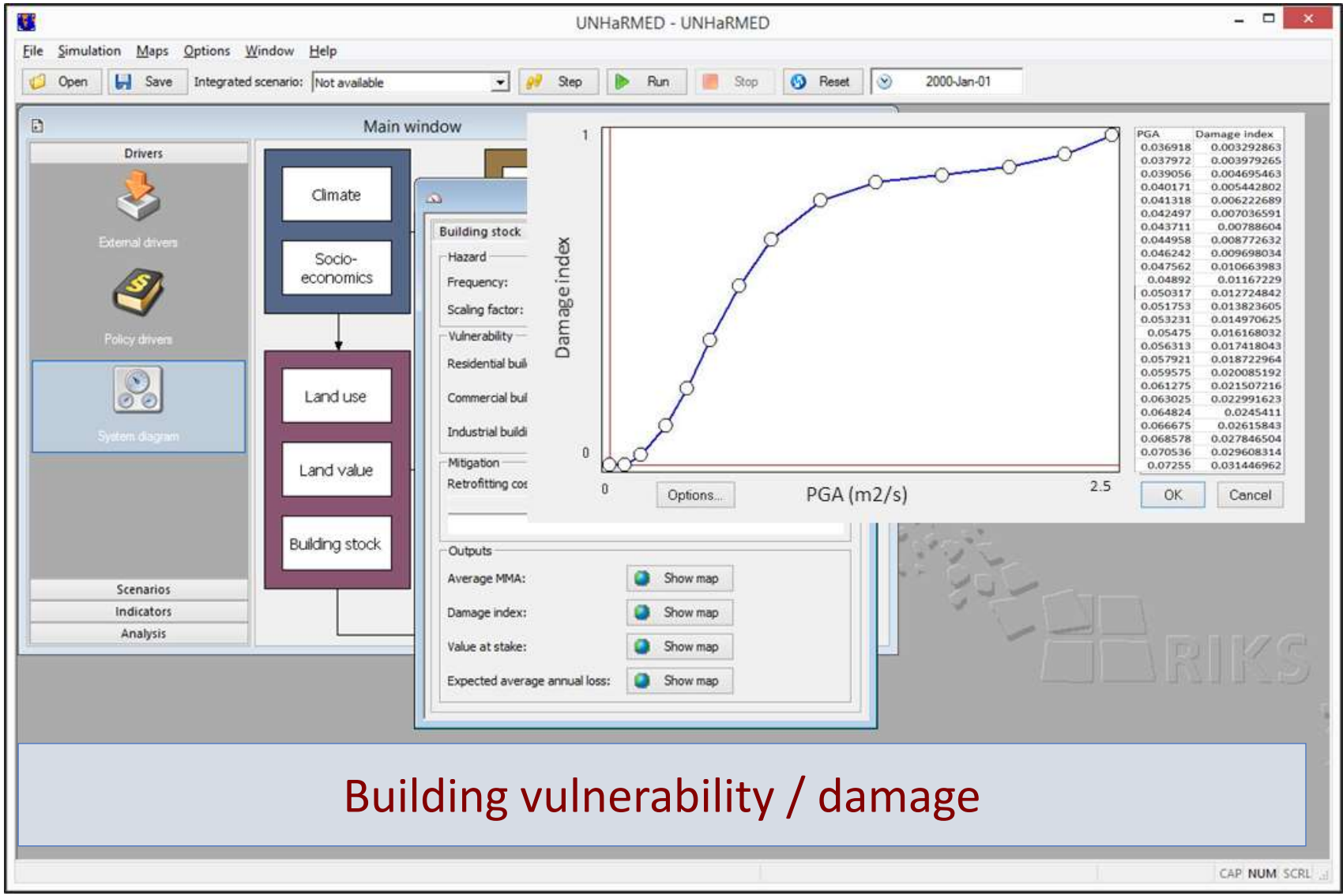
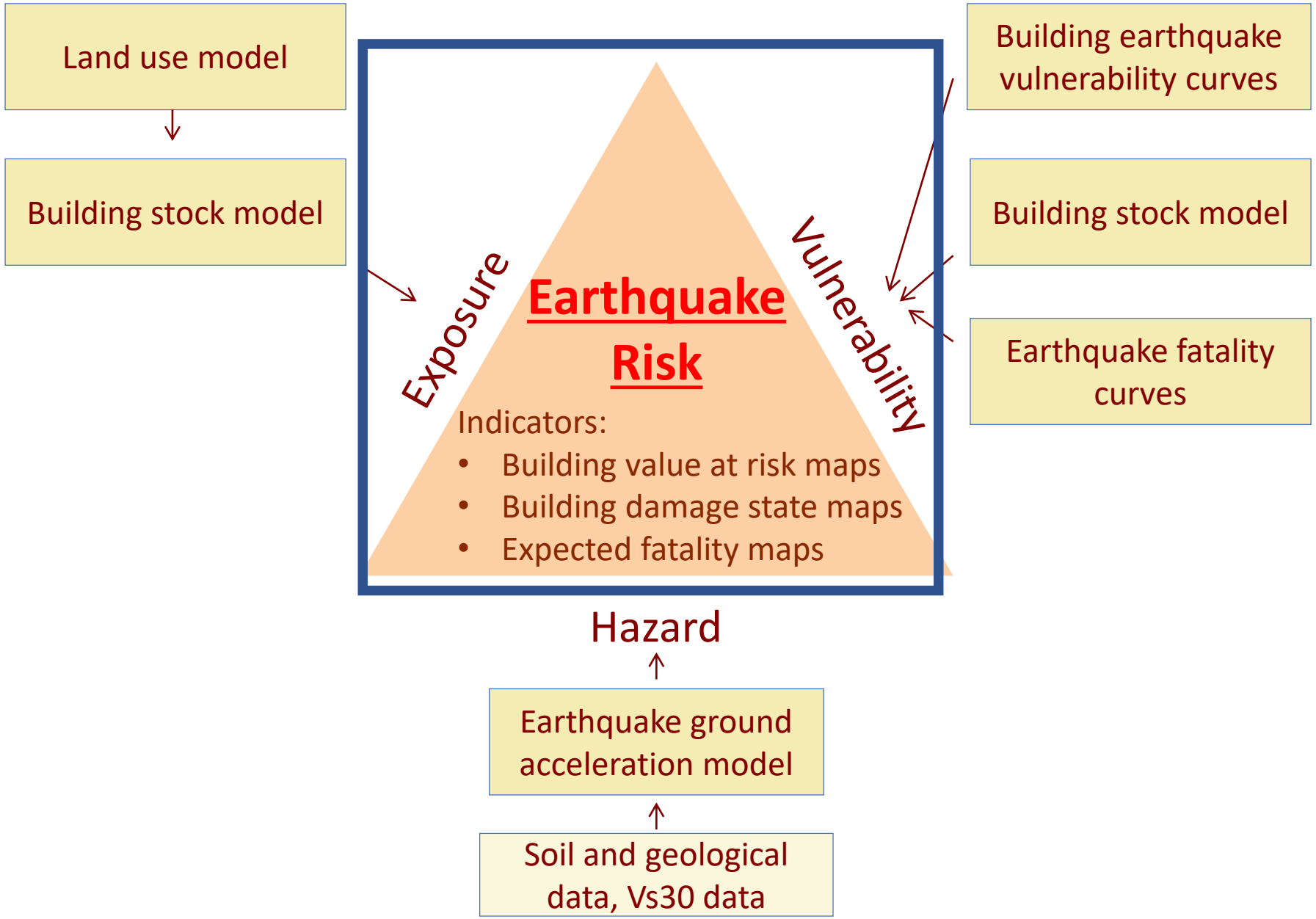
Modeller interface Earthquake





Building vulnerability / damage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For each 100m x 100 grid cell:

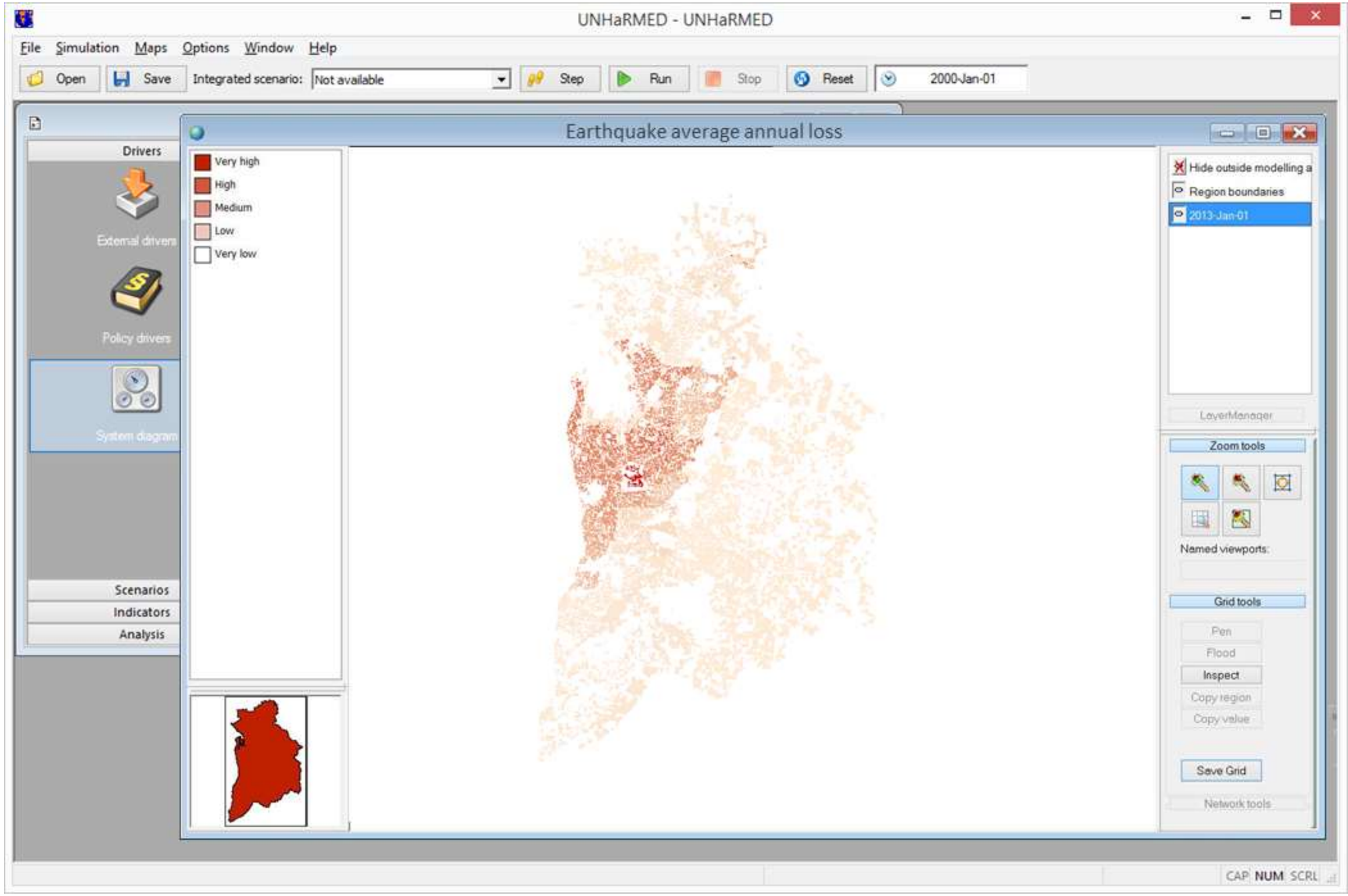
1. Take ground acceleration for 1 stochastic EQ event
2. Look at building type in grid cell and corresponding vulnerability / fragility curve
3. Calculate damage and corresponding annual loss
4. Repeat 2 and 3 for all other stochastic EQ events
5. Average annual loss in cell over all stochastic EQ events

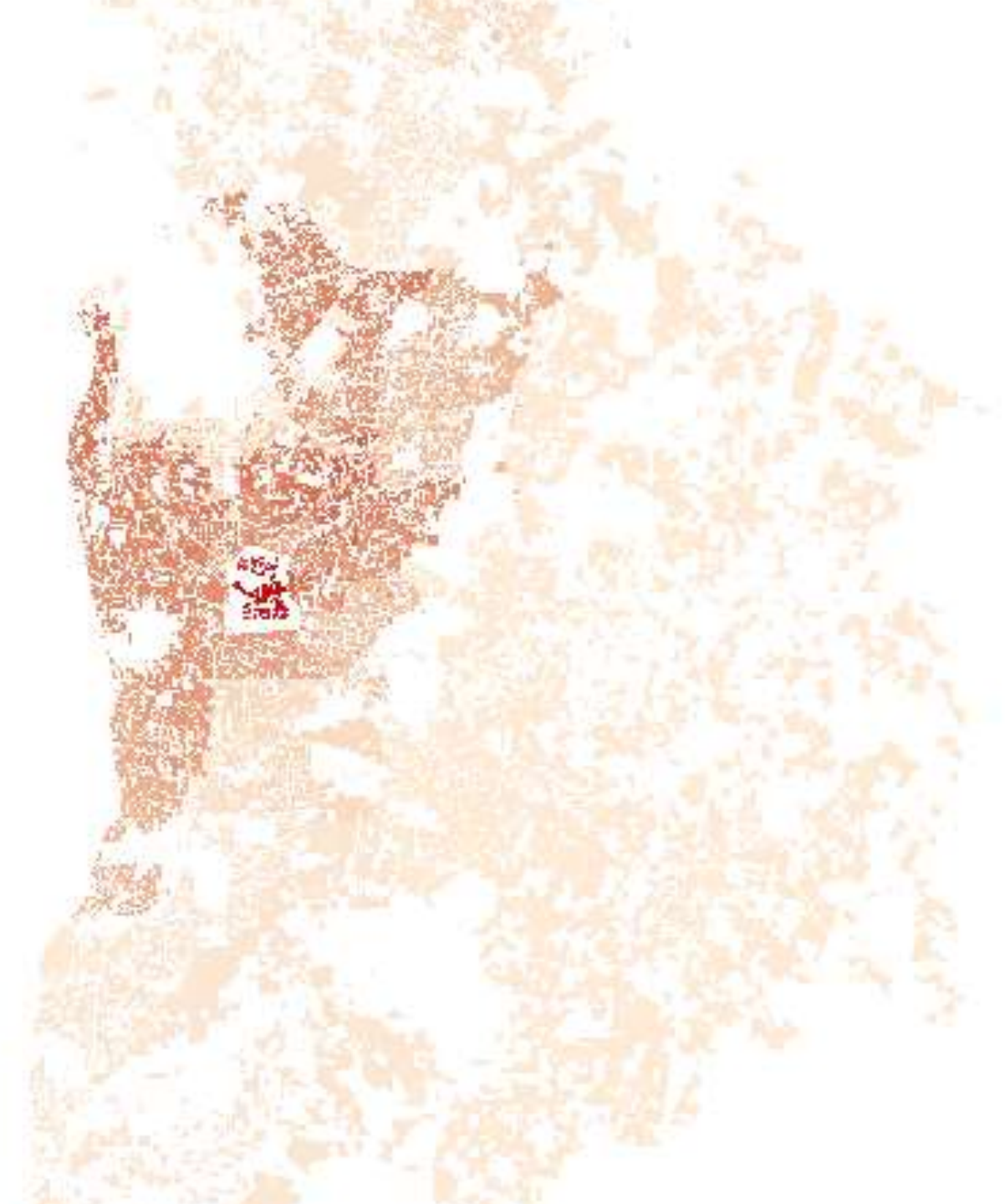
Repeat the above steps for all 100mx100m grid cells

Modeller interface Earthquake

Repeat calculations on previous slide for each year in the simulation, with changes from one year to the next corresponding to:

- Changes in land use obtained from land use model for a particular socio-demographic and economic scenario and land use planning regime
- Changes in building stock and value corresponding to changes in land use from land use model and natural renewal rate
- Changes in building stock vulnerability curves due to building hardening etc.





Expected average annual
loss from earthquakes
2013-2050

Dynamically changing earthquake risk under a particular scenario (video):

- Population
- Socio-economic
- Land use planning
- Building hardening and renewal

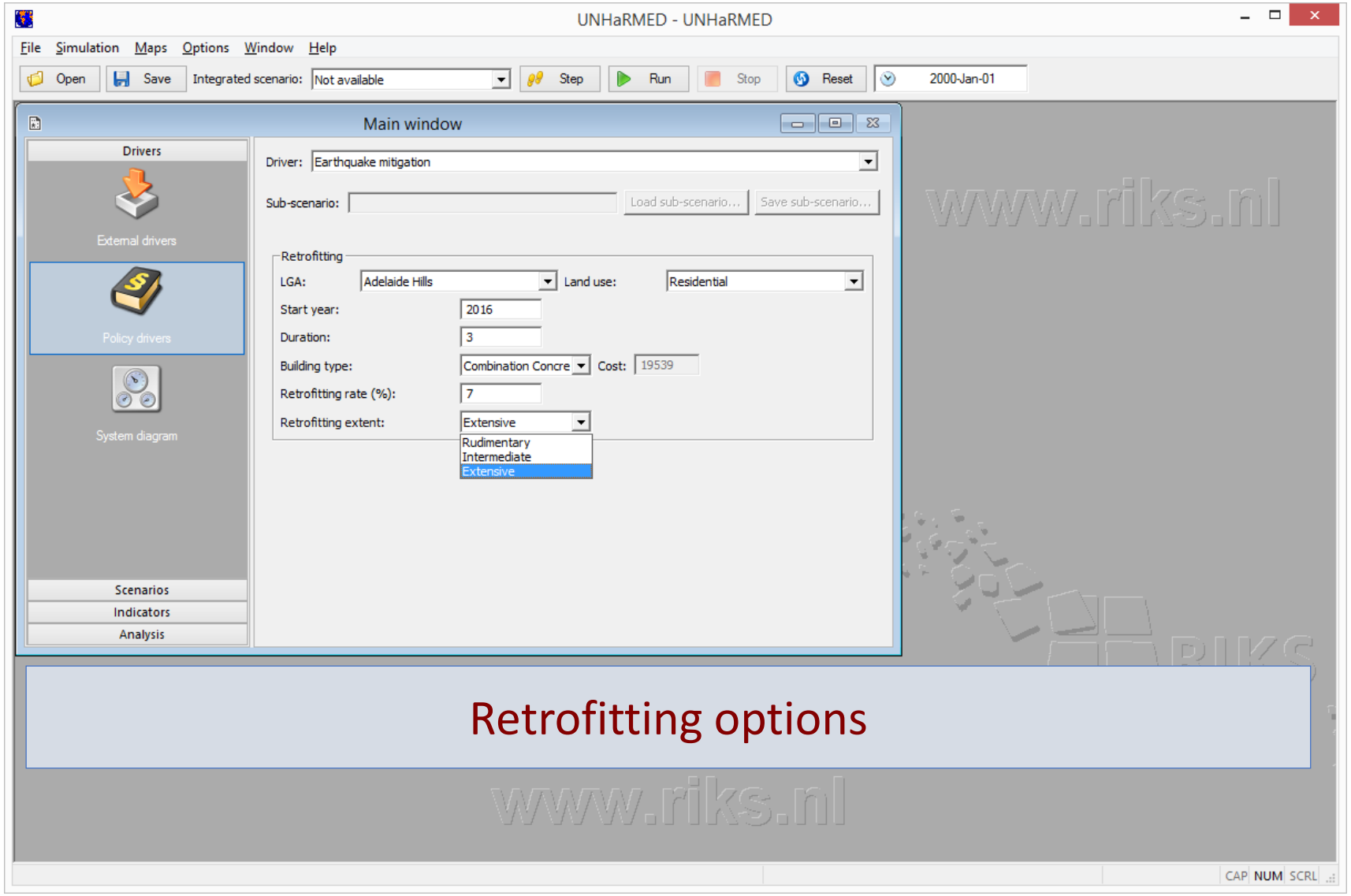
Mitigation options Earthquake

- **Hazard**
- -

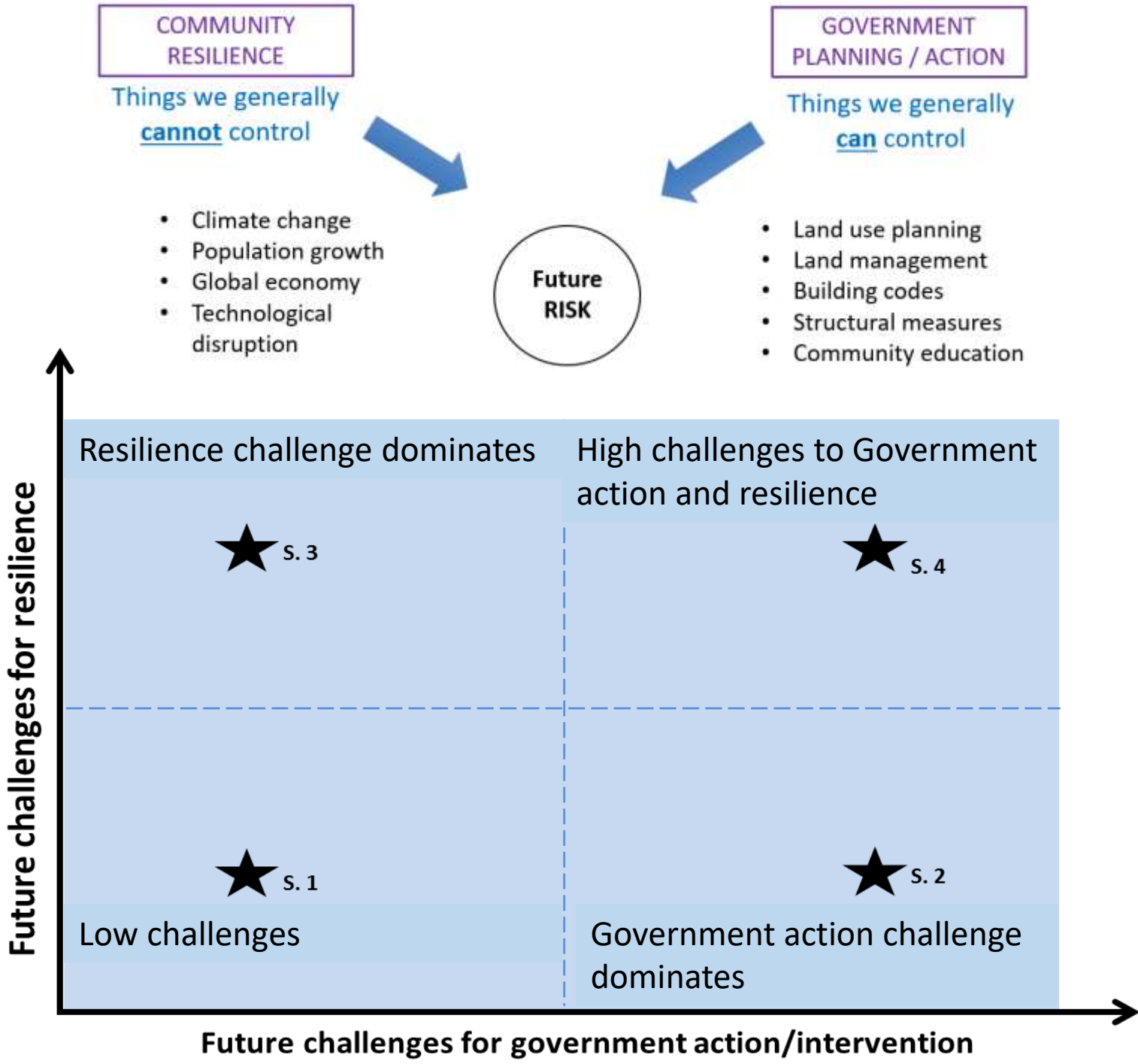
- **Vulnerability**
- **Retrofitting building types**
- **Changes to the building stock mix**

- **Exposure**
- **Land use planning**

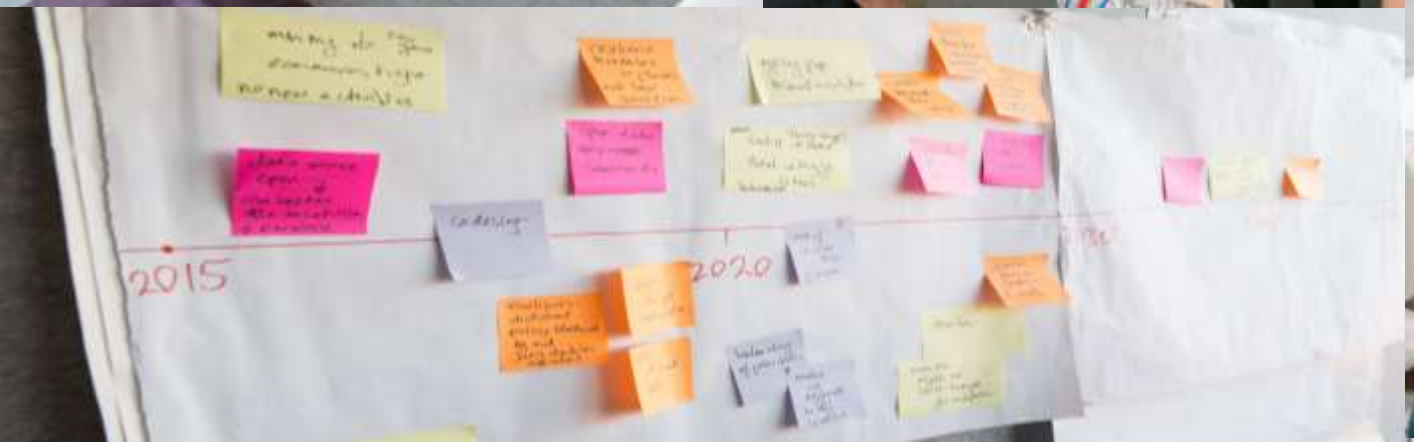
Policy interface Earthquake



PLAUSBLE FUTURES – EXPLORATORY SCENARIOS

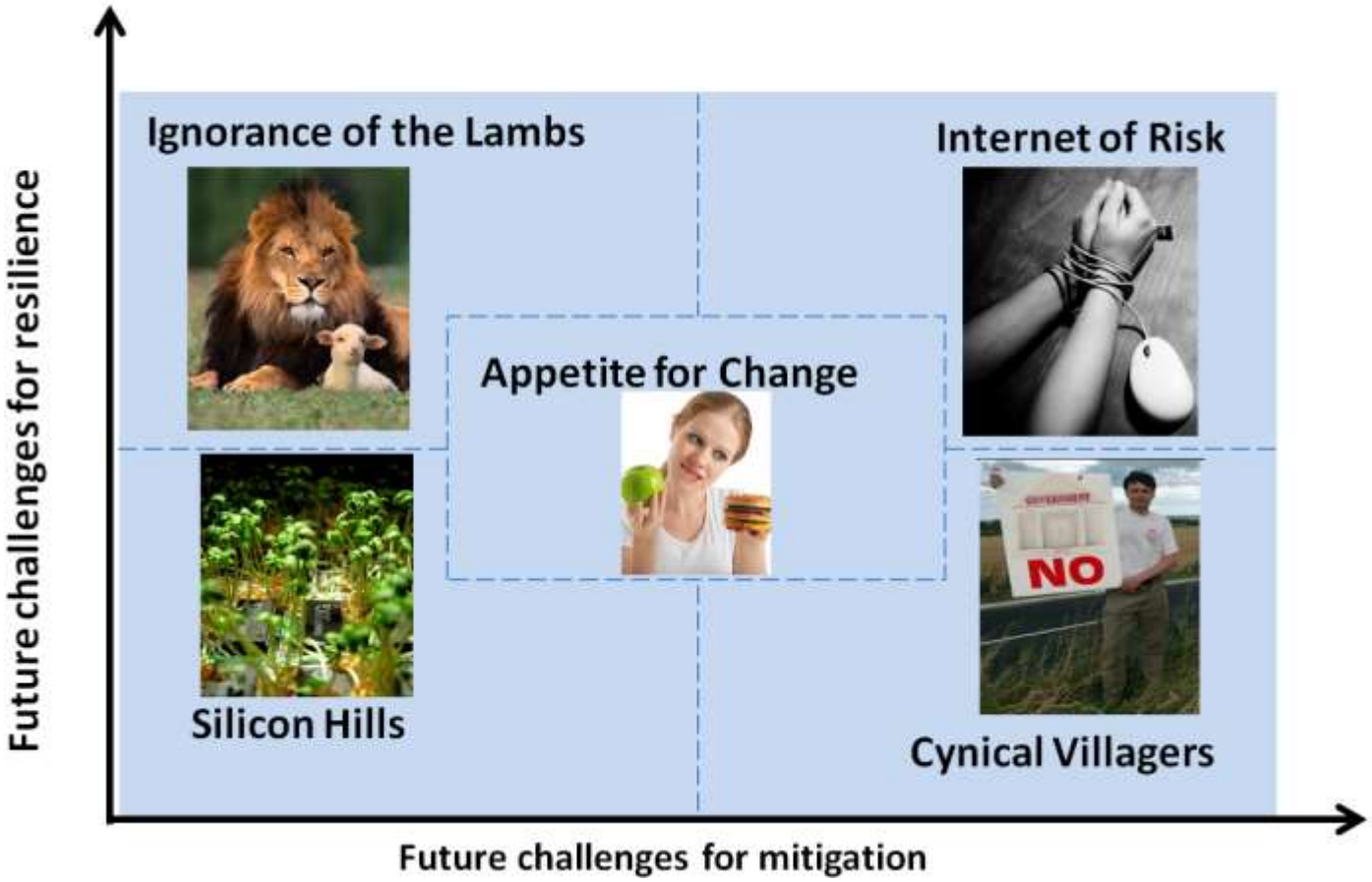


Maier H.R., Guillaume J.H.A., van Delden H., Riddell G.A., Haasnoot M. and Kwakkel J.H. (2016) An uncertain future, deep uncertainty, scenarios, robustness and adaptation: How do they fit together?, *Environmental Modelling and Software*, **81**, 154-164, DOI: 10.1016/j.envsoft.2016.03.01


2015
2020

An exploration of disaster risk and the future

Graeme A. Riddell, Hedwig van Delden, Graeme C. Dandy, Holger R. Maier, Aaron C. Zecchin, Jeffrey P. Newman, and Charles Newland
School of Civil, Environmental & Mining Engineering, The University of Adelaide, SA
Research Institute for Knowledge Systems, Maastricht, the Netherlands



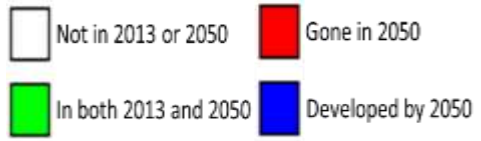
Riddell G.A., van Delden H., Dandy G.C., Zecchin A.C. and Maier H.R. (2018) Enhancing the policy relevance of exploratory scenarios: Generic approach and application to disaster risk reduction, *Futures*, **99**, 1-15, DOI:10.1016/j.futures.2018.03.006

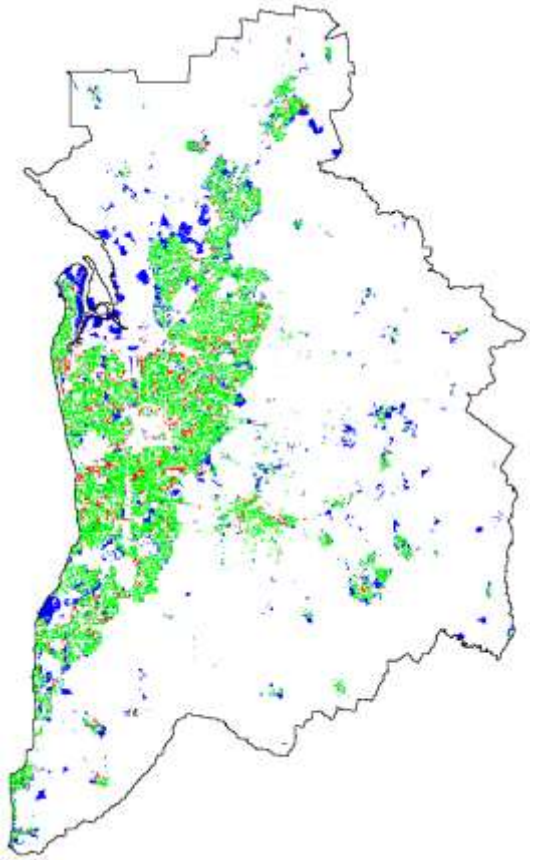
Main scenario drivers and outcomes

	Silicon Hills	Cynical Villagers	Ignorance of the Lambs	Appetite for Change	Internet of Risk
Population in 2050	1.9 M	1.5 M	2.5 M	1.8 M	1.5 M
Economy					
Community resilience					
Building stock resilience					
Residential land use developments	*Gradual growth urban and rural areas*	*Large increase in rural residential, mixed with other land uses*	*Residential commuter communities in the hills*	*Infill, some sprawl on the fringe and rural residential development*	*Large increase in rural residential*
Land use planning					
Education & awareness					
Structural mitigation					

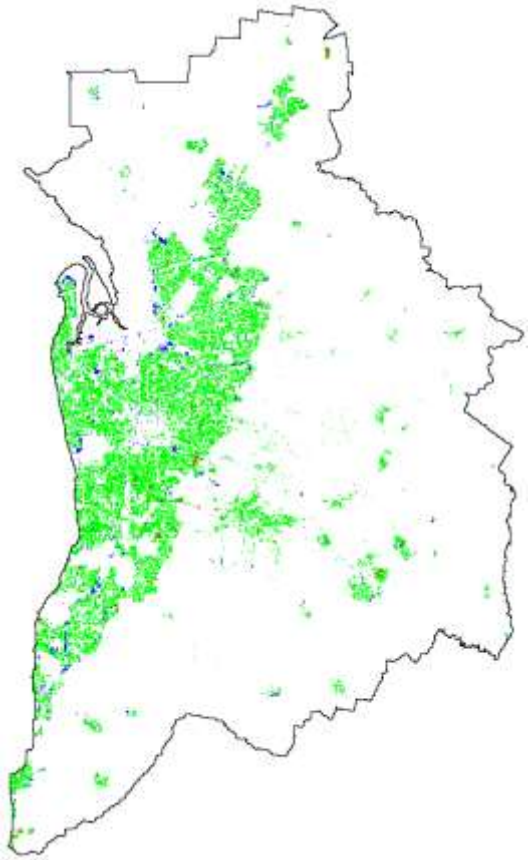
Scenarios

RESIDENTIAL LAND USE CHANGES 2013 - 2050

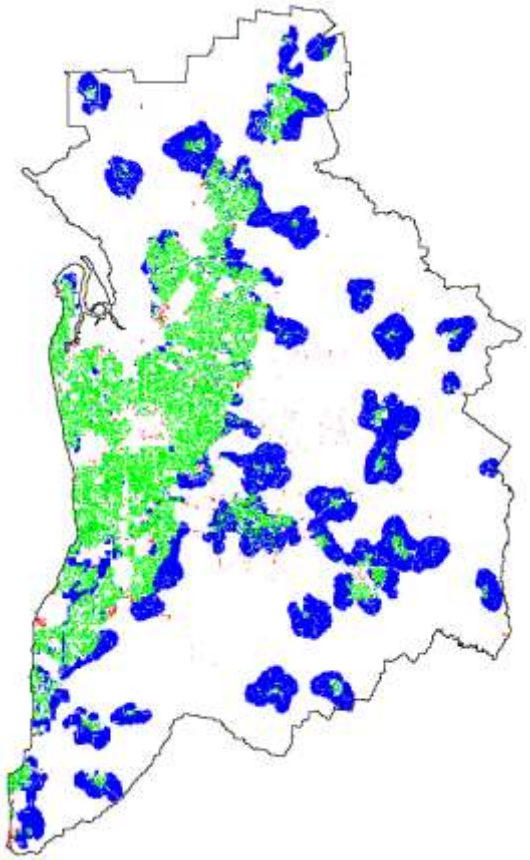




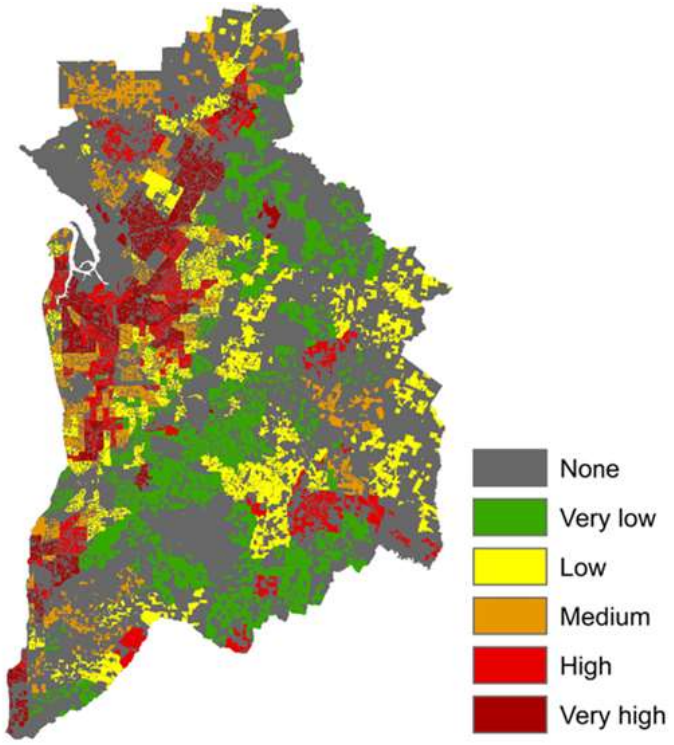
Low challenges



High challenges to Government action



High challenges to resilience



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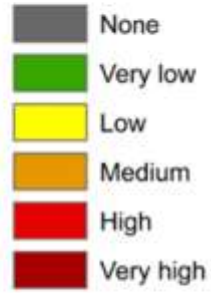

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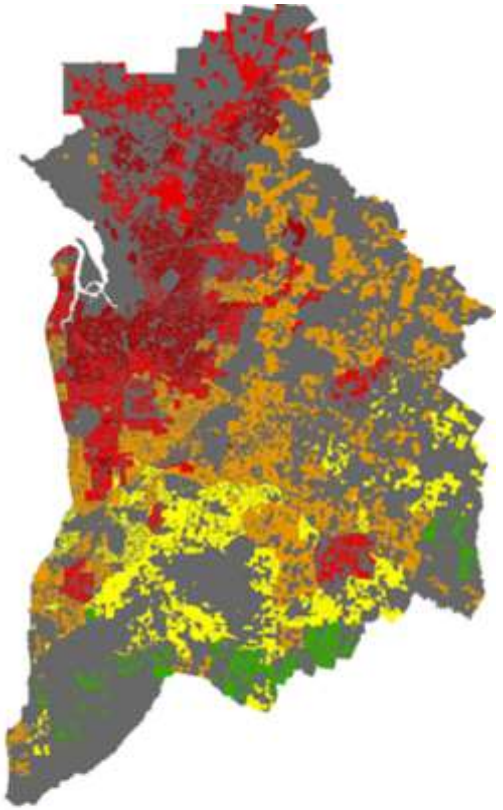
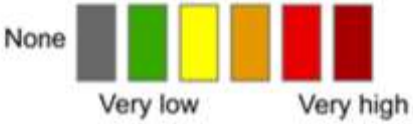


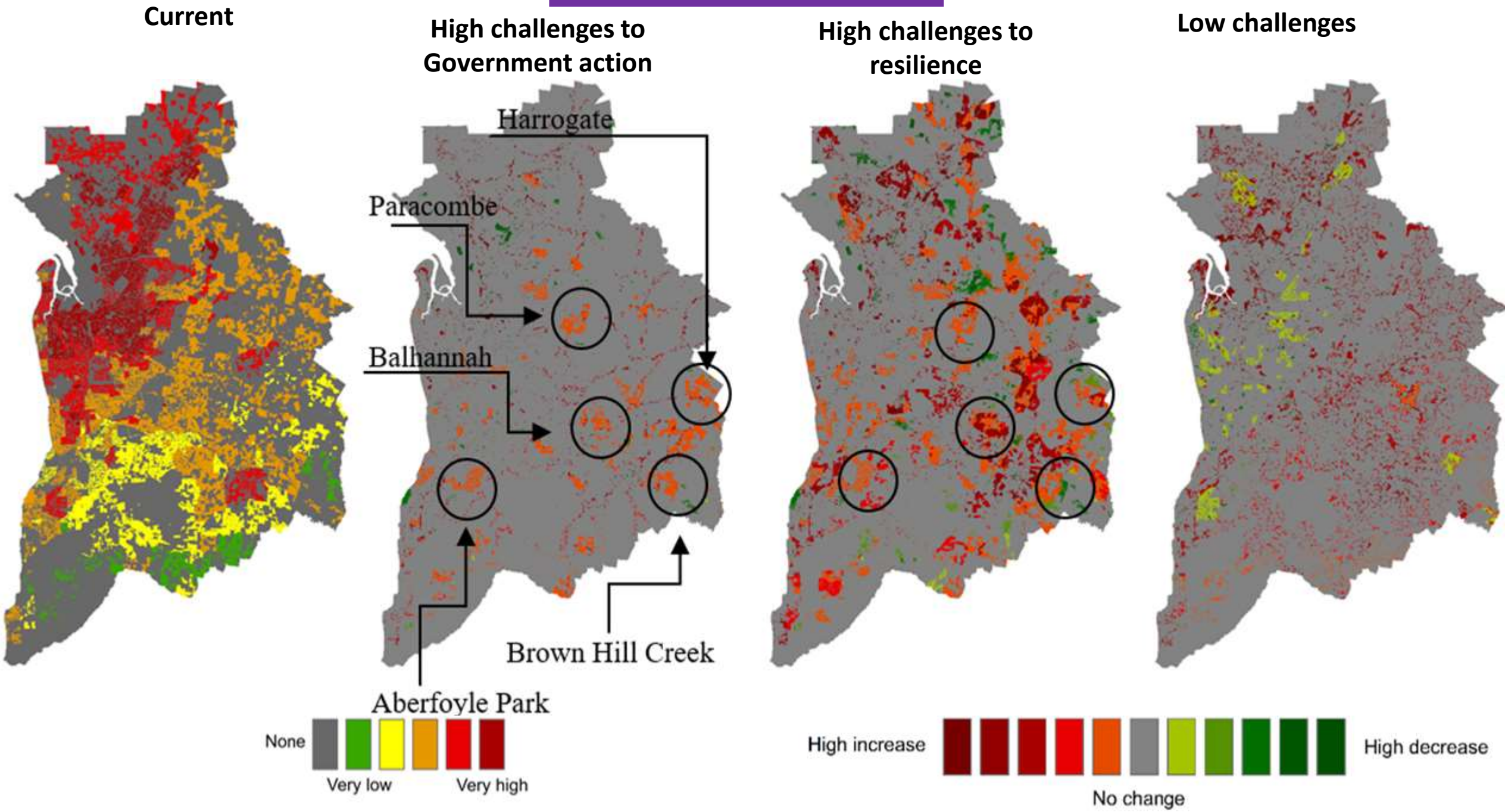


CURRENT SOCIAL VULNERABILTY

CURRENT EARTHQUAKE HAZARD

CURRENT EARTHQUAKE RISK

EARTHQUAKE RISK



Uses

Strategic risk analysis

- SWOT analysis of organisation
- TCFD Physical Risk Assessment

Modelling to inform long-term resource needs and vulnerabilities

Modelling to inform future ‘hotspots’ or areas of concern

- Test opportunities to reduce these
- Identify areas/factors that agencies have limited control over

Assessment of climate resilience of systems

- Can consider individual systems or regions
- Can assess the resilience of supply chains

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Thank you

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holger.maier@adelaide.edu.au