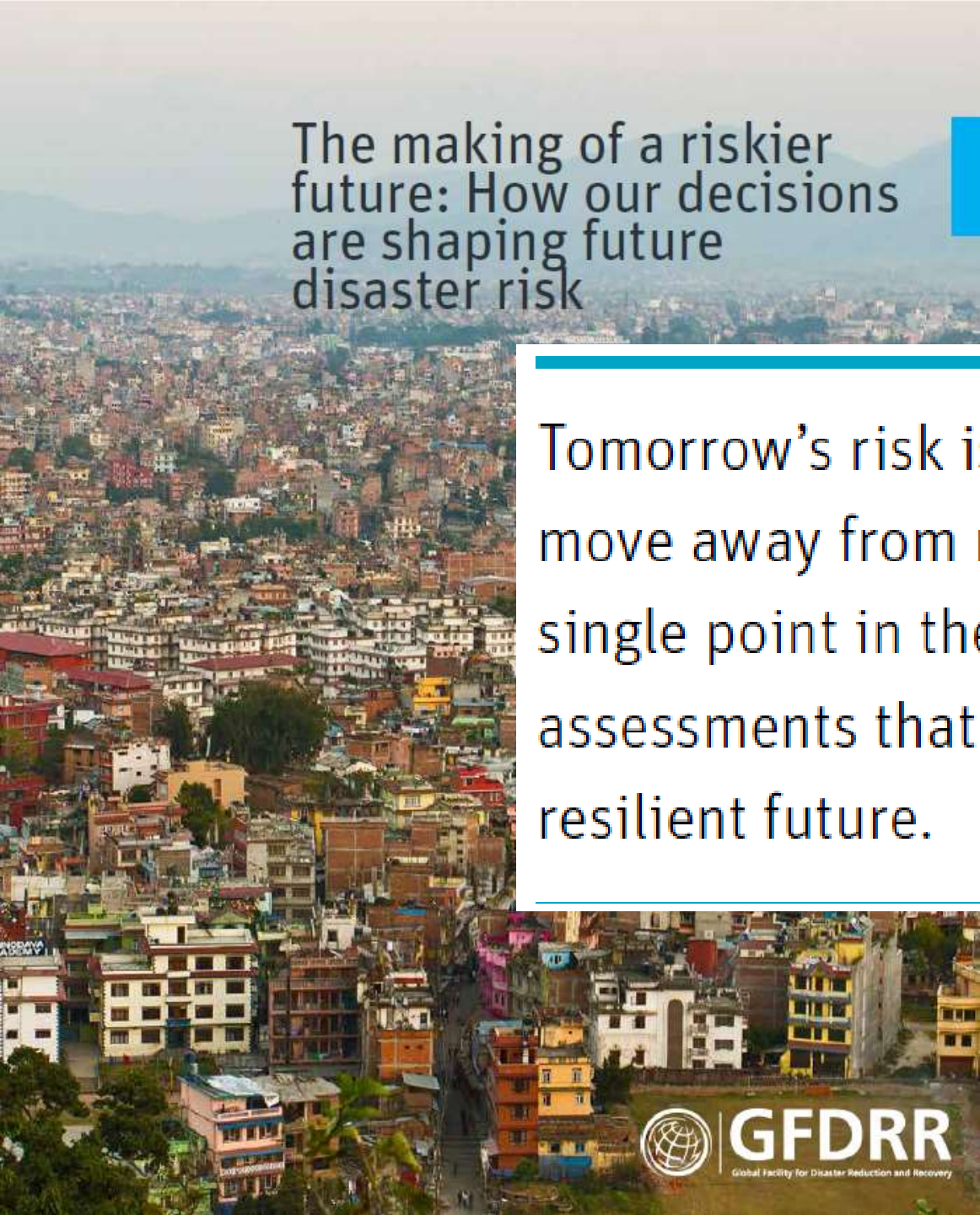


A Spatio-Temporal Decision Support System for Natural Hazard Risk Reduction Policy Assessment and Planning

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



MOTIVATION

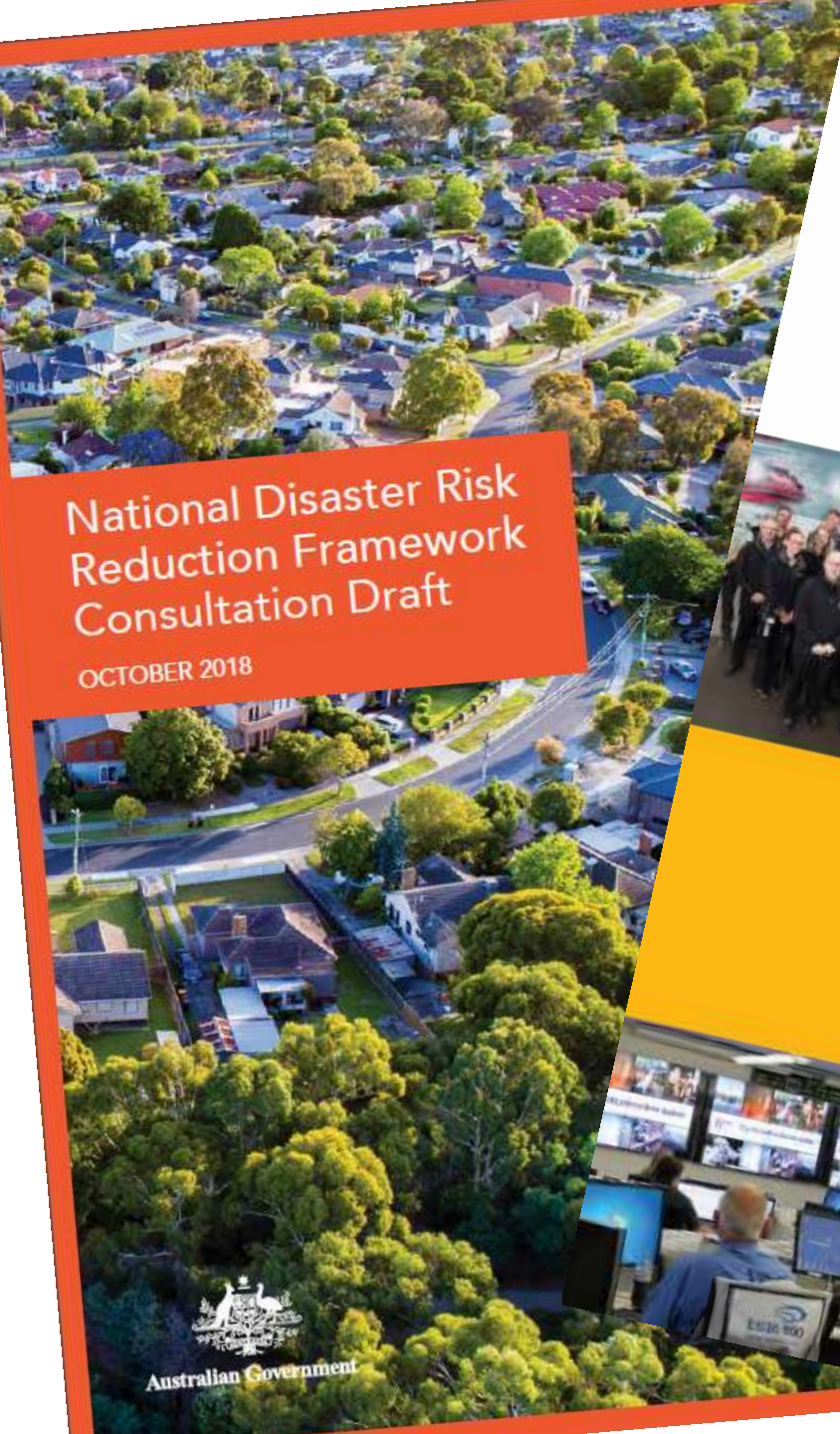


The making of a riskier
future: How our decisions
are shaping future
disaster risk

Tomorrow's risk is being built today. We must therefore move away from risk assessments that show risk at a single point in the present and move instead towards risk assessments that can guide decision makers towards a resilient future.



Global Facility for Disaster Reduction and Recovery
(2016) The making of a riskier future: How our decisions
are shaping future disaster risk.



National Disaster Risk Reduction Framework Consultation Draft

OCTOBER 2018



EMV's Strategic Plan 2020



Working in conjunction with Communities, Government, Agencies and Business



Climate Change and the Emergency Management Sector



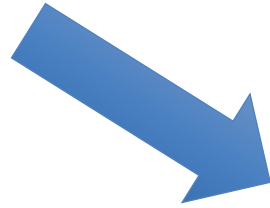
DISCUSSION PAPER
Version 1.0
3 July, 2018

CONCEPT



**Future
RISK**

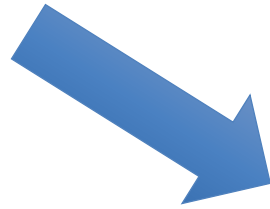
Things we generally
cannot control



- Climate change
- Population growth
- Global economy
- Technological disruption



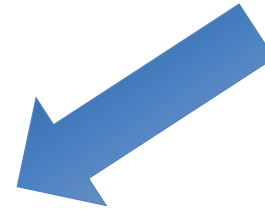
Things we generally
cannot control



- Climate change
- Population growth
- Global economy
- Technological disruption



Things we generally
can control



- Land use planning
- Land management
- Building codes
- Structural measures
- Community education

COMMUNITY RESILIENCE

GOVERNMENT PLANNING / ACTION

Things we generally
cannot control

Things we generally
can control

- Climate change
- Population growth
- Global economy
- Technological disruption

**Future
RISK**

- Land use planning
- Land management
- Building codes
- Structural measures
- Community education

COMMUNITY
RESILIENCE

GOVERNMENT
PLANNING / ACTION

Things we generally
cannot control

Things we generally
can control

- Climate change
- Population growth
- Global economy
- Technological disruption

- Land use planning
- Land management
- Building codes
- Structural measures
- Community education

**Future
RISK**

HOW DO WE QUANTIFY IMPACTS?
HOW DO WE OBTAIN EVIDENCE / DATA
TO SUPPORT DECISION-MAKING?

COMMUNITY
RESILIENCE

GOVERNMENT
PLANNING / ACTION

Things we generally
cannot control

Things we generally
can control

- Climate change
- Population growth
- Global economy
- Technological disruption

- Land use planning
- Land management
- Building codes
- Structural measures
- Community education

UNHaRMED

HOW DO WE QUANTIFY IMPACTS?
HOW DO WE OBTAIN EVIDENCE / DATA
TO SUPPORT DECISION-MAKING?

COMMUNITY RESILIENCE

GOVERNMENT PLANNING / ACTION

Things we generally
cannot control

Things we generally
can control

- Climate change
- Population growth
- Global economy
- Technological disruption

UNHaRMED

- Land use planning
- Land management
- Building codes
- Structural measures
- Community education

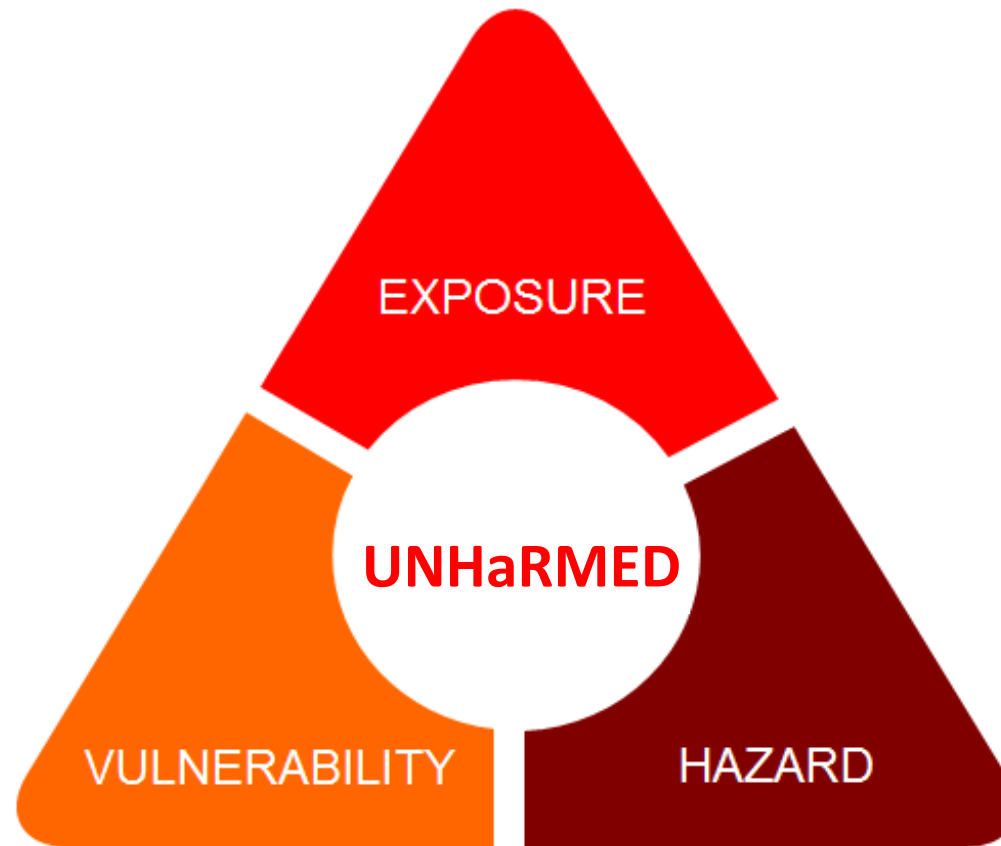


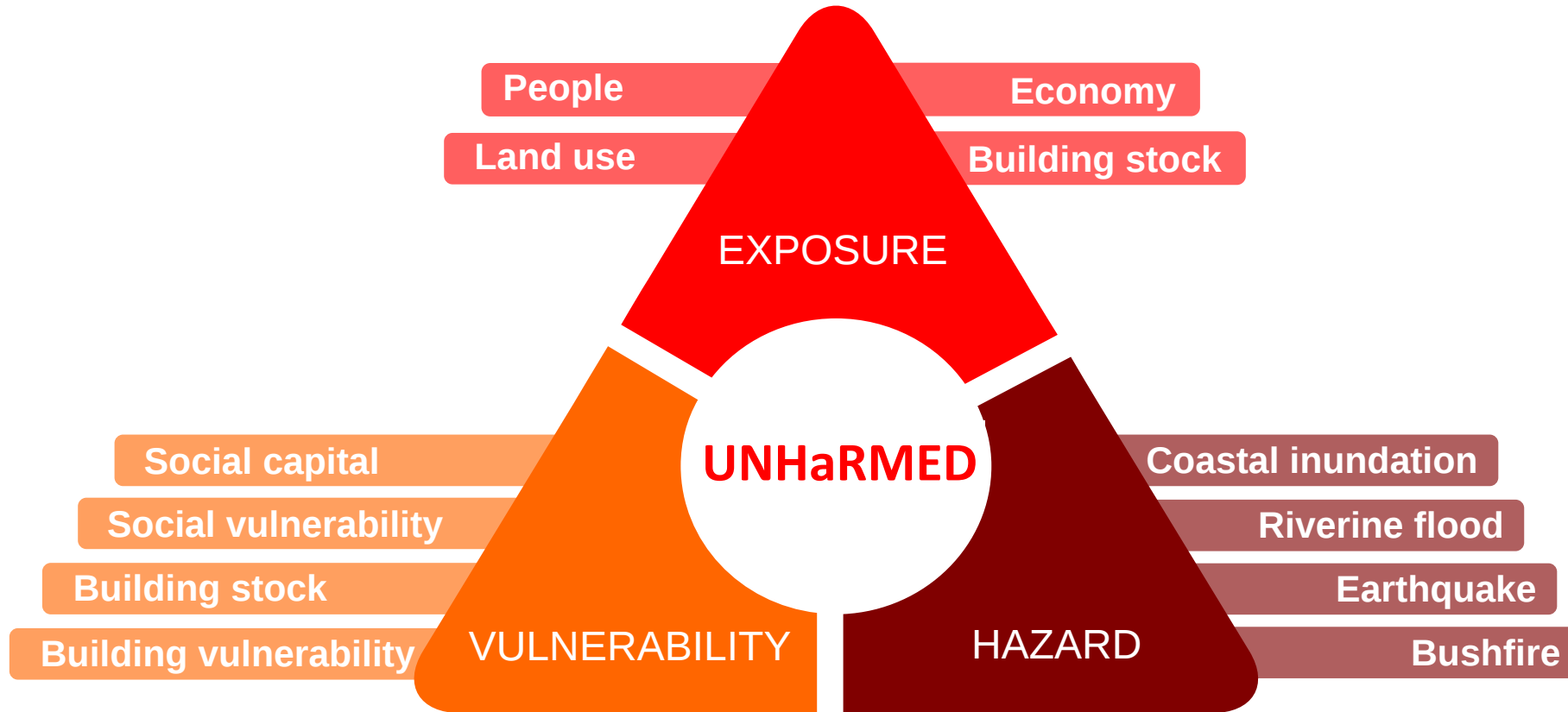
HOW DO WE QUANTIFY IMPACTS?
HOW DO WE OBTAIN EVIDENCE / DATA
TO SUPPORT DECISION-MAKING?

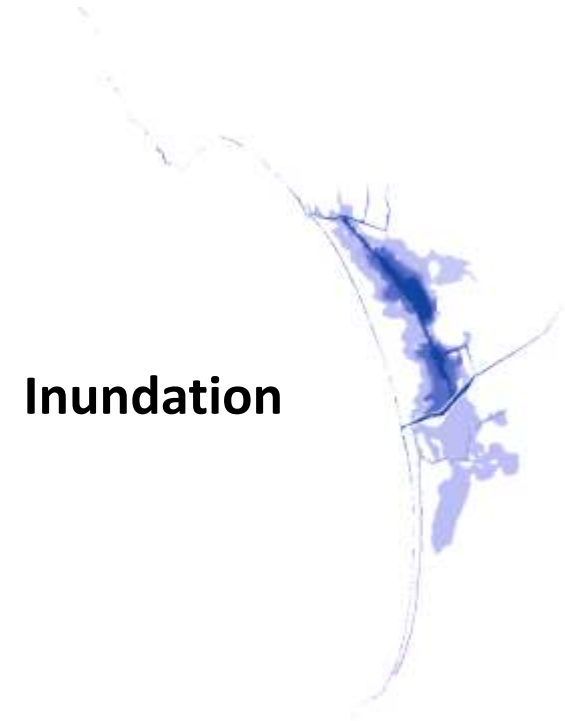
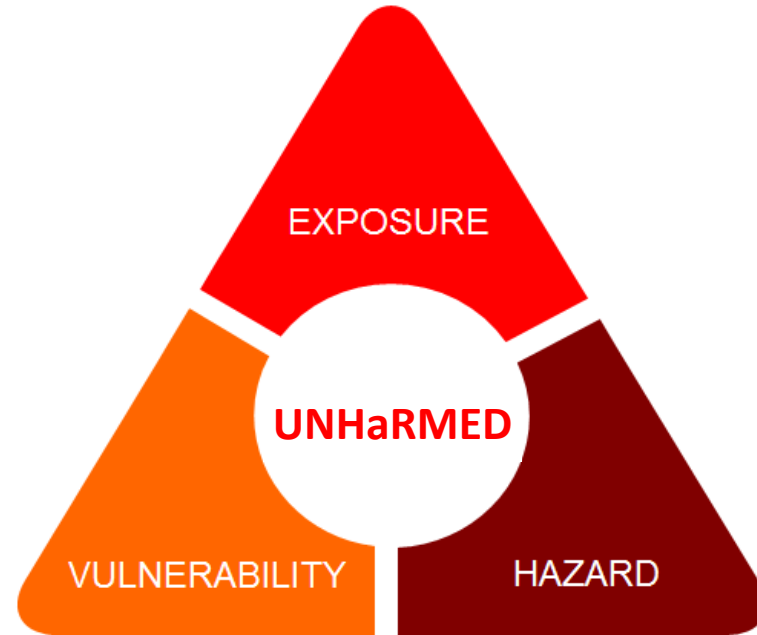
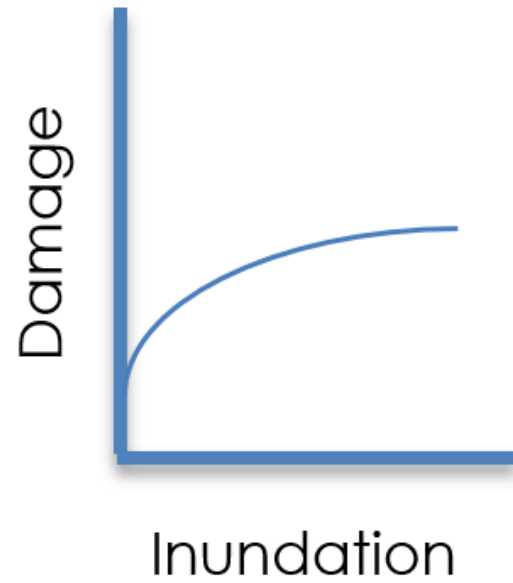


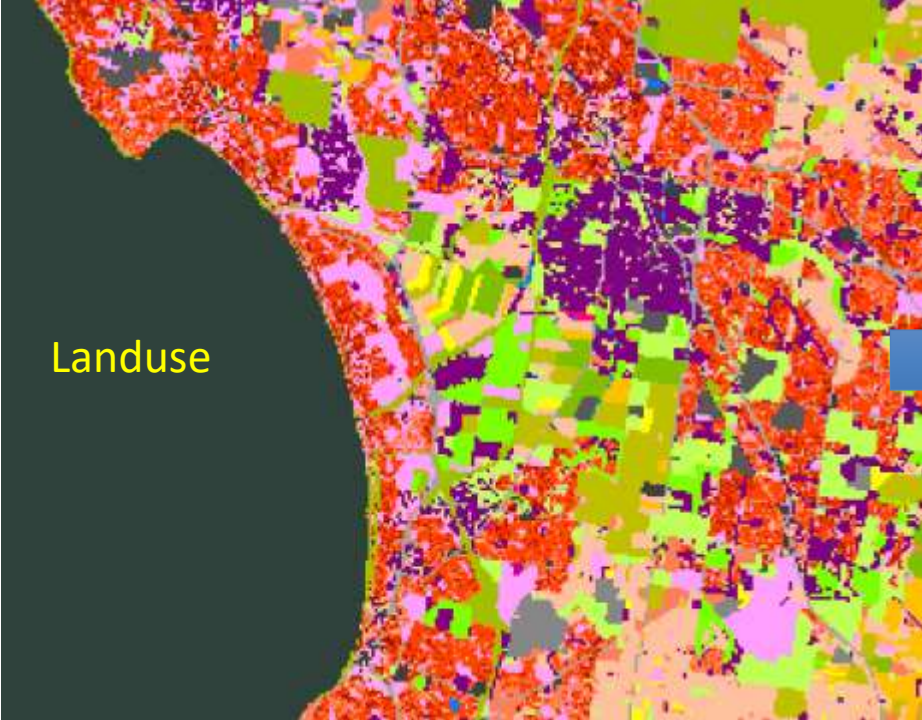
We can assess how risk will change and what risk reduction portfolios are most effective in different plausible future worlds using a “policy wind tunnel”





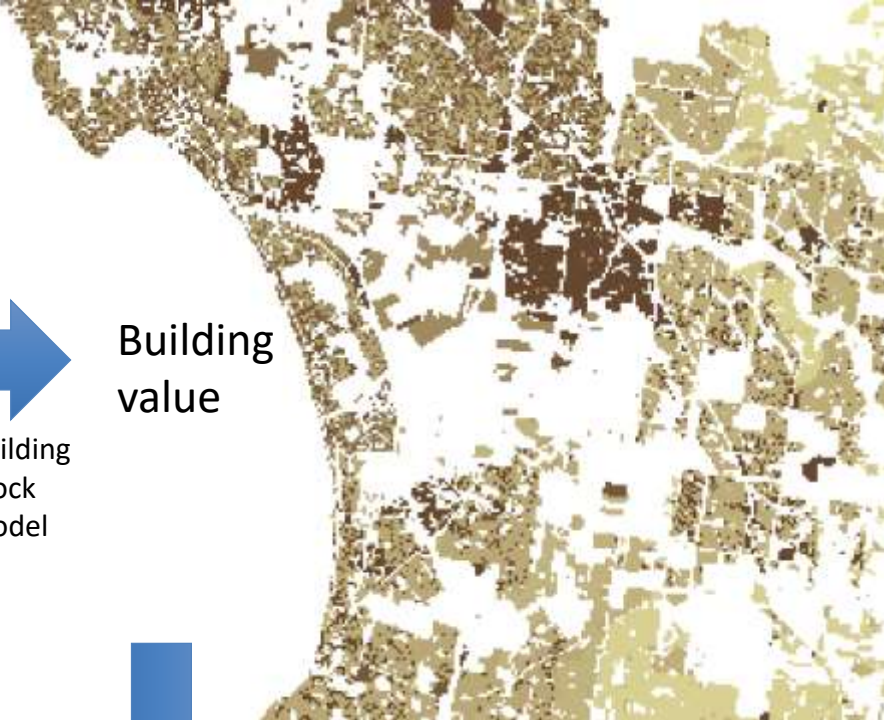




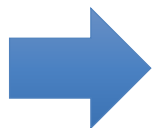
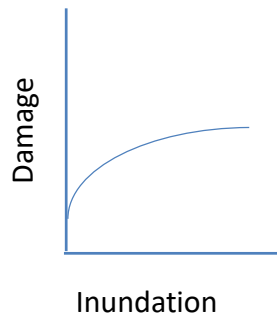


Building
Stock
model

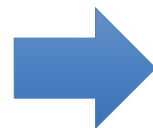
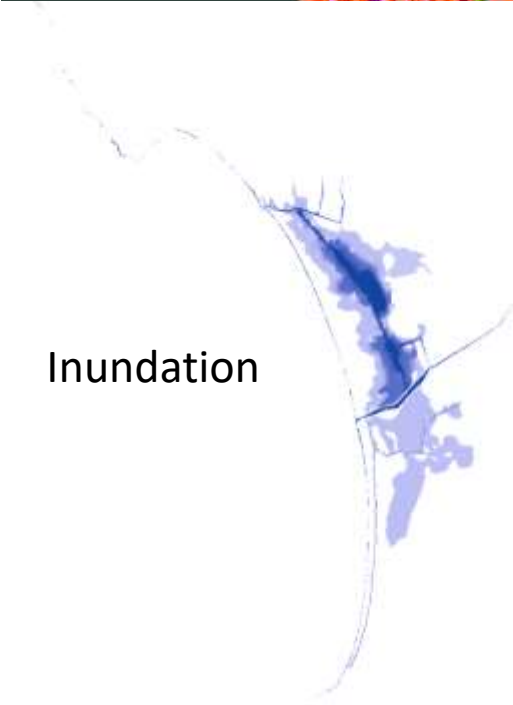
Building
value



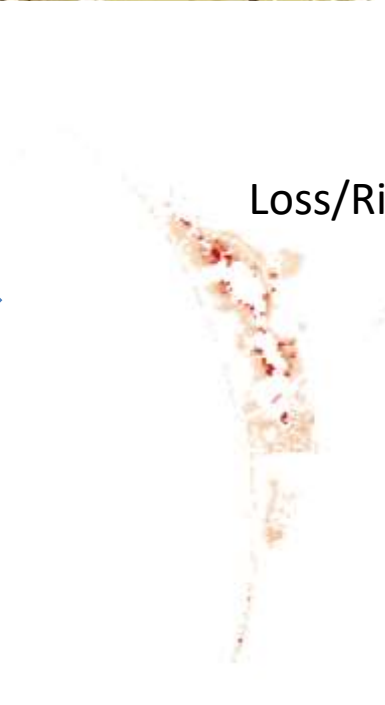
Building vulnerability curves

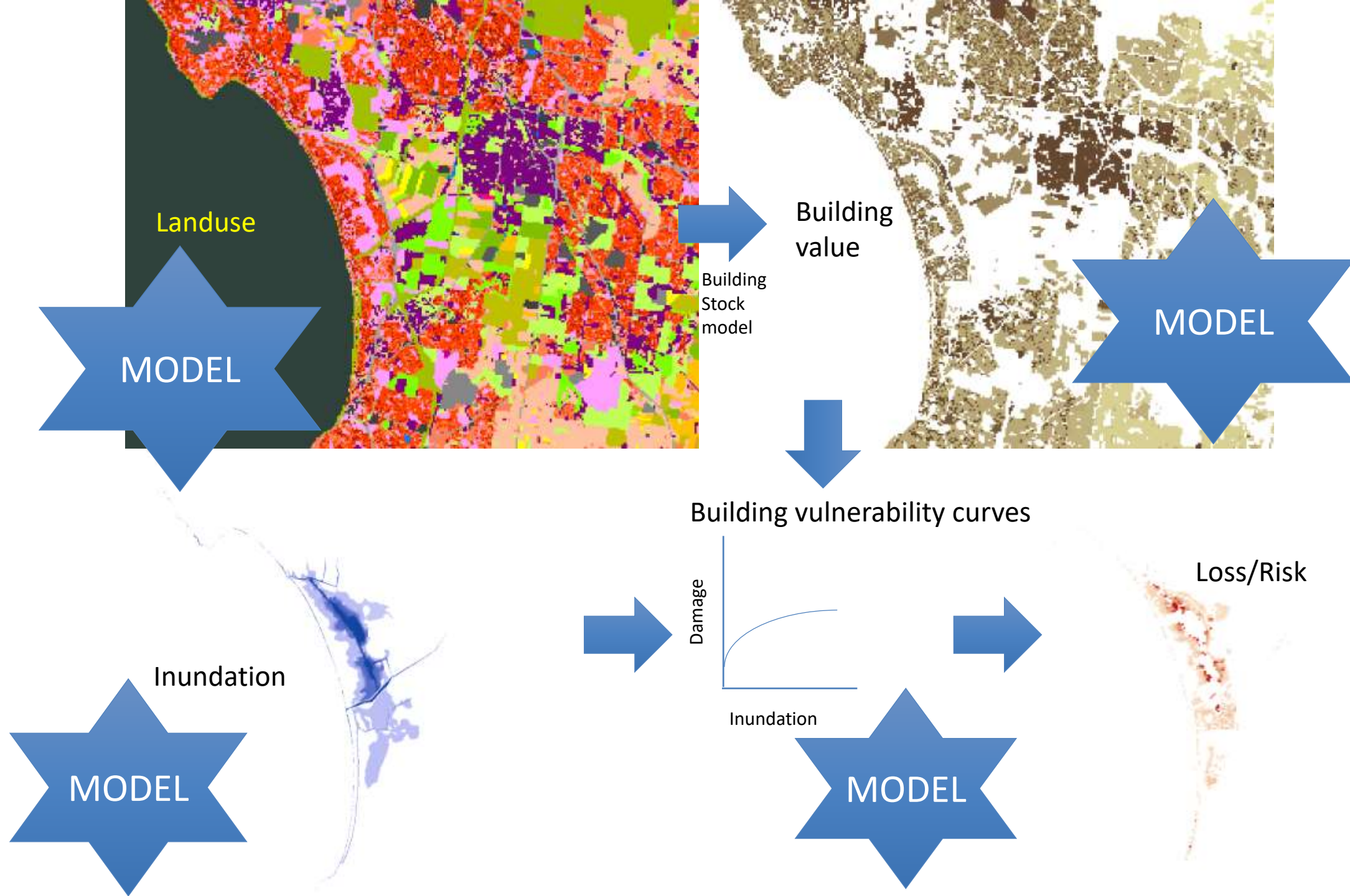


Inundation



Loss/Risk





Landuse

Building
value

Building
Stock
model

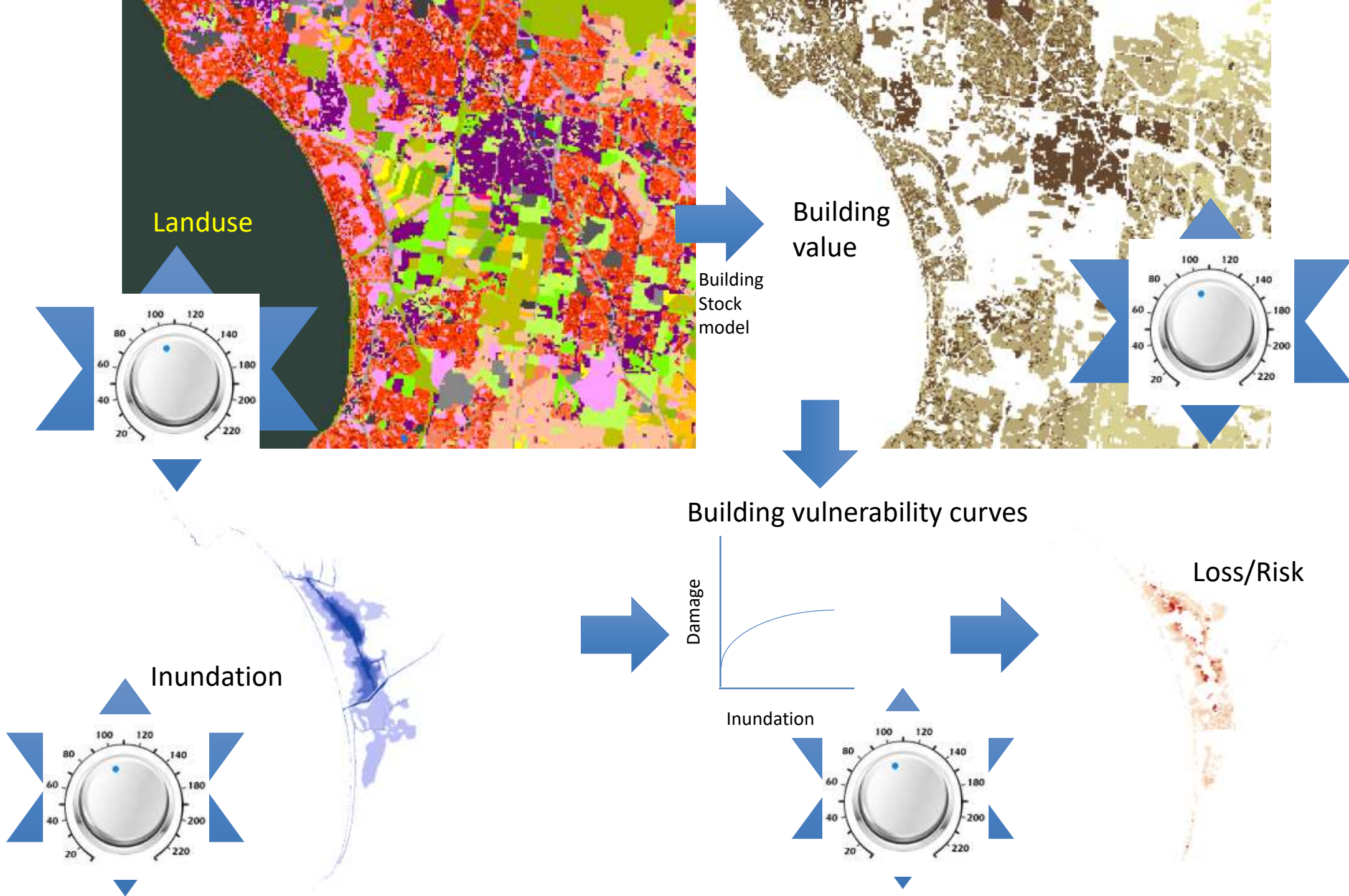
Building vulnerability curves

Loss/Risk

Inundation

Damage

Inundation



Landuse

Building
value

Building
Stock
model

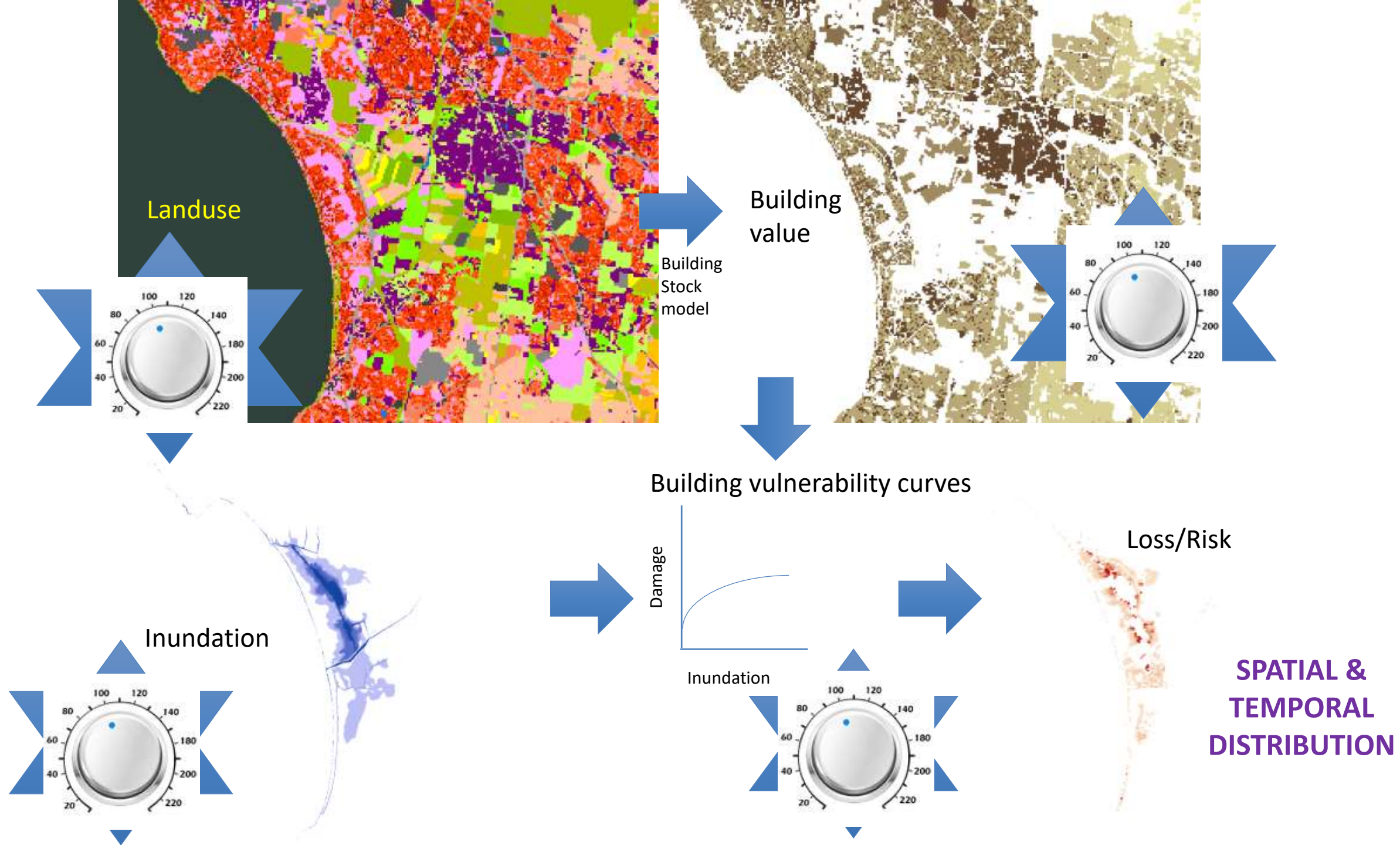
Building vulnerability curves

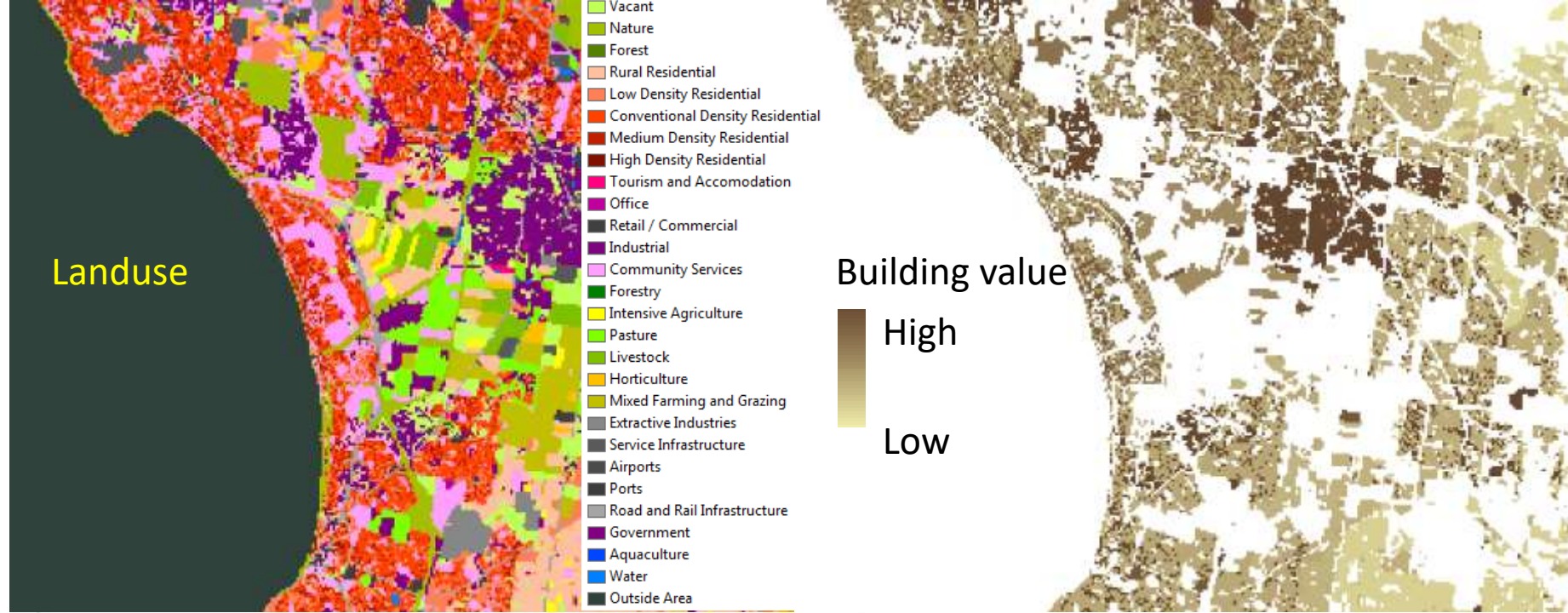
Loss/Risk

Inundation

Inundation

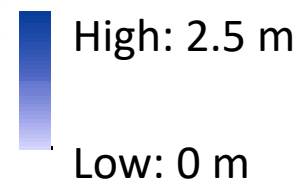
**SPATIAL &
TEMPORAL
DISTRIBUTION**



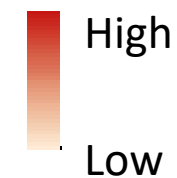


2015

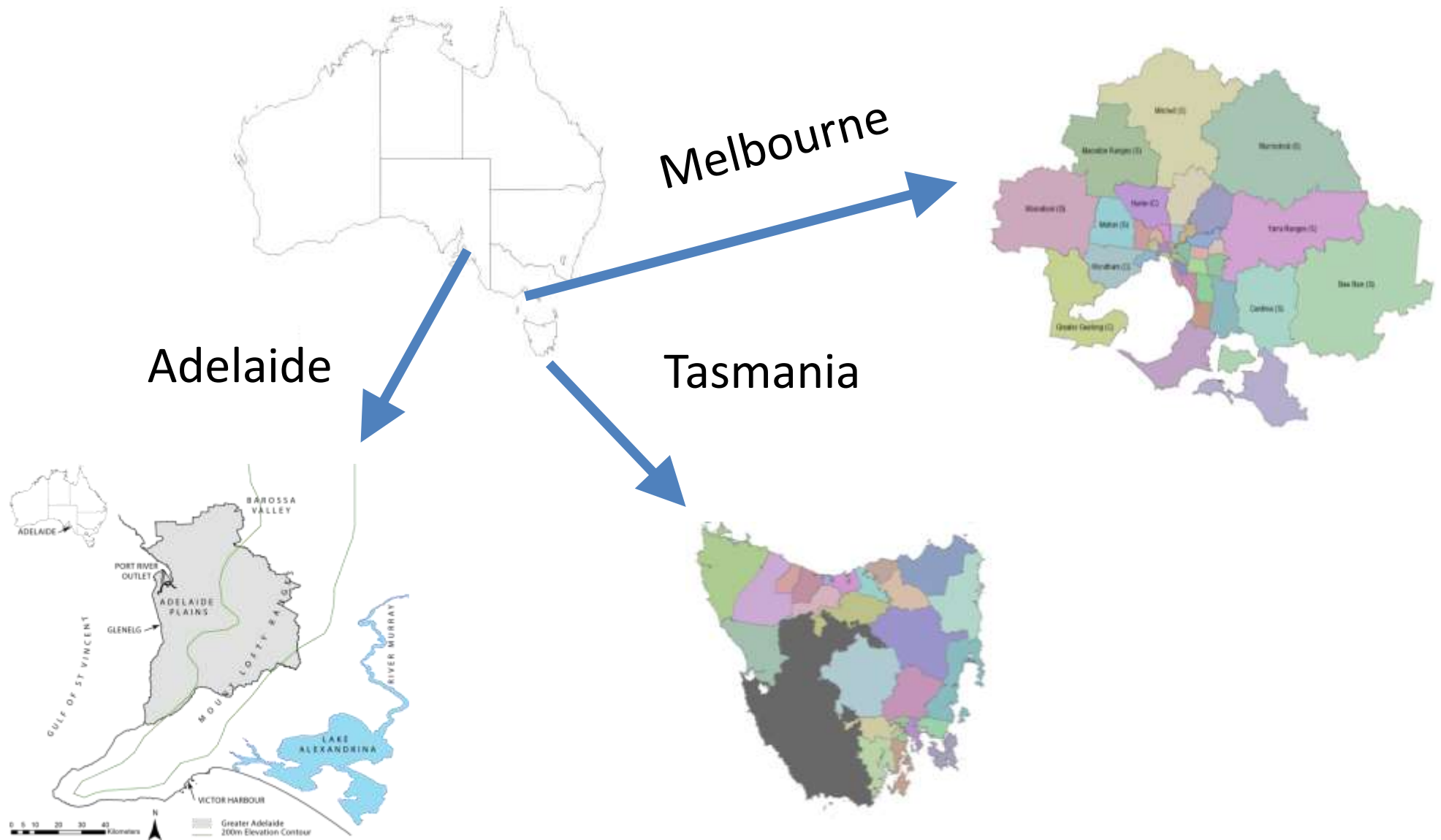
Inundation



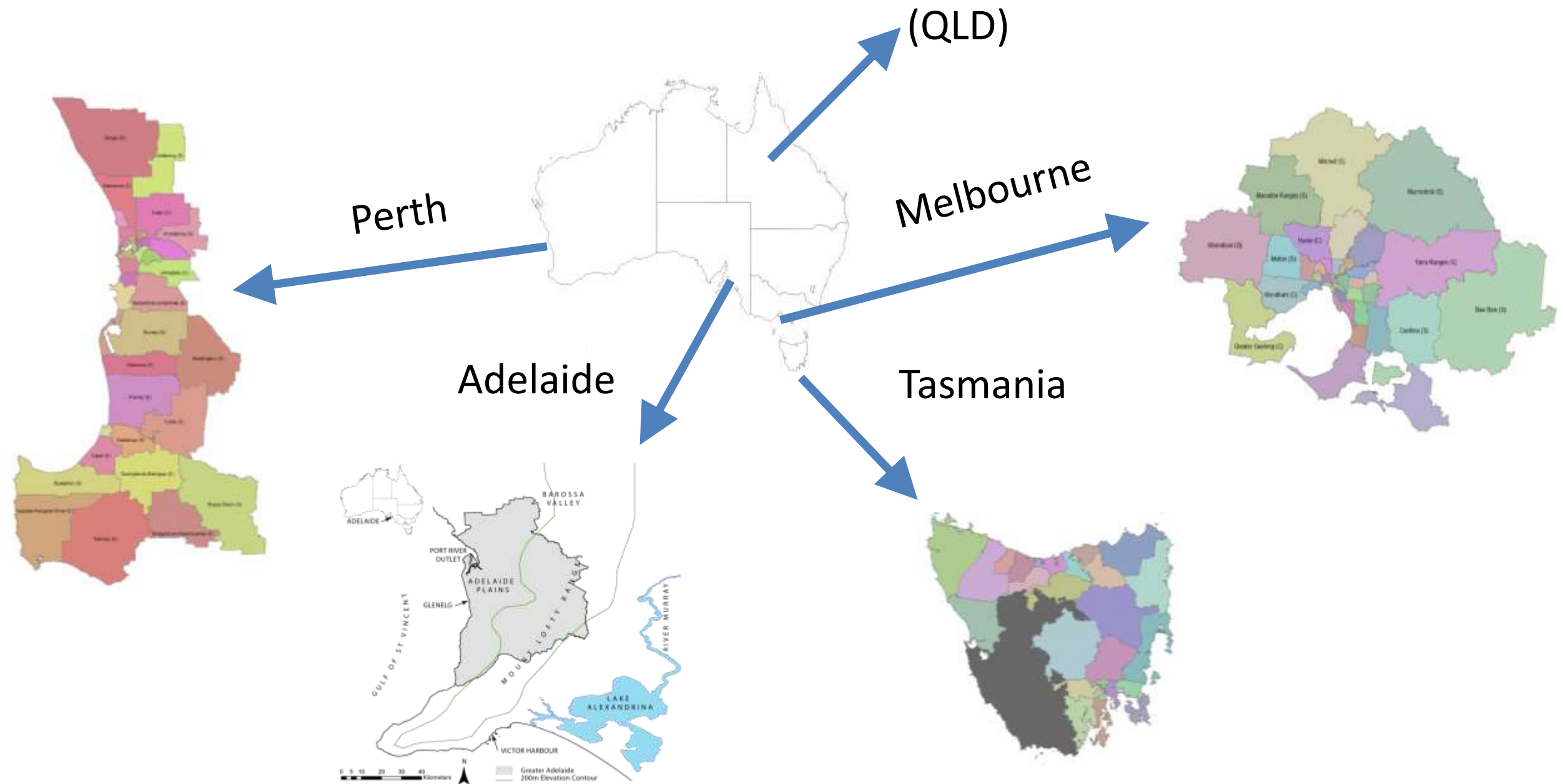
Loss/Risk



IMPLEMENTATION









Perth

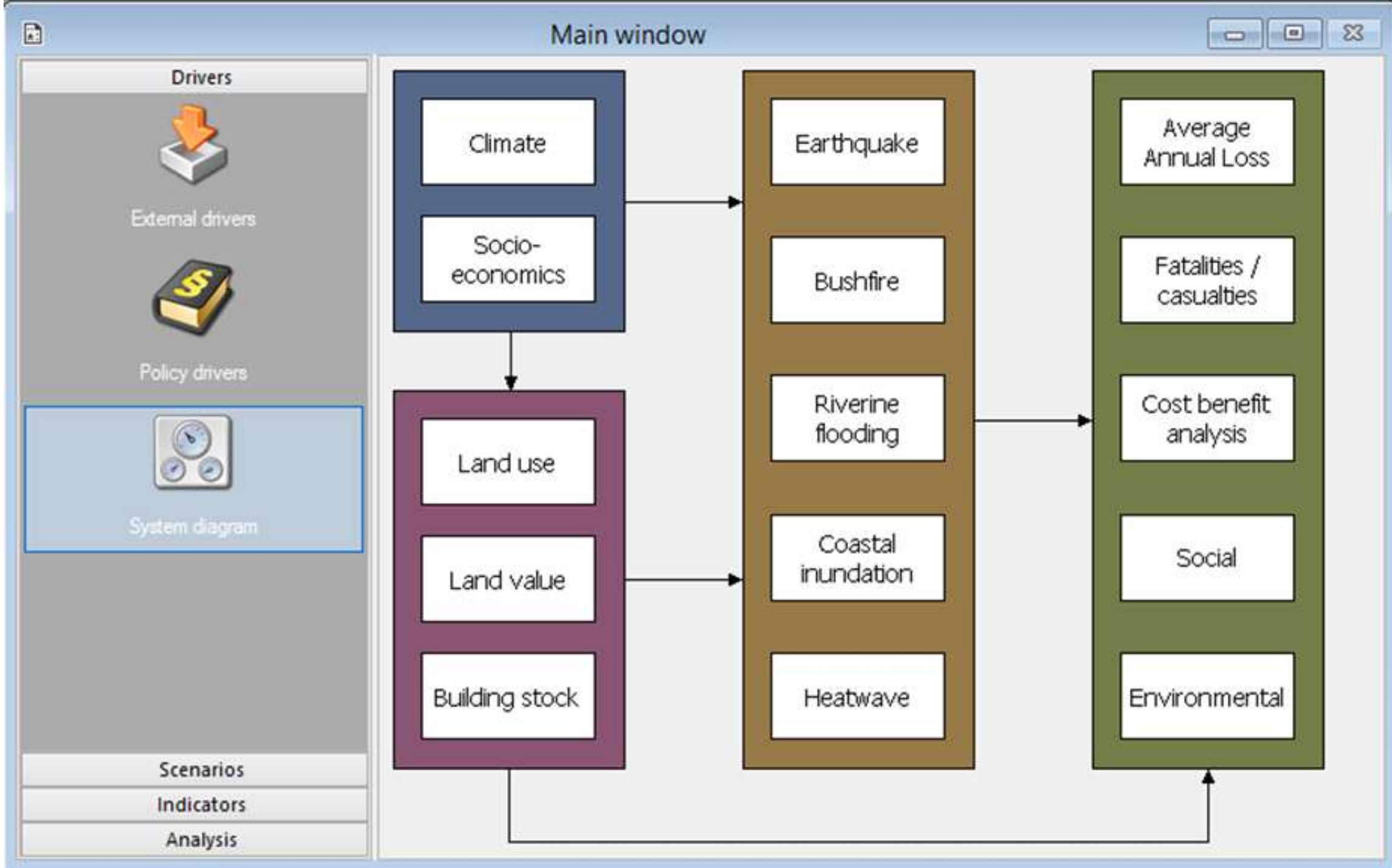
Adelaide

(QLD)

Melbourne

Tasmania







Main window



Drivers



External drivers



Policy drivers



System diagram

Scenarios

Indicators

Analysis

Climate

Socio-
economics

Land use

Land value

Building stock

Earthquake

Bushfire

Riverine
flooding

Coastal
inundation

Heatwave

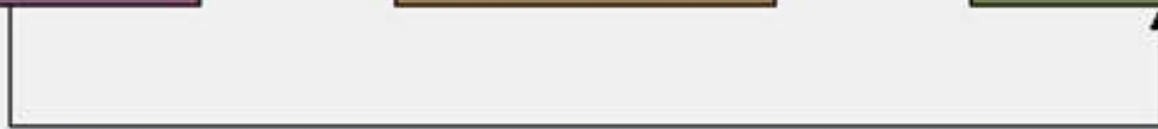
Average
Annual Loss

Fatalities /
casualties

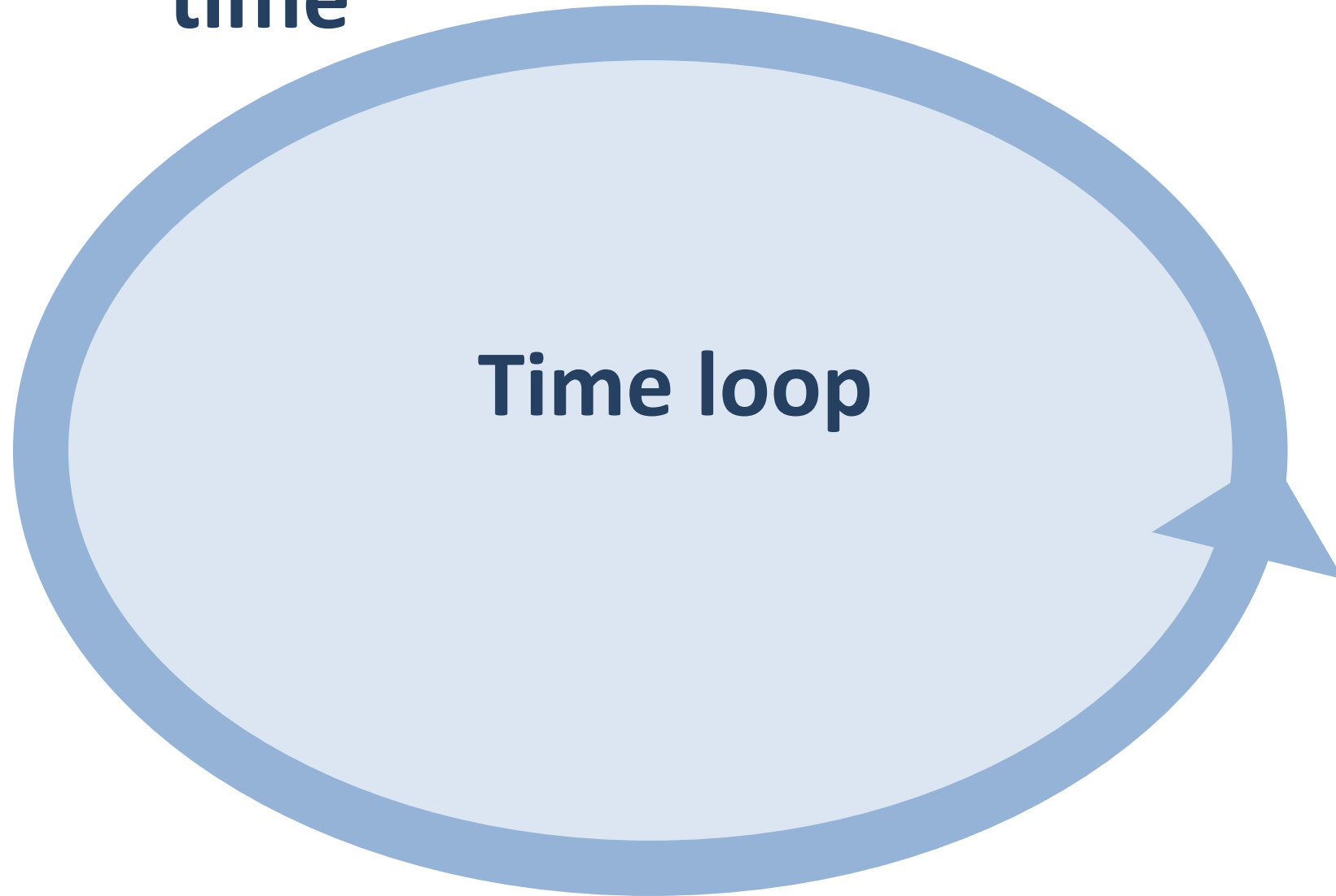
Cost benefit
analysis

Social

Environmental



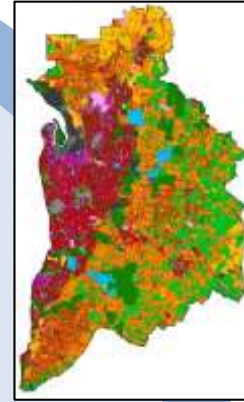
Land use change with time



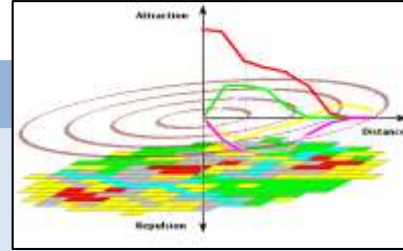
Time loop

&

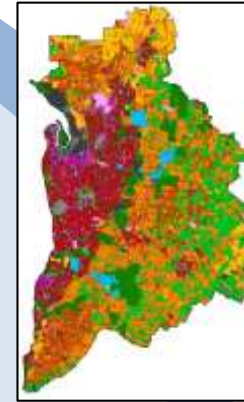
Land use at time T



Interaction Rules



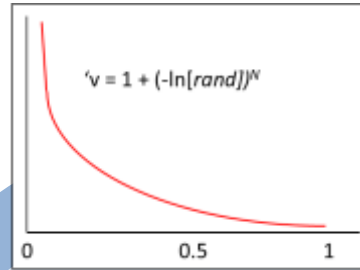
Land use at time T



Time loop

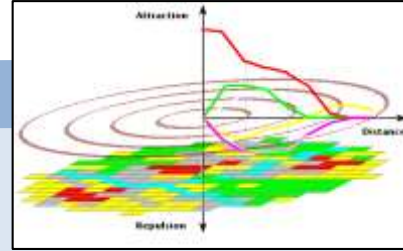
Stochastic Perturbation

&



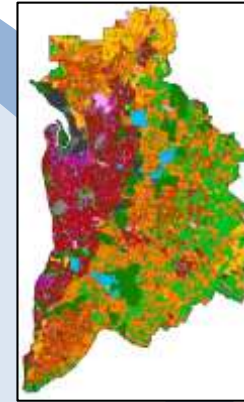
&

Interaction Rules

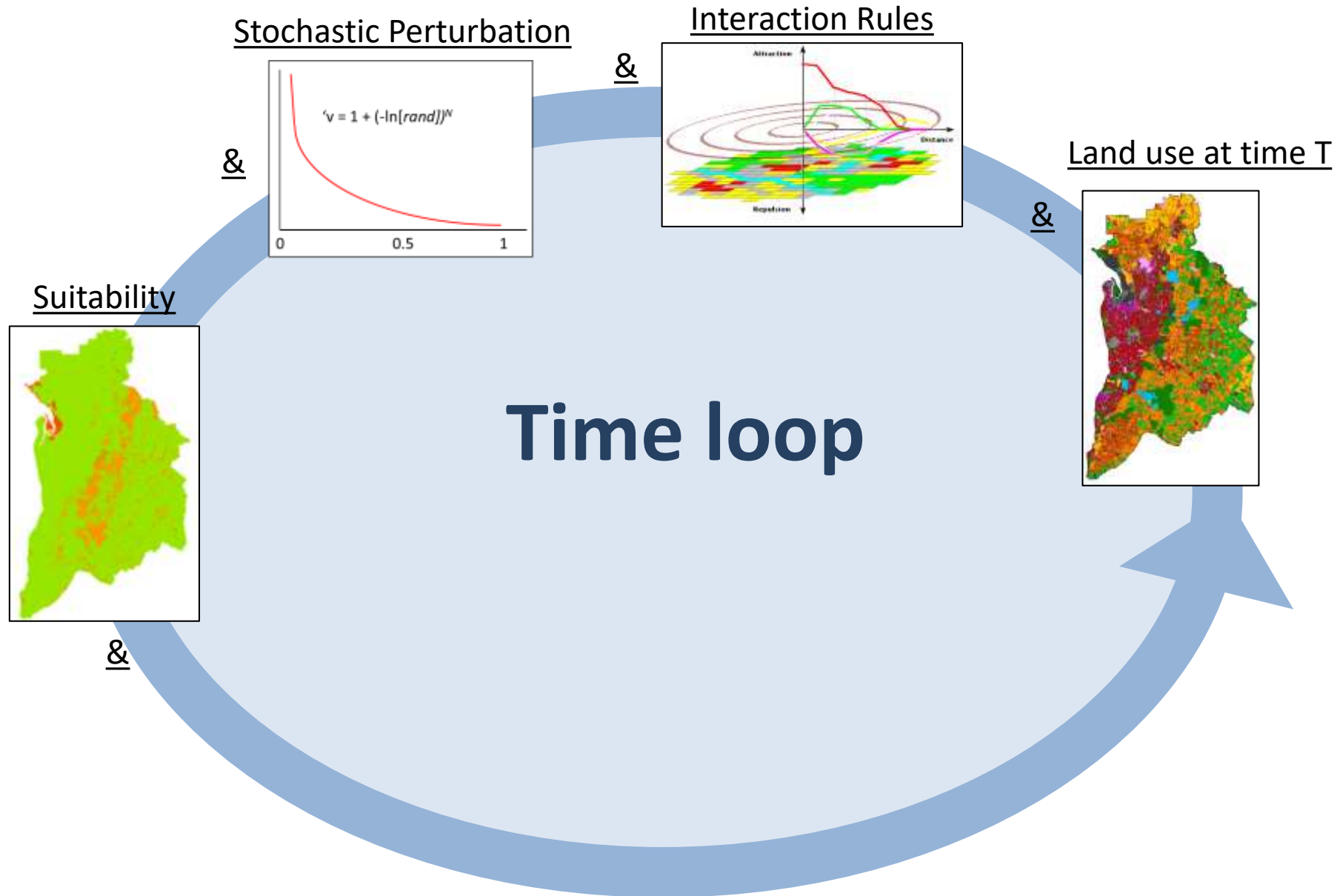


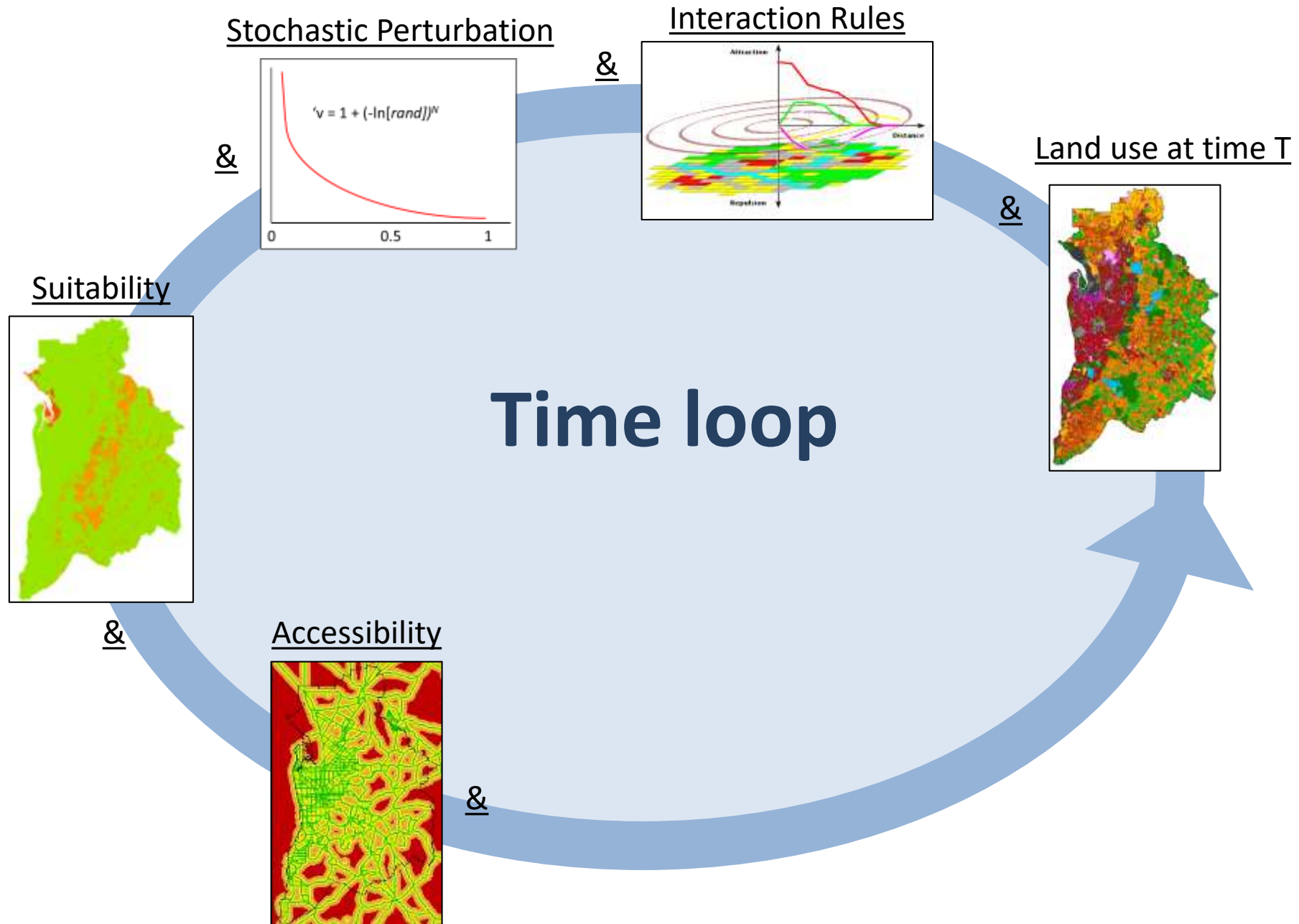
Land use at time T

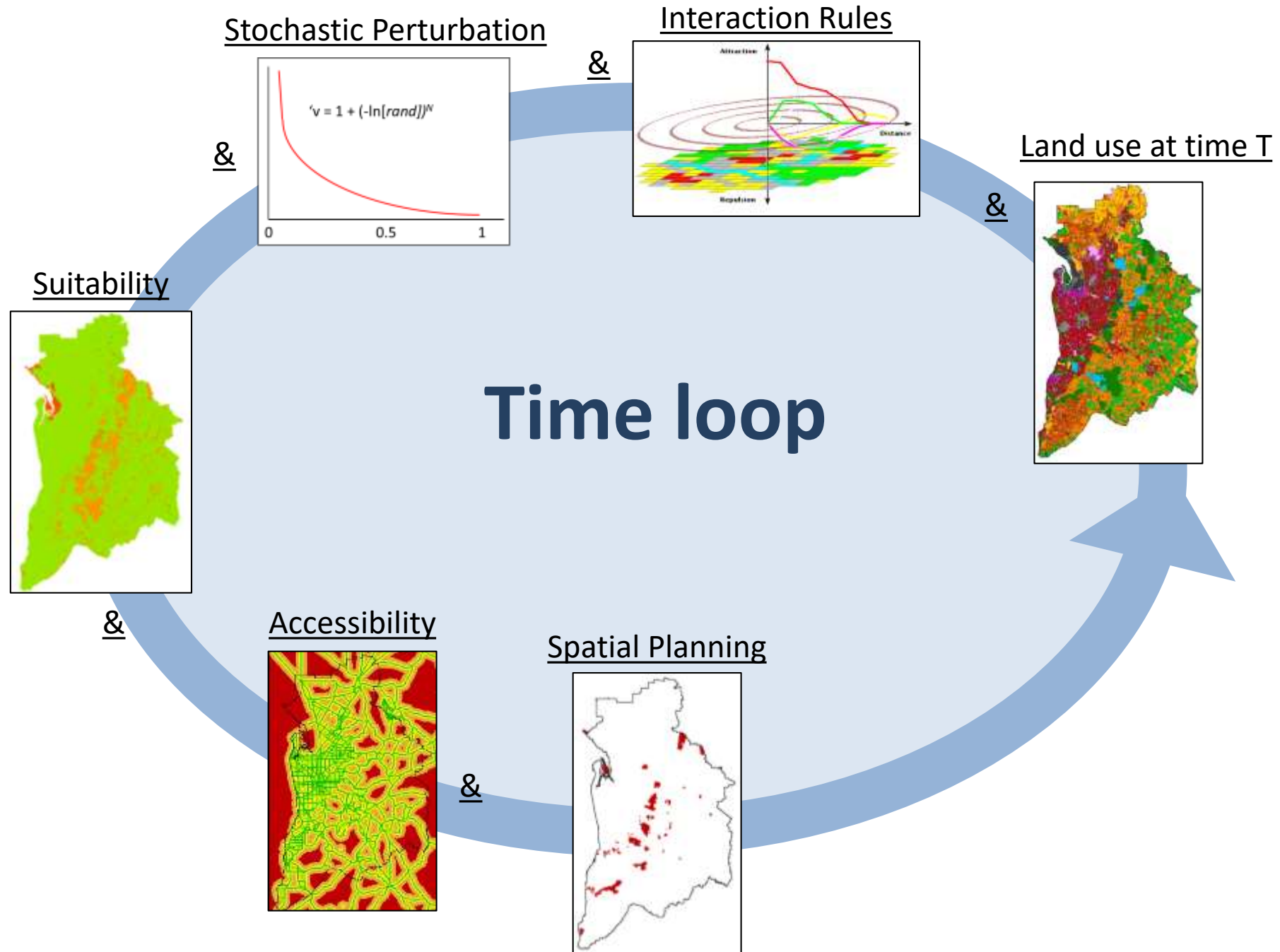
&

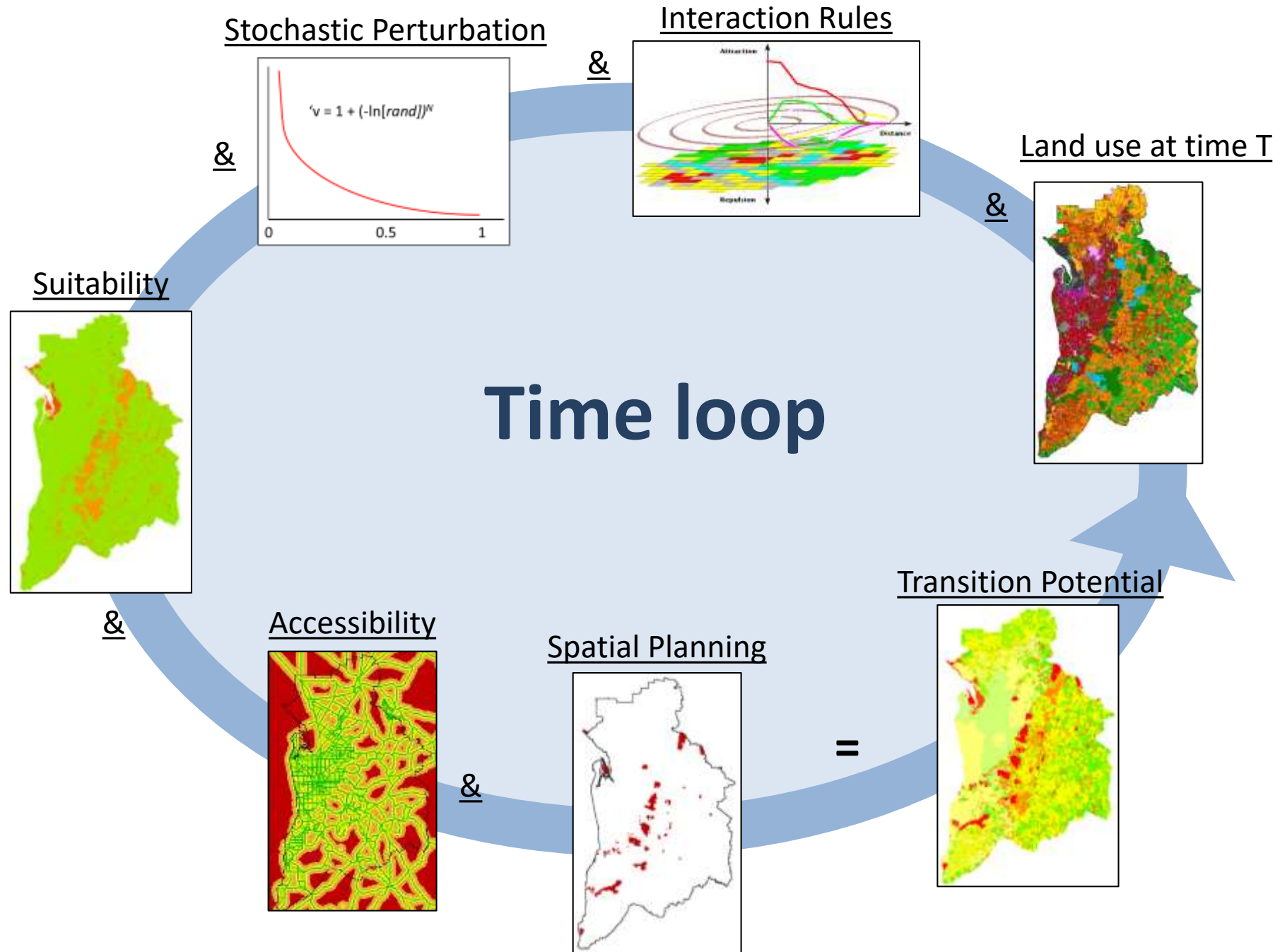


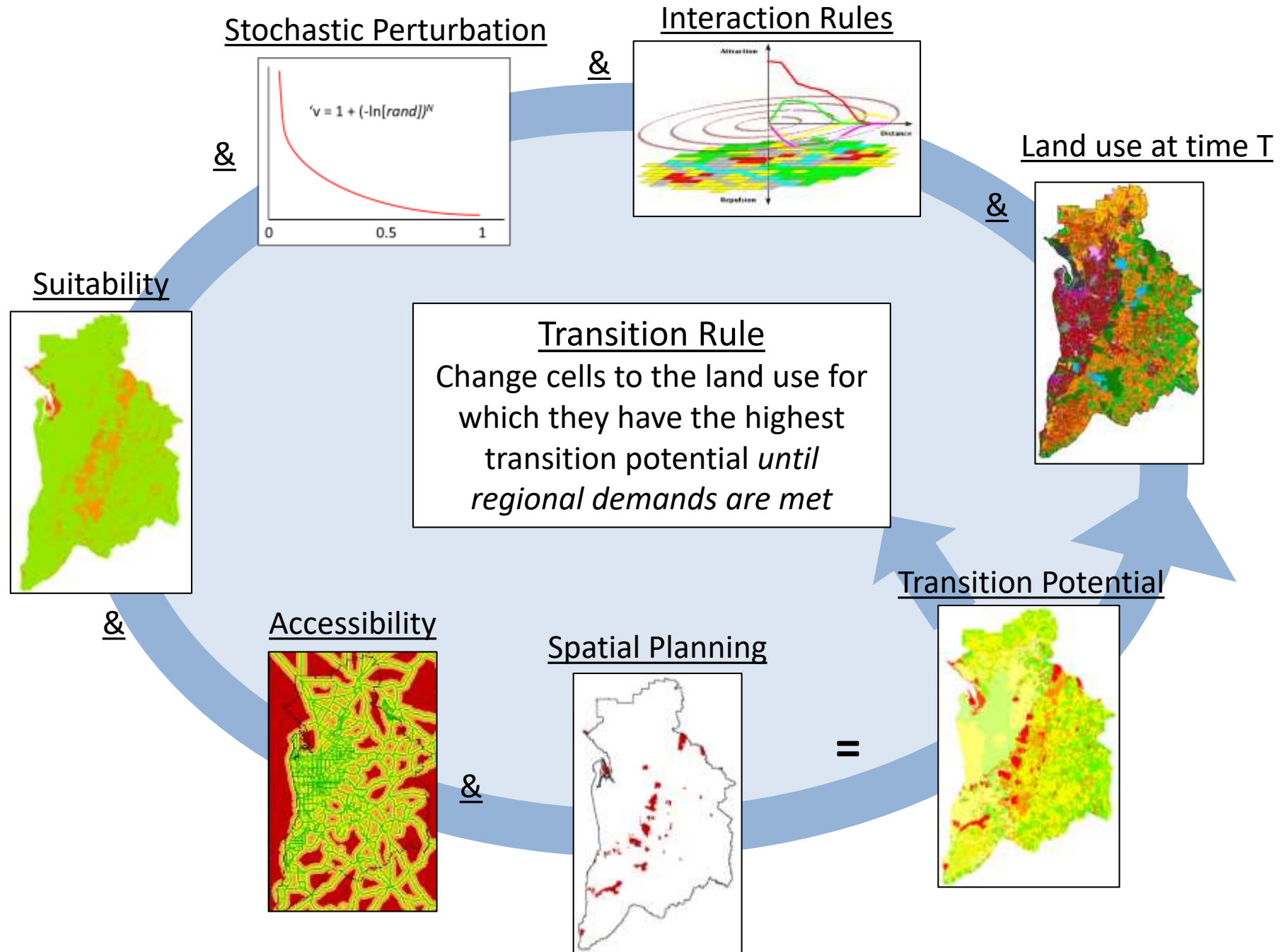
Time loop

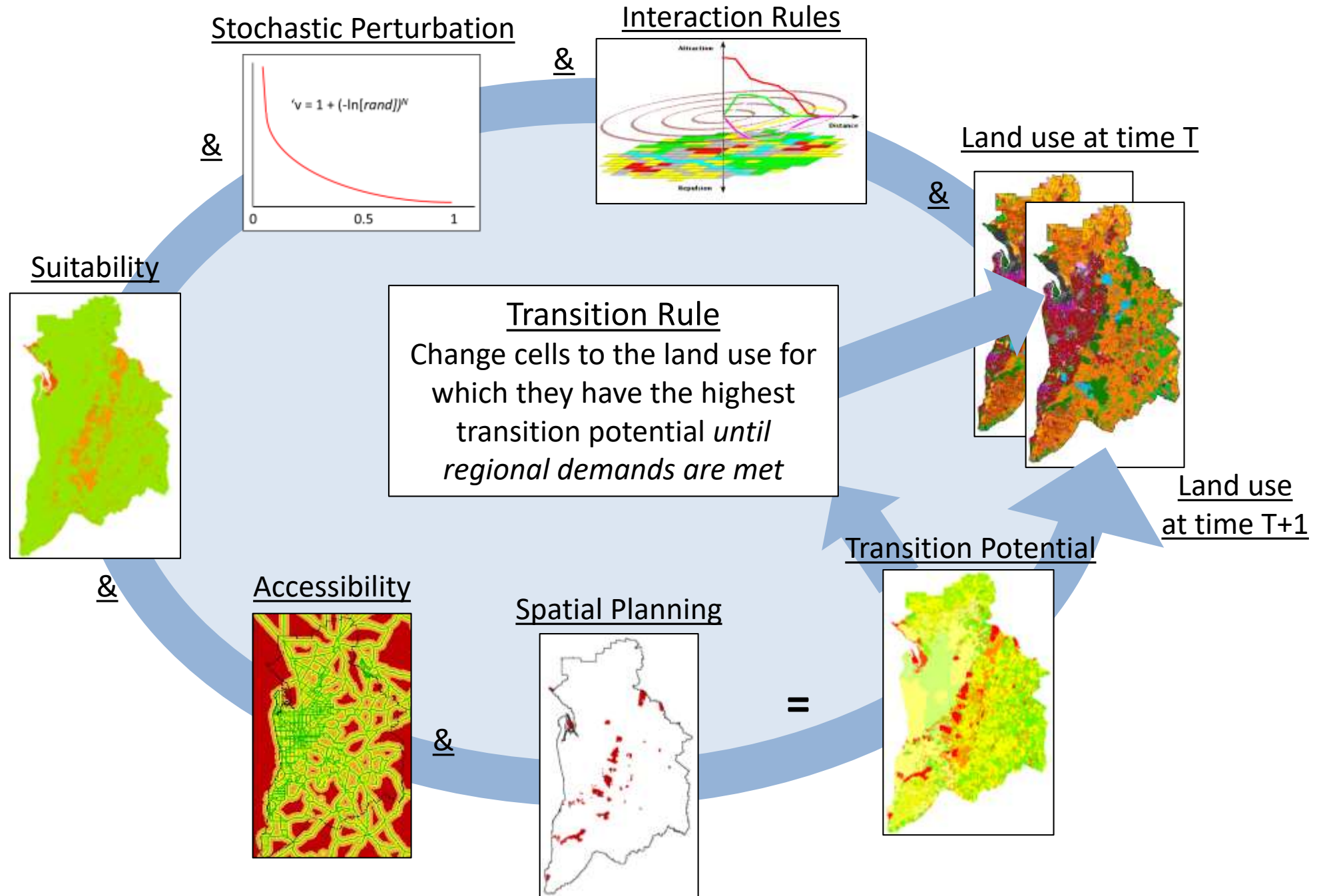




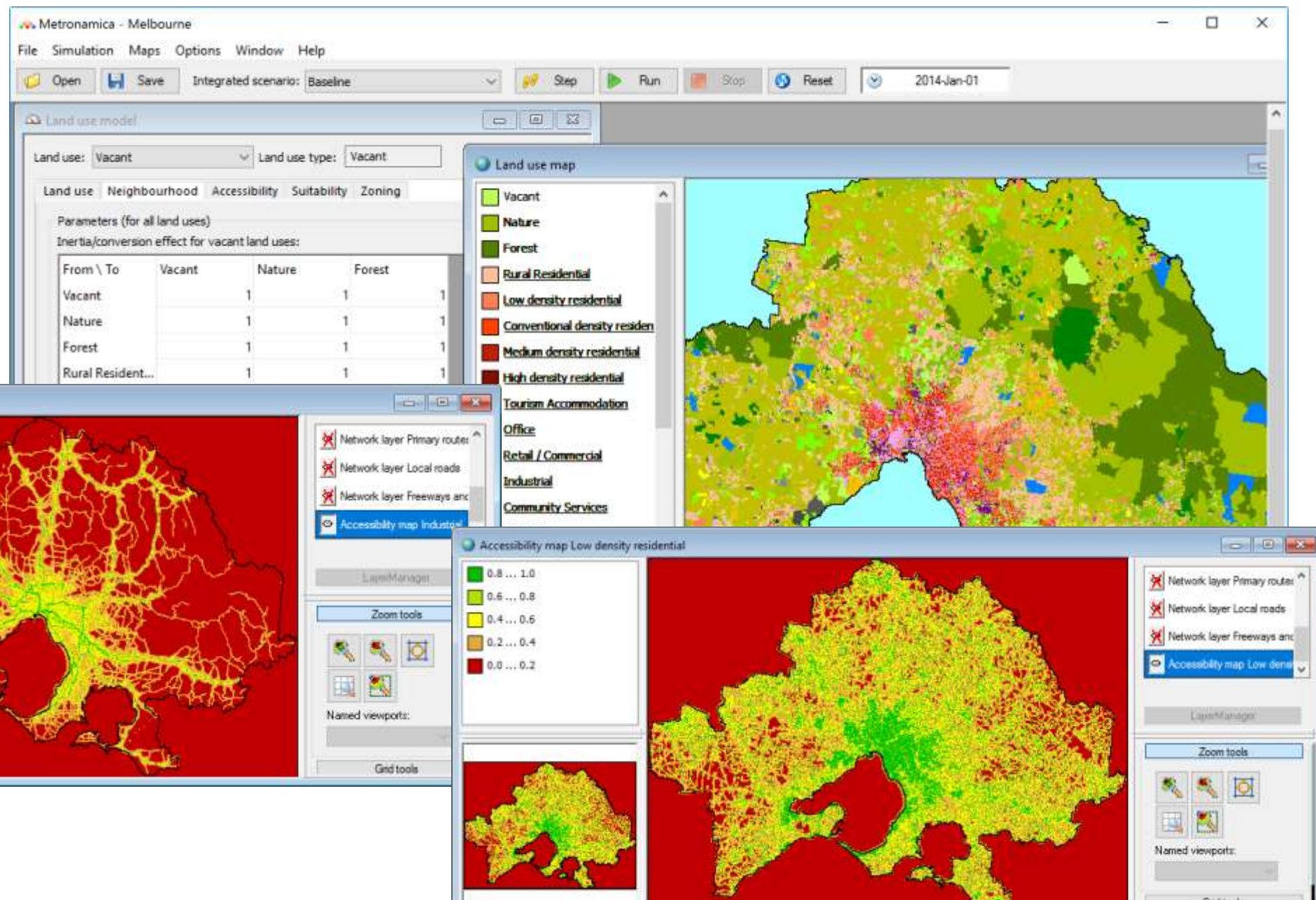




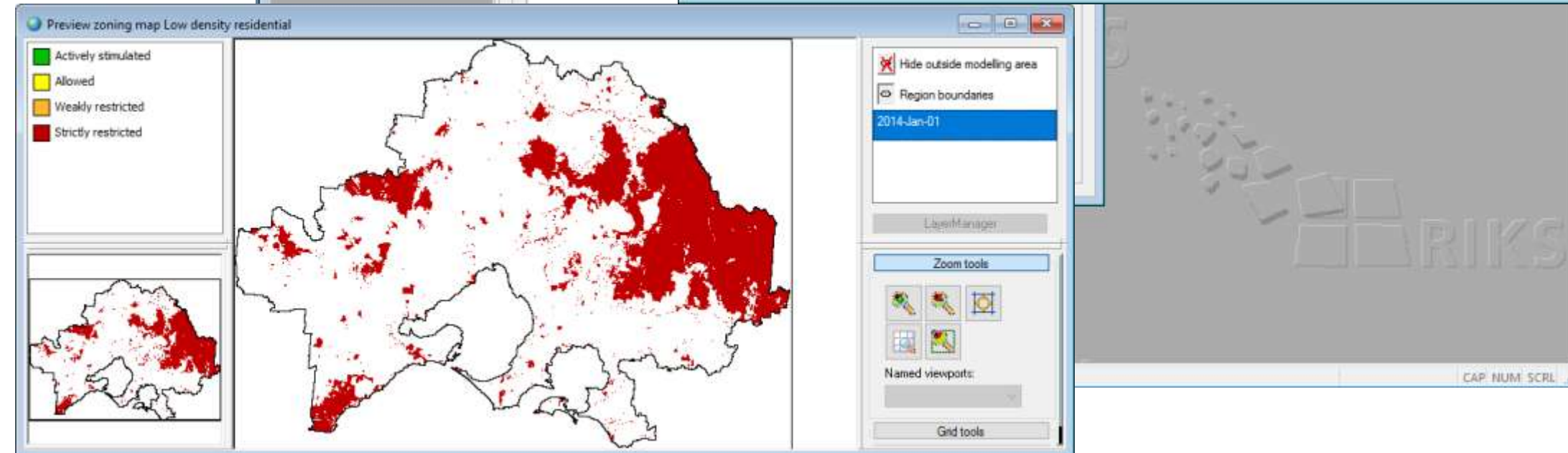
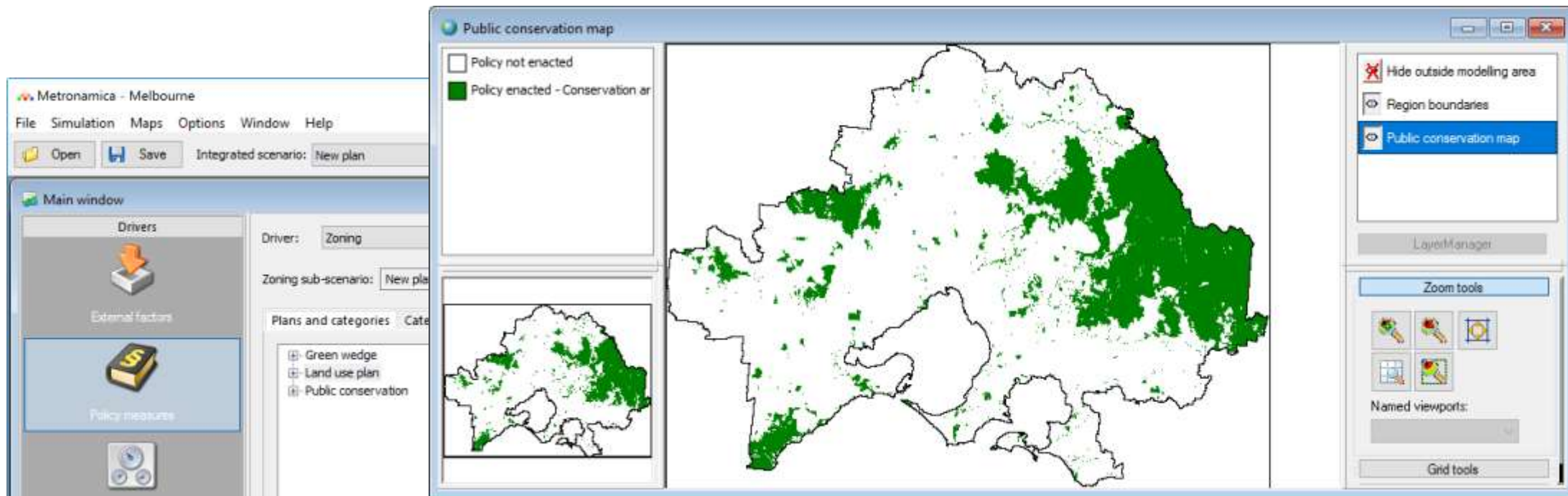




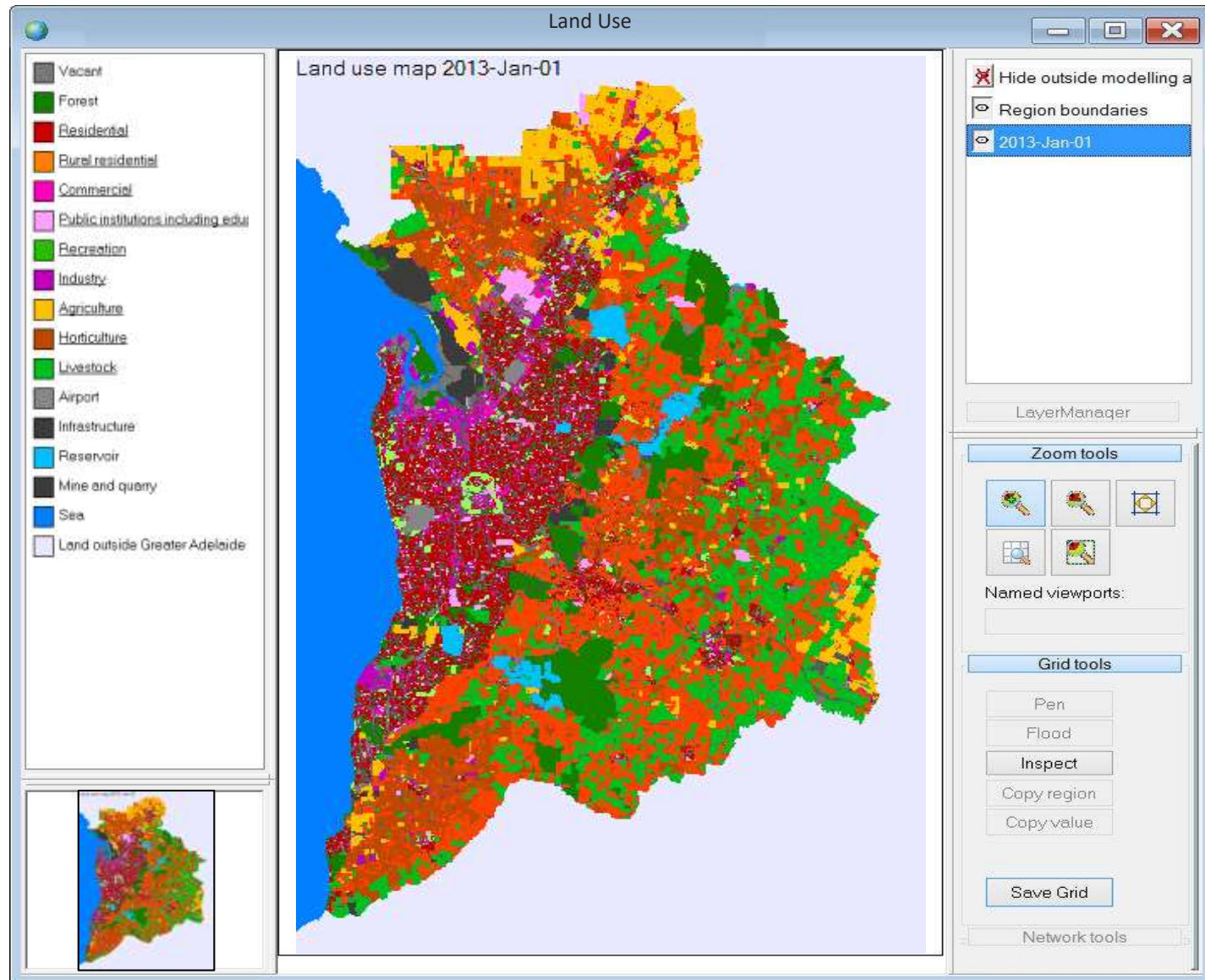
LAND USE



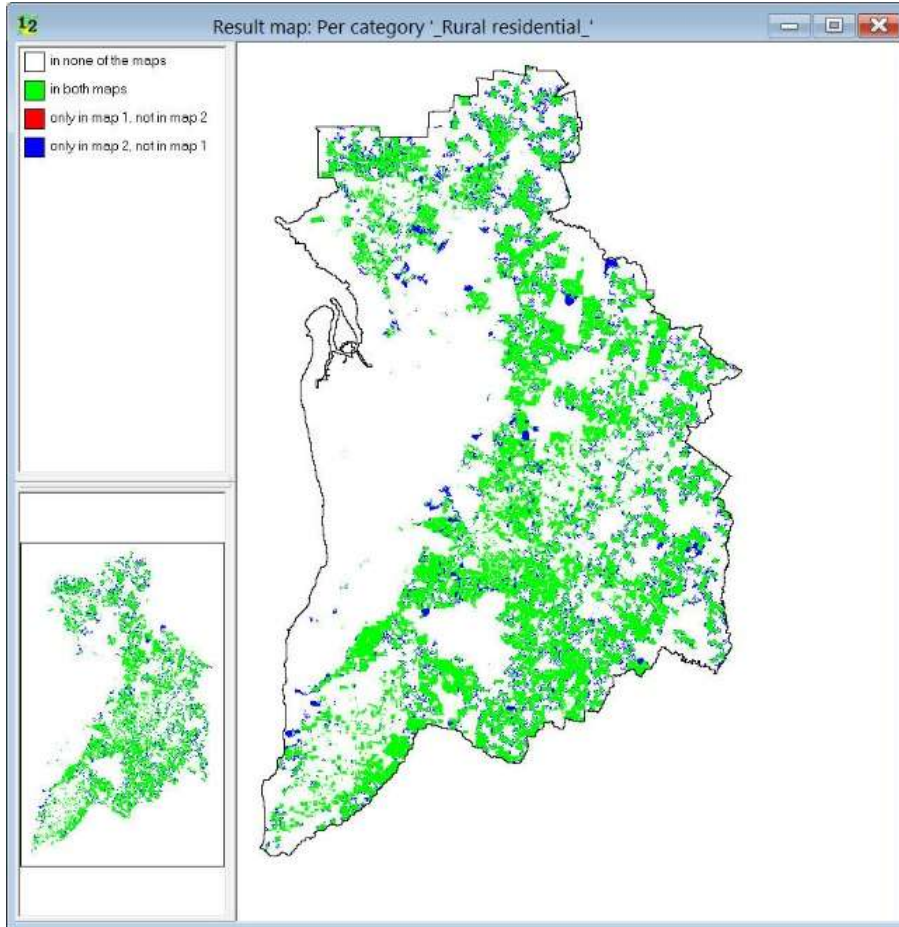
LAND USE



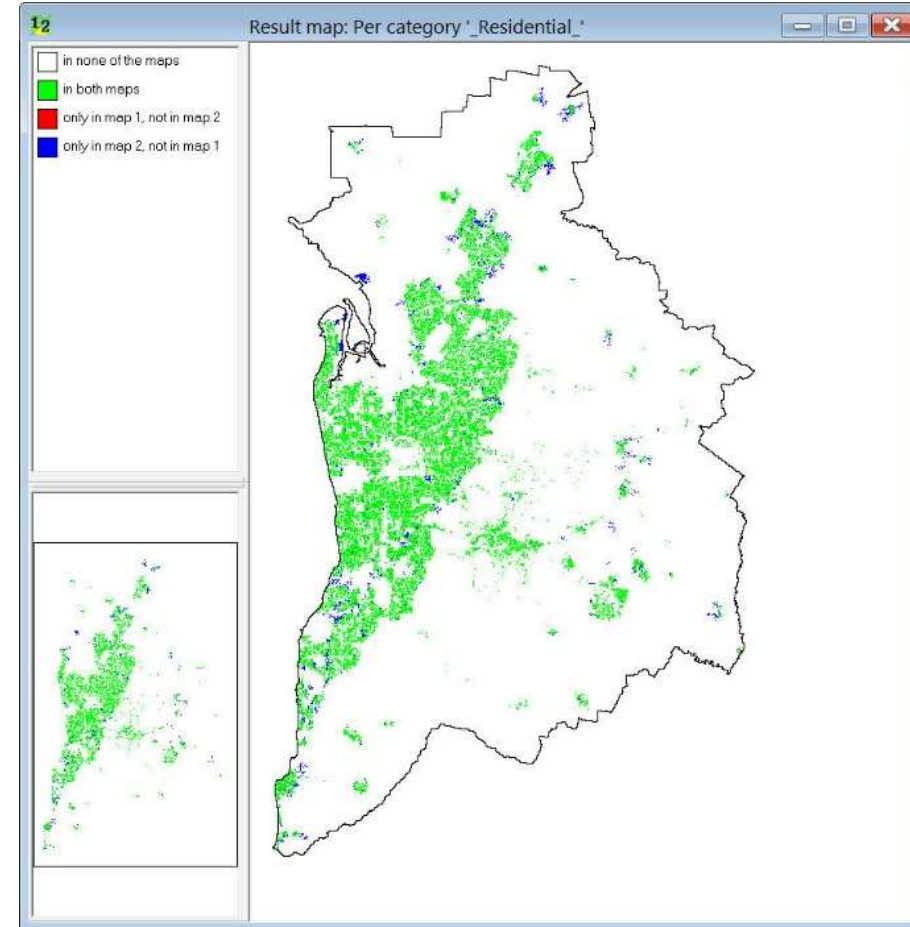
What is future land-use?



What is future land-use?

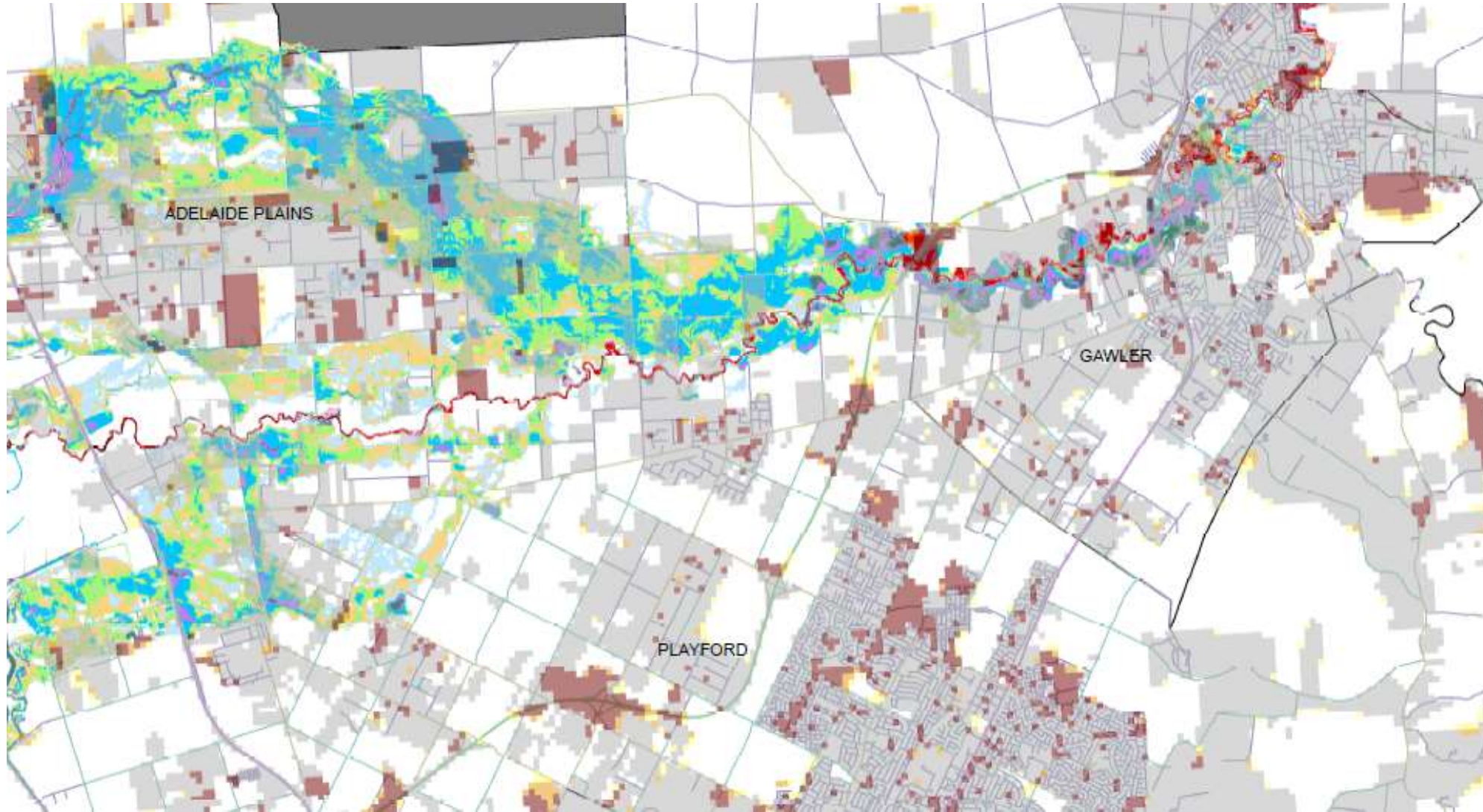


Change Map – Rural
Residential



Change Map – Residential

What is the probability of urbanisation in the future?





Main window



Drivers



External drivers



Policy drivers



System diagram

Scenarios

Indicators

Analysis

Climate

Socio-
economics

Land use

Land value

Building stock

Earthquake

Bushfire

Riverine
flooding

Coastal
inundation

Heatwave

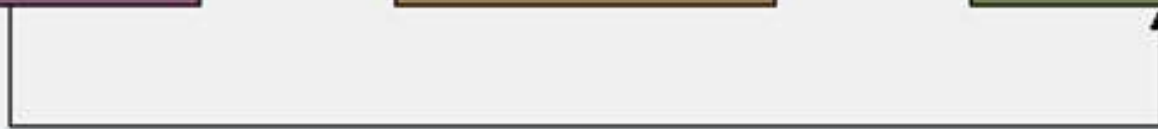
Average
Annual Loss

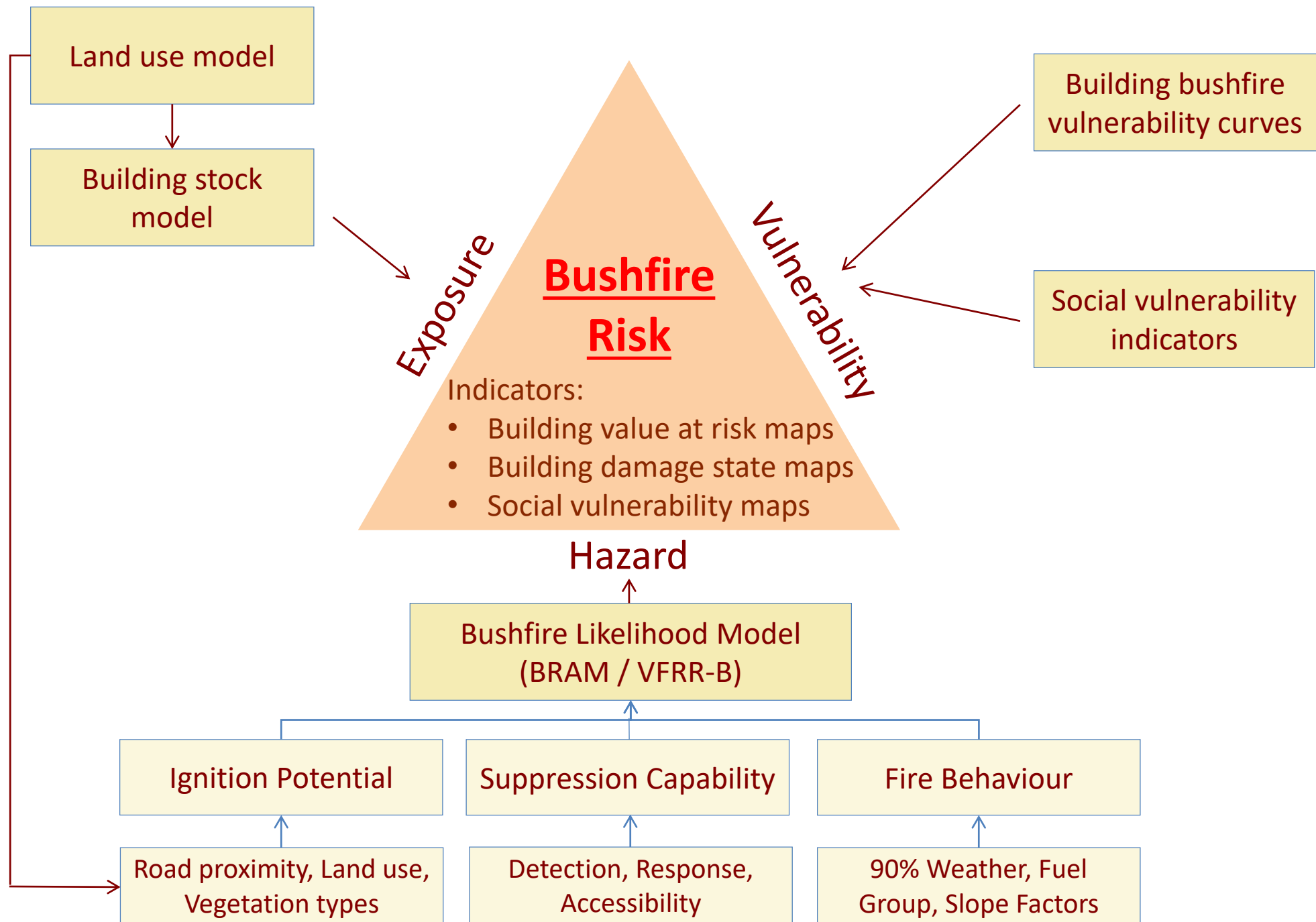
Fatalities /
casualties

Cost benefit
analysis

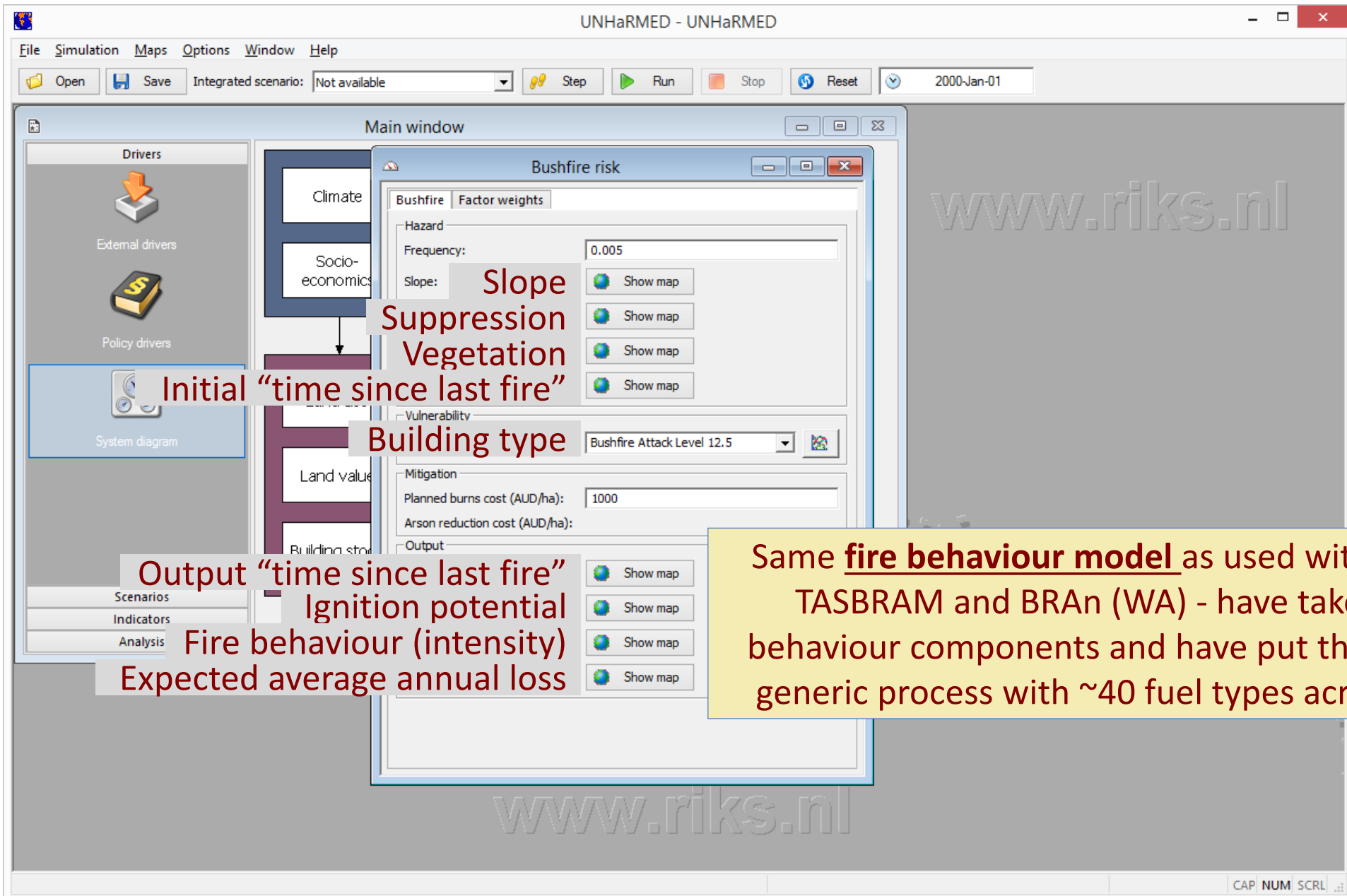
Social

Environmental

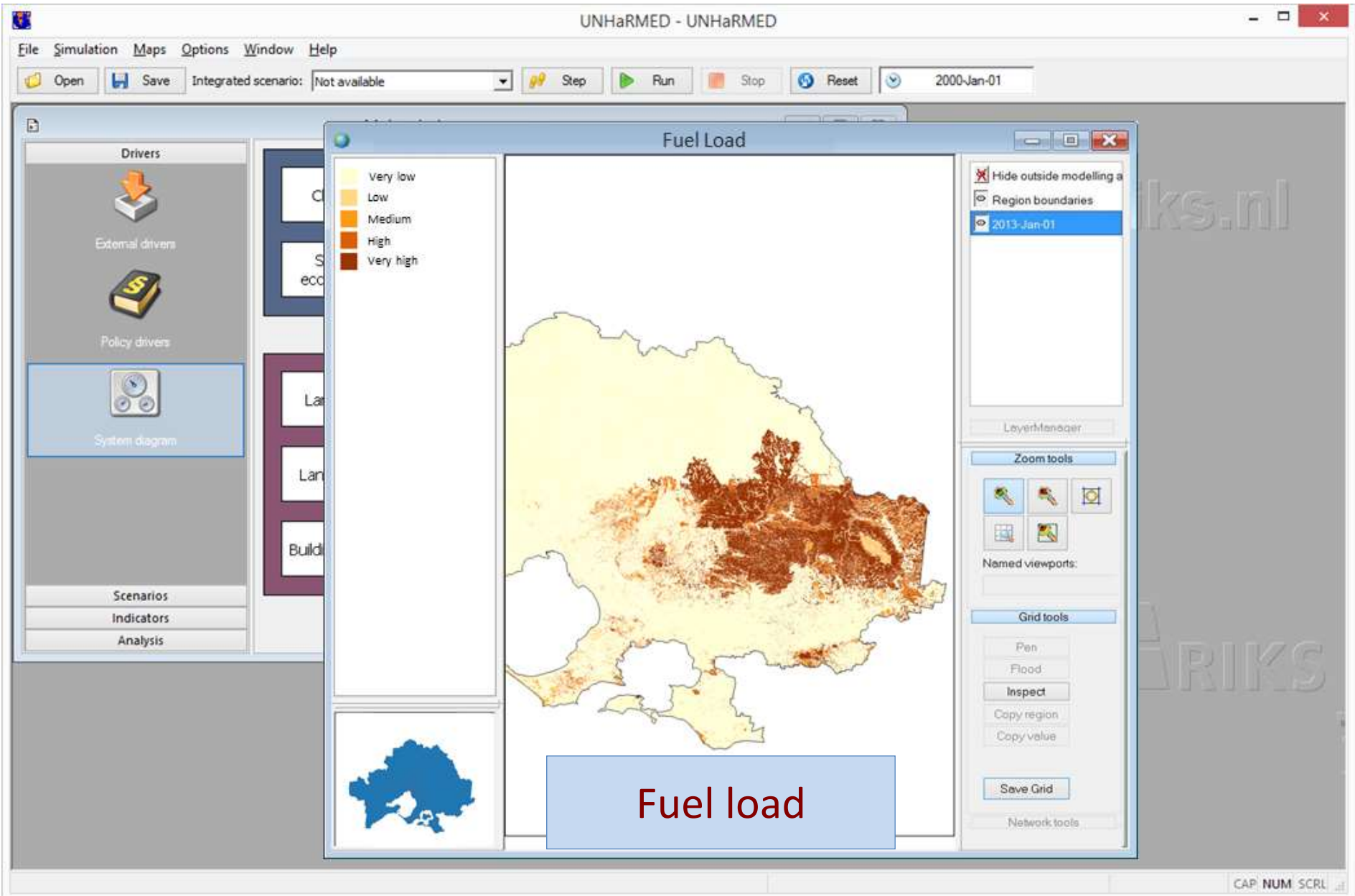




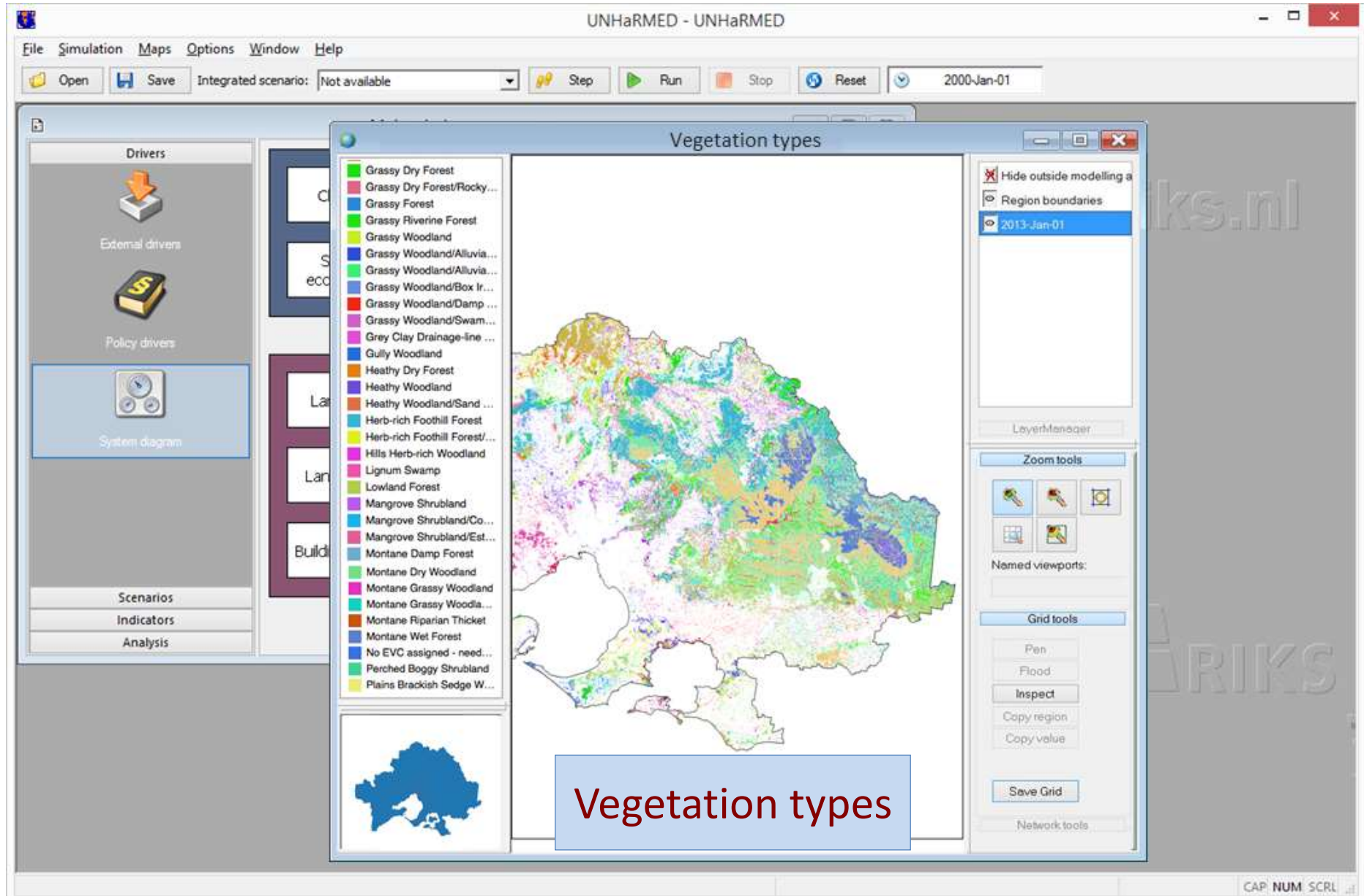
MODELLER INTERFACE BUSHFIRE



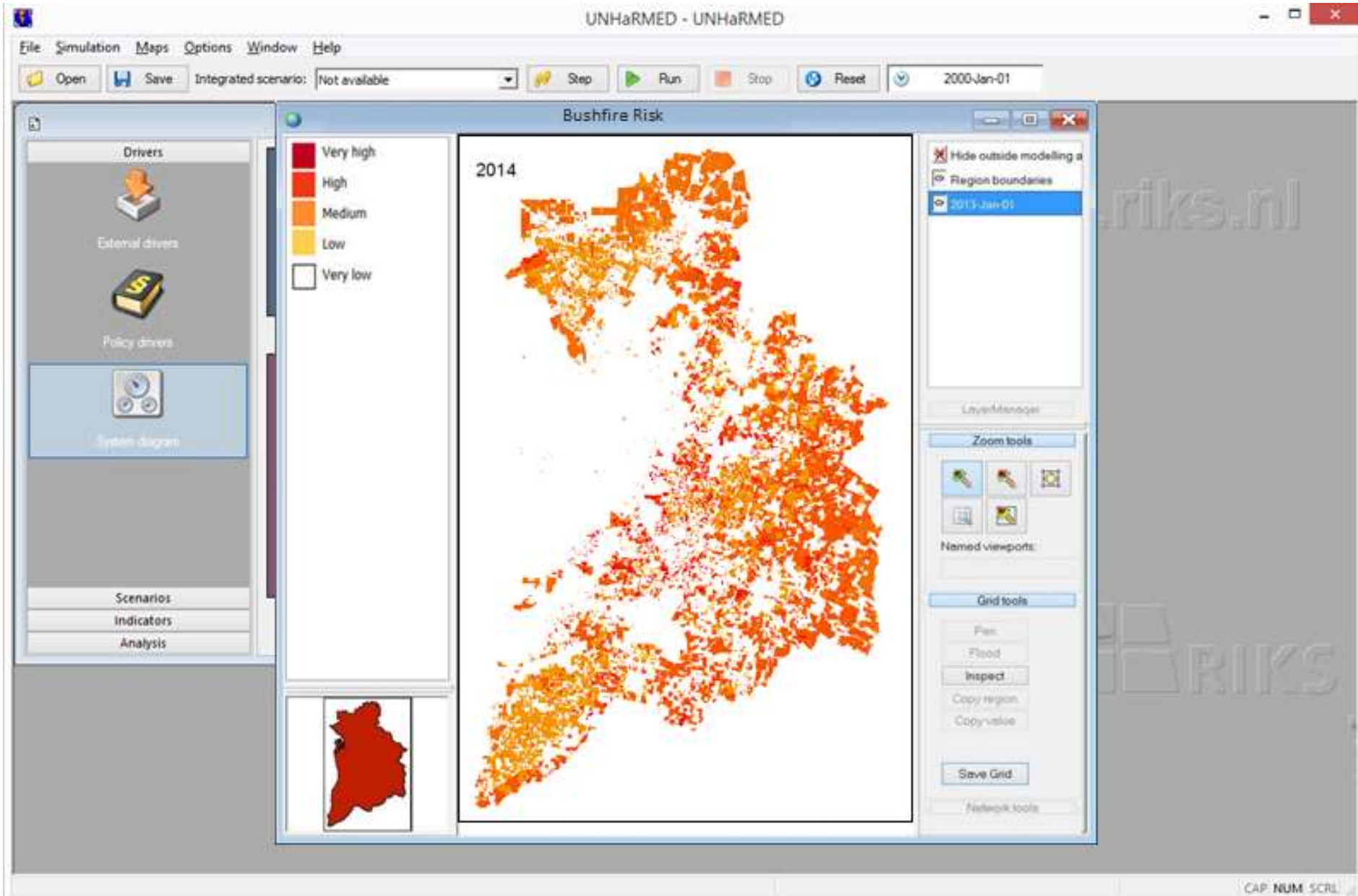
MODELLER INTERFACE BUSHFIRE



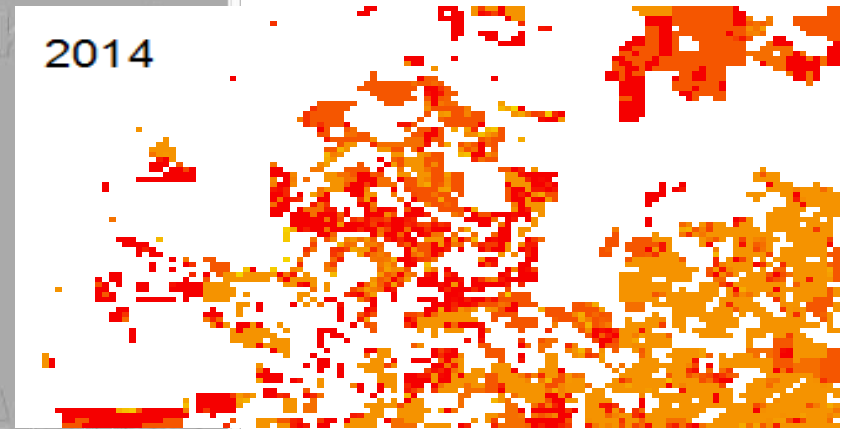
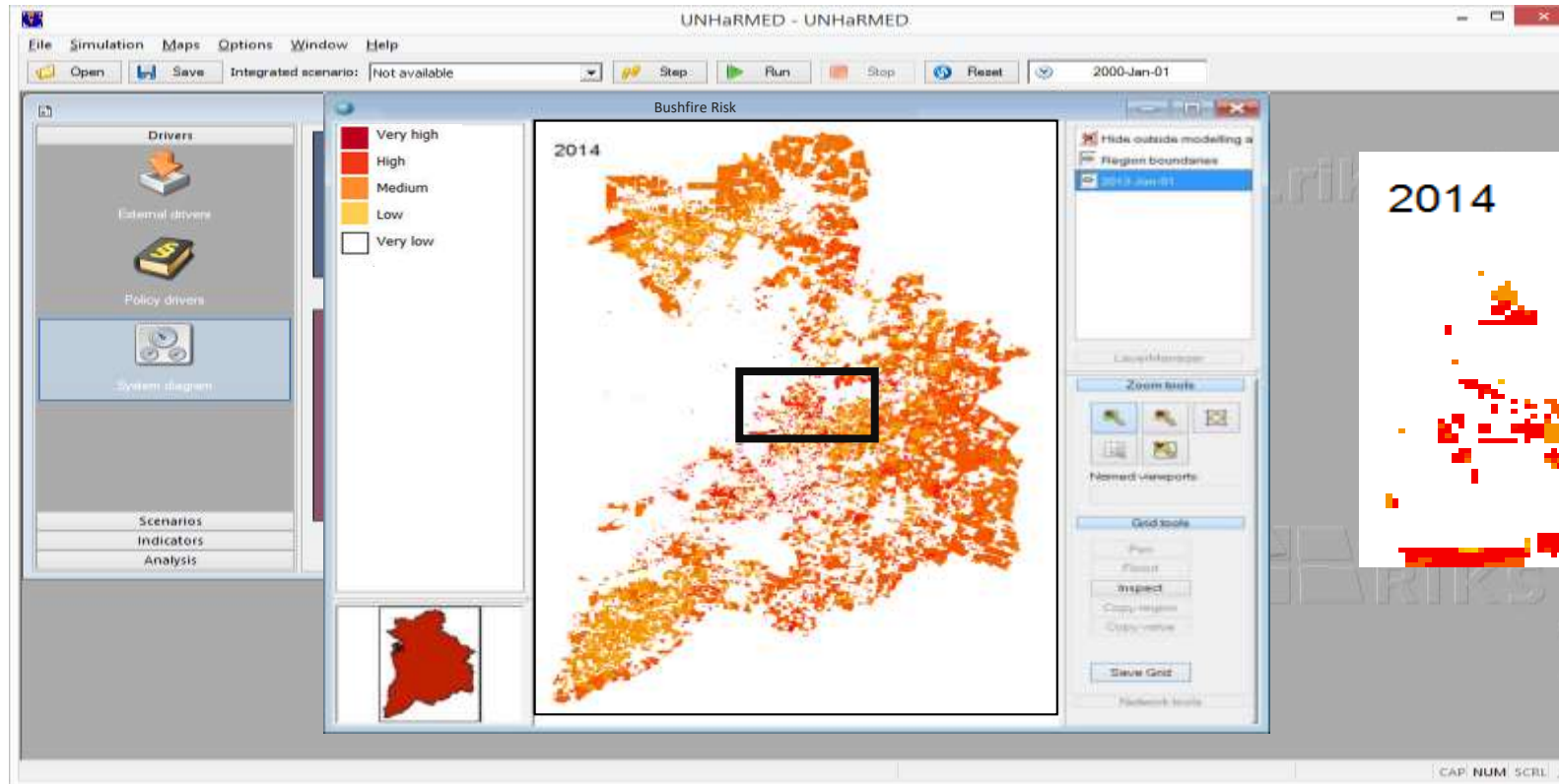
MODELLER INTERFACE BUSHFIRE



What is the current bushfire risk?



What is the future bushfire risk?



POLICY INTERFACE BUSHFIRE – RISK REDUCTION

UNHaRMED - UNHaRMED

File Simulation Maps Options Window Help

Open Save

Integrated scenario: Not available

Step Run Stop Reset

2000-Jan-01

Drivers

External drivers

Policy drivers

System diagram

Scenarios

Indicators

Analysis

Main window

Driver: Bushfire mitigation

Sub-scenario: Load sub-scenario... Save sub-scenario...

Arson reduction

	Reduction	Cost	Start	End
Break O'Day	0	153	2016	2020
Brighton	0	341	2016	2020
Central Coast	0	214	2016	2020

Community resilience

	Reduction	Cost	Start	End
Break O'Day	Medium	12	2016	2020
Brighton	Medium	32	2016	2020
Central Coast	High	42	2016	2020

Planned burns

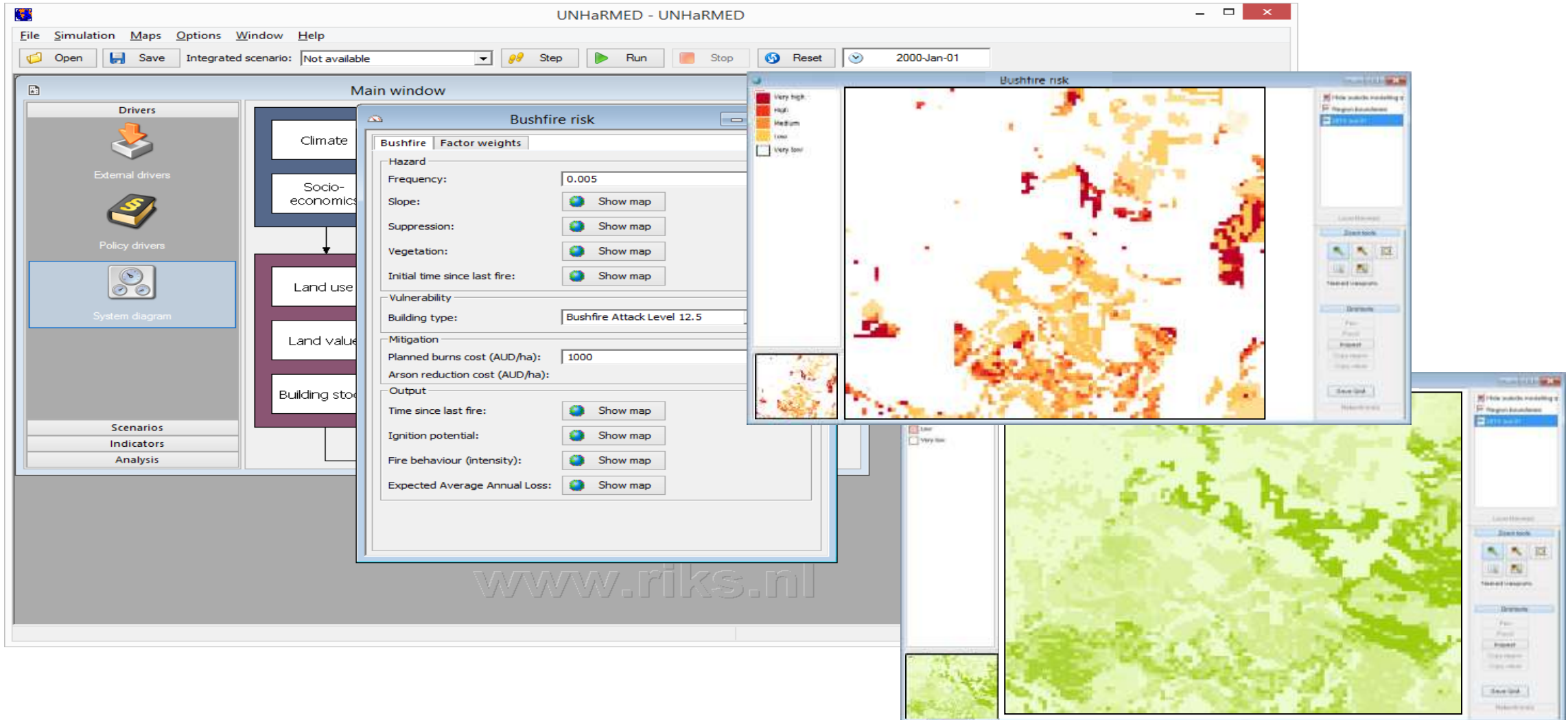
www.riks.nl

RIKS

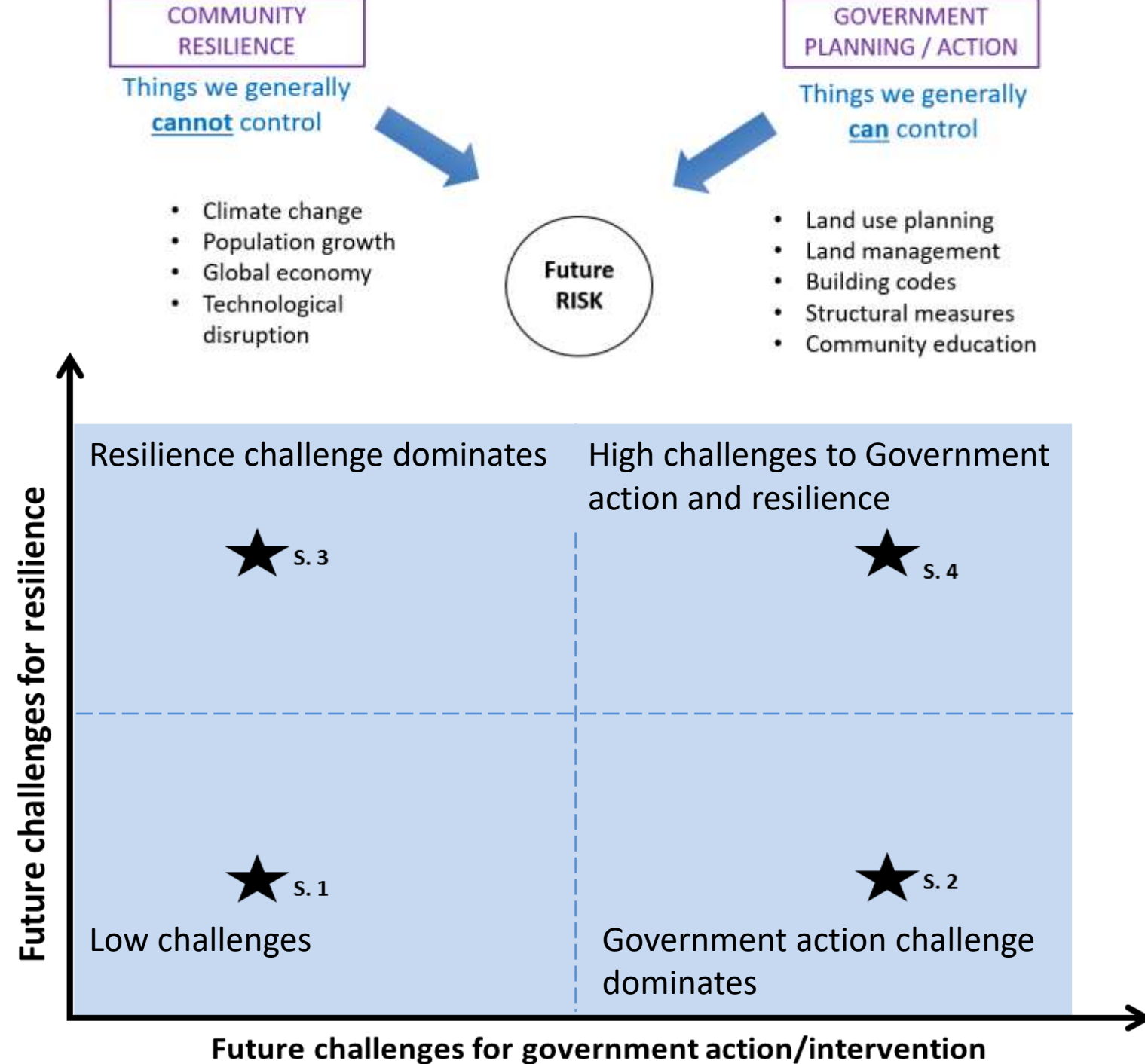
Hazard mitigation

CAP NUM SCRL

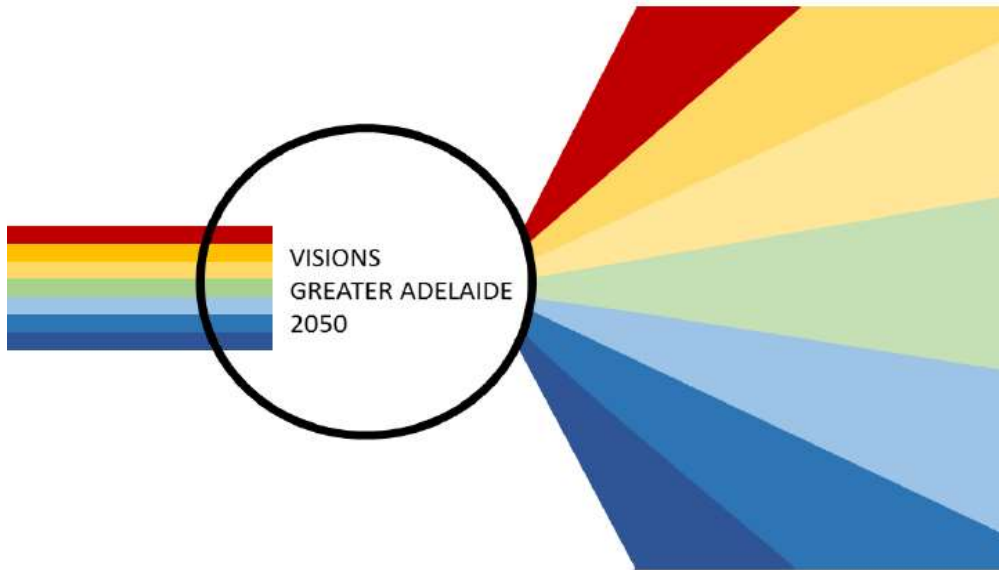
What is the future bushfire risk under planned burning?



PLAUSIBLE FUTURES – INTEGRATED SCENARIOS

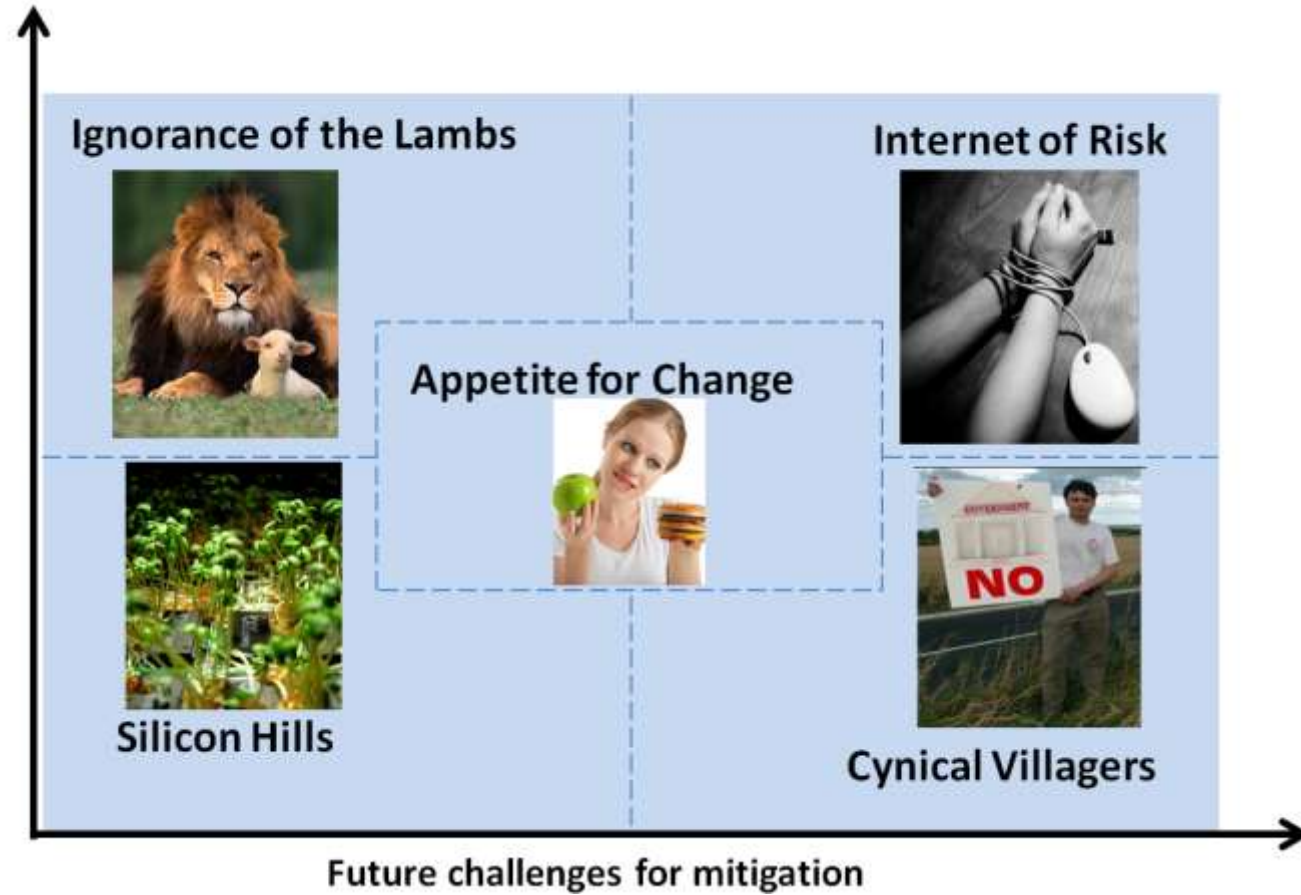






An exploration of disaster risk and the future

Future challenges for resilience

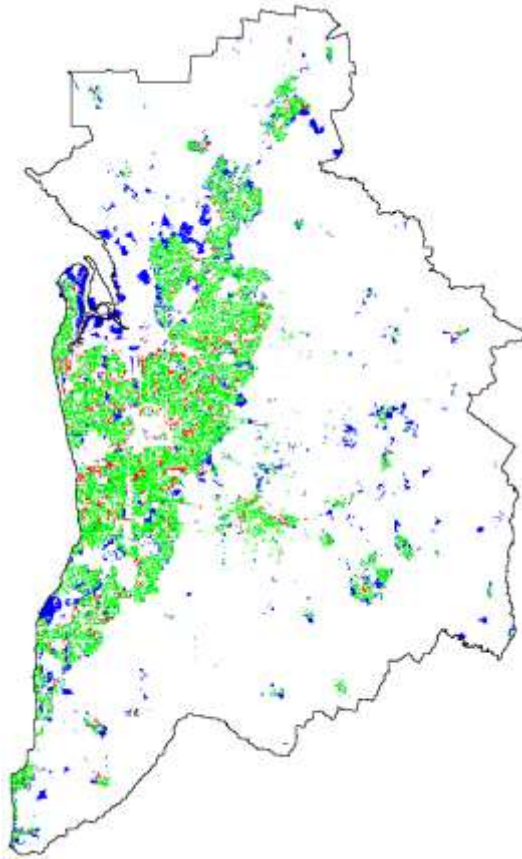
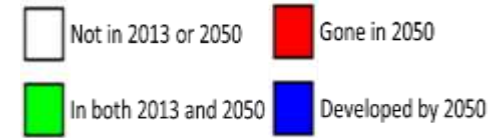


Main scenario drivers and outcomes

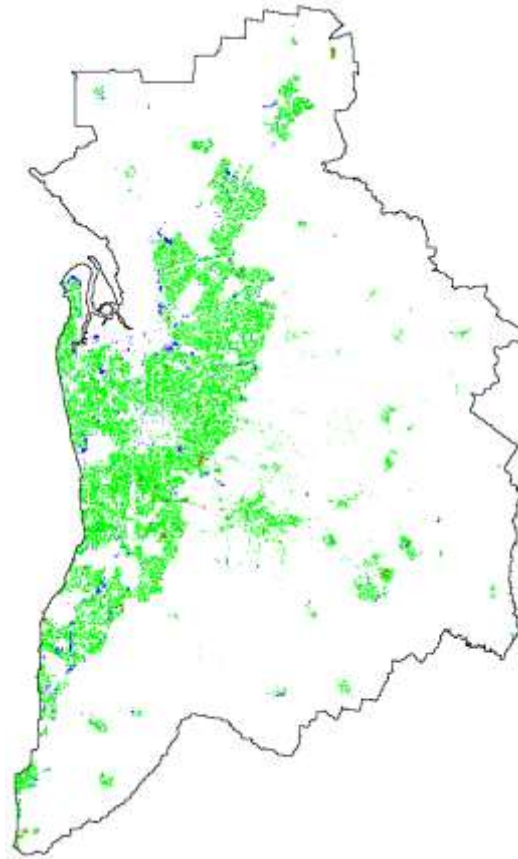
	Silicon Hills	Cynical Villagers	Ignorance of the Lambs	Appetite for Change	Internet of Risk
Population in 2050	1.9 M	1.5 M	2.5 M	1.8 M	1.5 M
Economy					
Community resilience					
Building stock resilience					
Residential land use developments	<i>Gradual growth urban and rural areas</i>	<i>Large increase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

Scenarios

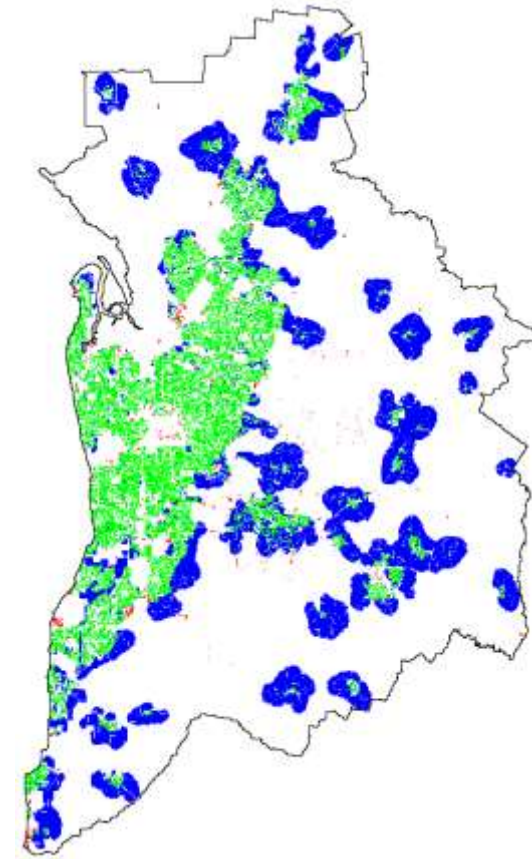
RESIDENTIAL LAND USE CHANGES 2013 - 2050



Low challenges



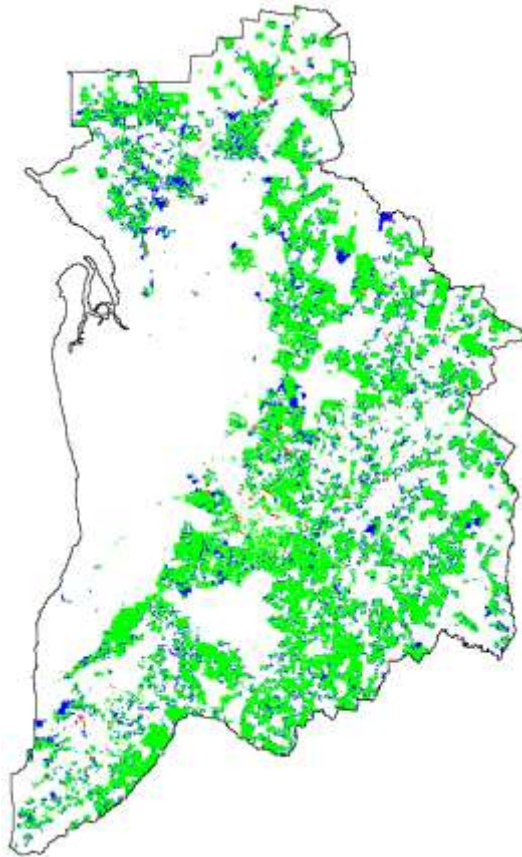
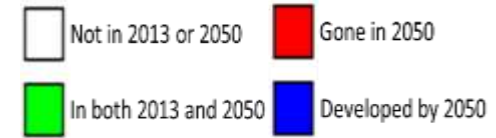
High challenges to
Government action



High challenges to
resilience

Scenarios

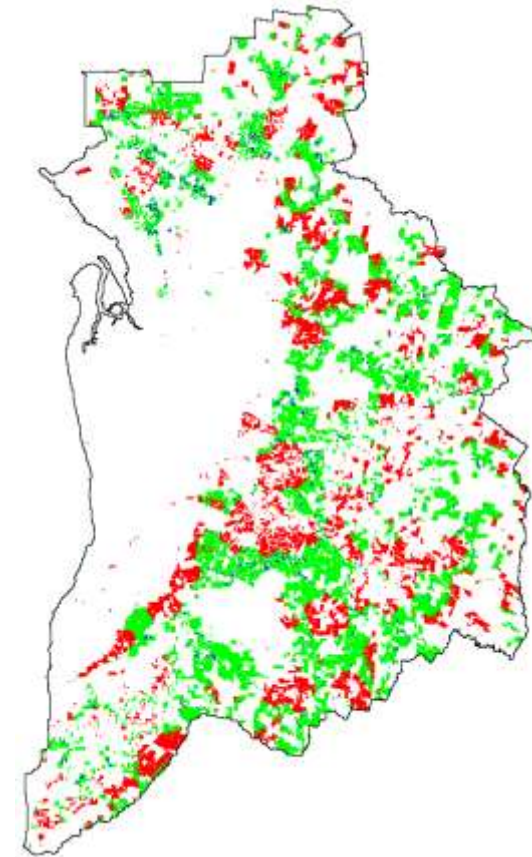
RURAL RESIDENTIAL LAND USE CHANGES 2013 - 2050



Low challenges



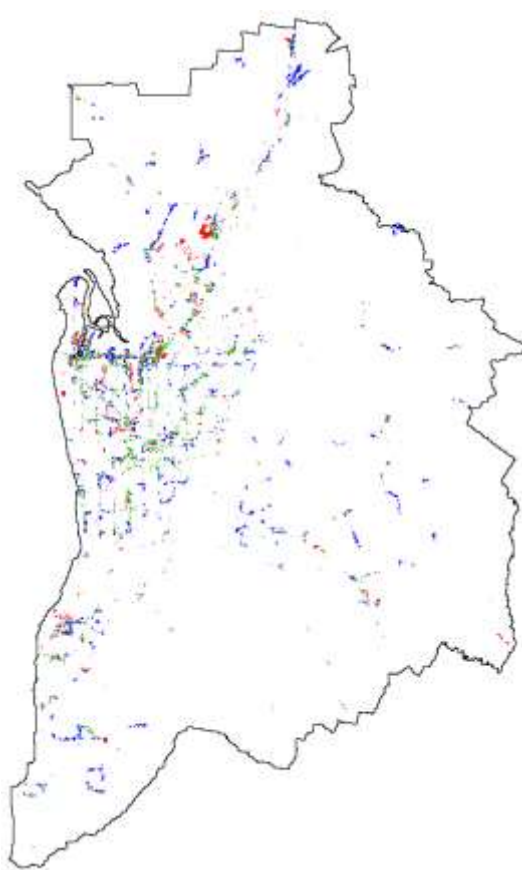
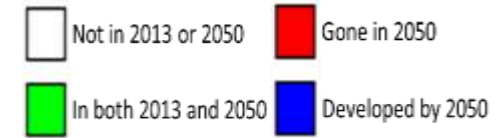
High challenges to
Government action



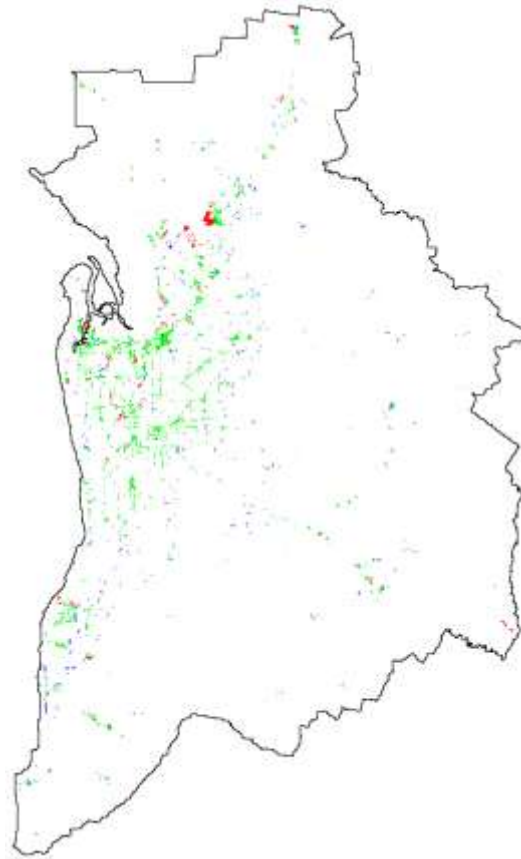
High challenges to
resilience

Scenarios

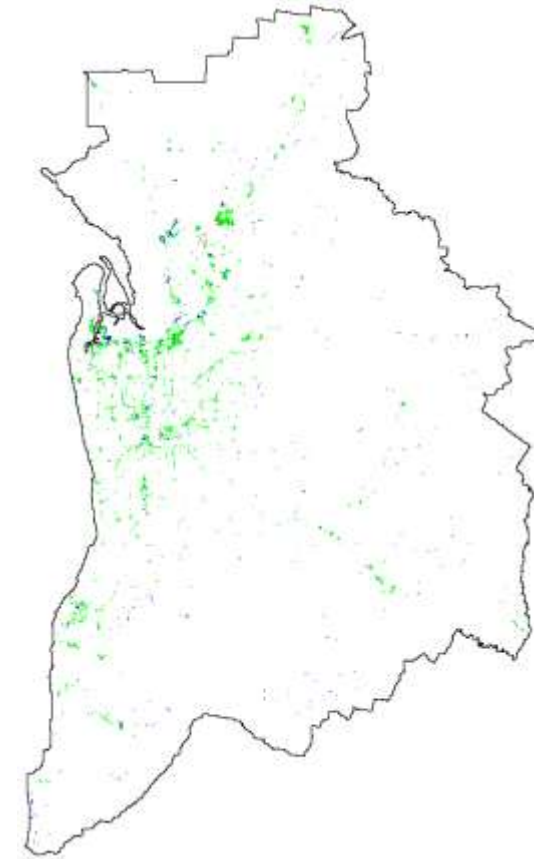
COMMERCIAL LAND USE CHANGES 2013 - 2050



Low challenges

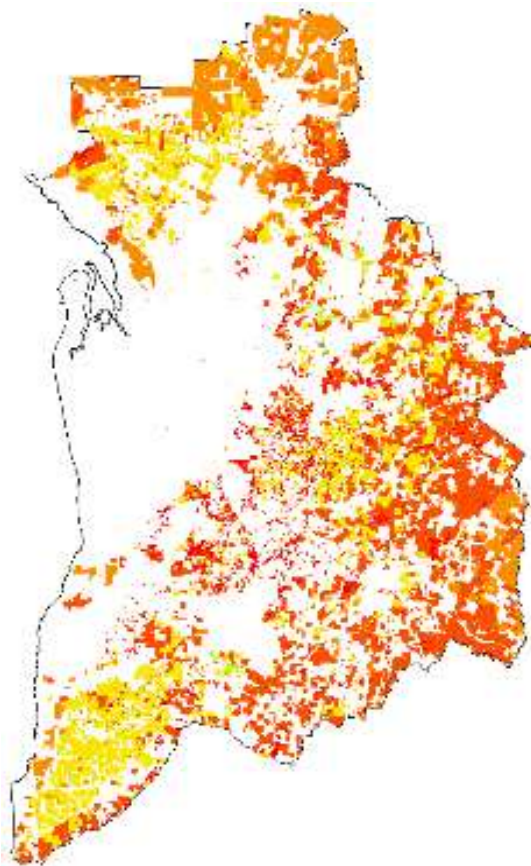


High challenges to
Government action

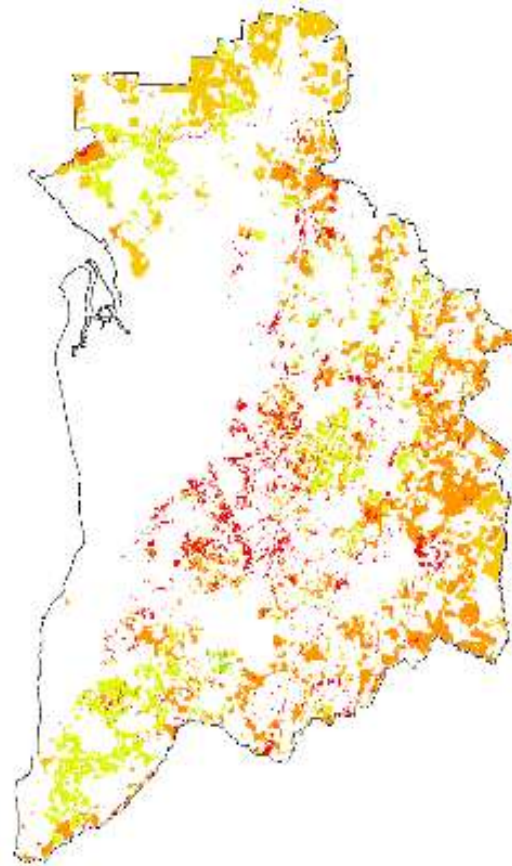


High challenges to
resilience

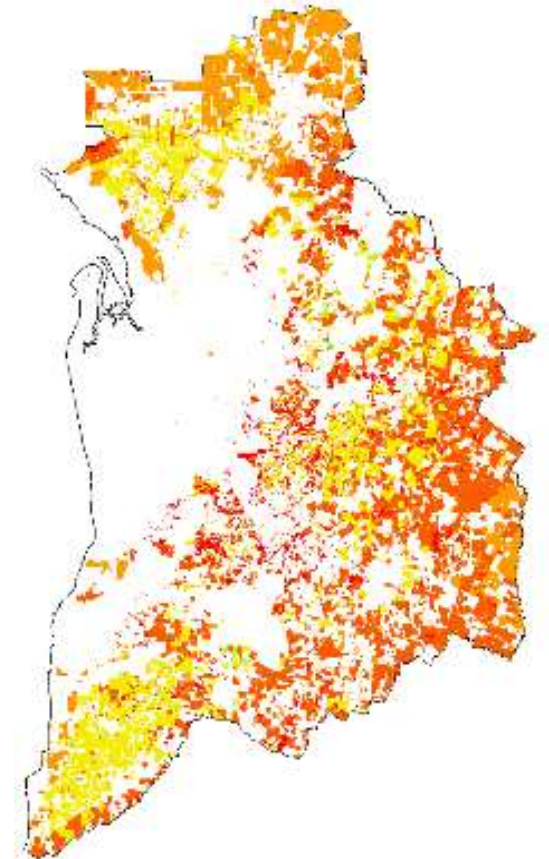
ANNUAL AVERAGE DAMAGE BUSHFIRE 2050



Low challenges



High challenges to
Government action

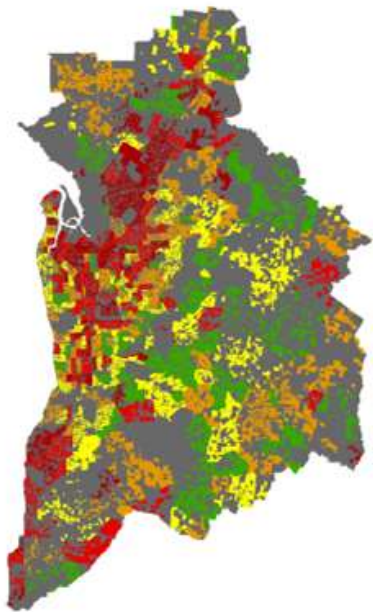


High challenges to
resilience

SOCIAL VULNERABILITY

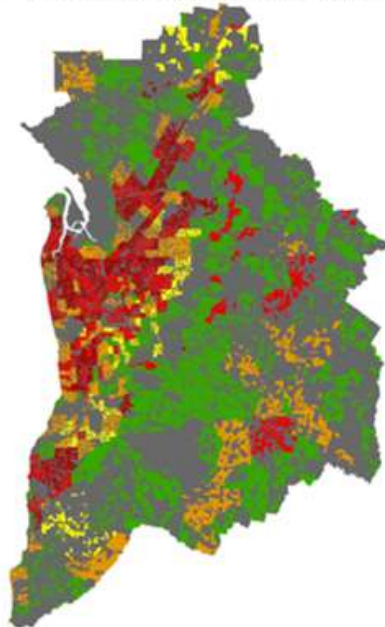
Indicators	Variable	Units
Personal wealth	Estimates of Personal Income (weekly) - Median total income	\$
Age	Estimated Resident Population - Persons - 0-14 years	%
	Estimated Resident Population - Persons - 65 years and over	%
Employment	Labour Force Statistics - Unemployment rate	%
Insufficient English	Proficiency in Spoken English - Not proficient in spoken English	%
Indigenous	Aboriginal and Torres Strait Islander Peoples - Proportion of total population	%
Family structure	Family Structure - Count of dependent children per parent	No. of dependents per parent
Volunteering	Voluntary Work for an Organisation or Group	%
New to region	Usual Address One Year Ago - Elsewhere in Australia and Overseas	%
Education	Highest Year of School Completed – Year 12 or equivalent	%
Need assistance	Core Activity Need for Assistance	%
Car ownership	Motor Vehicles – One or more motor vehicles per dwelling	%
Population Growth	Total Estimated Residential Population in 2011 – Total Estimated Residential Population in 2006	%
Public Housing	Number of Dwellings Rent from the State or Territory Housing Authority	%

Proportion of Unemployment



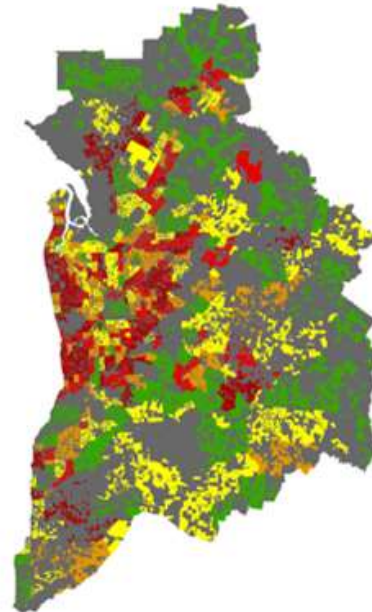
(a)

Proportion of Public Housing



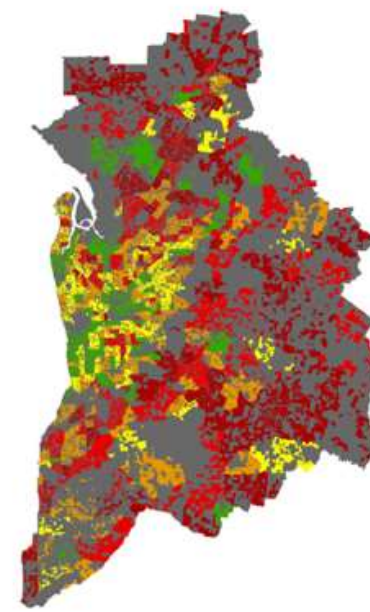
(b)

Proportion of Elderly People



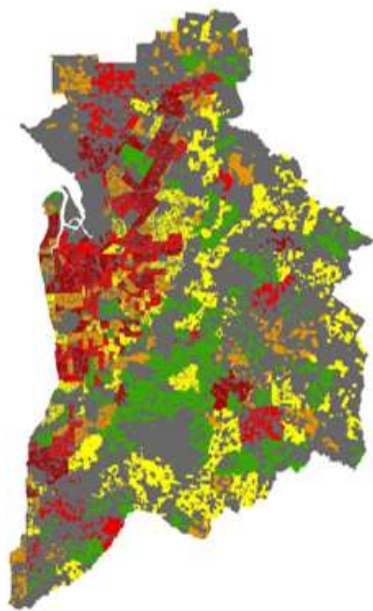
(c)

Proportion of Young People

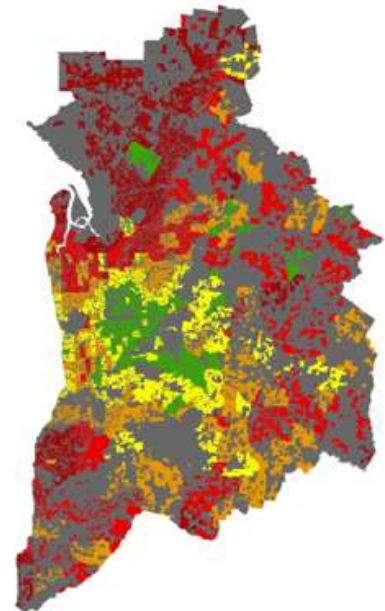


(d)

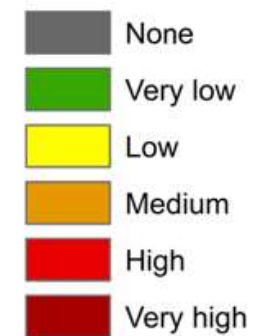
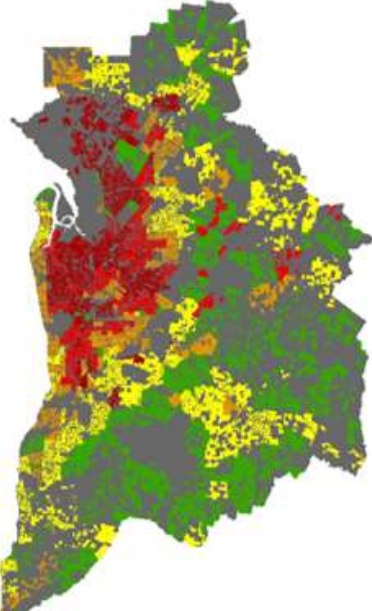
Proportion of Individuals Needing Assistance



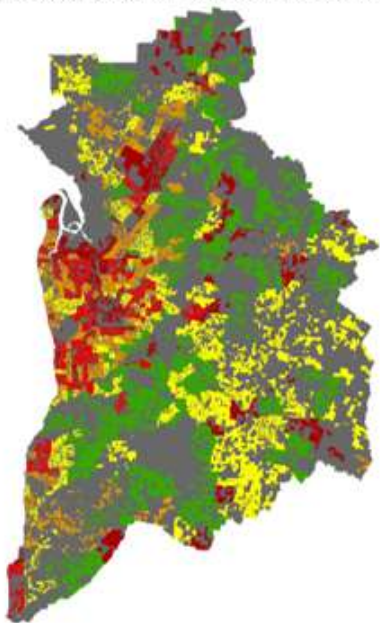
Proportion of Low Education



Proportion of Low English Proficiency

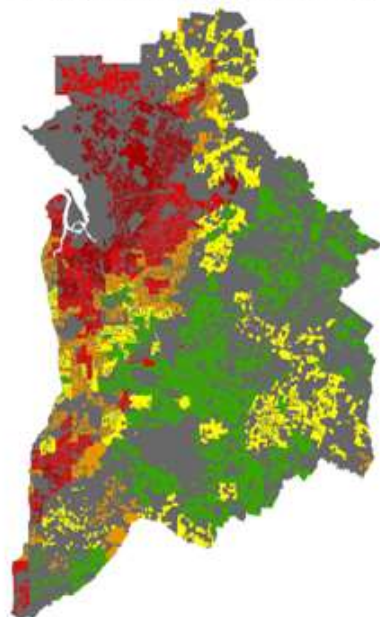


Proportion of Car Ownership

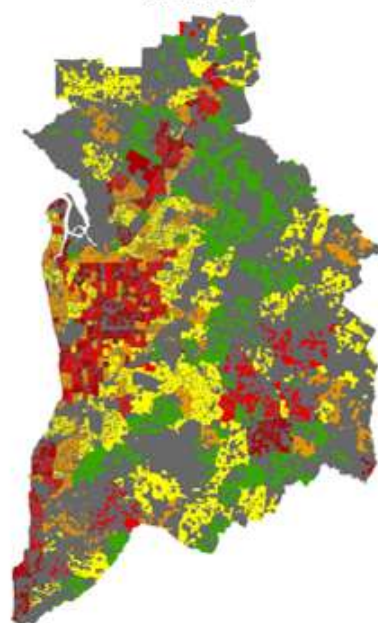


(a)

Proportion of Volunteers

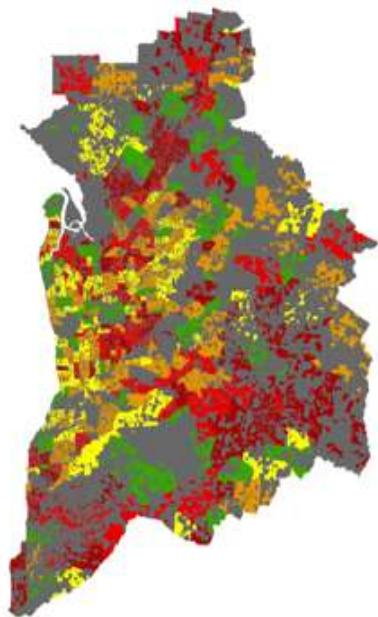


Proportion of Individuals Recently Moved to the Area

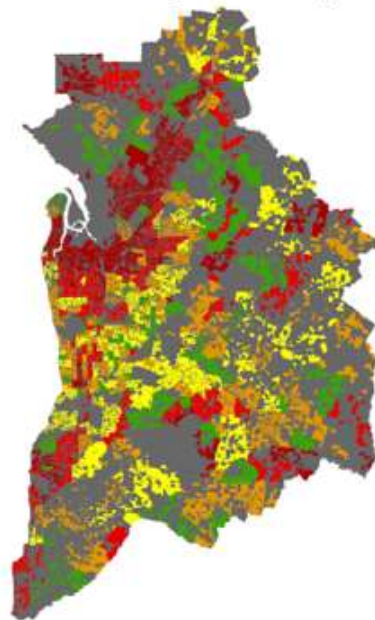


(b)

Family Structure

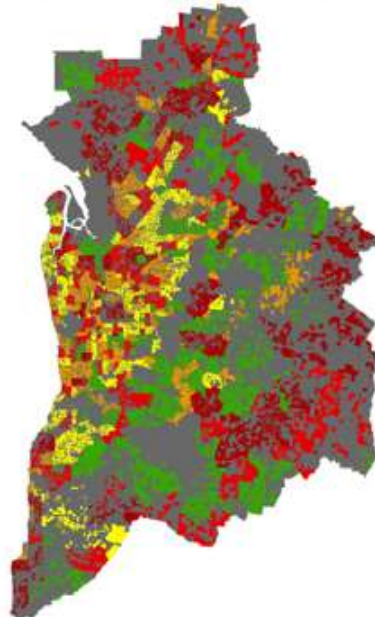


Proportion of Indigenous Population

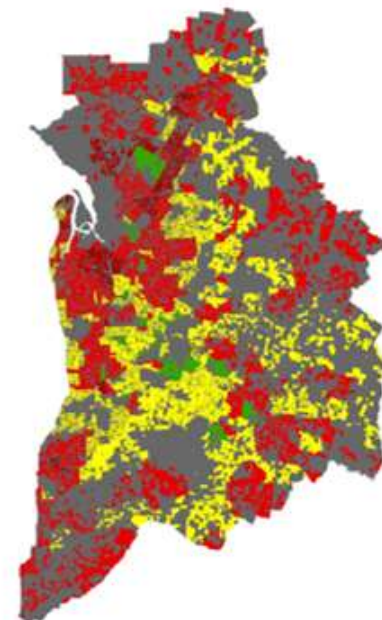


(c)

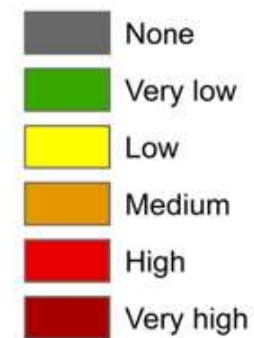
Net Population Growth



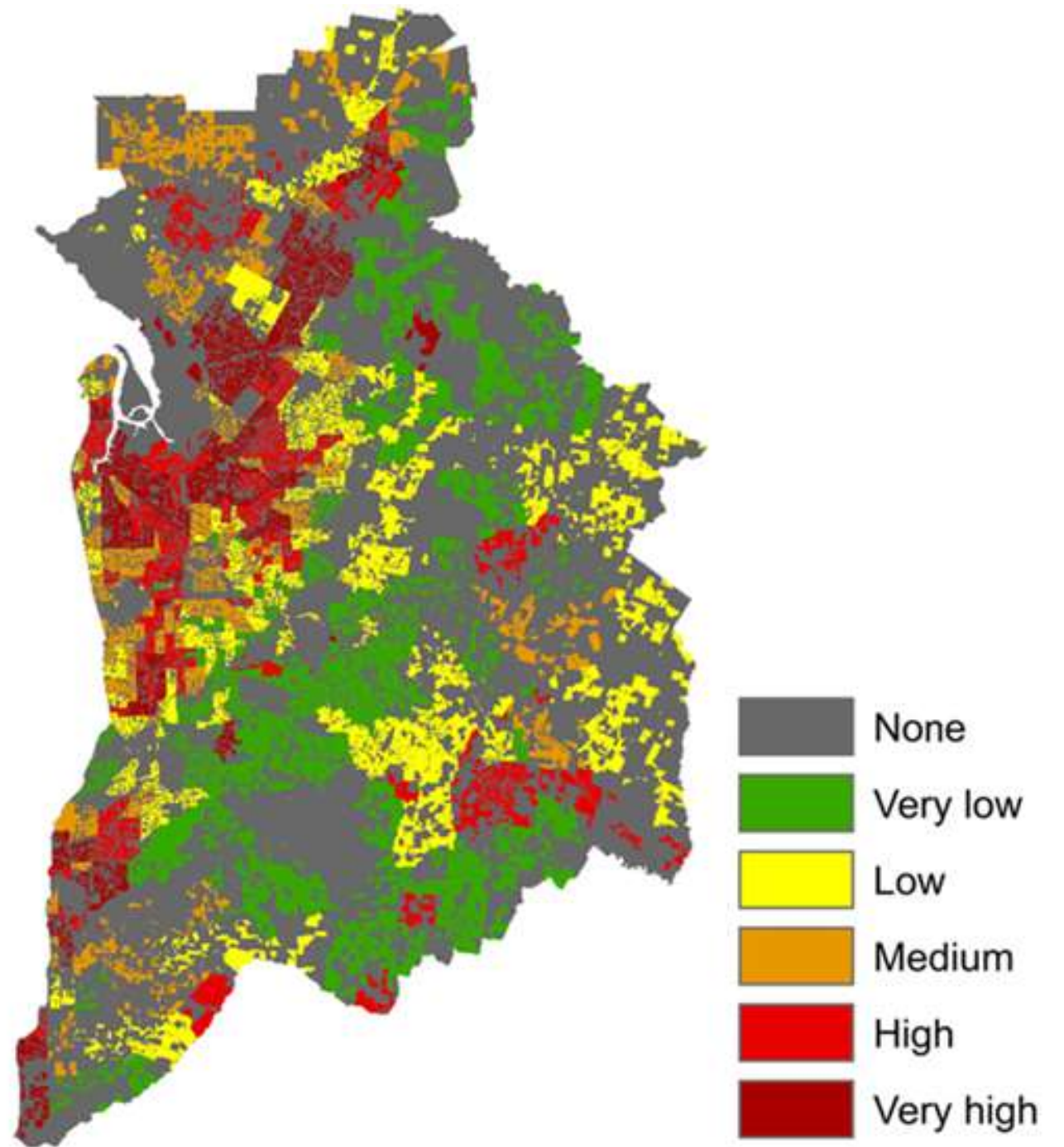
Personal Wealth



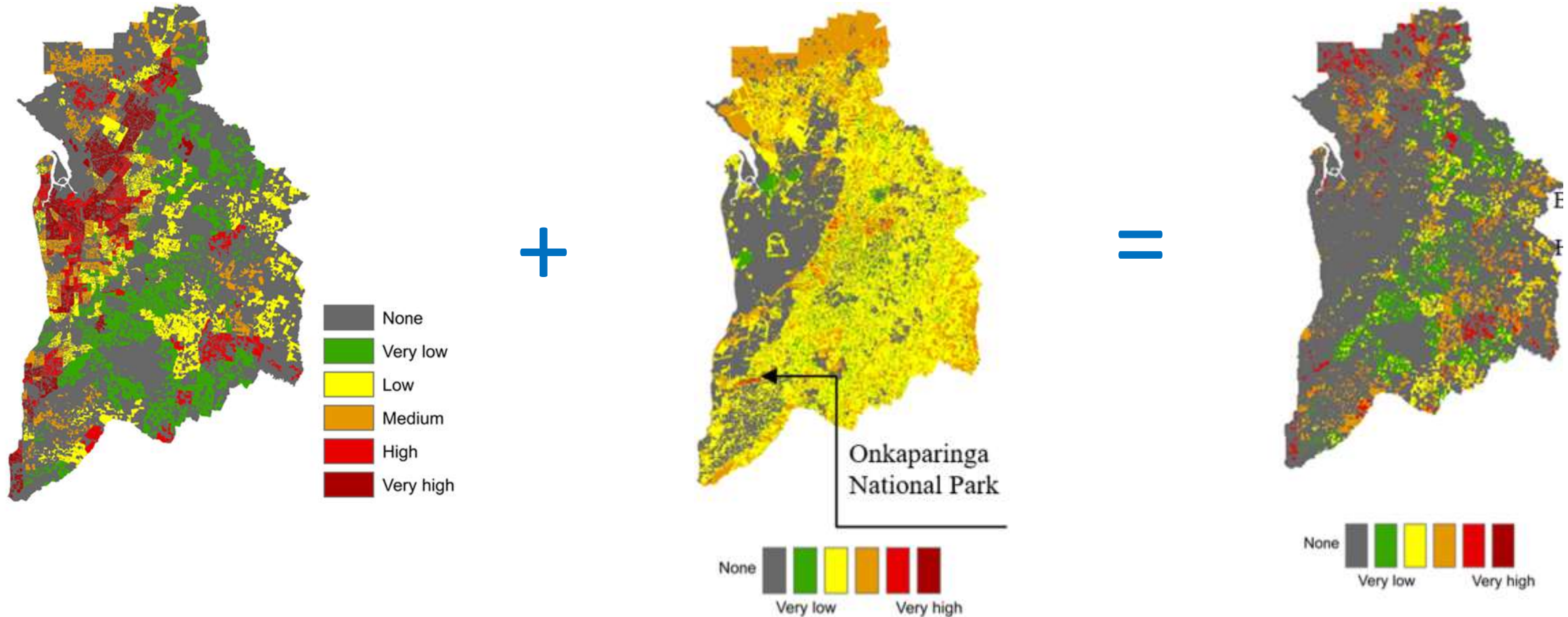
(d)



COMBINED SOCIAL VULNEARBILITY INDEX



What is the current bushfire risk due to social vulnerability?



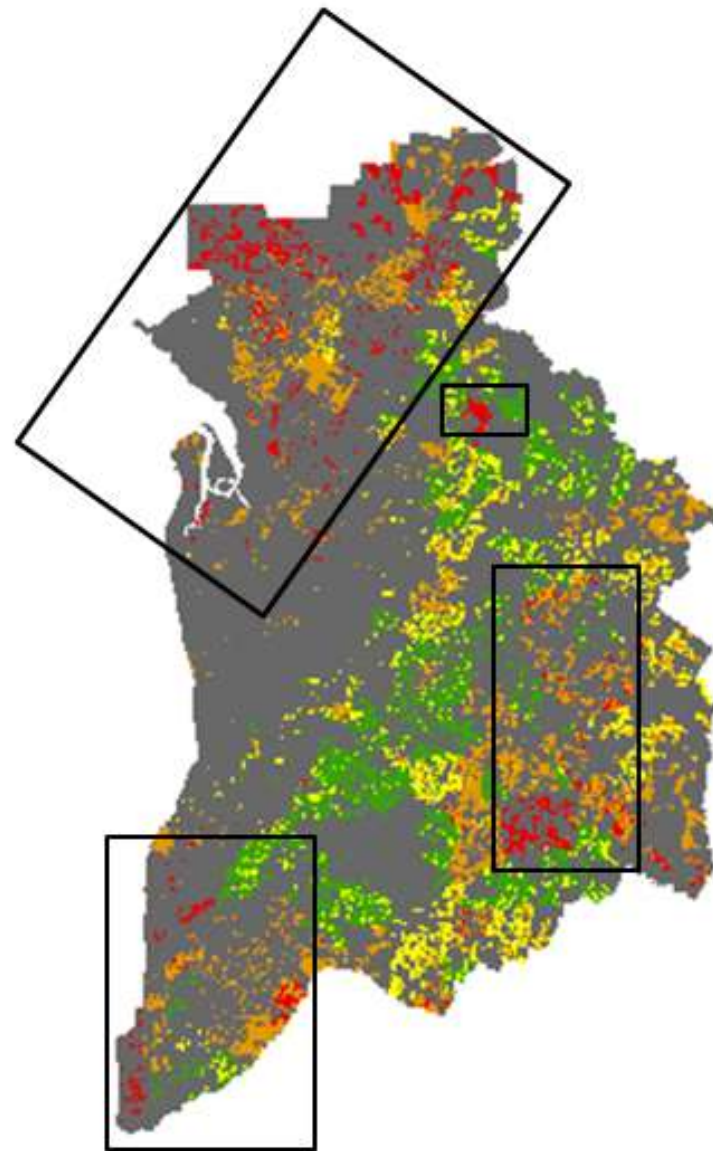
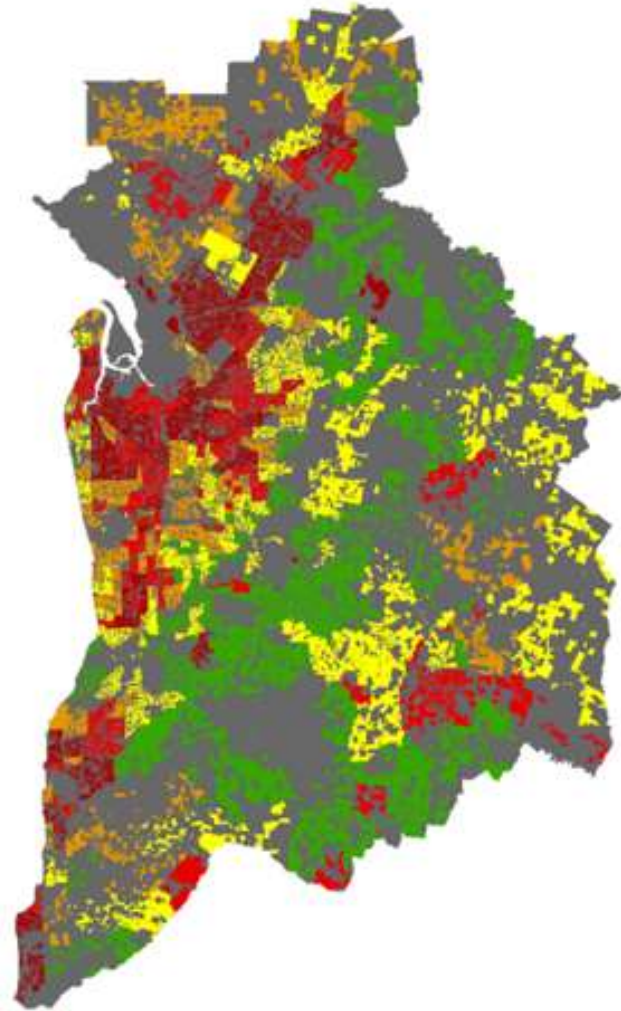
CURRENT SOCIAL
VULNERABILTY

CURRENT BUSHFIRE
HAZARD

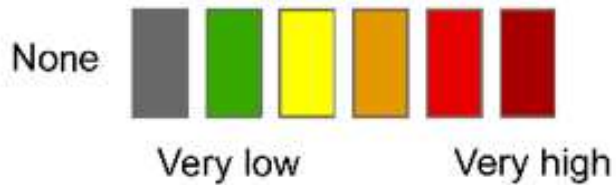
CURRENT BUSHFIRE
RISK

POTENTIAL
MITIGATION
STRATEGIES

CURRENT SOCIAL
VULNEARBILITY

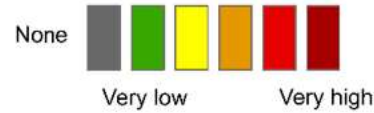
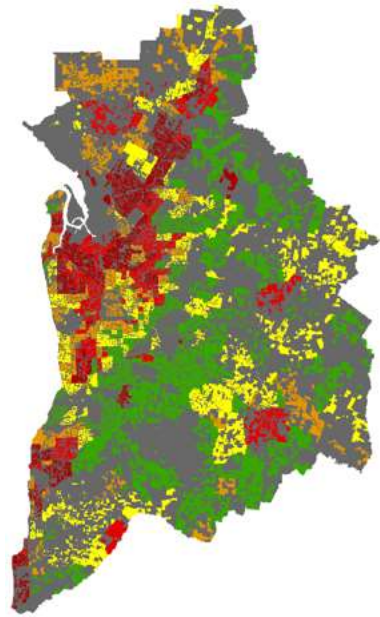


CURRENT
BUSHFIRE RISK



10% INCREASE IN EDUCATION

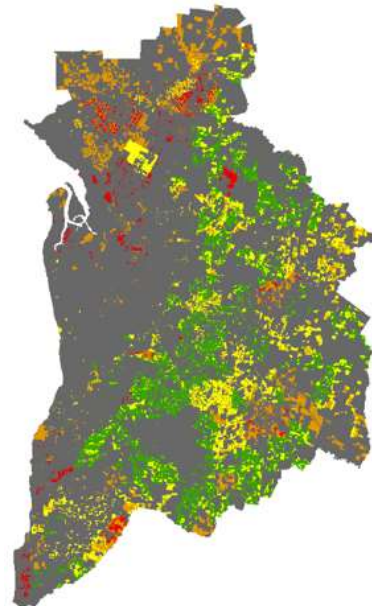
RESULTING SOCIAL
VULNERABILITY



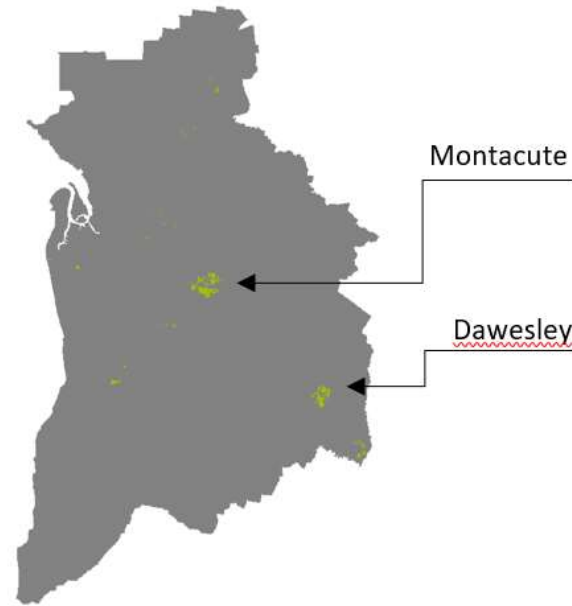
RESULTING CHANGE
IN SOCIAL
VULNERABILITY



RESULTING BUSHFIRE
RISK

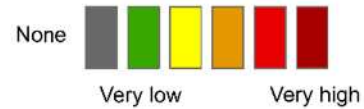
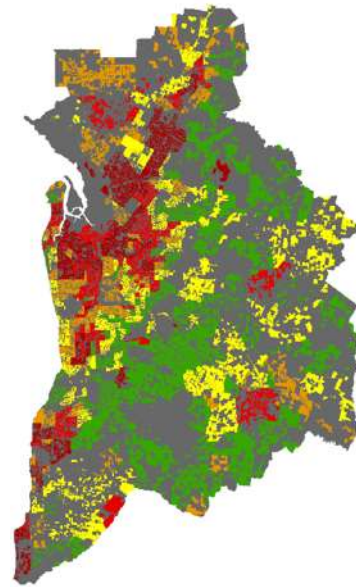


RESULTING CHANGE
IN BUSHFIRE RISK



10% INCREASE IN VOLUNTERING

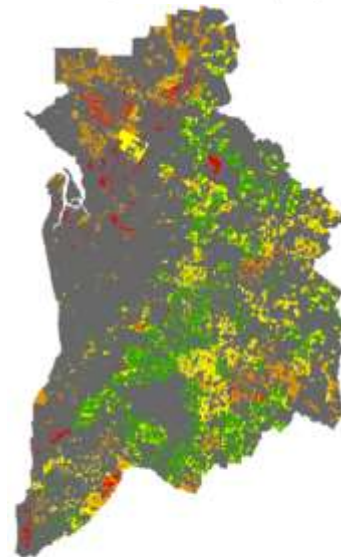
RESULTING SOCIAL
VULNERABILITY



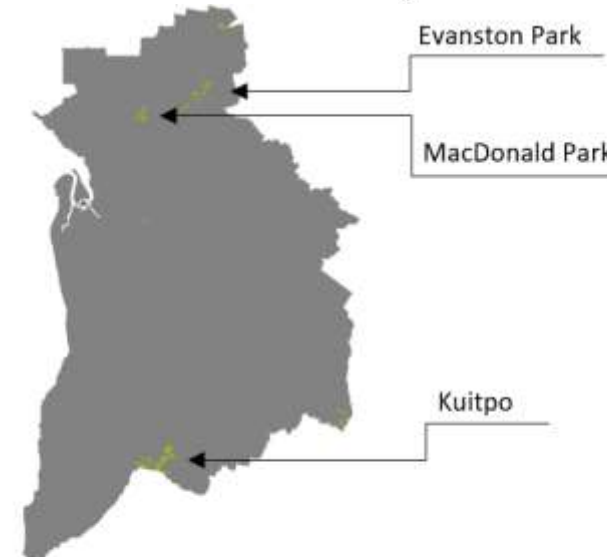
RESULTING CHANGE
IN SOCIAL
VULNERABILITY



RESULTING BUSHFIRE
RISK

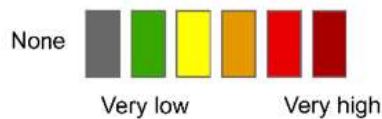
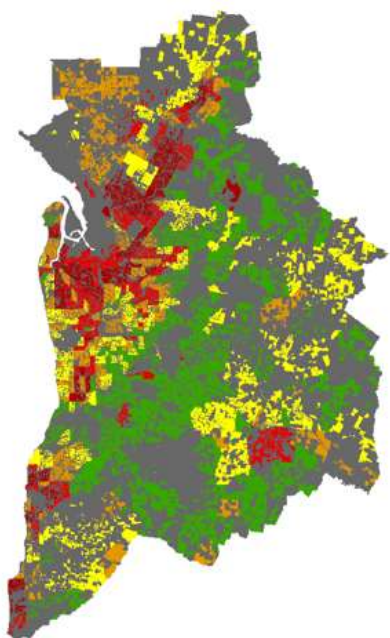


RESULTING CHANGE
IN BUSHFIRE RISK



10% INCREASE IN EDUCATION,
WEALTH, VOLUNTEERING, 10%
DECREASE IN YOUNG PEOPLE

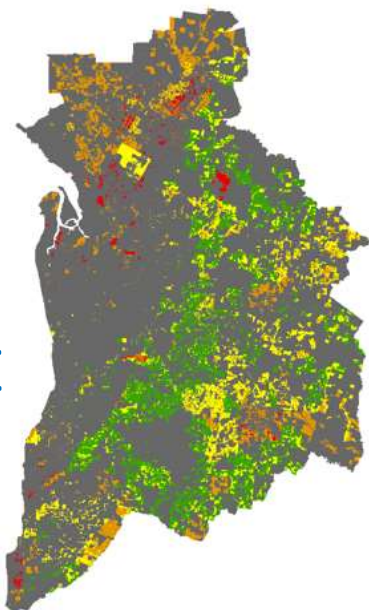
RESULTING SOCIAL
VULNERABILITY



RESULTING CHANGE
IN SOCIAL
VULNERABILITY



RESULTING BUSHFIRE
RISK



RESULTING CHANGE
IN BUSHFIRE RISK

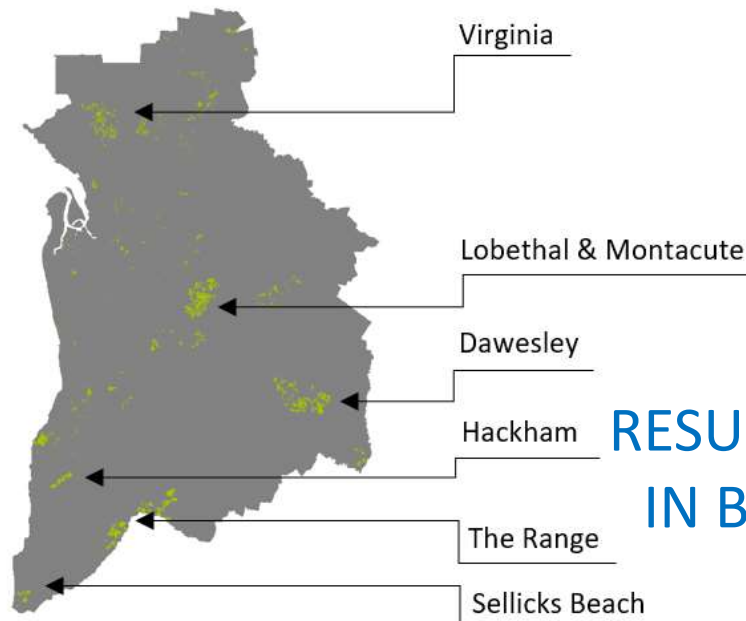


Table 6-1 Summary of the socially vulnerable suburbs effected by the risk reduction measures imposed

Suburb (areas to target)	Indicator	Level of Social Vulnerability		Level of Hazard Risk		Approximate number of people effected
		No risk reduction measure	With risk reduction measure	No risk reduction measure	With risk reduction measure	
MacDonald Park	Proportion of People Volunteering	Medium	Low	Medium	Low	456
	Personal Wealth	Medium	Low	Medium	Low	
	Proportion of Young people	Medium	Low	Medium	Low	
	All four indicators	Medium	Low	Medium	Low	
Evanston Park	Proportion of people Volunteering	High	Medium	High	Medium	4003
	Personal Wealth	High	Medium	High	Medium	
	Proportion of Young people	High	Medium	High	Medium	
	All four indicators	High	Medium	High	Medium	
Hackham	Personal Wealth	Very high	High	High	Medium	4103
	Proportion of Young people	Very high	High	High	Medium	
	All four indicators	Very high	High	High	Medium	
The Range	Personal Wealth	High	Medium	High	Medium	217
	Proportion of Young people	High	Medium	High	Medium	
	All four indicators	High	Medium	High	Medium	
Virginia	All four indicators	High	Medium	High	Medium	1747
Lobethal	All four indicators	High	Medium	High	Medium	2343
Sellicks Beach	All four indicators	Very high	High	High	Medium	2337

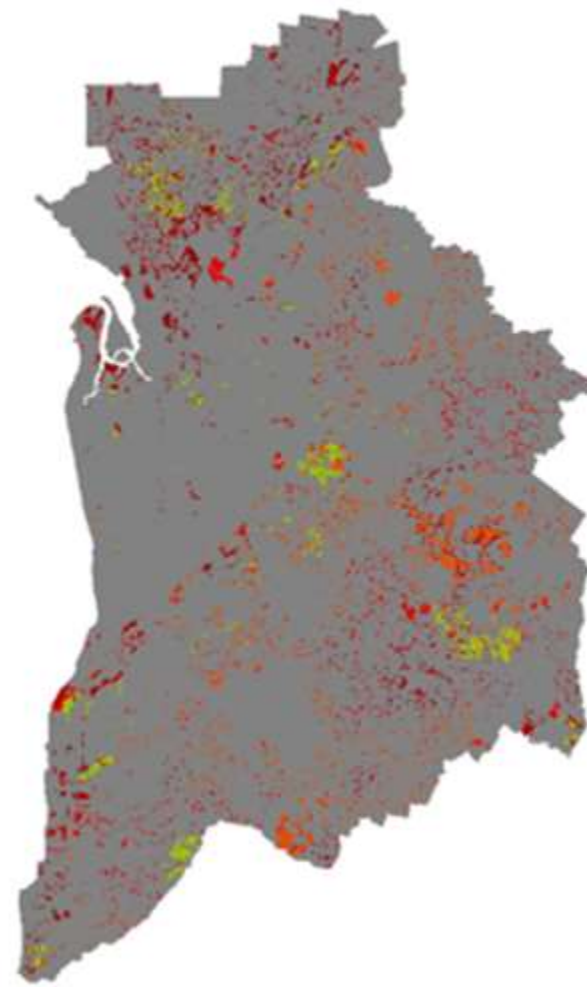
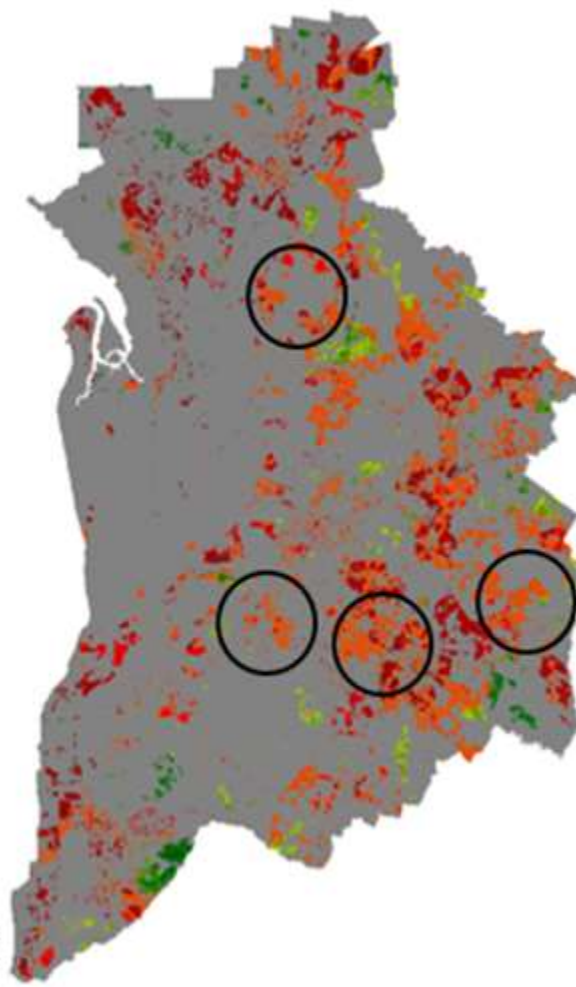
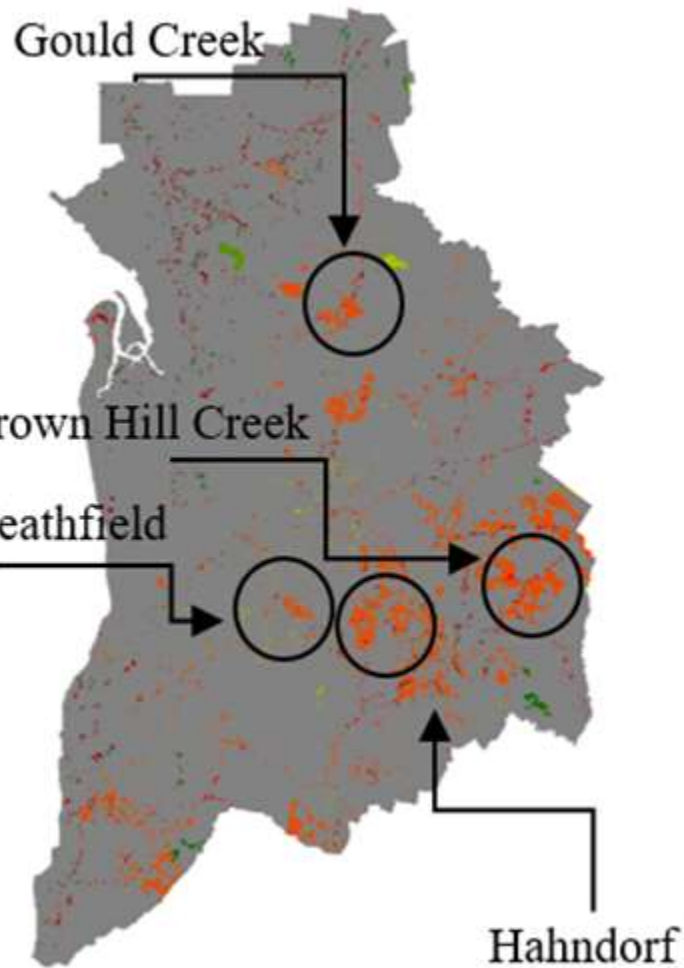
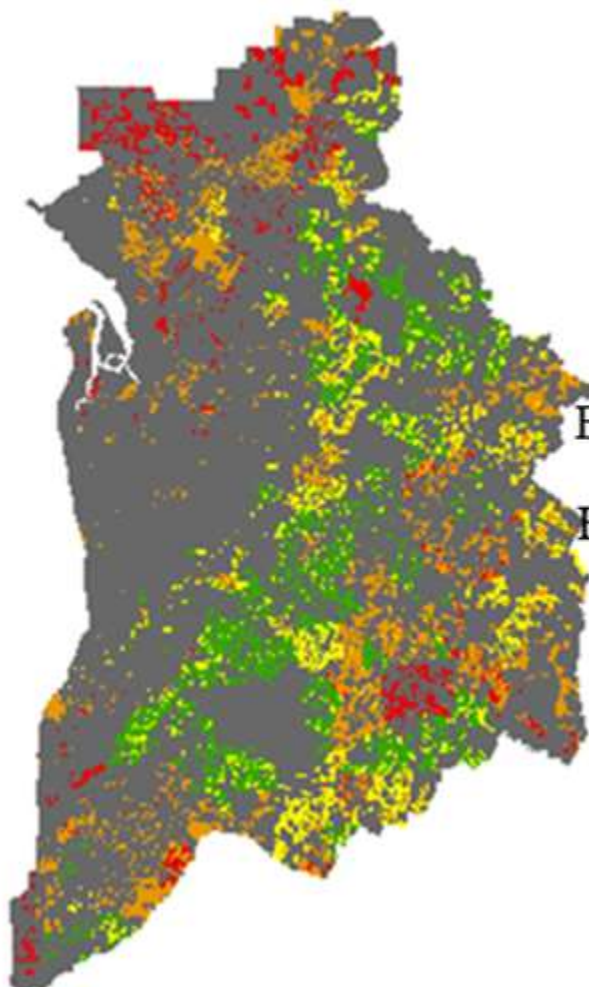
BUSHFIRE HAZARD RISK

Current

High challenges to
Government action

High challenges to
resilience

Low challenges



High increase



No change

High decrease

Suburb (areas to target)	Hazard Risk		Approximate number of people affected
	2015	2050	
Gould Creek	Medium	High	206
Hahndorf	Low	Medium	2548
Heathfield	Medium	High	1033
Brown Hill Creek	Low	Medium	163

POTENTIAL FUTURE OPPORTUNITIES

- Integration of other models

The Australian Natural Disaster Resilience Index A system for assessing the resilience of Australian communities to natural hazards

UNDERSTANDING AND ENHANCING RESILIENCE



POTENTIAL FUTURE OPPORTUNITIES

- Integration of other models

The Australian Natural Disaster
for assessing the resilience of
natural hazards

UNDERSTANDING AND ENHANCING RESILIENCE



SCIENCE-BACKED TOOLS ENHANCE WATER CATCHMENT MANAGEMENT



AFAC RESEARCH UTILISATION CASE STUDY

Critical success factors:

- Build strong researcher-end user partnerships from the outset
- Understand the research, scientific approach, findings and the practical implications, benefits and limitations
- Collaborate with stakeholders nationally through AFAC

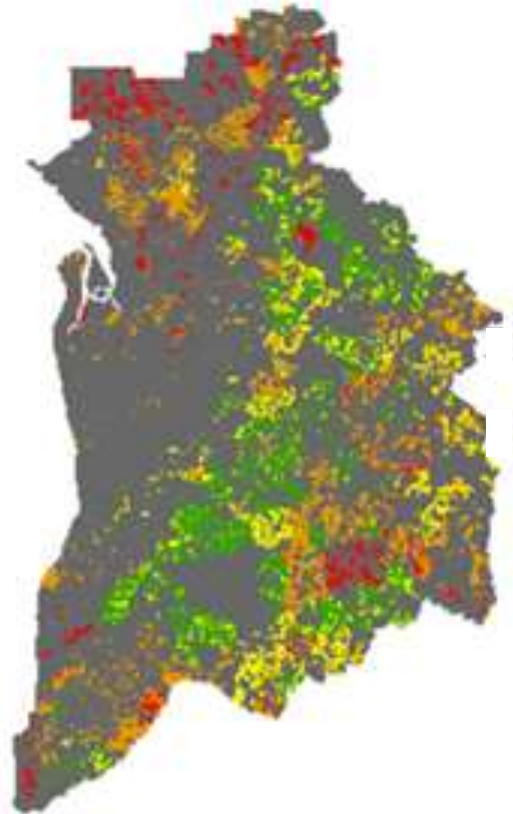


March 2017

POTENTIAL FUTURE OPPORTUNITIES

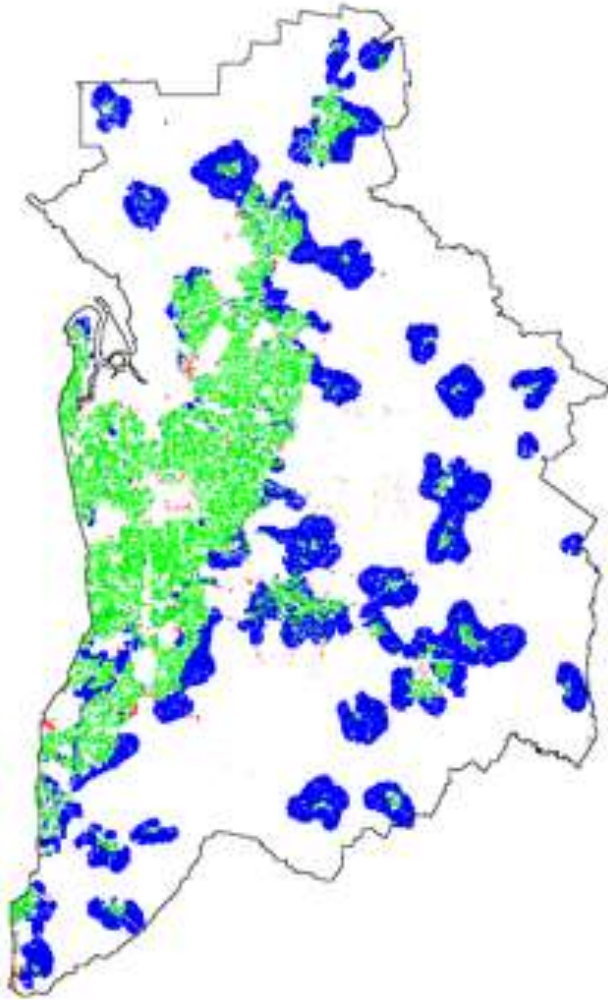
- Integration of other models
- VEGETATION MODELLING
- BIODIVERSITY IMPACTS

POTENTIAL FUTURE OPPORTUNITIES



- Integration of other models
- Use as communication / public education tool

POTENTIAL FUTURE OPPORTUNITIES



- Integration of other models
- Use as communication / public education tool
- **Resource and infrastructure planning**

POTENTIAL FUTURE OPPORTUNITIES



Climate Change and the Emergency Management Sector

- PHYSICAL RISKS
 - Weather and ocean hazards
 - Consequences of ecosystem changes
 - Impacts on the effectiveness of risk mitigation activities
 - Coincident and cascading events
- TRANSITIONAL RISKS
 - Reputational damage
 - Population changes
 - Land use planning and building codes

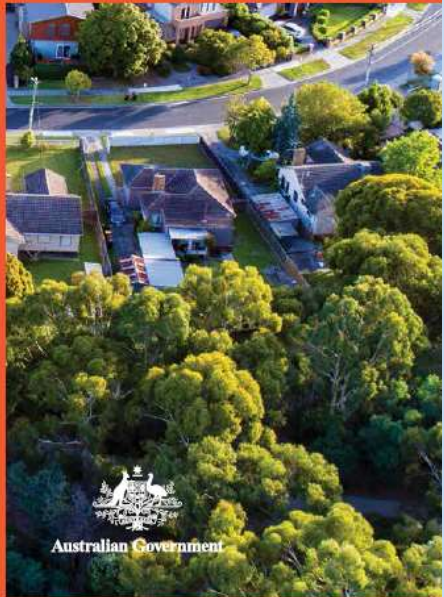
- Integration of other models
- Use as communication / public education tool
- Resource and infrastructure planning
- **Assessment of impact of future change**

POTENTIAL FUTURE OPPORTUNITIES



National Disaster Risk
Reduction Framework
Consultation Draft

OCTOBER 2018



- ACCOUNTABLE DECISIONS
 - Decision-making processes and models...adequately address current and future disaster risks
 - Priority disaster risks are identified and actively mitigated
 - Integrated and robust frameworks are used to assess and reduce disaster risk in infrastructure, land use and development planning
- ENHANCED INVESTMENT
 - Existing and future disaster risk reduction investments target high priority locally and nationally significant disaster risks
 - Investments in disaster risk reduction and resilience are designed to limit future disaster recovery costs

- Integration of other models
- Use as communication / public education tool
- Resource and infrastructure planning
- **Assessment of impact of future change**

POTENTIAL FUTURE OPPORTUNITIES

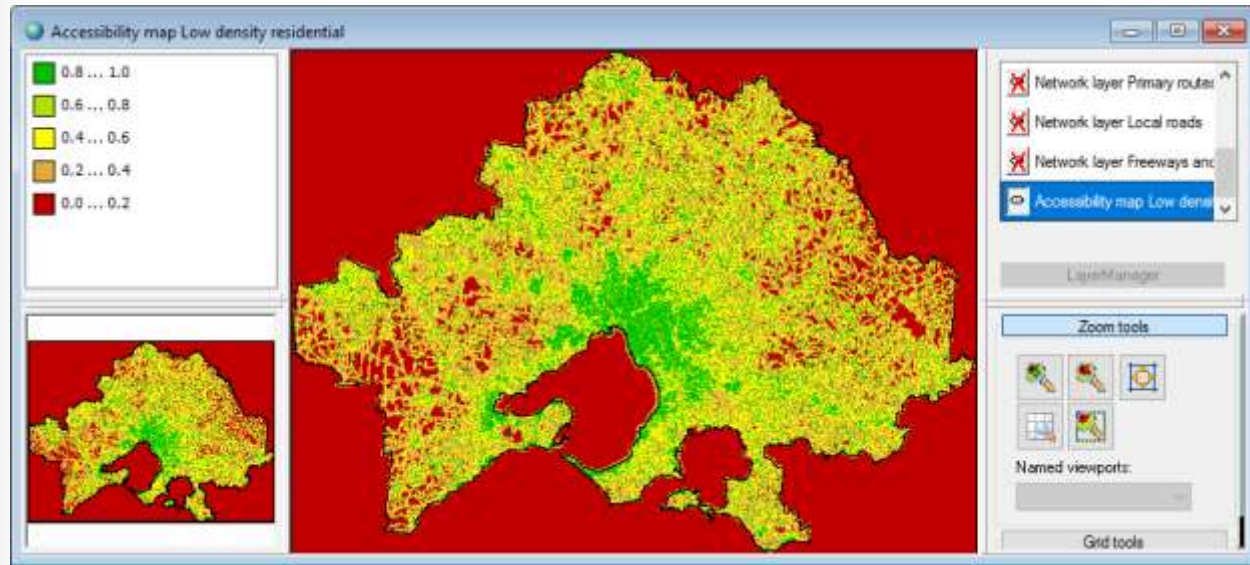


EMV's Strategic Plan 2020

- DEMOGRAPHIC AND SOCIAL
 - Rapid population growth
 - Changing urban settlement patterns
 - Greater mobility of people around the globe
- ENVIRONMENTAL
 - Climate change
 - Reduction in biodiversity
- ECONOMIC AND INFRASTRUCTURE
 - Highly optimised linear supply chains
 - Economically and socially disadvantaged groups in the community

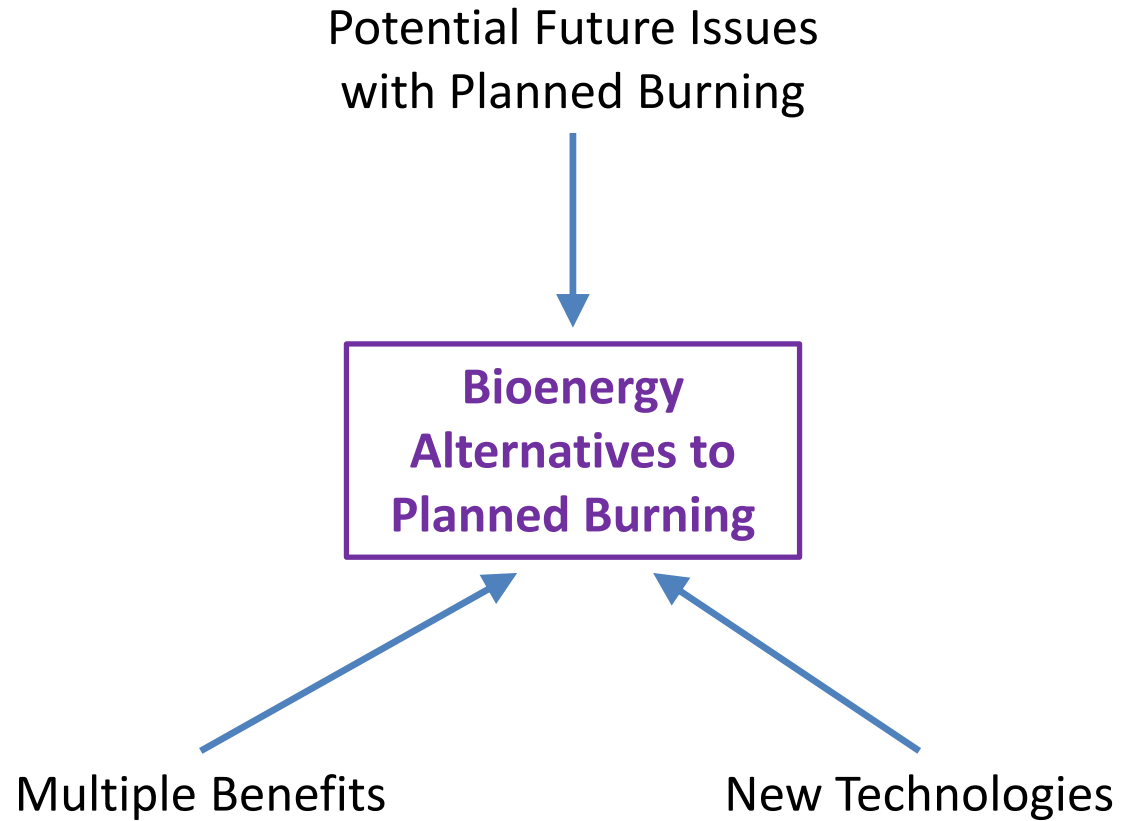
- Integration of other models
- Use as communication / public education tool
- Resource and infrastructure planning
- **Assessment of impact of future change**

POTENTIAL FUTURE OPPORTUNITIES



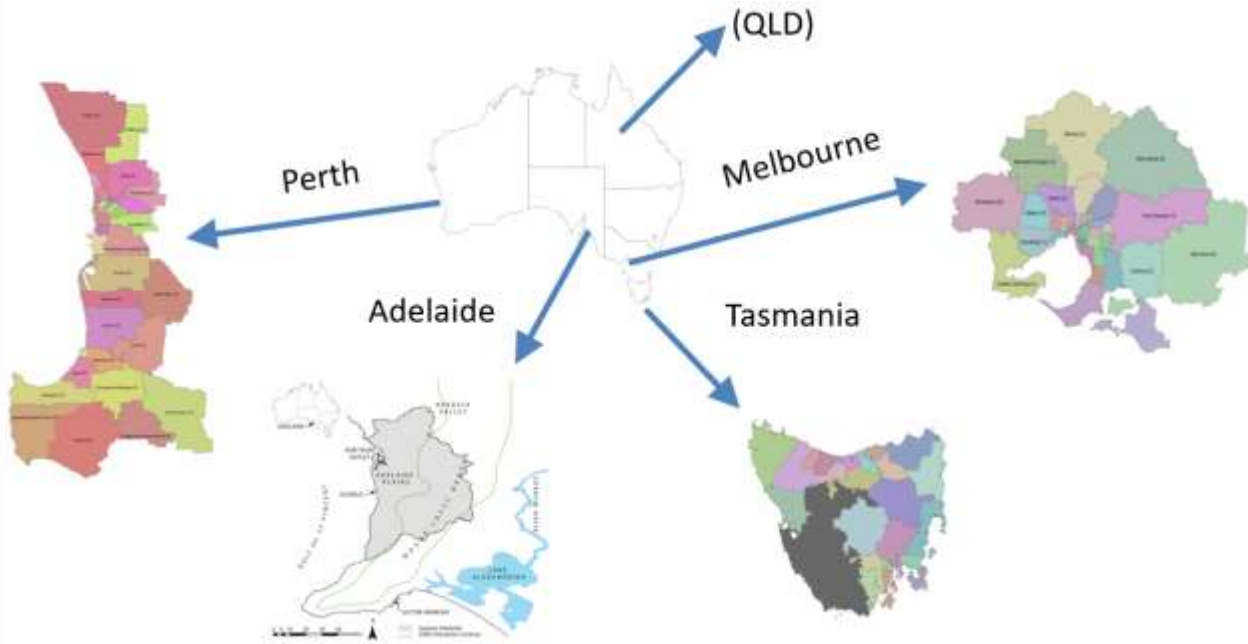
- Integration of other models
- Use as communication / public education tool
- Resource and infrastructure planning
- Assessment of impact of future change
- **Exploration of alternative mitigation options**

POTENTIAL FUTURE OPPORTUNITIES



- Integration of other models
- Use as communication / public education tool
- Resource and infrastructure planning
- Assessment of impact of climate change
- **Exploration of alternative mitigation options**

POTENTIAL FUTURE OPPORTUNITIES

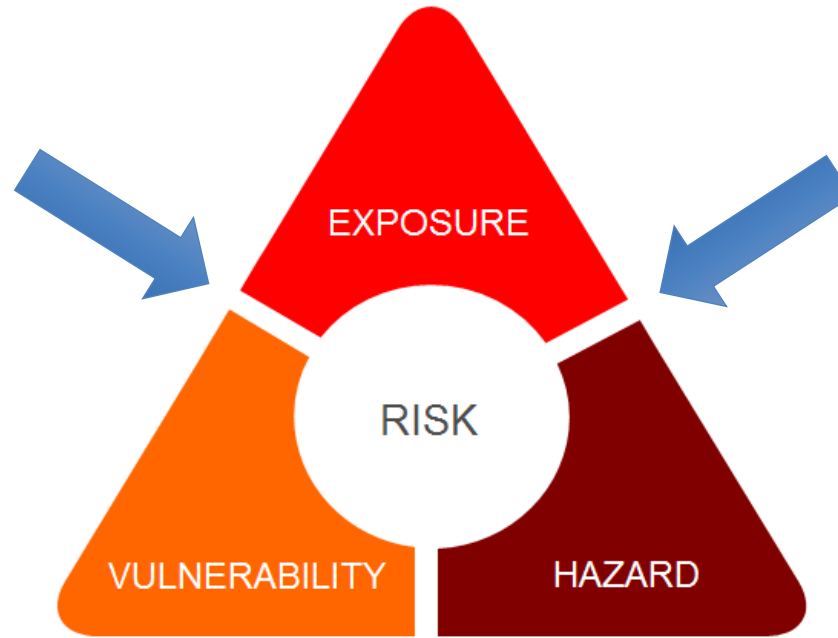


Same fire behaviour model as used within VFRR-B, TASBRAM and BRAn (WA) - have taken all fire behaviour components and have put them into one generic process with **~40 fuel types across 4 states**

- Integration of other models
- Use as communication / public education tool
- Resource and infrastructure planning
- Assessment of impact of climate change
- Exploration of alternative mitigation options
- **Development of a multi-state approach to bushfire risk reduction**

Things we
generally
cannot control

- Population growth
- Economic change
- Technological change
- Climate change



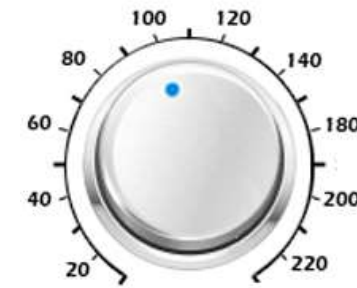
UNHaRMED



Evolution over
time and space

Things we
generally can
control

- Land use planning
- Structural measures
- Building codes
- Community education



Holger Maier

Professor of Environmental Engineering
The University of Adelaide

holger.maier@adelaide.edu.au

<https://www.adelaide.edu.au/directory/holger.maier>

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