Agenda

9.00 – 10.30	Refresher
10.30 – 11.00	Morning Tea
11.00 – 13.00	Guided Tour using 'What if?' Questions
13.00 – 14.00	Lunch
14.00 – 16.30	Scenario Topic: Modelling the Land Use Implications of a Zoning Rule Change
16.30 – 17.00	Discussion and Feedback

Indicative only

m.e environment

sustainable pathways

The Integrated Scenarios Explorer ‘ISE’ [1]

Dr Garry McDonald

m.e environment

Sustainable pathways 2

- 2009 to 2015 MBIE funded research programme focused on achieving sustainable urban futures ($3.8 million over 6 years)
- Builds on previous 'Sustainable Pathways' (2003-9) and 'Creating Futures' (2006-10) programmes
- Collaborative policy-science research programme

Auckland Council
Te Kaunihera o Tāmaki Makaurau

Waikato Regional Council
Te Kaunihera ā Rohe o Waikato

greater Wellington Regional Council
Te Pane Matua Taiao

m.e market economics environment • spatial

Massey University
Te Kunenga ki Pūrehuroa
University of New Zealand

Ministry of Business, Innovation & Employment

Science + Innovation

RIKS
research institute for knowledge systems

m.e environment

sustainable pathways

Sustainable pathways 2

- ***Mediated Modelling (Assoc Prof Marjan van den Belt).*** Stakeholders directly engaged in formulating and building models. Reduces gap between model builders and end-users.

- ***Spatial Dynamic Modelling (Dr Garry McDonald).*** Enables end-users to simulate visually future implications. Integrates socio-economic, environmental, land use, and transport models into a spatially explicit and dynamic computer model.

- ***Embedding into Council Processes (Melanie Thornton GW, Regan Solomon AC and Dr Beat Huser WRC).*** Reduces gap between model building capacity and use of models. An end-user led objective.

m.e environment

sustainable pathways

Sustainable pathways 2

- ***Mediated Modelling (Assoc Prof Marjan van den Belt).*** Stakeholders directly engaged in formulating and building models. Reduces gap between model builders and end-users.

- ***Spatial Dynamic Modelling (Dr Garry McDonald).*** Enables end-users to simulate visually future implications. Integrates socio-economic, environmental, land use, and transport models into a spatially explicit and dynamic computer model.

- ***Embedding into Council Processes (Melanie Thornton GW, Regan Solomon AC and Dr Beat Huser WRC).*** Reduces gap between model building capacity and use of models. An end-user led objective.

m.e environment

sustainable pathways

Who is using ISE?

- ISE was originally developed for the Waikato Region in the Creating Futures Programme (http://www.youtube.com/watch?v=RgEABCz1RrI)
- ISE is also being developed in Auckland under Sustainable Pathways 2, and in Christchurch under Economics of Resilient Infrastructure
- Each version of ISE has slightly different sub-modules, but they are easily transferred from one version to another
- ISE is still a prototype – any comments, suggested changes are welcome, have your say!

m.e environment

sustainable pathways

Why new planning tools?

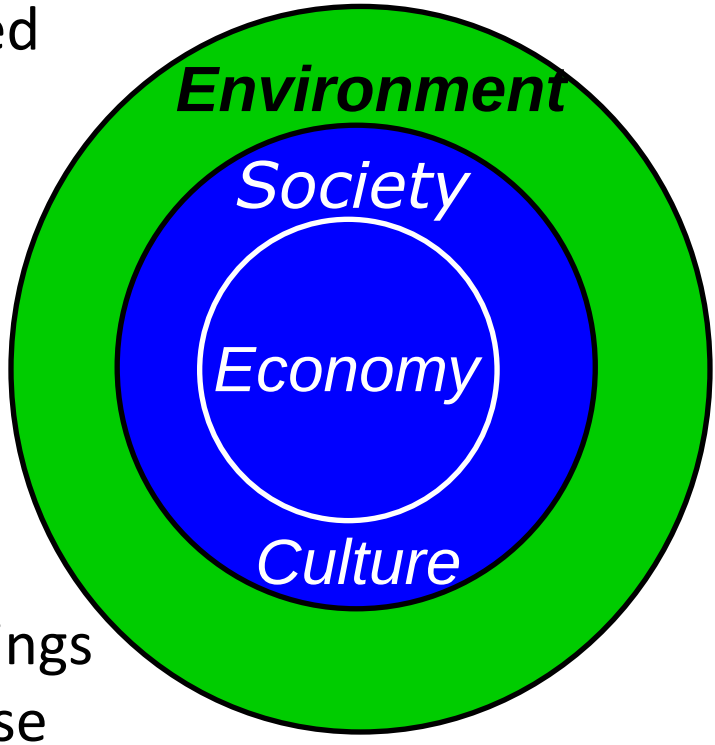
Long term and **spatial** planning and enhanced strategic focus are needed

Linking policy and science

- Informed and evidenced based decision-making
- Tools required to spatially evaluate policy options and their associated trade-offs

Integration

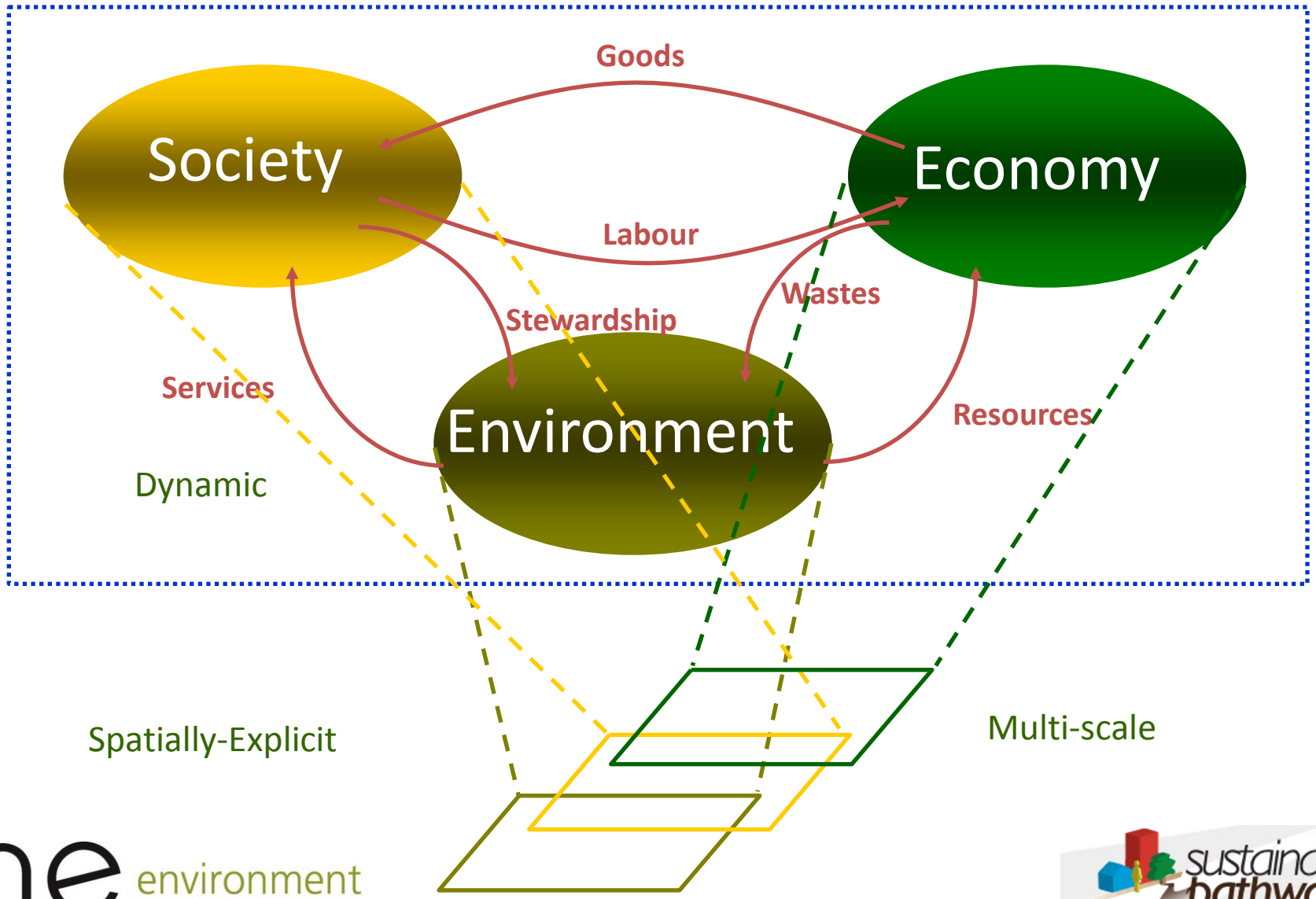
- Dynamic feedbacks exist between well-beings
- Existing models/datasets only capture these effects in isolation, feedbacks between the well-beings are often missing
- Strategic partnerships (multi-disciplinary)



m.e environment

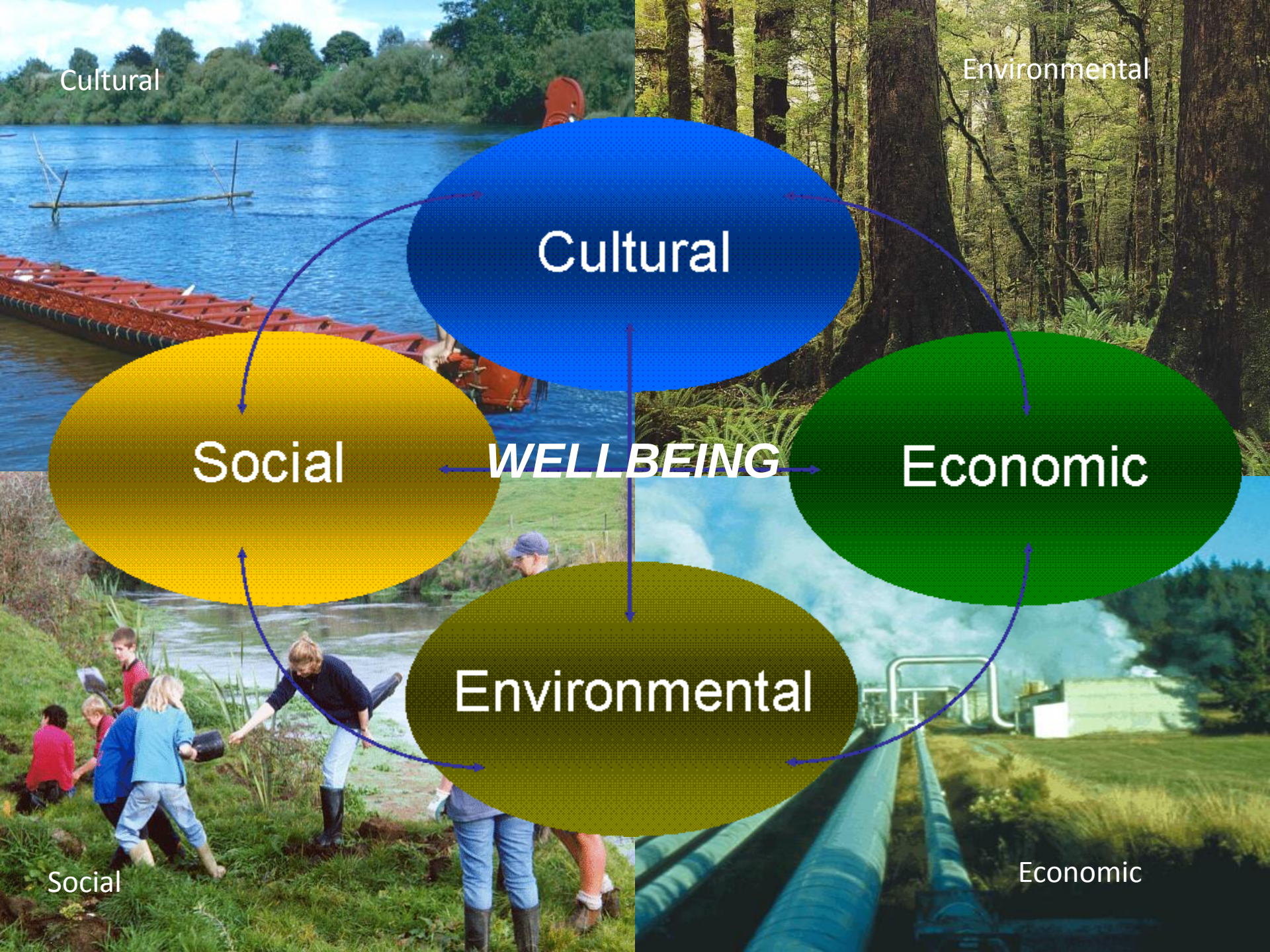
sustainable pathways

What is ISE?

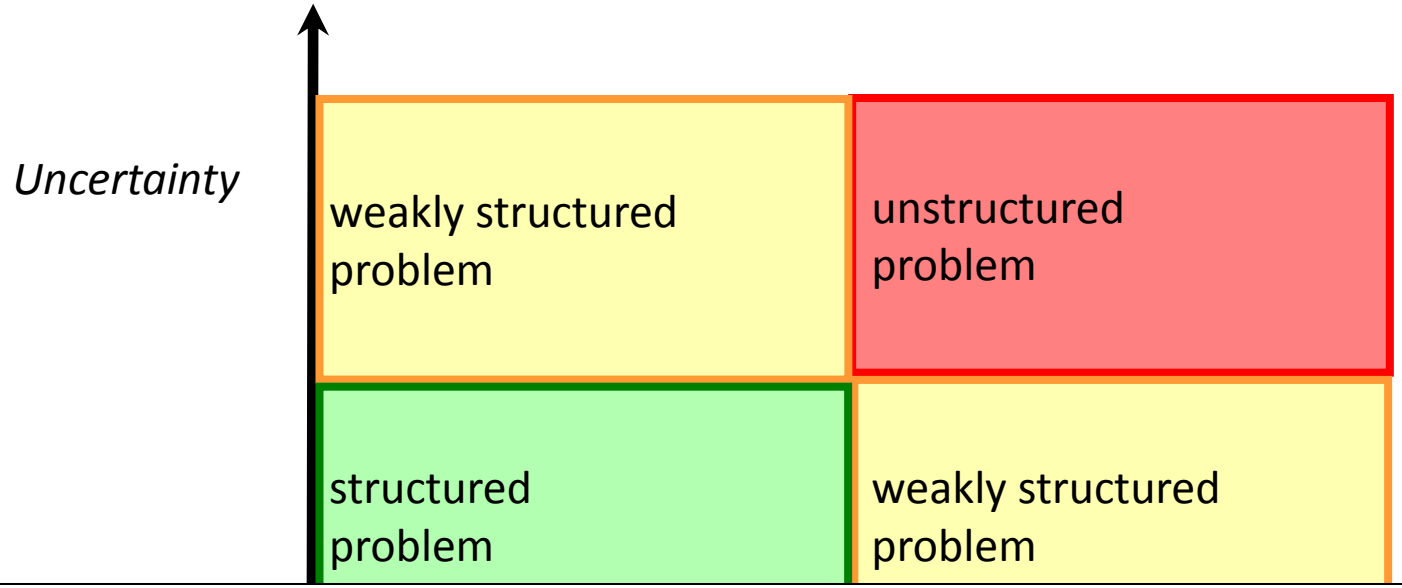


m.e environment

sustainable pathways


Cultural
Environmental
Cultural
Social
WELLBEING
Economic
Environmental
Social
Economic

What types of problems does ISE address?



<u>Example: New road construction</u>

Structured problem: How many lanes are required to handle a peak of 5,000 vehicles per hour in an urban environment ?

Weakly structured problem: Can we guarantee congestion free traffic every day for the next 15 years ?

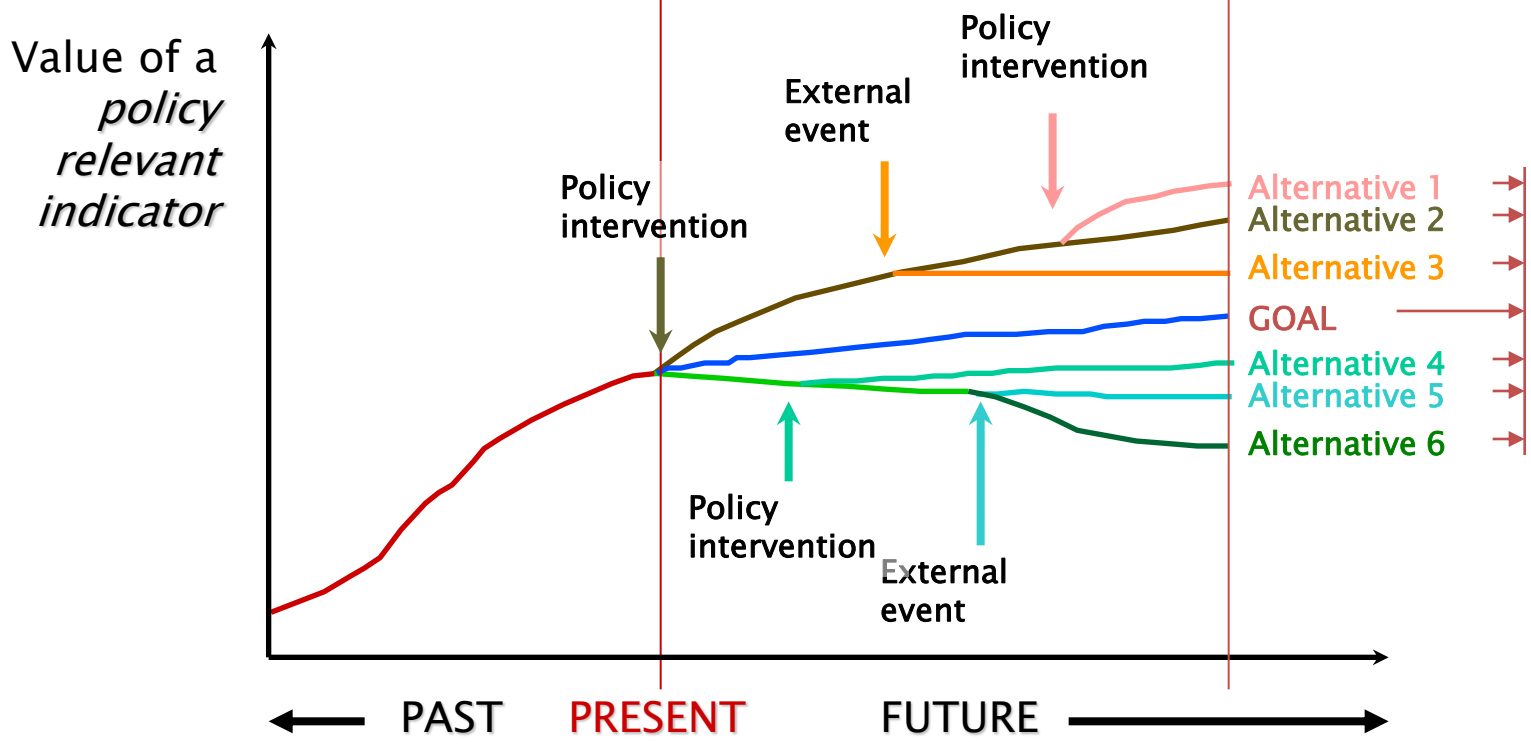
Unstructured problem: Is the construction of a new motorway a good decision for all concerned now and in the future ?

Simulating policy options

- Recognition
- Diagnosis

- Problem identification
- Design of solutions
- Exploration of solutions

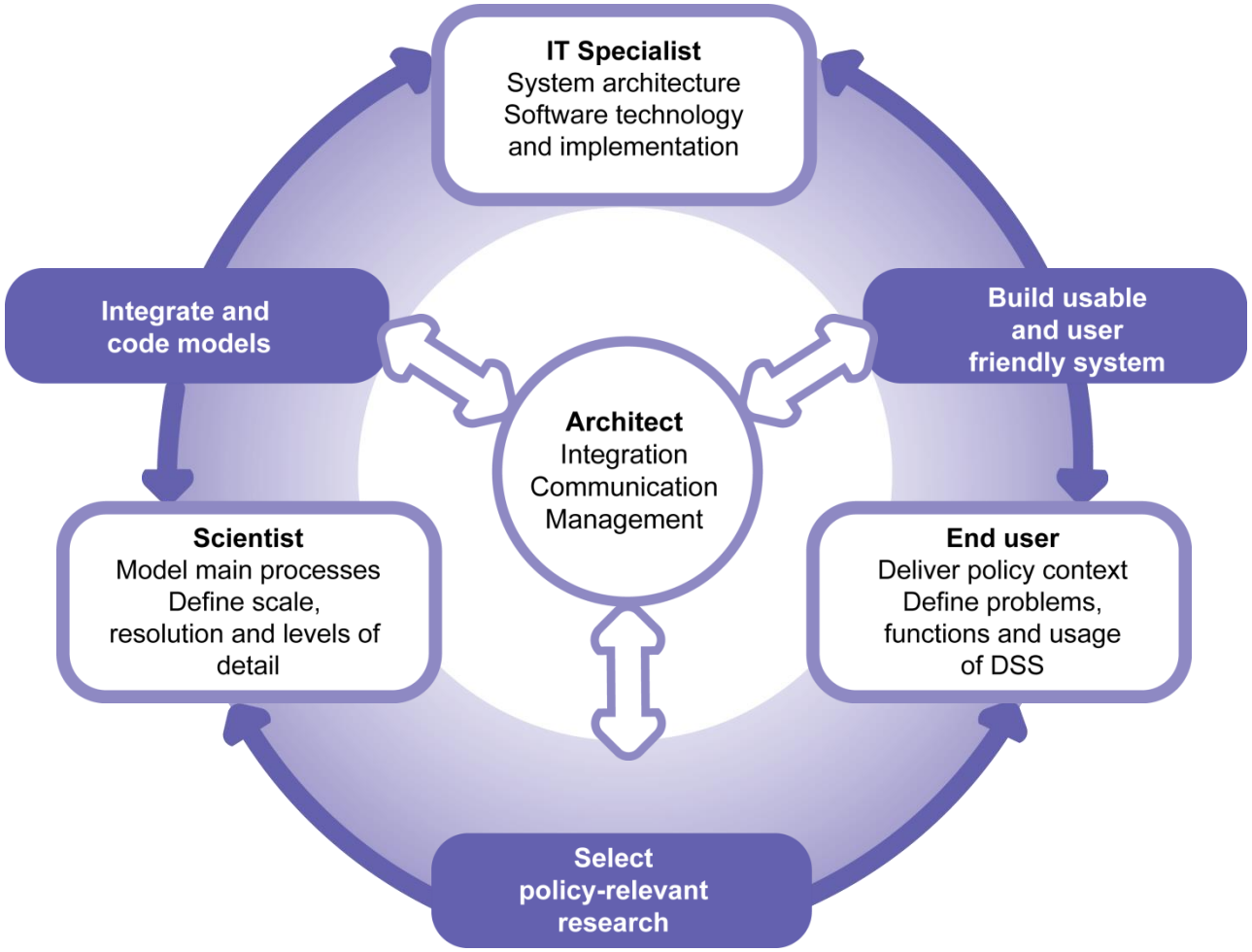
- Analysis
- Evaluation
- Selection
- Authorization

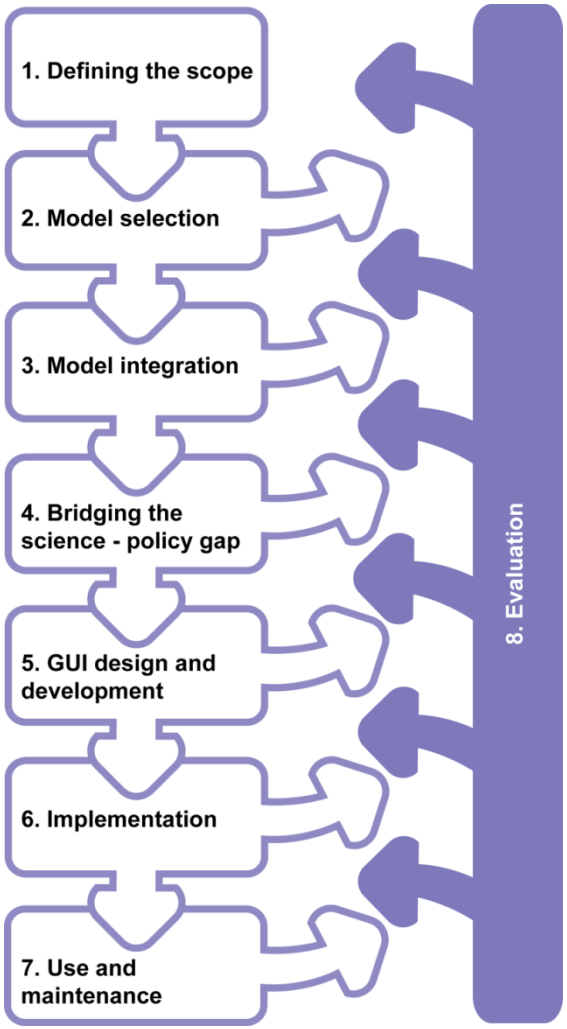


m.e environment

sustainable pathways

How is ISE being developed?

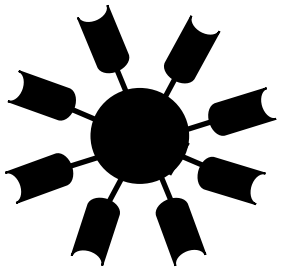




m.e environment

sustainable pathways

ISE integrated sub-modules



Geonamica model integration platform

Land use

Demography

Economy

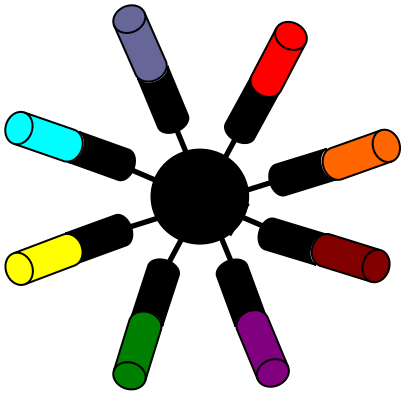
Transport

Climate

Hydrology

GIS datasets – statistical, use, cover, zoning, etc

Other models

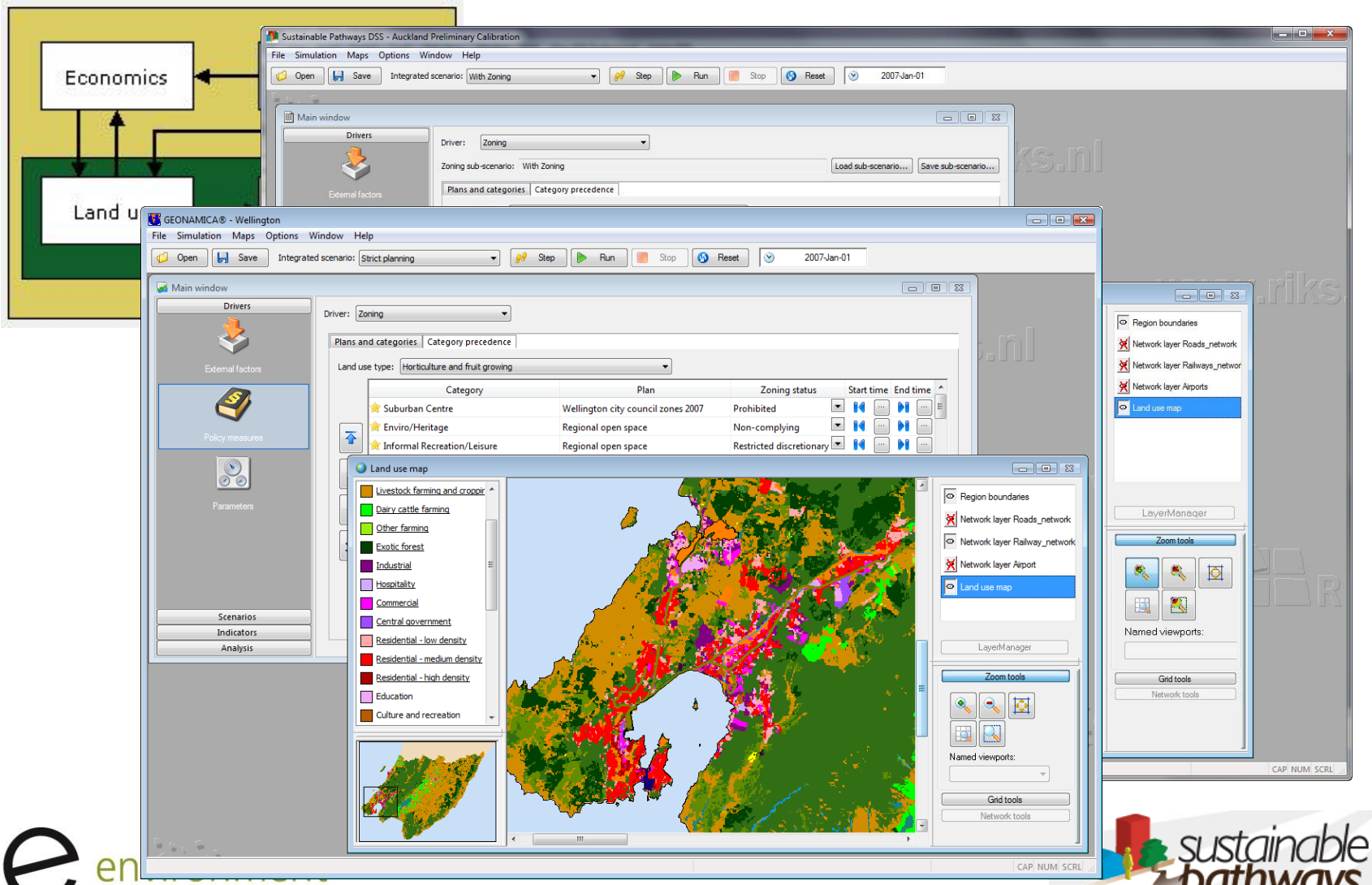


Integrated Scenarios Explorer

m.e environment

sustainable pathways

ISE integrated sub-modules

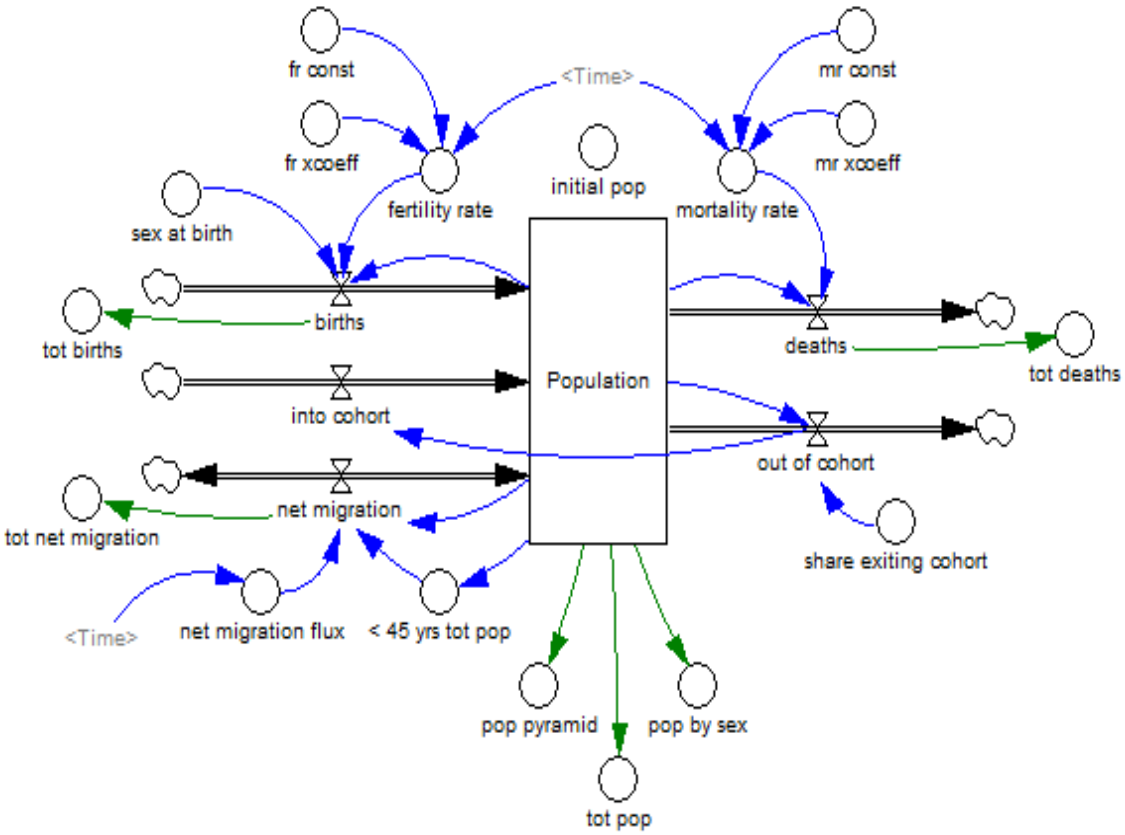


m.e environment

sustainable pathways

Population sub-module

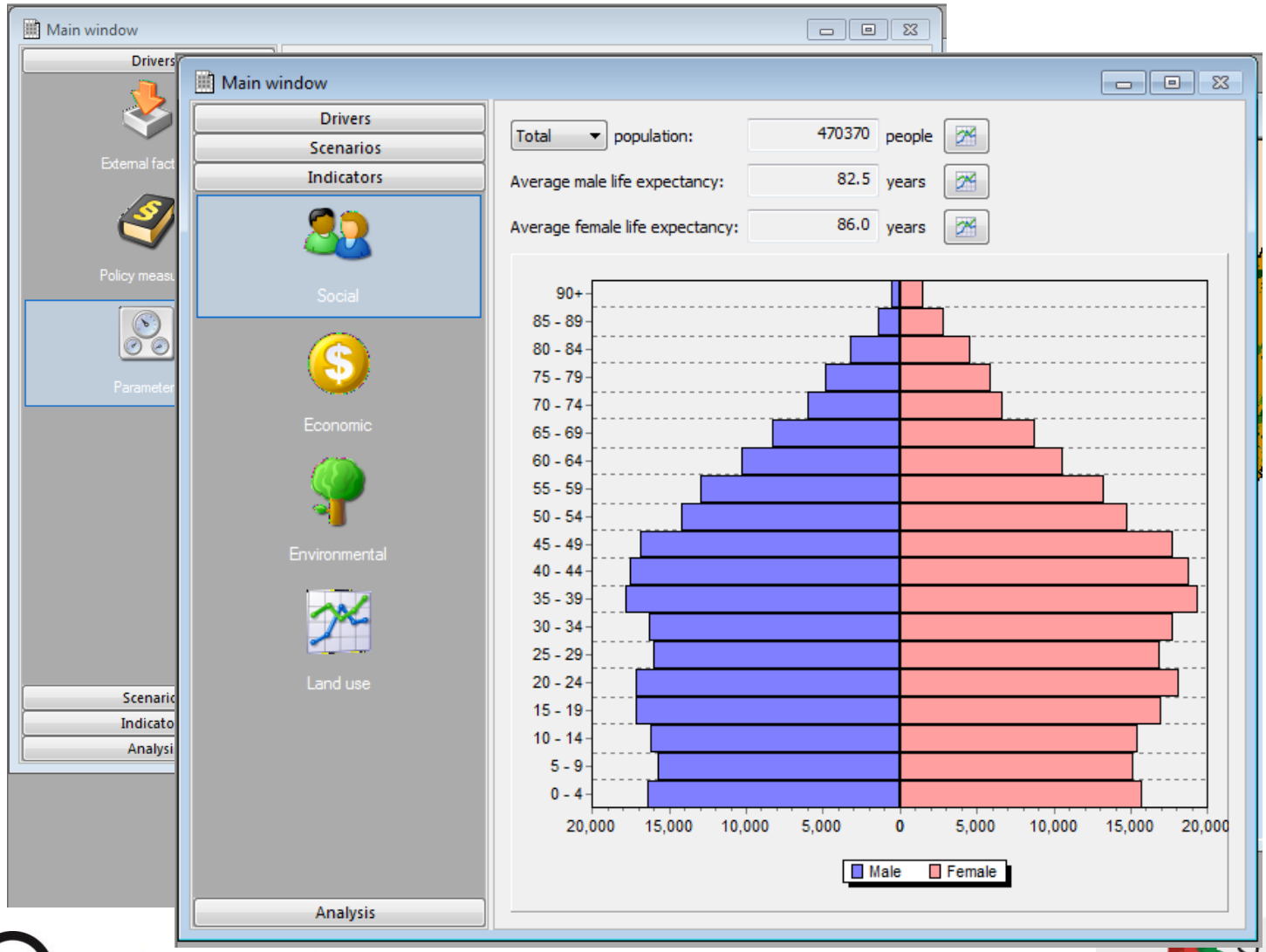
- Single year age-sex cohort model for region
- SNZ Sub-national population forecasts by CAU
- Fertility, mortality, net migration, average life expectancy & people living in each land use category



m.e environment

sustainable pathways

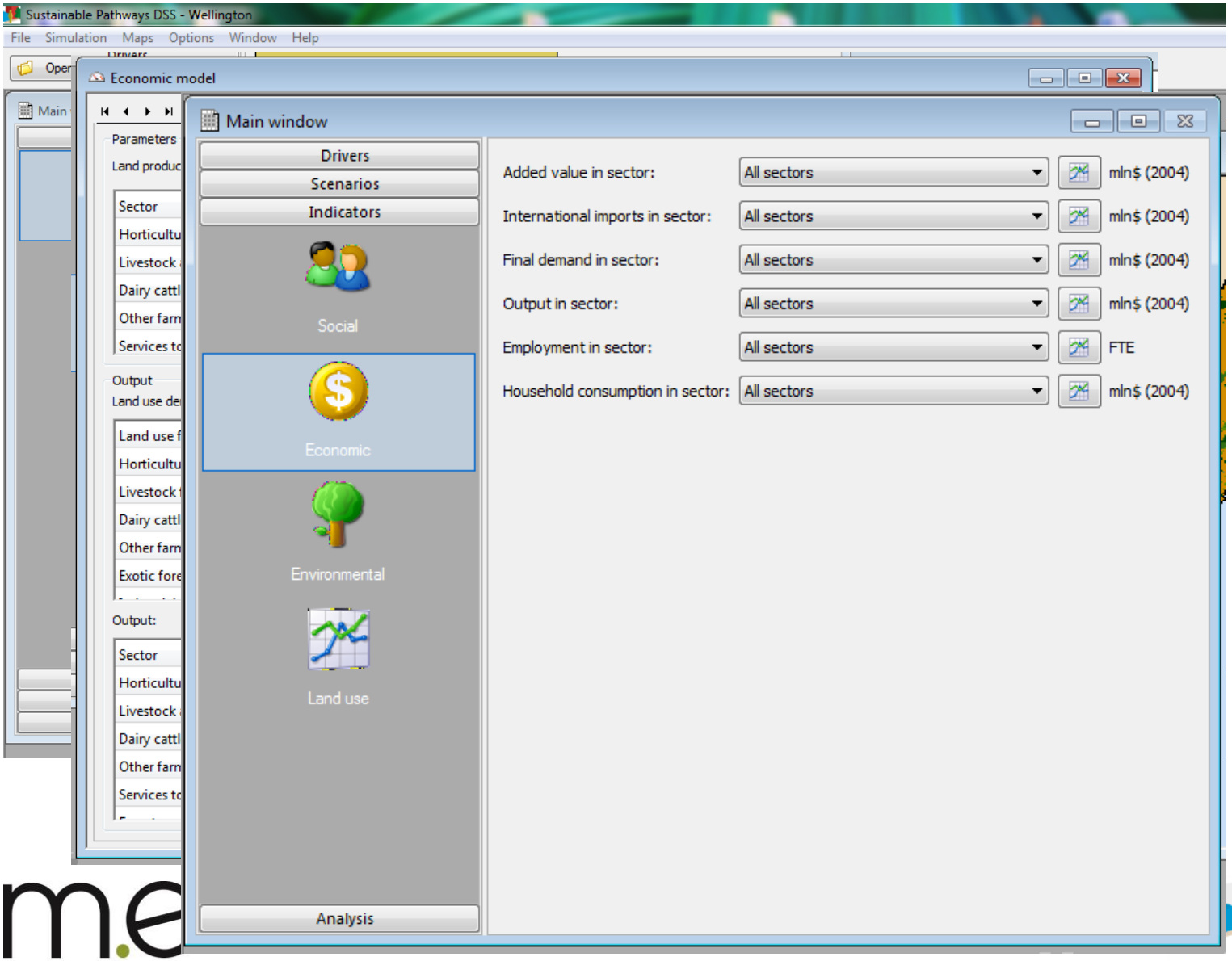
Population sub-module



m.e environment

sustainable pathways

Economic sub-module



Economic sub-module

		Industries					Consumption	
		Ag	Manuf	Utils & Cons	Svcs	Govt	Hhld	Export
Commodities	Ag							
	Manuf							
	Utils & Cons							
	Svcs							
	Govt							
Value Added	Hhld Inc							
	Profits							
	Imports							

Household & export projections for all goods and services consumed under each scenario

Economy growth rates

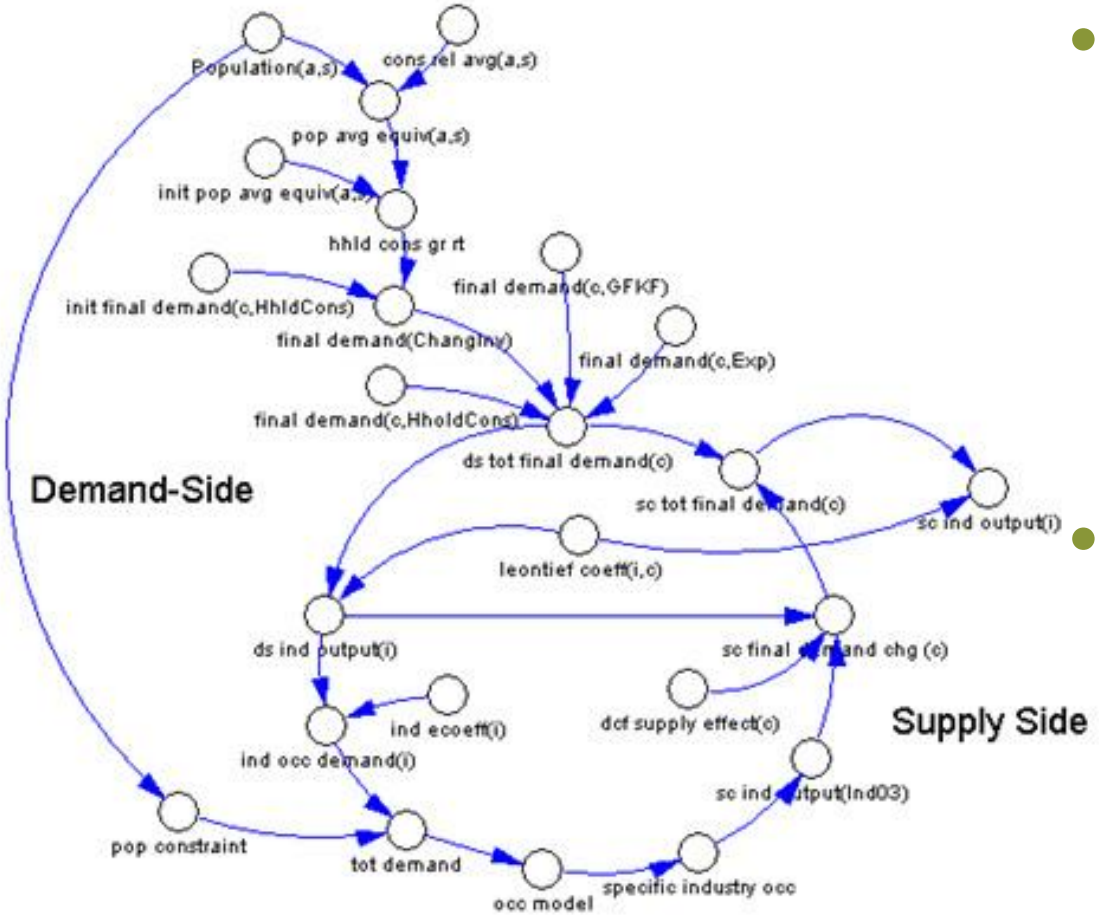
Key socio-economic measures: output, value added, employment, businesses, occupations

Key environmental measures energy by type, emissions by type, land use, solid waste, ecosystem services

m.e environment

sustainable pathways

Economic futures

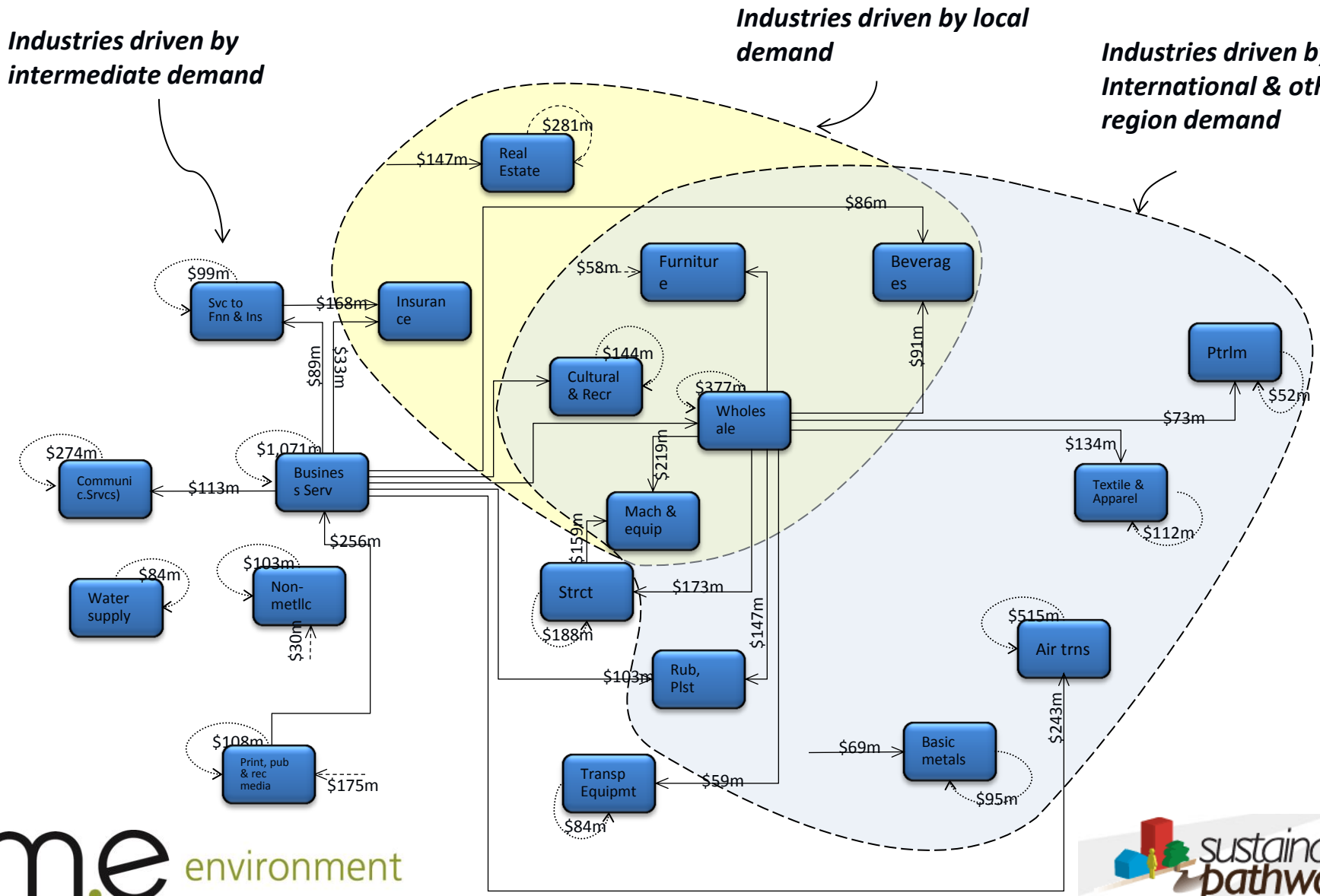


- **Demand** driven (household consumption, exports, capital), but with **supply** constrains e.g. land use, water
- Other supply side effects are possible: labour shortages, skills shortages, peak oil, and so on

m.e environment

sustainable pathways

Economic interdependencies



m.e environment

sustainable pathways

Land use change sub-module

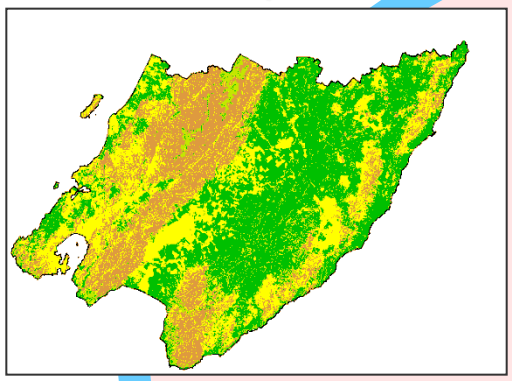
Local drivers of change include:

- Zoning regulations
- Spatial interaction
- Suitability of the location
- Accessibility

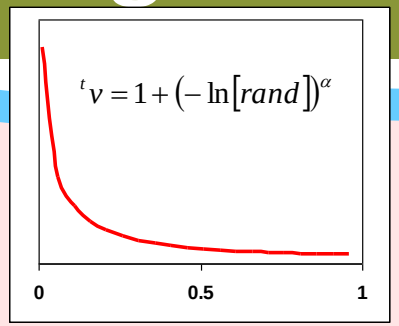
Bringing it all together

Land use
at time T+1

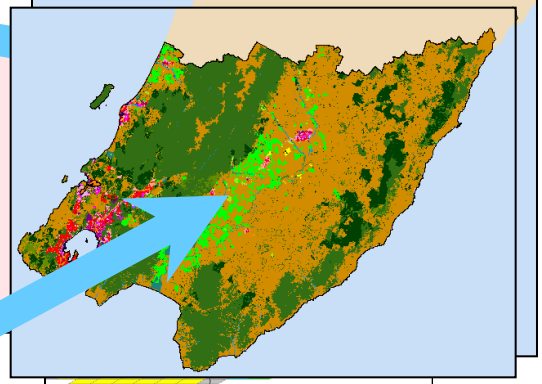
Suitability



&

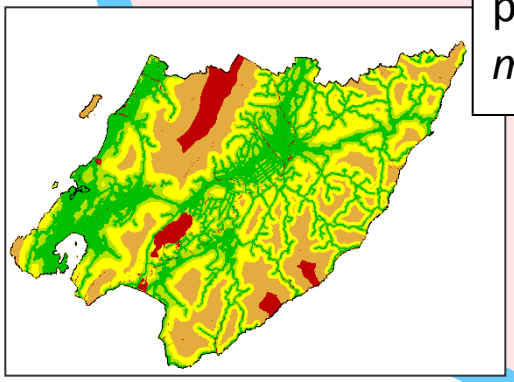


Stochastic perturbation



&

Accessibility

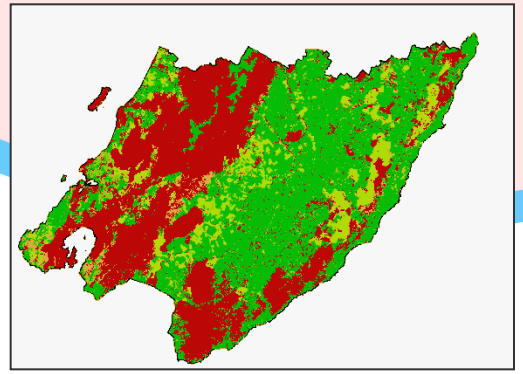


Transition Rule

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

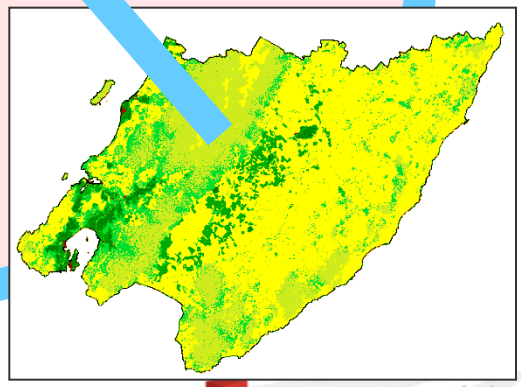
&

Zoning



=

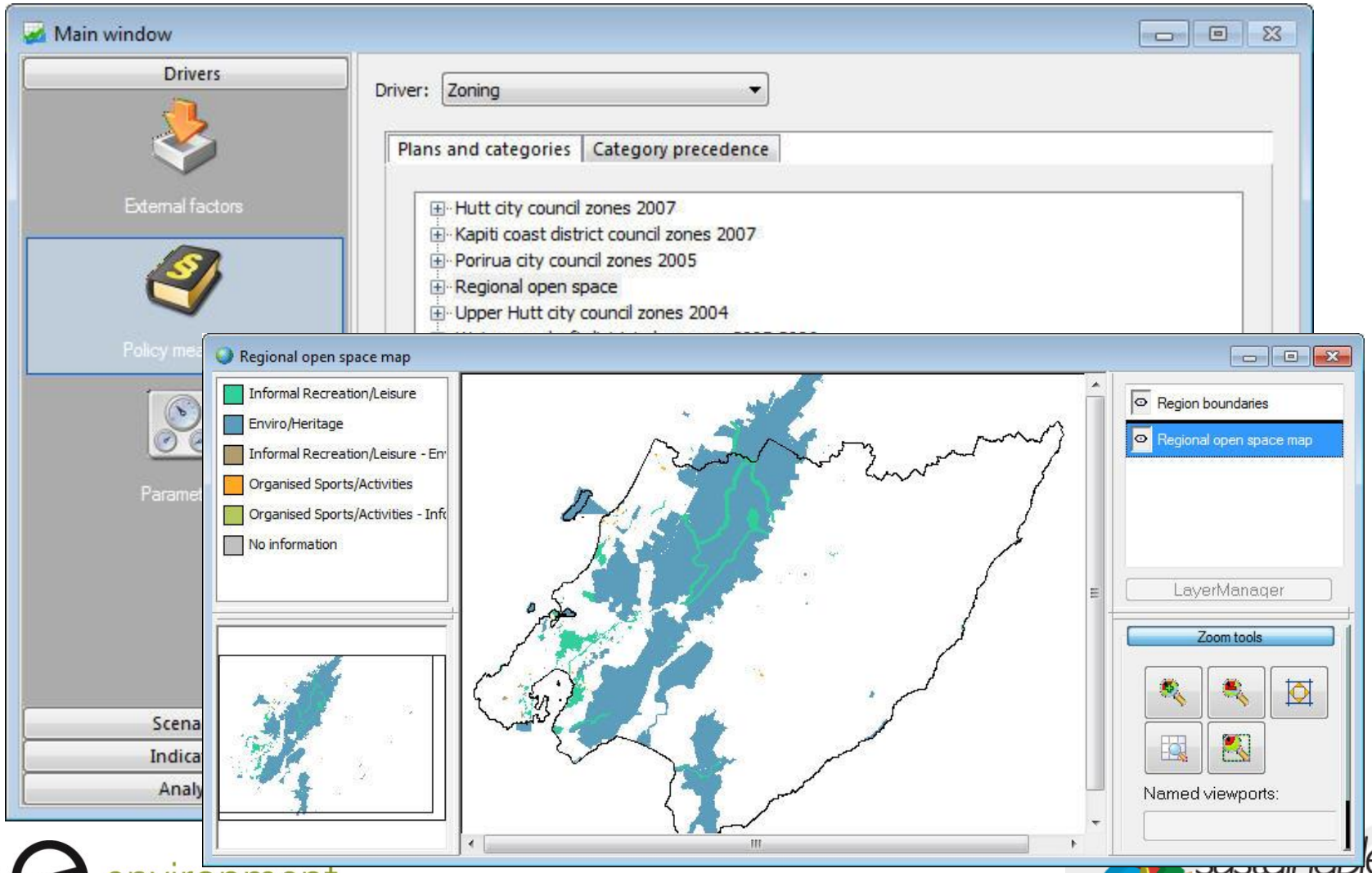
Transition Potentials



m.e environment

sustainable pathways

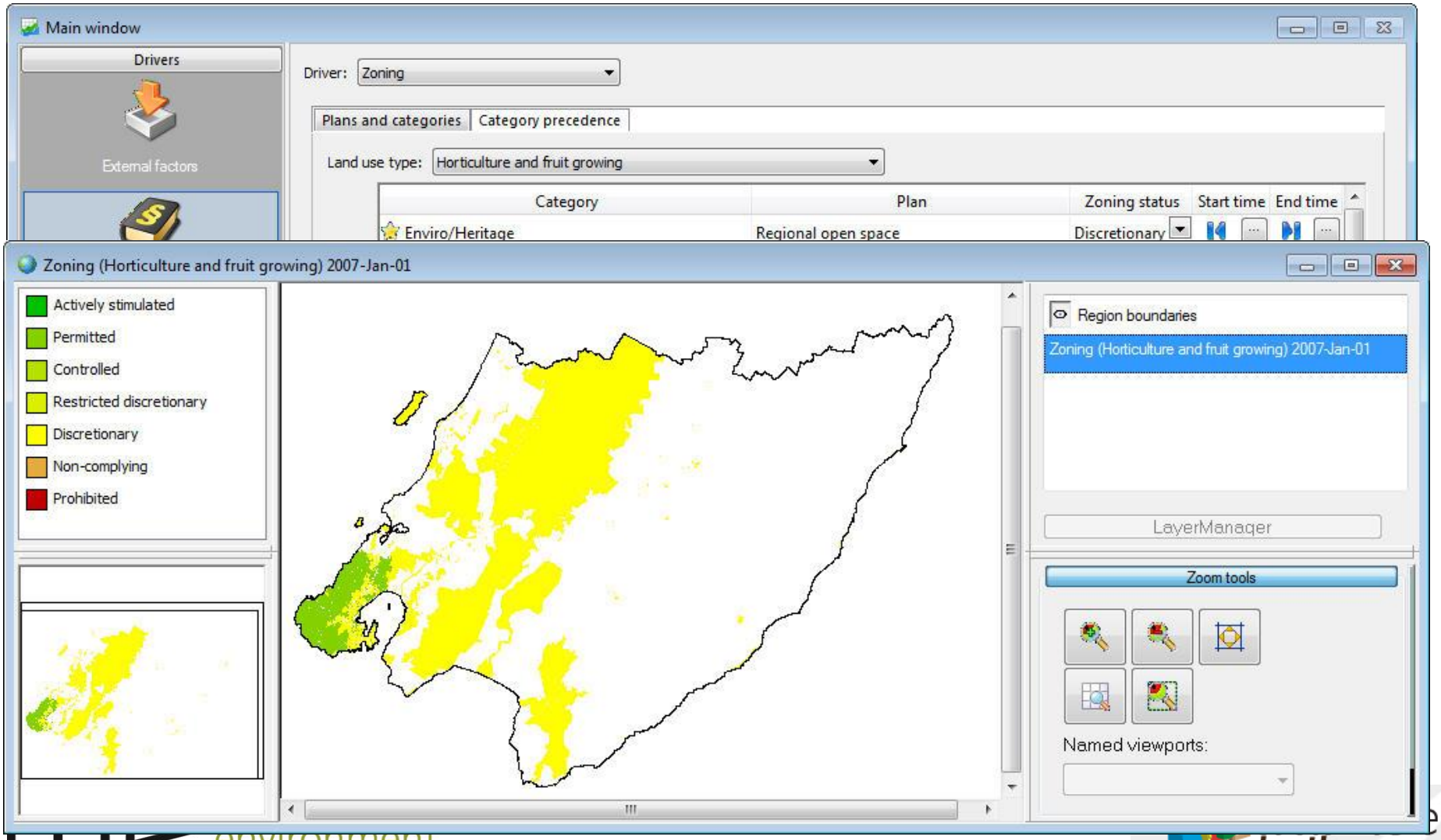
Zoning



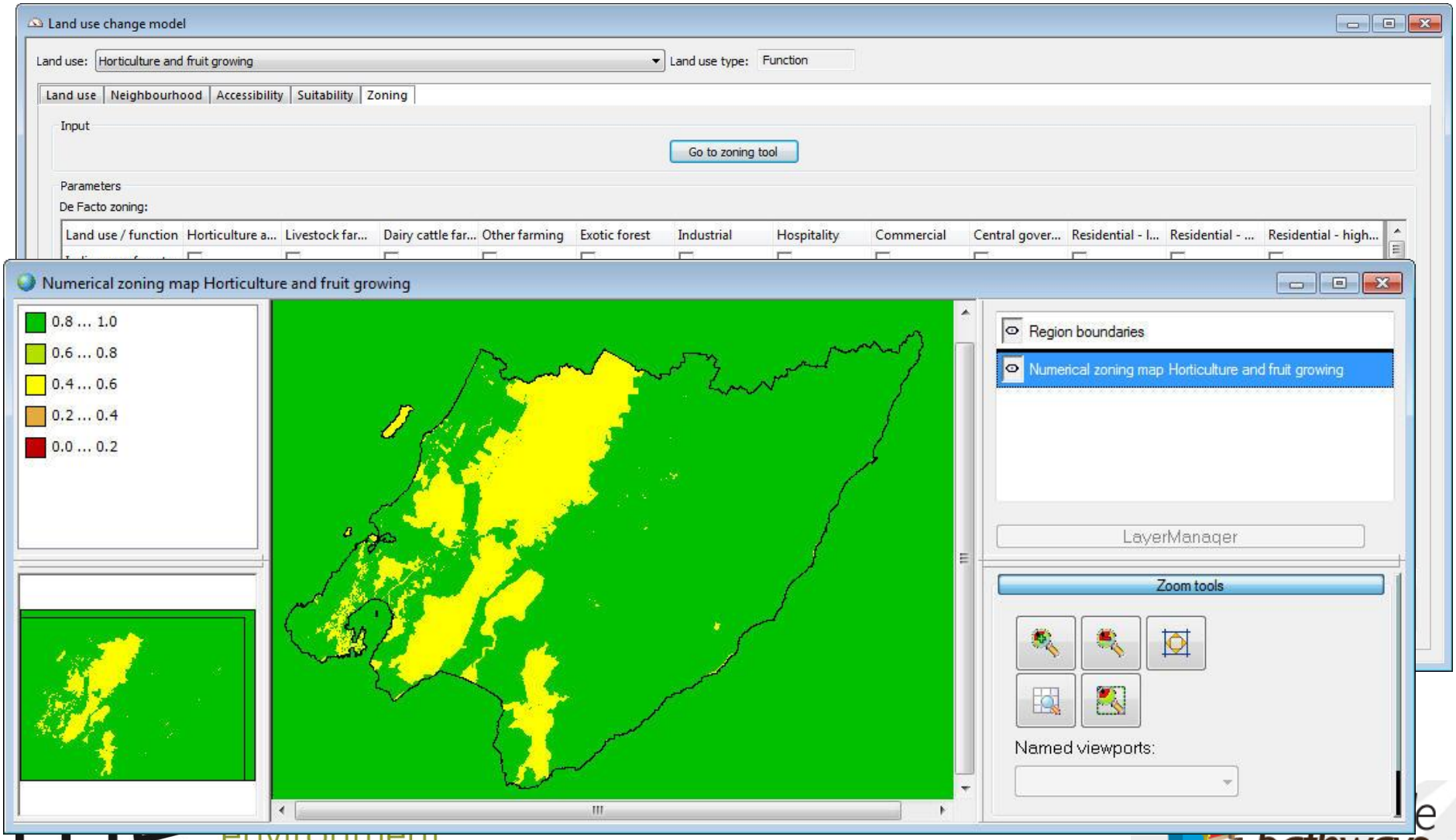
m.e environment

sustainable pathways

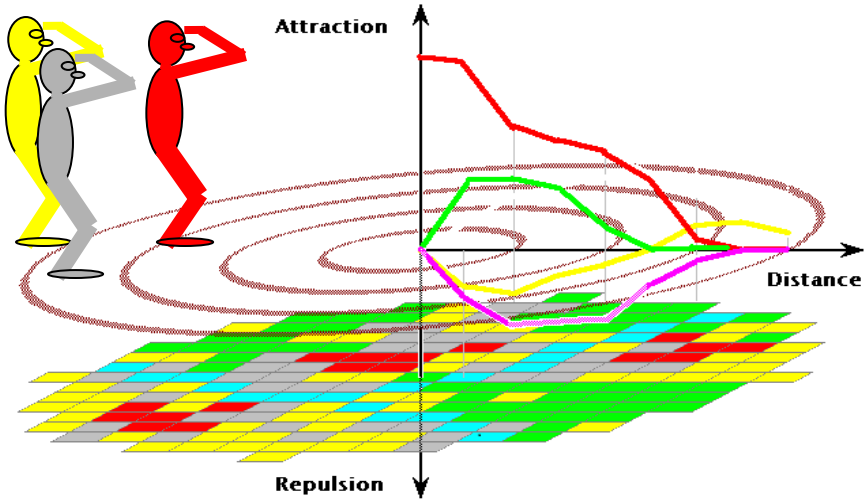
Zoning


Main window
Drivers
External factors
Driver: Zoning
Plans and categories
Category precedence
Land use type: Horticulture and fruit growing
Category
Plan
Zoning status
Start time
End time
Enviro/Heritage
Regional open space
Discretionary
Zoning (Horticulture and fruit growing) 2007-Jan-01
Actively stimulated
Permitted
Controlled
Restricted discretionary
Discretionary
Non-complying
Prohibited
Region boundaries
Zoning (Horticulture and fruit growing) 2007-Jan-01
LayerManager
Zoom tools
Named viewports:

Zoning

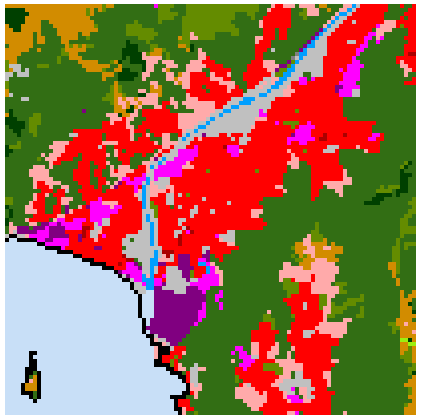

Land use change model
Land use: Horticulture and fruit growing
Land use type: Function
Land use
Neighbourhood
Accessibility
Suitability
Zoning
Input
Go to zoning tool
Parameters
De Facto zoning:
Land use / function
Horticulture a...
Livestock far...
Dairy cattle far...
Other farming
Exotic forest
Industrial
Hospitality
Commercial
Central gover...
Residential - l...
Residential - ...
Residential - high...
Numerical zoning map Horticulture and fruit growing
0.8 ... 1.0
0.6 ... 0.8
0.4 ... 0.6
0.2 ... 0.4
0.0 ... 0.2
Region boundaries
Numerical zoning map Horticulture and fruit growing
LayerManager
Zoom tools
Named viewports:

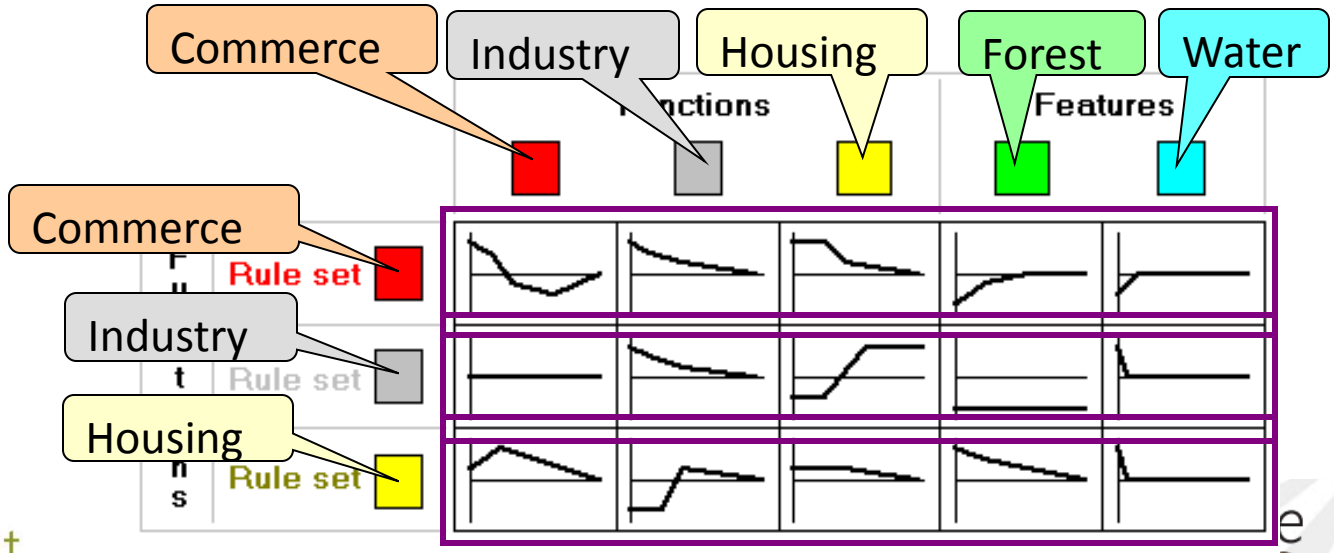
Spatial interactions



- Distance rules representing locational preferences of land uses in competition for space
- Based on 'Cellular Automata'

- 50-100m resolution

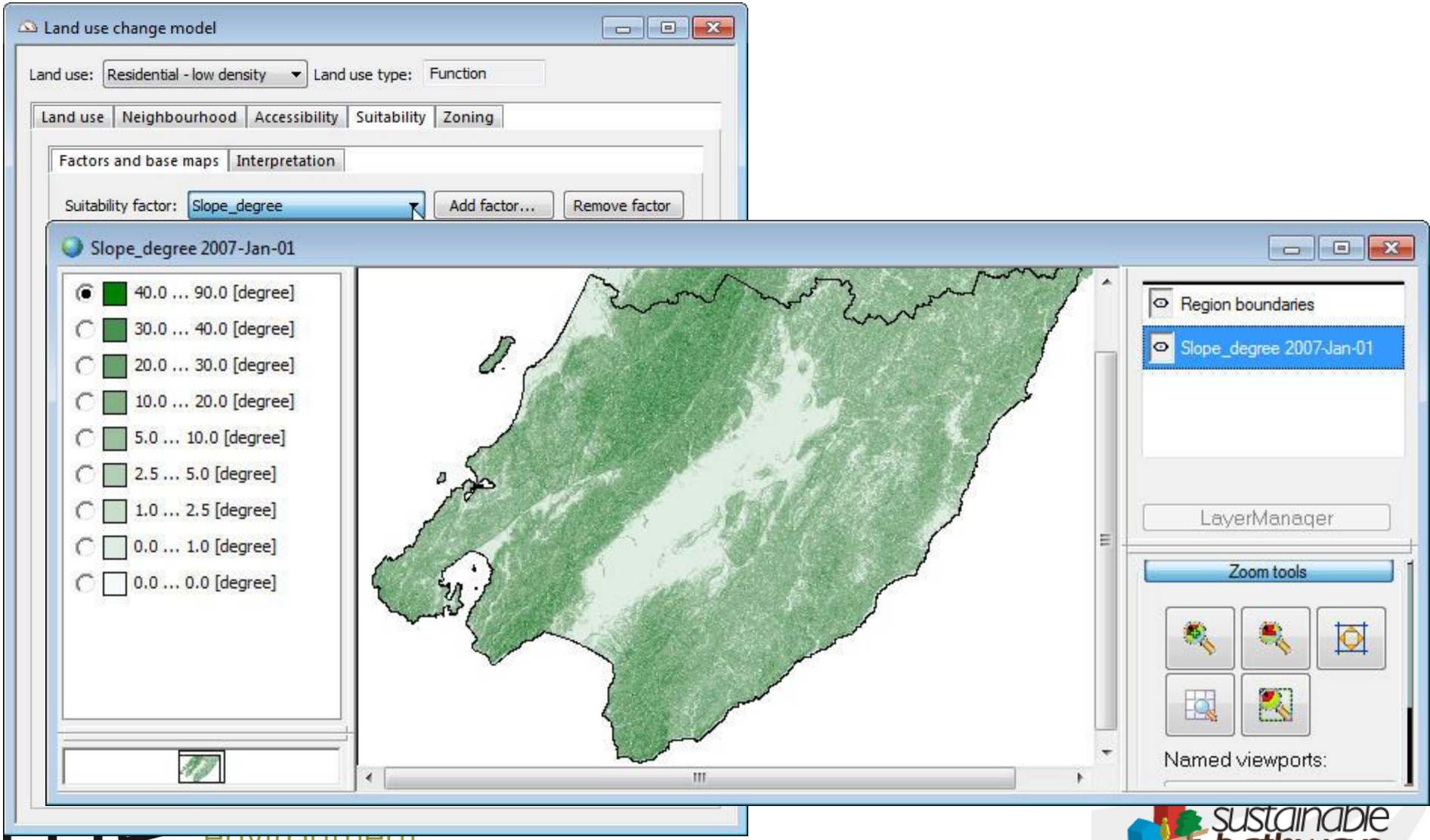




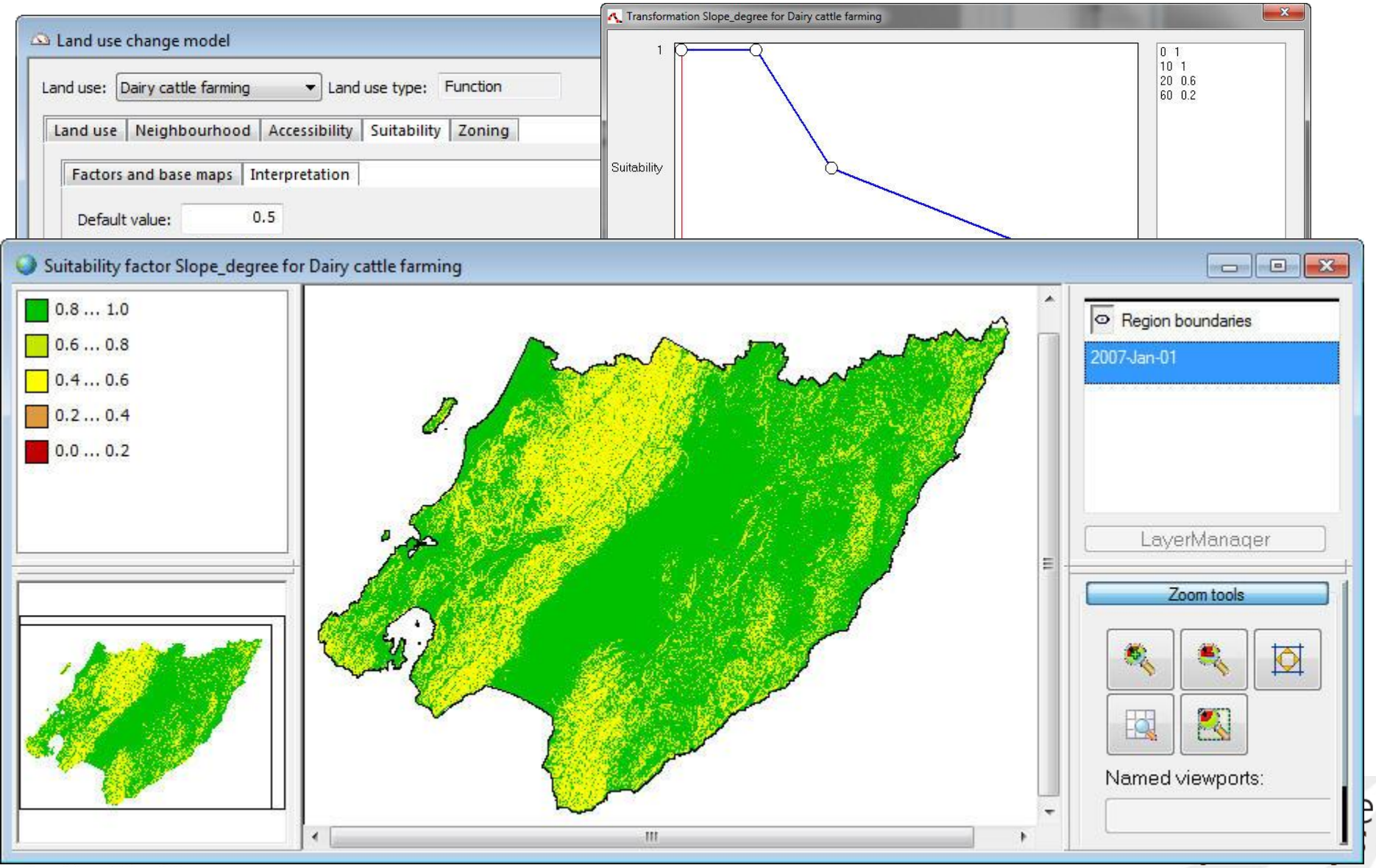
m.e environment

pathways

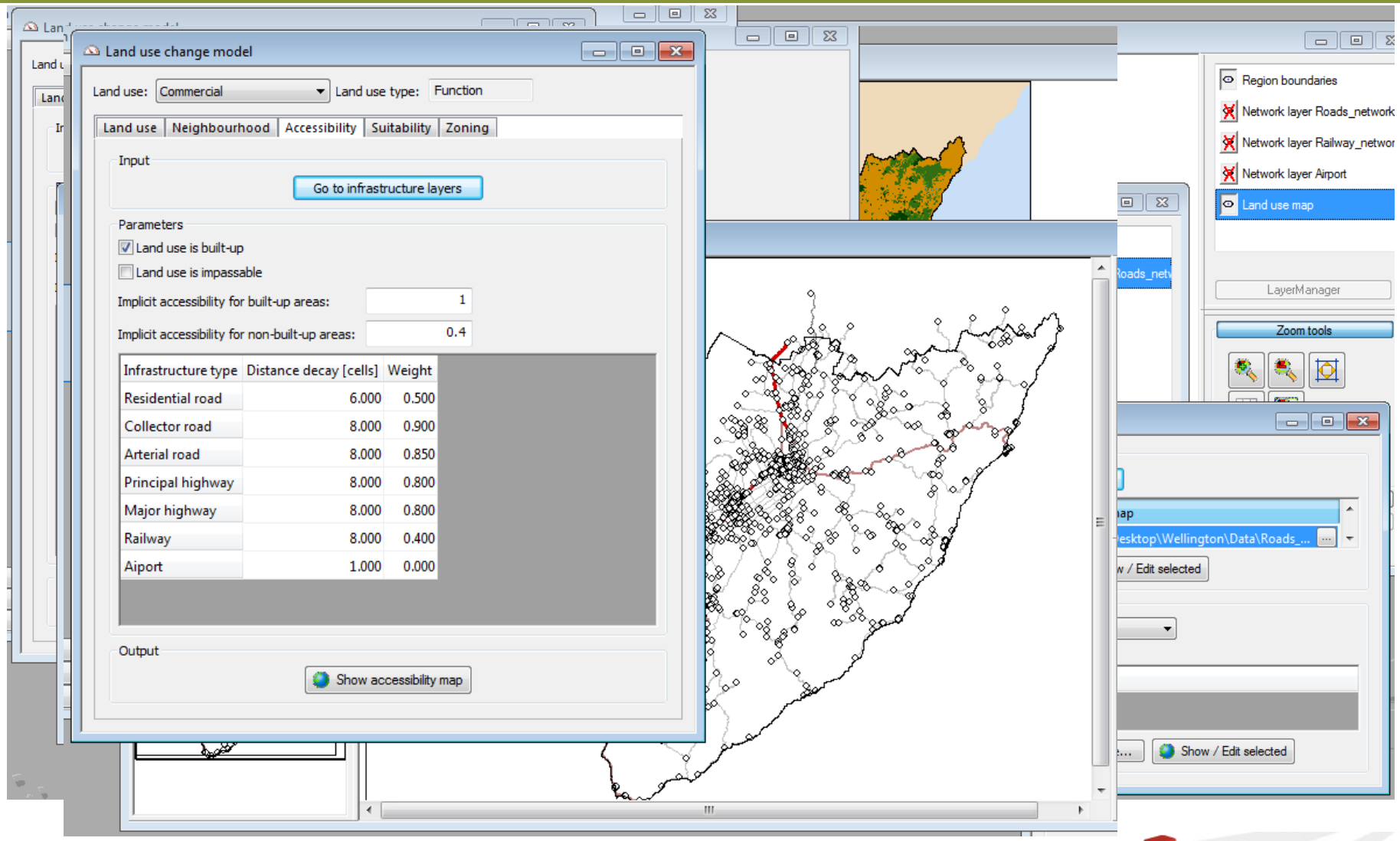
Suitability



Suitability



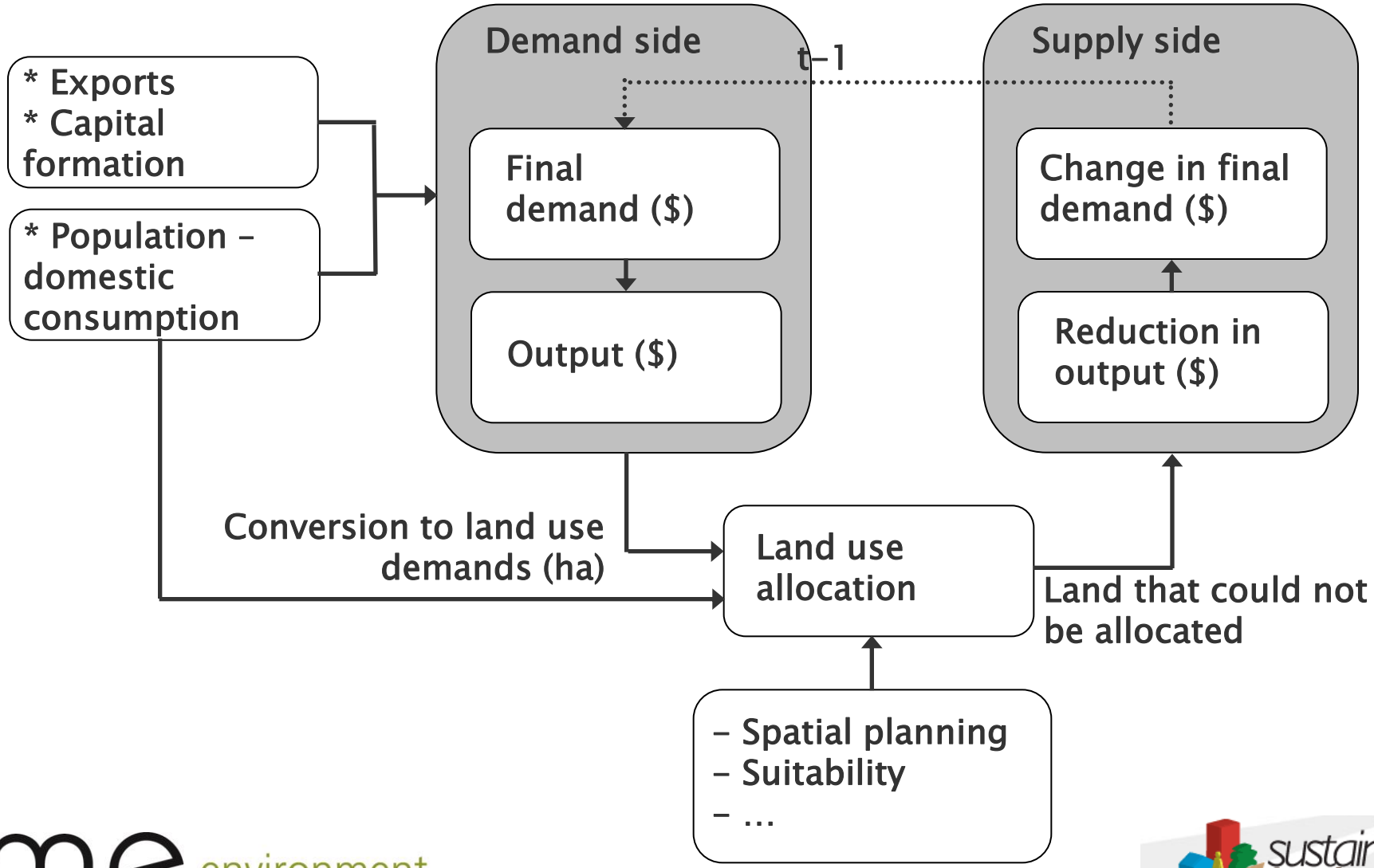
Accessibility



m.e environment

sustainable pathways

ISE is about integration!



m.e environment

sustainable pathways

What can ISE be used for?

Assessing the socio- economic and environmental impacts associated with:-

Urban issues

- Spatial planning e.g. the Auckland plan
- Understanding the implications of zoning and road/port/airport infrastructure changes e.g. CRL, Transmission Gully, Western Link
- Residential, business and urban growth strategies e.g. Future proof
- Economic development strategies e.g. Auckland EDS
- Medium-long term planning

Rural issues

- Catchment issues such as N, P loadings and sediment associated with intensive farming e.g. WRISS, EBoP, ES
- Land use change e.g. dairy conversion, carbon forestry

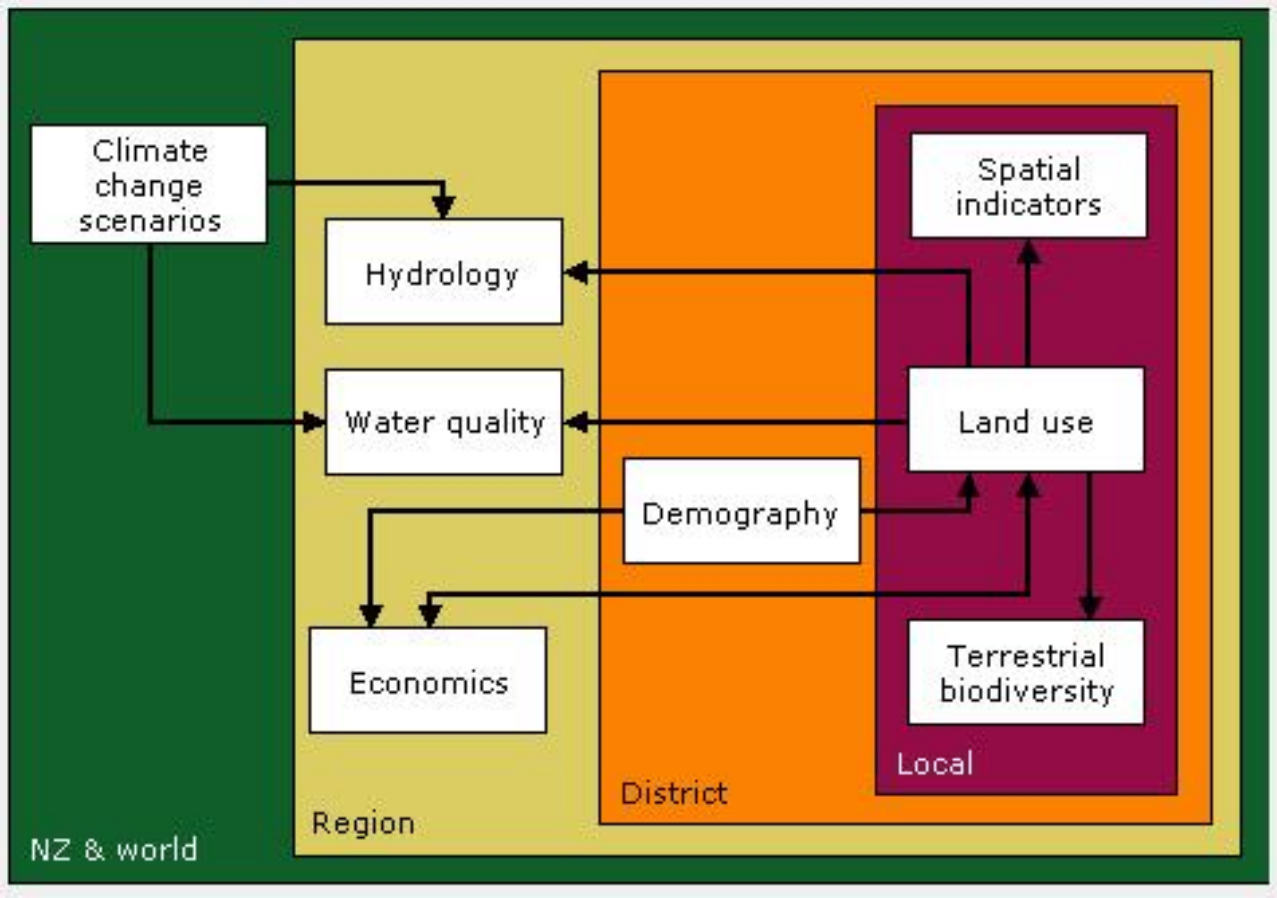
What can ISE be used for?

- ***Policy evaluation***
  - Quantifying trade-offs of different growth scenarios
  - Implications of city form questions e.g. compact versus extended MULs
  - Hazard impacts
- ***Spatial Economy***
  - Business land use and requirements by economic sector
  - Residential land use by household type
  - Infrastructure delivery programming (quanta and timing)
- ***Socio-Economic Impacts***
  - Future skills demand
  - Labour force projections
  - Identifies the mismatch between future jobs and skills

Eg. Waikato region - carbon forestry

- Implications of conversion of marginal land into carbon forestry
- Modified economic model to include carbon forestry
- Modeled conversion of marginal sheep, beef and dairy land into carbon forestry
- Taking account of improvements in land use productivity and interdependencies between industries within Waikato economy

Waikato ISE



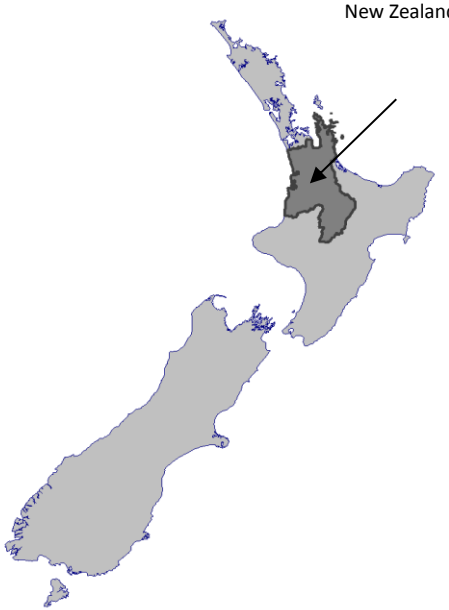
m.e environment

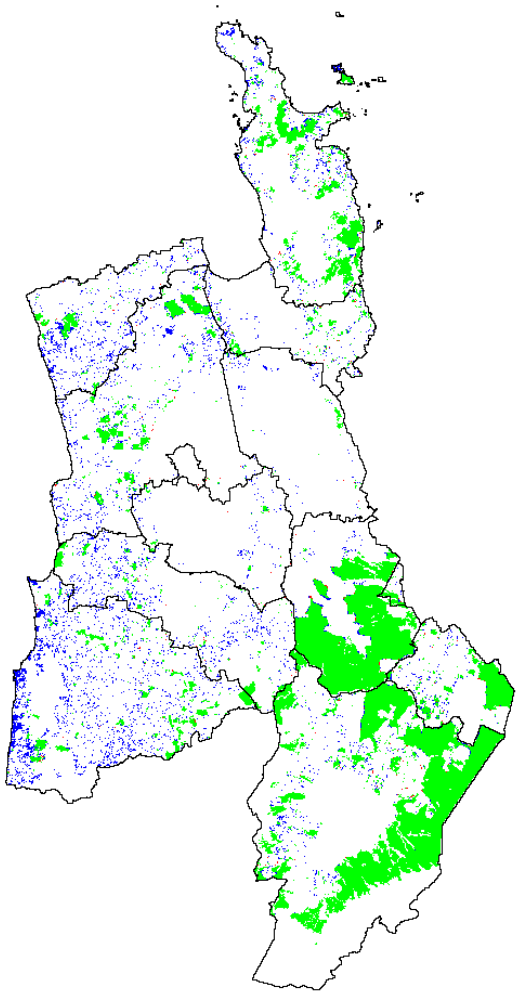
sustainable pathways

Land use conversions

Period	From Sheep and Beef Farming to Carbon Forestry ha	From Dairy Farming to Carbon Forestry ha
2011 to 2016	-10,000	-625
2016 to 2021	-20,000	-625
2021 to 2026	-15,000	-625
2026 to 2031	-15,000	-625
2031 to 2050	-15,000	-2,500
Total 2011 to 2050	-75,000	-5,000

Resulting land use changes



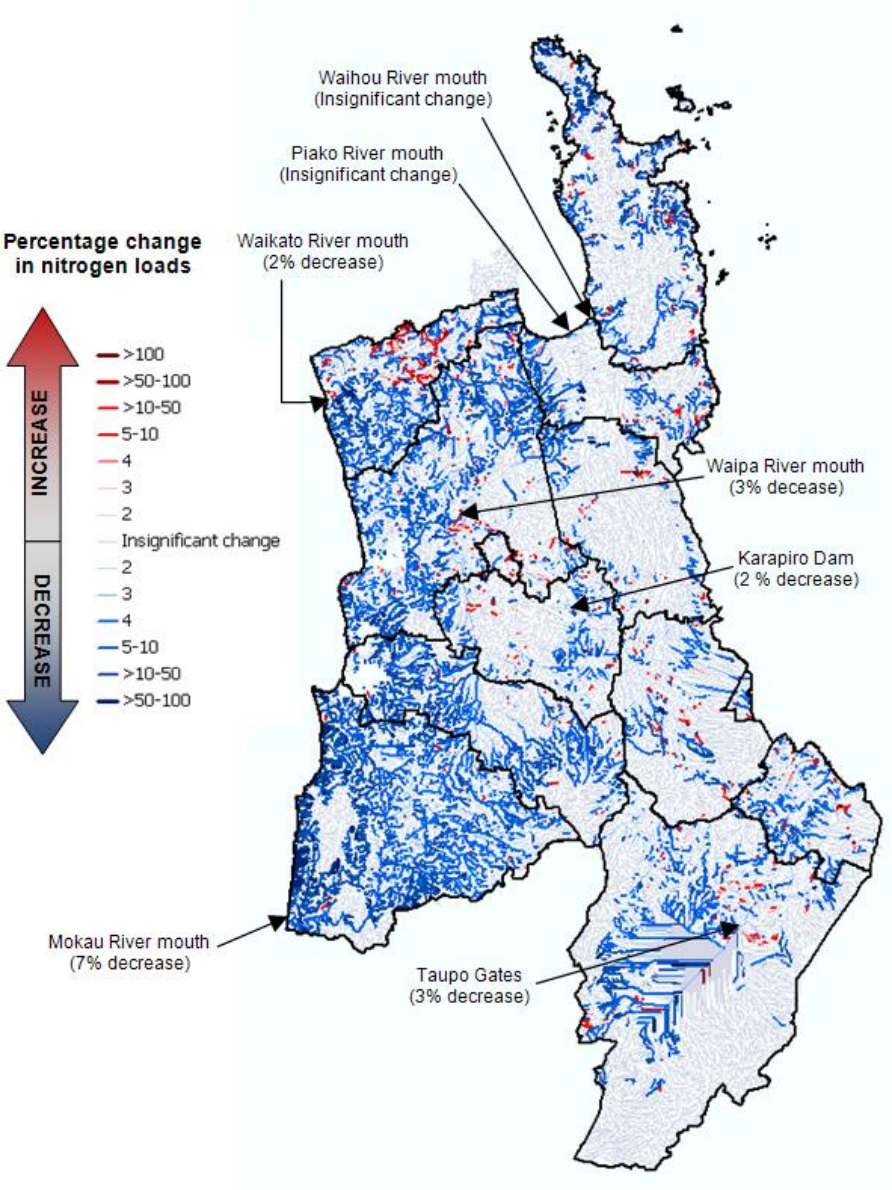


- Not forestry in either scenario
- Forestry in both scenarios
- Only forestry in the reference scenario
- Only forestry in the carbon forestry scenario

m.e environment

sustainable pathways

Resulting change in N-loads



m.e environm

sustainable pathways

Eg. Protecting indigenous vegetation - Wellington region

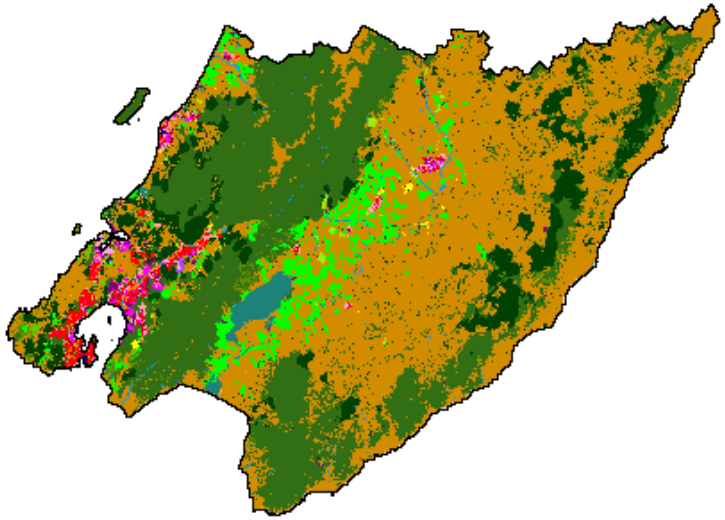
How does the region change over time under the baseline scenario?

- Taking into account land as a limiting resource
- Using a purely demand-driven approach

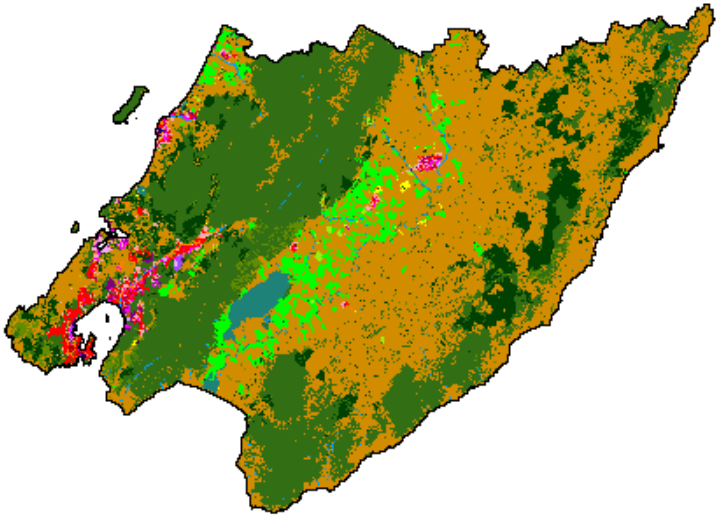
What would be the impact of protecting the current areas of indigenous vegetation

- On land use?
- On economic development?

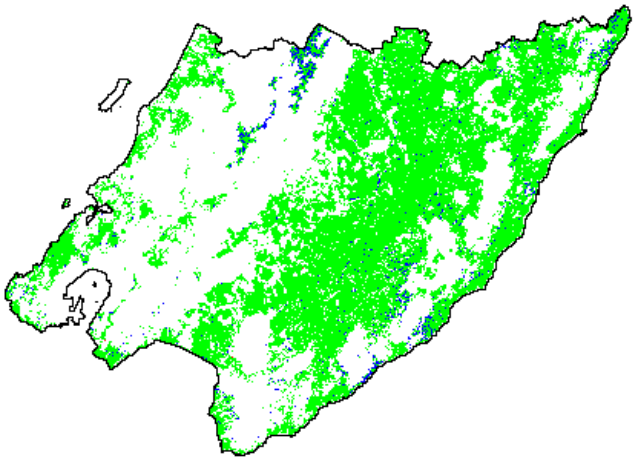
- Indigenous forest and vegetation
- Other exotic vegetation
- Horticulture and fruit growing
- Livestock farming and cropping
- Dairy cattle farming
- Other farming
- Exotic forest
- Industrial
- Hospitality
- Commercial
- Central government
- Residential - low density
- Residential - medium density
- Residential - high density
- Education
- Culture and recreation
- Mines, quarries and dumps
- Aquaculture
- Freshwater
- Wetlands
- Marine
- Airports and ports
- Motorway
- Open space (urban parkland/grassland)
- Coastal and estaurine areas
- Bare land
- Land outside of study area



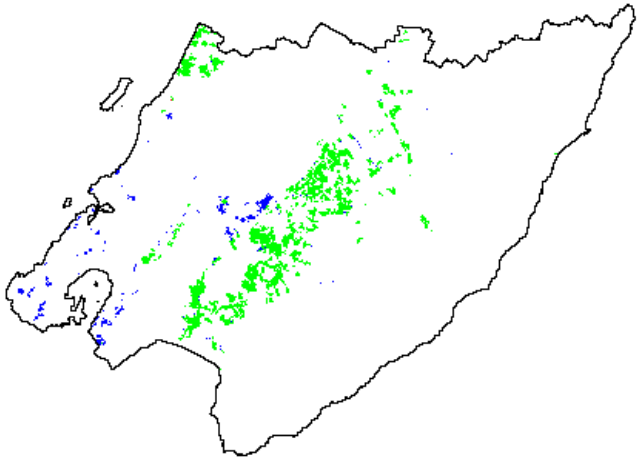
2005



2025



Increase in livestock farming

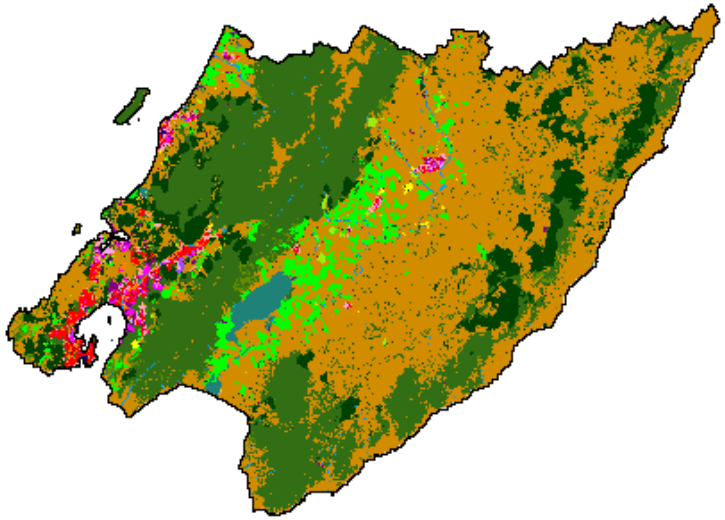


Increase in dairy cattle farming

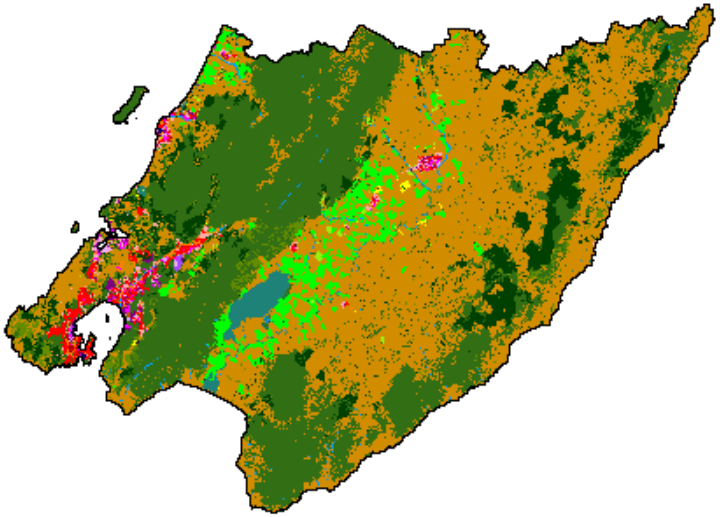
m.e environment

sustainable pathways

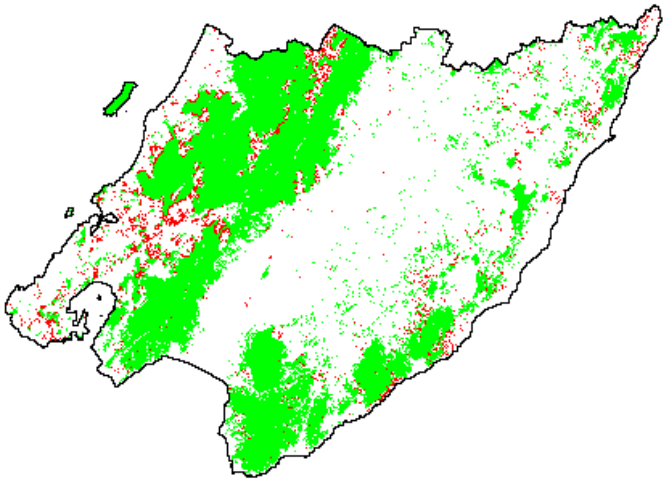
- Indigenous forest and vegetation
- Other exotic vegetation
- Horticulture and fruit growing
- Livestock farming and cropping
- Dairy cattle farming
- Other farming
- Exotic forest
- Industrial
- Hospitality
- Commercial
- Central government
- Residential - low density
- Residential - medium density
- Residential - high density
- Education
- Culture and recreation
- Mines, quarries and dumps
- Aquaculture
- Freshwater
- Wetlands
- Marine
- Airports and ports
- Motorway
- Open space (urban parkland/grassland)
- Coastal and estaurine areas
- Bare land
- Land outside of study area



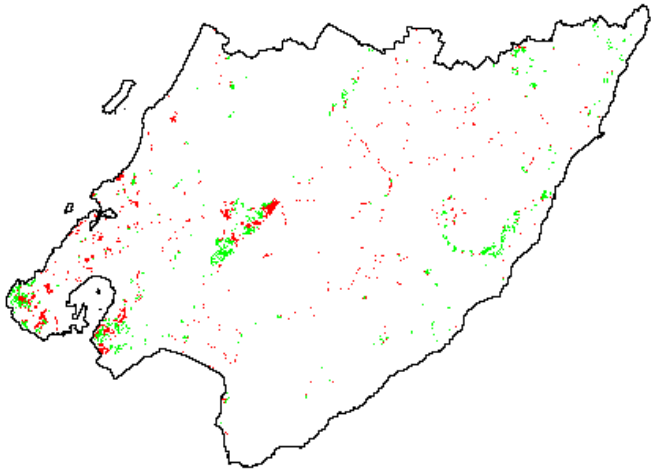
2005



2025



Decrease in indigenous vegetation

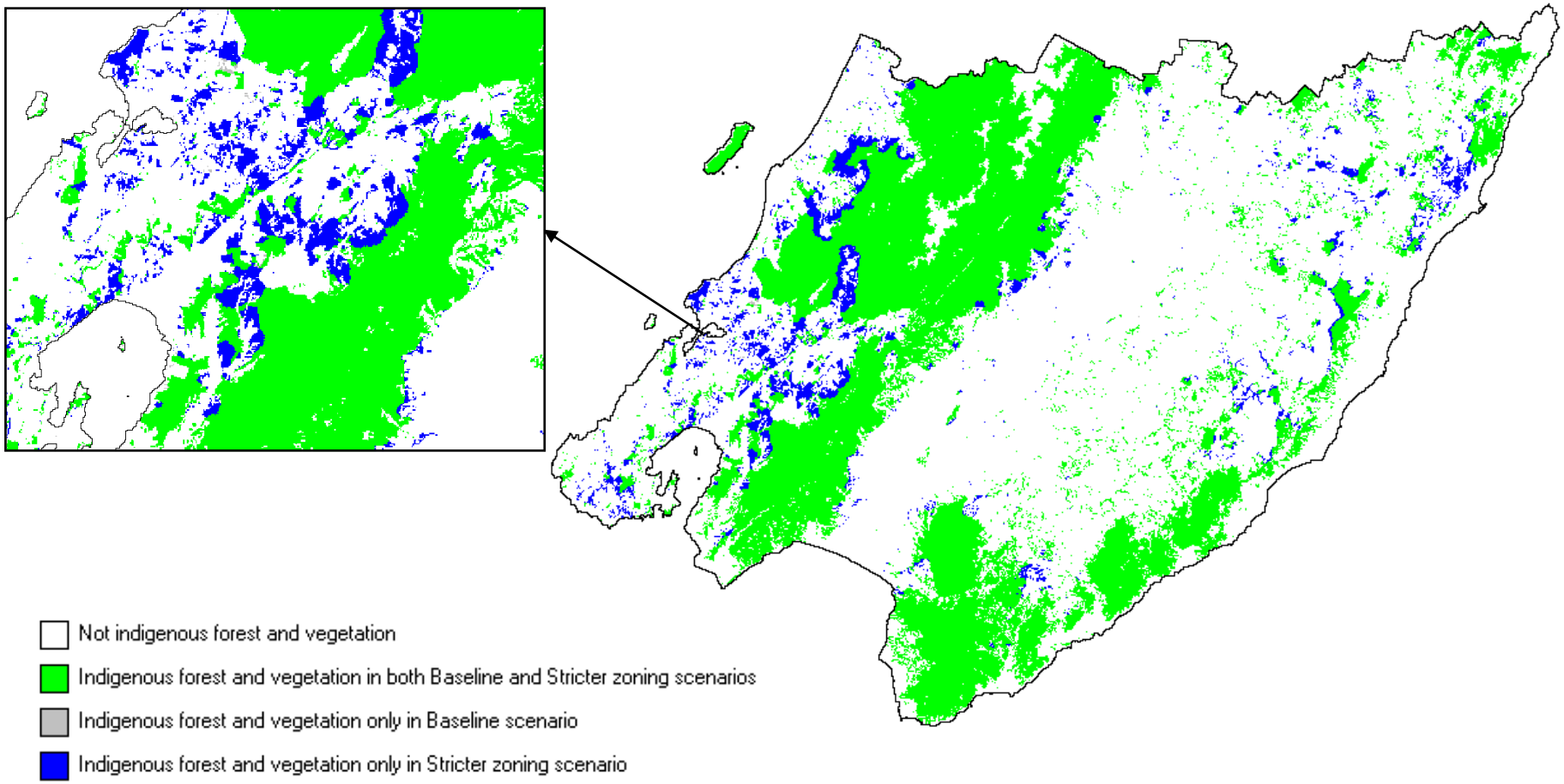


Decrease in other exotic vegetation

m.e environment

sustainable pathways

Difference between options



m.e environment

sustainable pathways

Land use results (ha)

Land use (ha)	2007	2031 Unlimited	2031 Baseline	2031 Planned
Horticulture and fruit growing	868	1289	1145	1121
Livestock farming and cropping	373730	419084	386991	369823
Dairy cattle farming	33877	48273	39770	36779
Other farming	1841	2610	2545	2538
Exotic forest	62433	79729	78458	77161
Industrial	3059	4920	4920	4920
Hospitality	336	371	371	371
Commercial	2406	3218	3218	3218
Central government	413	496	496	496
Residential - low density	5312	5578	5578	5578
Residential - medium density	9379	9848	9848	9848
Residential - high density	427	448	448	448
TOTAL	494081	575864	533788	512301

m.e environment

sustainable pathways

Economic impact results ($\$_{2007}$mil)

Scenarios → Results from the economic model ↓	2007	Baseline 2051	Unlimited 2051	Planned 2051
Total economic output (mln $2004)	37604	64872	64897	64837
Output in Livestock and cropping farming in 2051 (mln $2004)	184	189	208	188
Output in Meat and meat product manufacturing in 2051 (mln $2004)	278	413	417	413
Overall economic growth over the period 2007-2051 (%)		73	73	72
Growth in Livestock and cropping farming over the period 2007-2051 (%)		2.4	12.6	1.8
Growth in meat and meat product manufacturing over the period 2007-2051 (%)		49	50	48

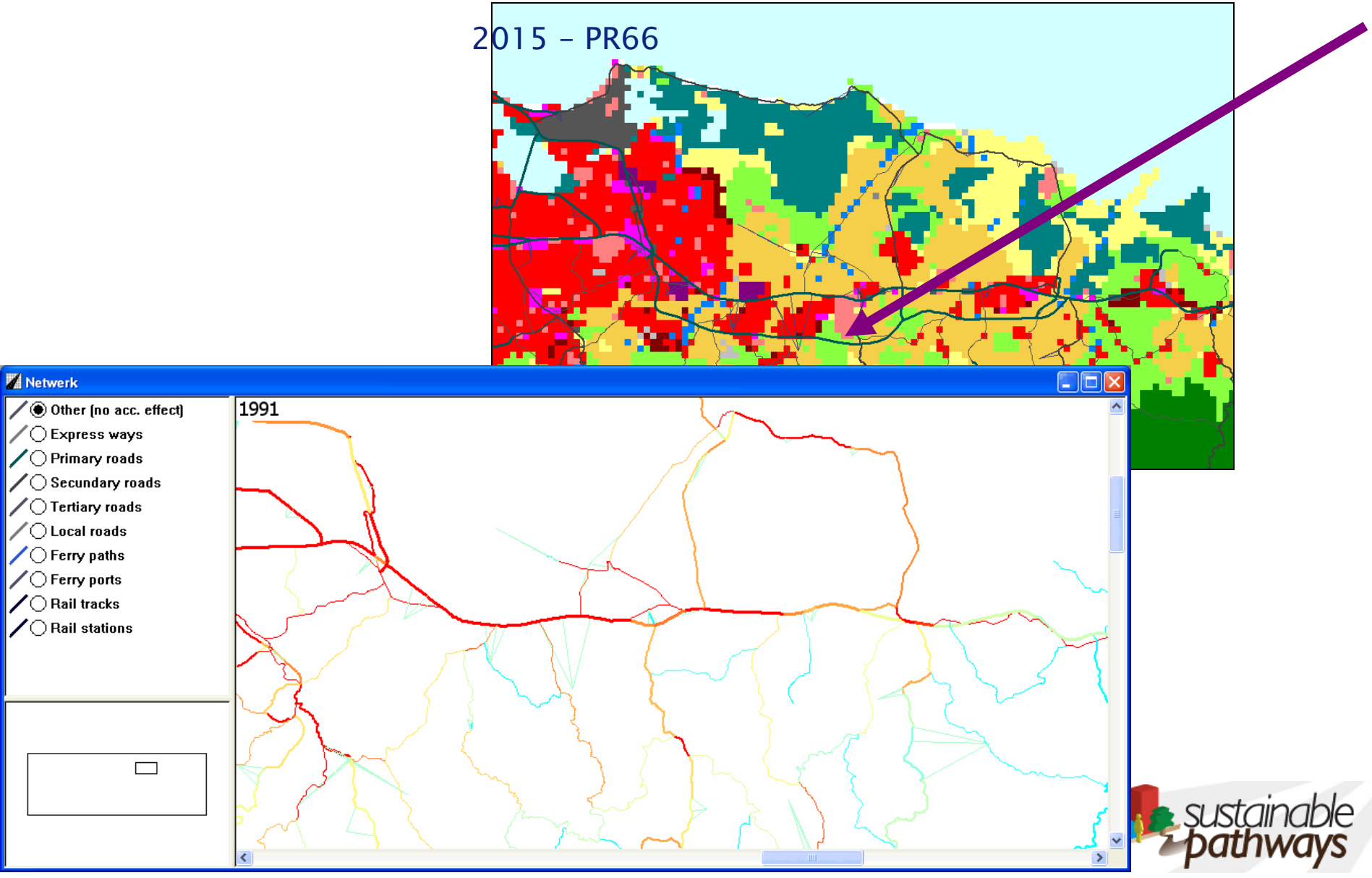
m.e environment

sustainable pathways

Impact on economic developments

- Overall economic growth in the baseline scenario over the period 2005-2025 is ~38%
- An unconstrained supply would give ~2% higher growth, stricter zoning ~0.5% less growth
- Impact on the agricultural sector, in particular dairying and livestock farming is much larger, in the order of 10-15%
- Spatial planning, interesting locational characteristics and competition between land uses determines what economic sectors will be most affected by limiting land resources

Eg. New highway (PR, 2005)



Economics of resilient infrastructure

- Successful 2012 Research Investment Round, $2.8 million over 4 years
- GNS Science led collaboration with M.E Environment, RIKS, Resilient Organisations, Auckland Council, CDC/CERA and others

GNS SCIENCE TE PŪ AO

Resilient ORGANISATIONS
A collaboration between research & industry

Auckland Council
Te Kaunihera o Tāmaki Makaurau

RIKS
research institute for knowledge systems

m.e environment

Ministry of Business, Innovation & Employment

Science + Innovation

cdc

CERA
Canterbury Earthquake Recovery Authority

Success factors

- Availability of models and data – garbage in, garbage out
- Ease of use – user-friendly interface
- Strategic value – usefulness, application, added value
- Credibility of system – assumptions, calibration, validation
- Institutional embedding – willingness, adoption, commitment
- Ongoing support – training, capability building, technical support, maintenance and cost

We are unable to do it without you!

m.e environment

sustainable pathways

Getting Started with ISE
Guided Tour Using 'What If' Questions [2]

m.e environment

Software and data

- ISE program files which are stored in the C:\Program Files\Geonamica\ISE

- ISE data files which are stored in C:\My Documents\Geonamica\ISE\Wellington
  - This includes the 'Wellington.geoproj' file which stores all of the data needed to run a simulation

- To run ISE you will need a license file (this has a .lic extension).
  - The license is only valid for one year, at which point you will need to request an updated file from M.E or RIKS

Setting up queries and scenarios

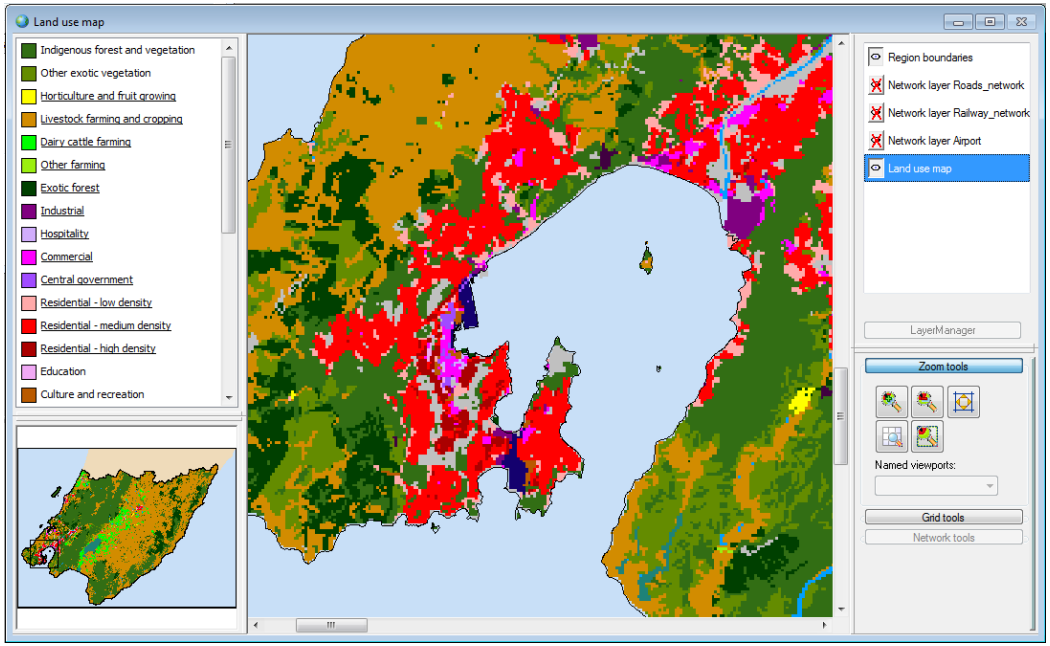
Two key methods for setting up Queries and Scenarios:-

- Simple ‘What if’ type queries? (No dependencies between modules)
  - Can be undertaken in the Policy User Interface

- Full scenarios with dependencies between modules
  - Requires a Scenario Development process
  - Requires use of both Policy and Expert Users Interfaces
  - Requires use of the Scenarios Manager

Exploring the land use map

- The land use map has a resolution of 100-by-100 metres
- *The top left-hand side* provides a legend
- *The bottom left-hand side* shows inset map of the entire region and your current view
- *The right-hand side* gives access to the 'Layer manager', 'Zoom tools' and 'Grid tools'



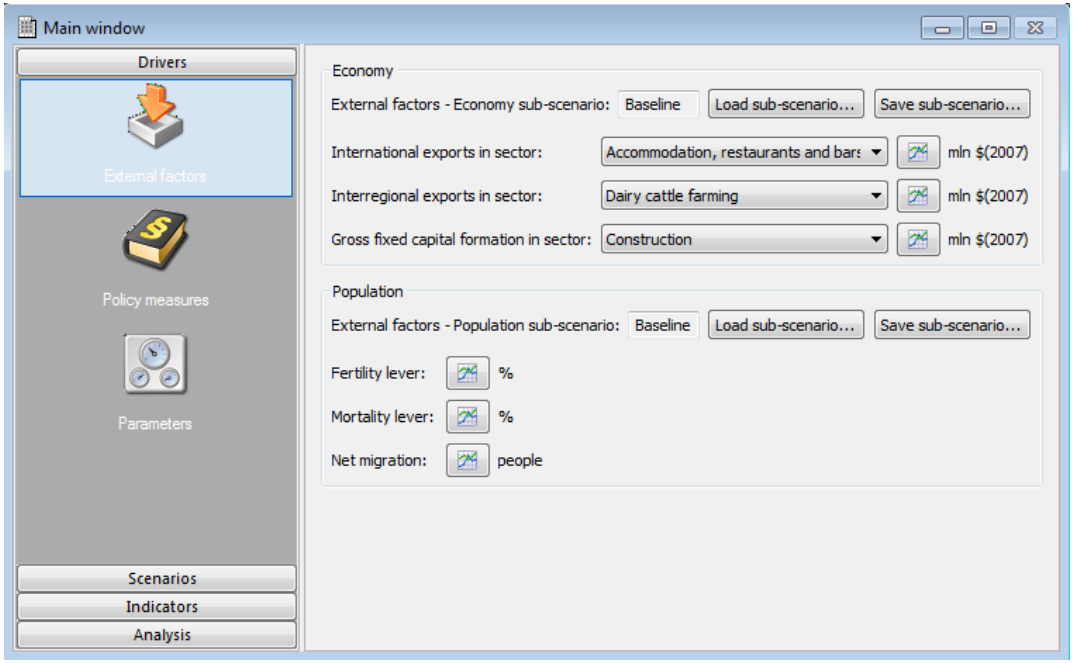
m.e environment

sustainable pathways

The main menu

- The Main Menu gives access to the ‘Policy’ and ‘Modeller’ interfaces

- Left hand side guides that user through setting up ‘Drivers’ (external factors, policy measures, parameters) ‘Scenarios’ and, in turn, following a run of the model, analyse results using ‘Indicators’ and ‘Analysis’



m.e environment

sustainable pathways

Key drivers of change

Requires detailed knowledge of Population, Economic and Land Use Change Modules to create a Baseline Scenario:-

- ***Population module*** – changes in base population, demographic makeup, fertility and mortality rates etc
- ***Economic module*** – changes in economic structure, growth rates for capital formation, exports, and household consumption*
- ***Land use change module*** – changes in zoning, accessibility and suitability
- ***Setting up of interface*** for reporting indicators, animations, logging of maps and writing of results to Excel

* Located in population module

m.e environment

sustainable pathways

Summary

- Software, file structure, licenses, and open simulation
- Exploring the land use map
- Setting up the drivers using ‘What if’ examples
- Running a simulation and recording results
- Exploring indicators
- Analysing results using write to Excel, animations and maps

Modelling the implications of a Zoning Rule Change [3]

m.e environment

Plan and zoning changes/variations

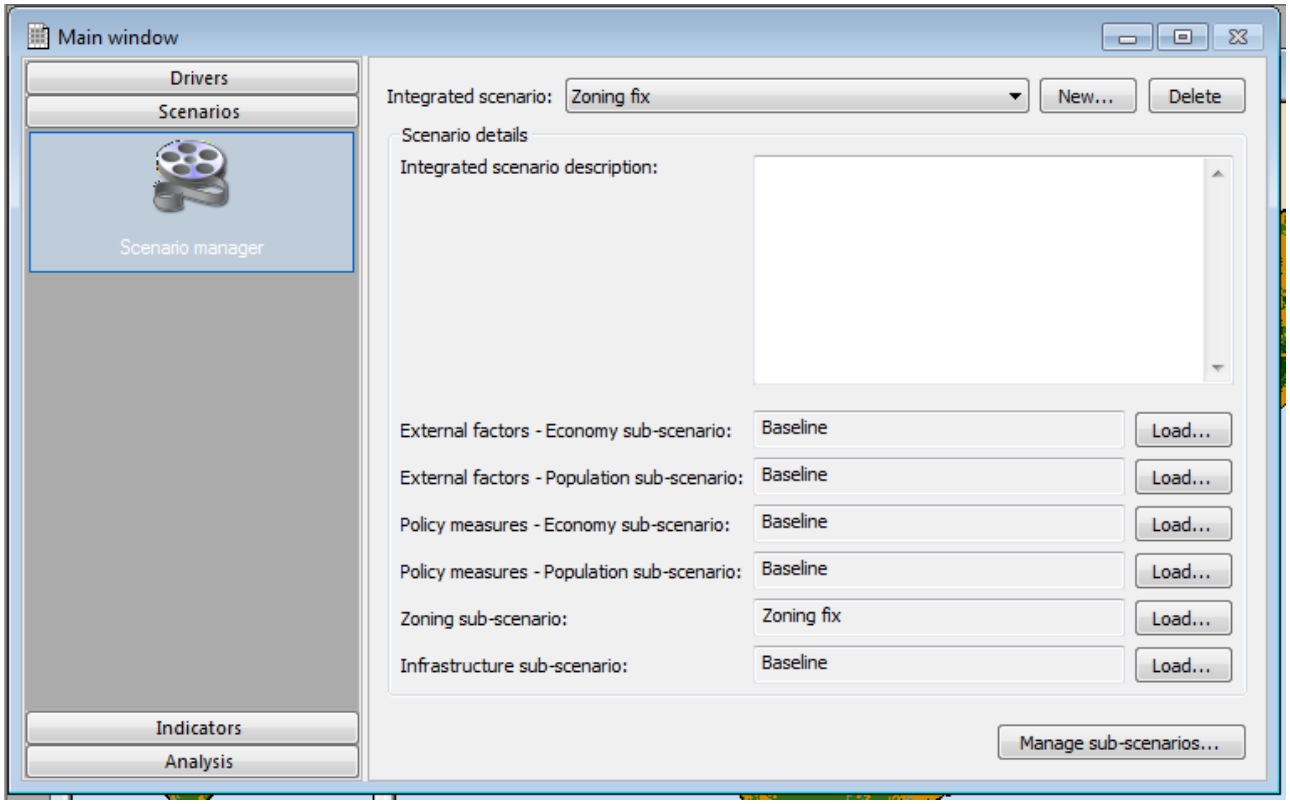
- Add and modify existing plans and land use map
- Change when plans will become active
- Set zone precedence for each land use category
- Set zoning status (unspecified, non-complying, restricted, discretionary, prohibited etc) for each land use category
- Restriction economic development through zoning
- Understand the land use and economic developments associated with the above

m.e environment

sustainable pathways

Scenario manager

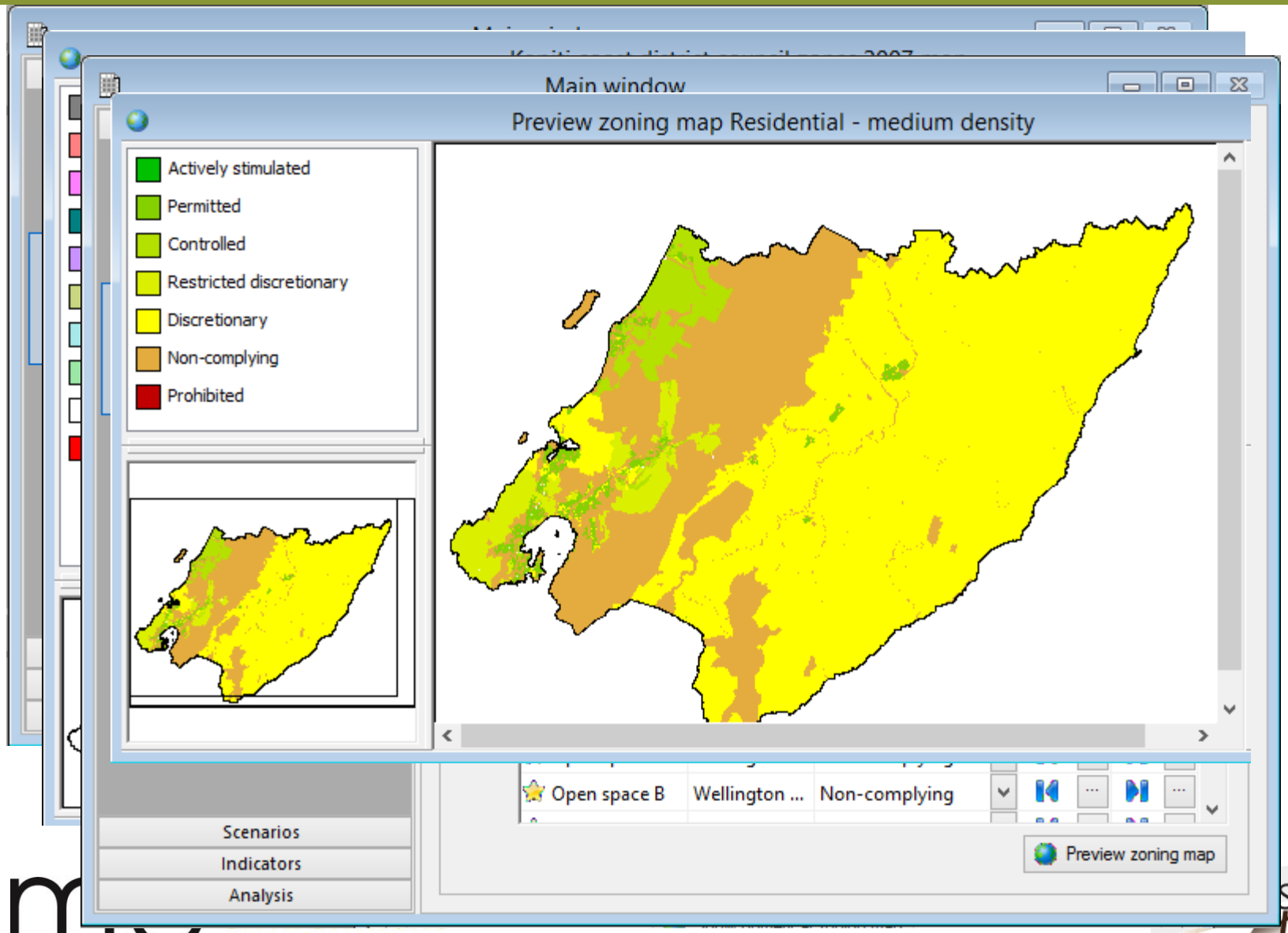
- Scenarios are built up as we go. First create sub-scenarios, then integrated scenarios. Through the use of the ‘scenario manager’.



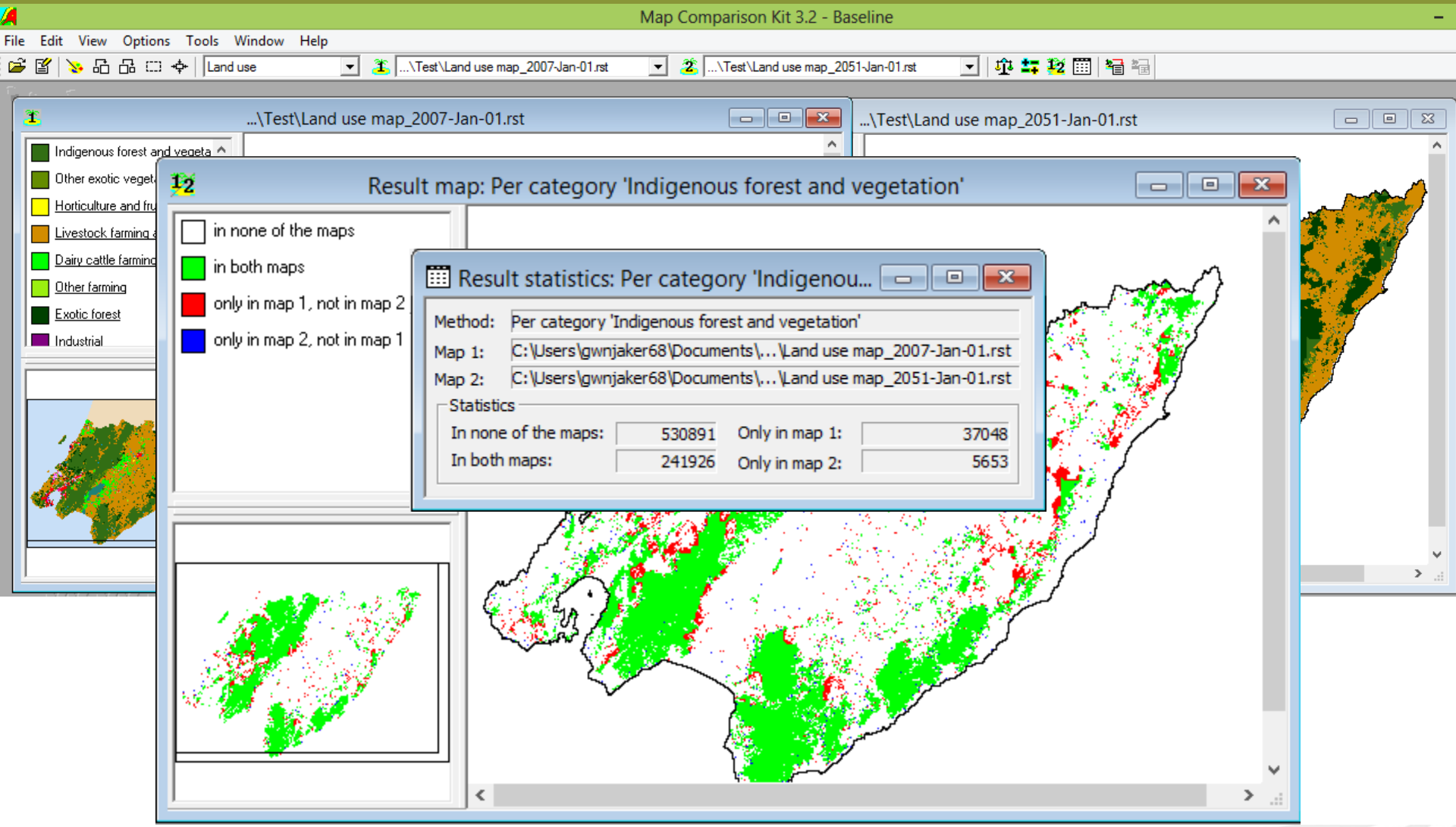
m.e environment

sustainable pathways

Change zoning using the 'Zoning tool'



Analyse results using ‘Map comparison kit’



m.e environment

sustainable pathways

Summary

- How to create scenarios using the Scenario Manager
- How to use the Zoning Tool
- Analysing results using the Map Comparison Kit

Discussion and Feedback

Discussion

- Do you think ISE would be of value to you are your Council?
- Who do you think would use ISE in your Council? Policy, GIS, etc
- What topics/case studies would you like to see discussed in the next workshops?
- Any other comments?

Feedback

- A feedback form will be email through to all who attended this form over the next week

m.e environment

sustainable pathways

Challenges

- Train others – Setup in your Council, go through GS guide again, train another *

- Future workshops (6-8 in total)
  - Will be more hands-on interactive
  - Will build on previous workshop and have some homework
  - I'll facilitate, but I expect others to be directly involved in setup, interpreting, presentation of results

- I am keen to have the base land use map and zoning tool validated

- New version will come out at the end of 2014

Contacts

- ***Mediated Modelling***
  - Assoc Prof Marjan van den Belt, Massey University
  - M.vandenBelt@massey.ac.nz

- ***Spatial Dynamic Modelling***
  - Dr Garry McDonald, Market Economics Ltd
  - garry@me.co.nz

- ***Embedding into Council Processes***
  - Melanie Thornton, Greater Wellington
  - Melanie.Thornton@gw.govt.nz

m.e environment

sustainable pathways