Data challenges in creating LURNZ, an econometrically based model of Land Use in Rural New Zealand

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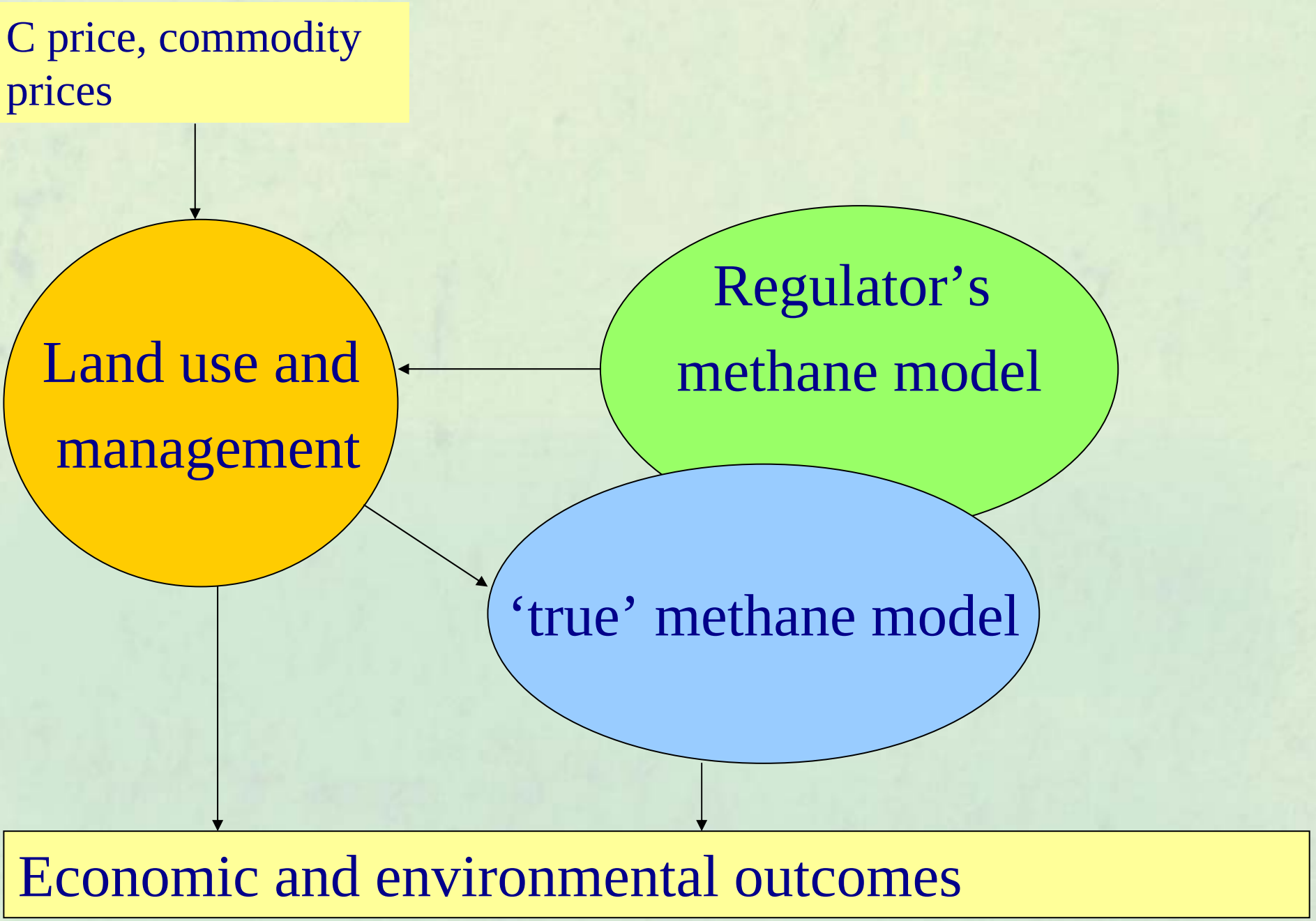
Motu integrated modelling approach

- Models motivated by policy design questions
- Economic theory basis for
  - human decision making; and
  - human responses to policy
- Want to base models on causal processes not just correlations therefore
  - Look for ‘natural experiments’
- Need data to:
  - Estimate parameters
  - Initialise model and downscale simulation results

Example: Inclusion of agricultural methane in emissions trading

Policy questions:

- What are the marginal costs of controlling methane?
- What land use change is likely to be induced?
- Where are changes likely to occur and with what local economic effects?
- How are management practices likely to change?
- What is the impact of a simple rather than complex monitoring system on farms?
- Who will bear the costs of the system?


C price, commodity prices
Land use and management
Regulator's methane model
'true' methane model
Economic and environmental outcomes

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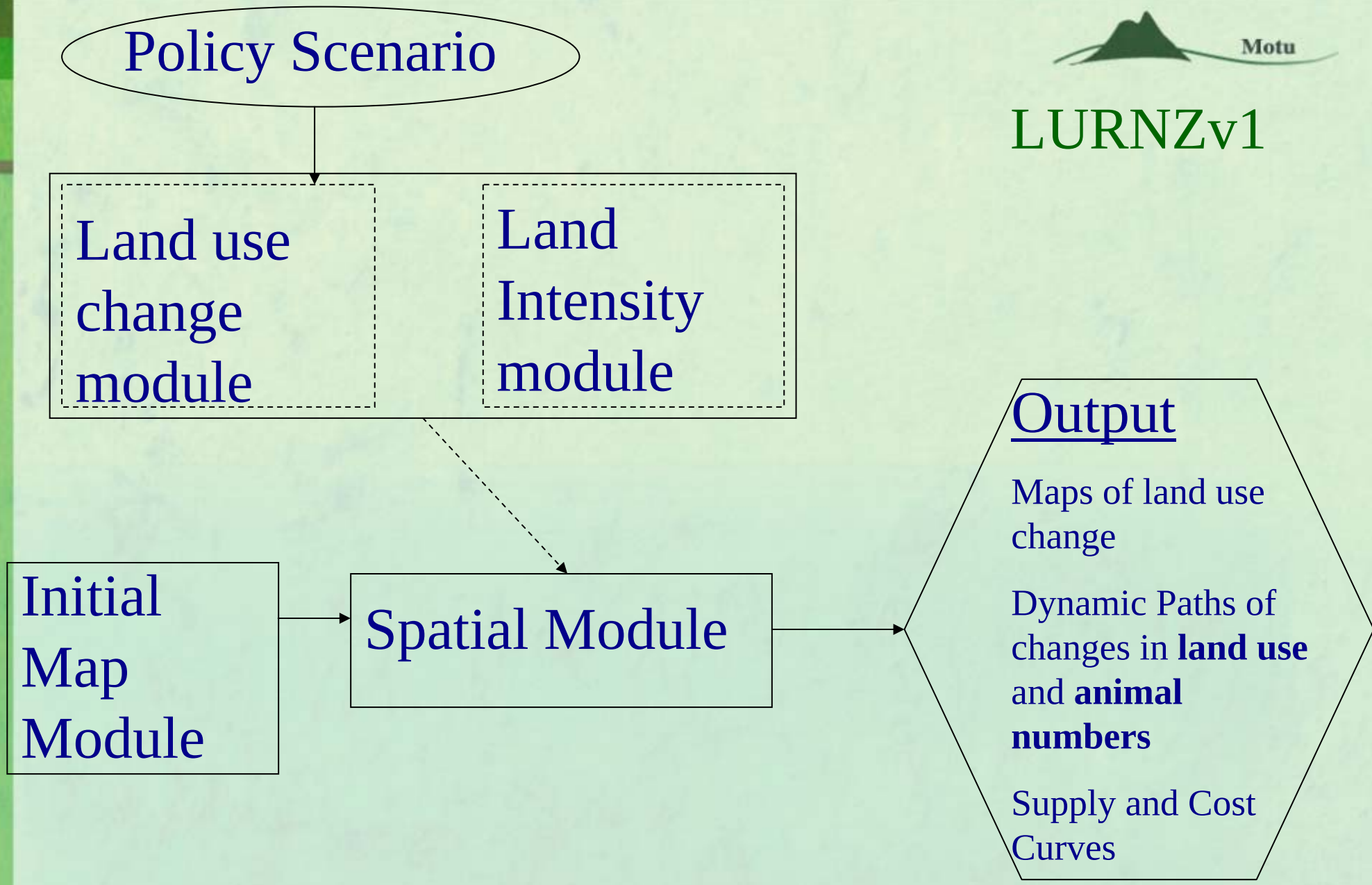
LURNZv1



Land use change module

- econometrically estimated
- partial equilibrium
- dynamic
- reduced form
- national level

Heuristic model:

Landowners choose land use (in part) to maximise future returns.

Potential returns depend on prices and the production function:

$$Returns_i = p_i.f_i(x) - w.x$$

where i={dairy,sheep/beef,plantation forests,scrub}

Changes in p (commodity prices) are exogenous and provide a ‘natural experiment’ with variability across time.

Economic instruments can be modelled as analagous to price changes

$$Returns_i = p_i.f_i(x) - w.x - p_c(CO_2 - e_i)$$

where i={dairy,sheep/beef,plantation forests,scrub}

Estimate price response

Currently estimate from time series only:

1974 – 2002 export prices for milk solids; sheep/beef meat; timber

Agricultural survey and census data on land use for same period

1996 – 2000 data missing: data filled in from alternative survey

$$Returns_i = p.f_i(x) - w.x$$

where i={dairy,sheep/beef,plantation forests,scrub}

The production function, $f_i(x)$, depends on:

- Natural capital (e.g. soil type, climate topography, altitude, access to water…)
- Physical/Social Infrastructure (e.g. roads, processing factories, milking sheds, local expertise and services, federated farmers…)
- Technology
- Variable inputs

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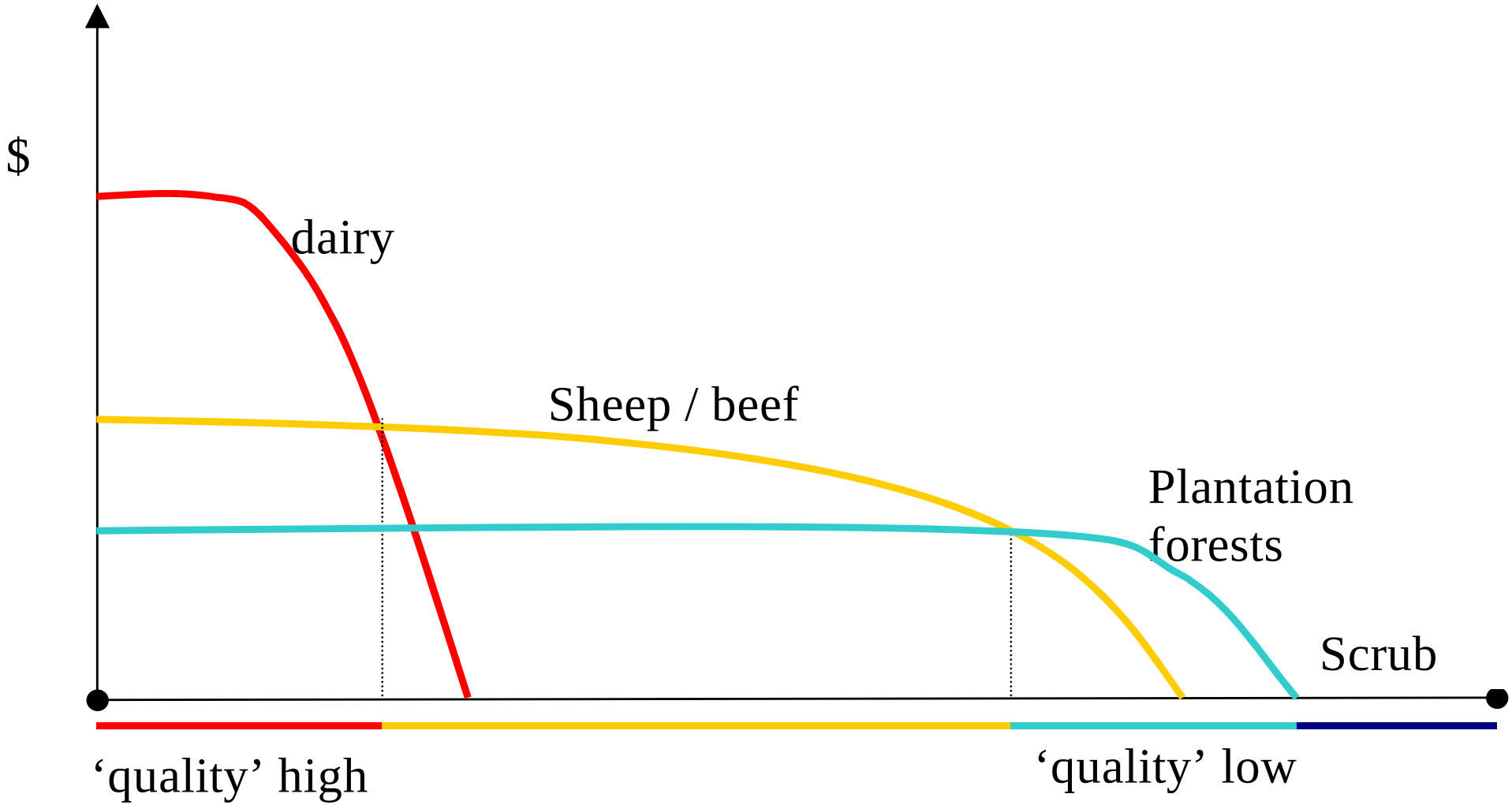
Land Quality

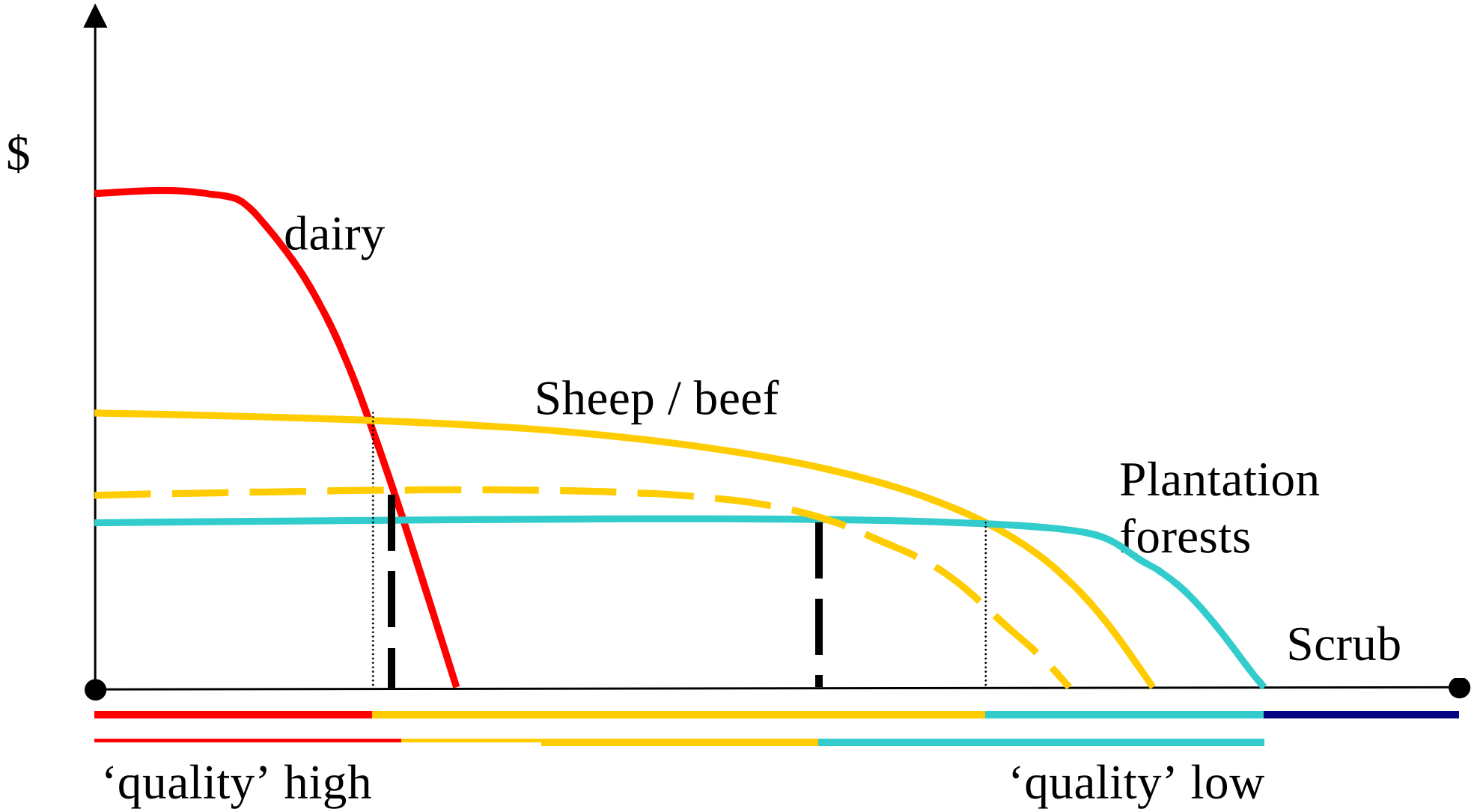
Land Quality

- varies across space
- drives the spatial variation in potential returns

Land use model



E.g. Effect of fall in sheep/beef prices



LURNZ: spatial module

Allocates national level land use changes across space – 25 ha grid.

Steps:

1. We created ‘land quality’ ranking for each land use
2. We developed algorithms that identify marginal land using the land quality rankings

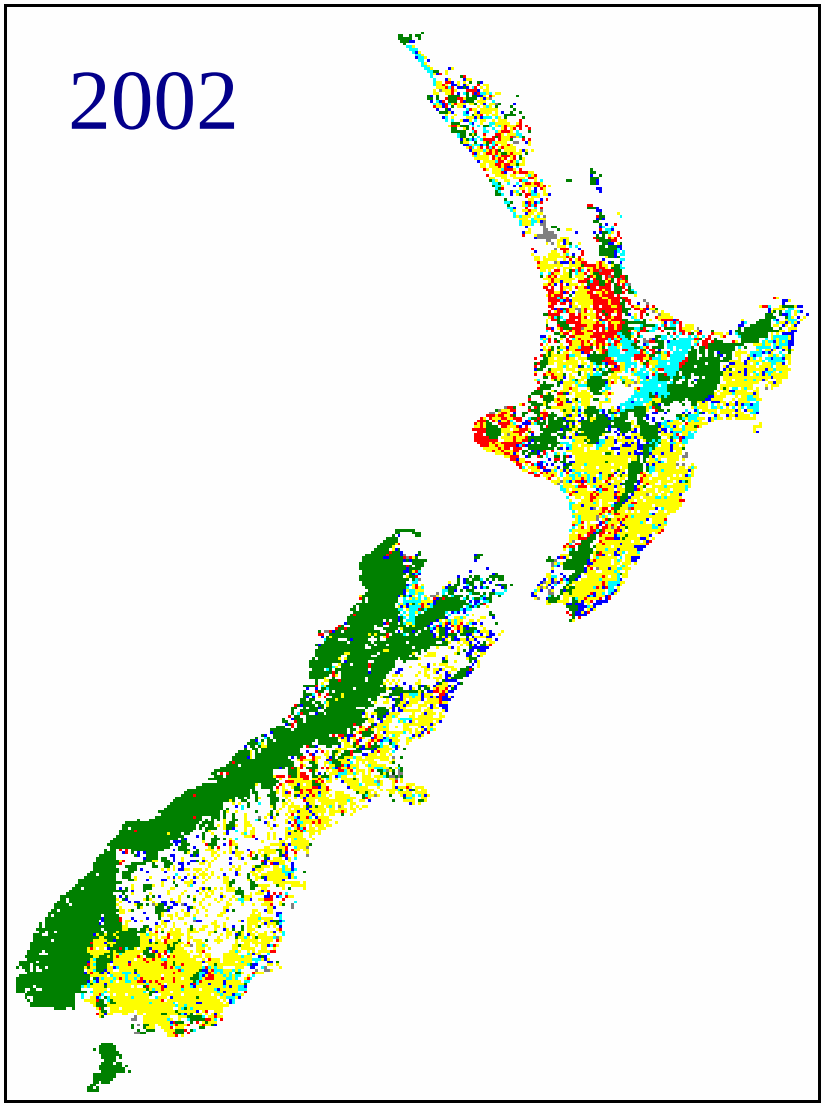
Land quality rankings

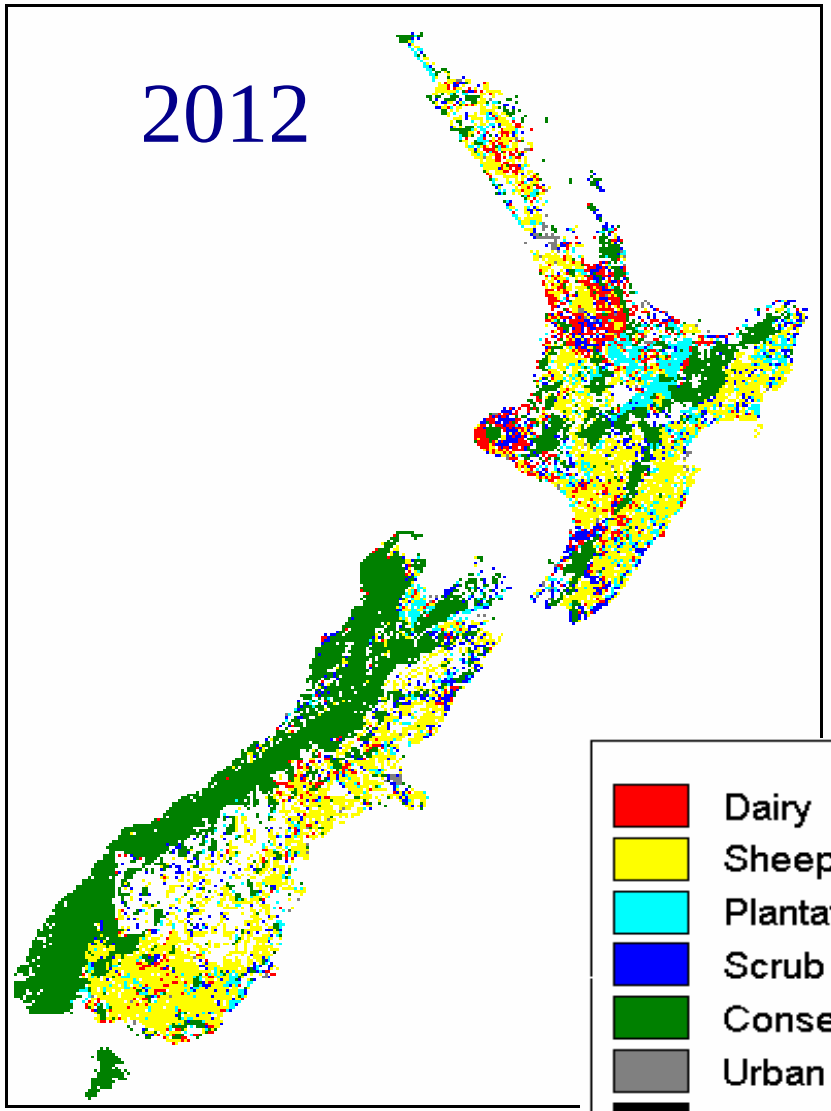
Ordinal relationship between land parcels for each land use

Land Quality Data:

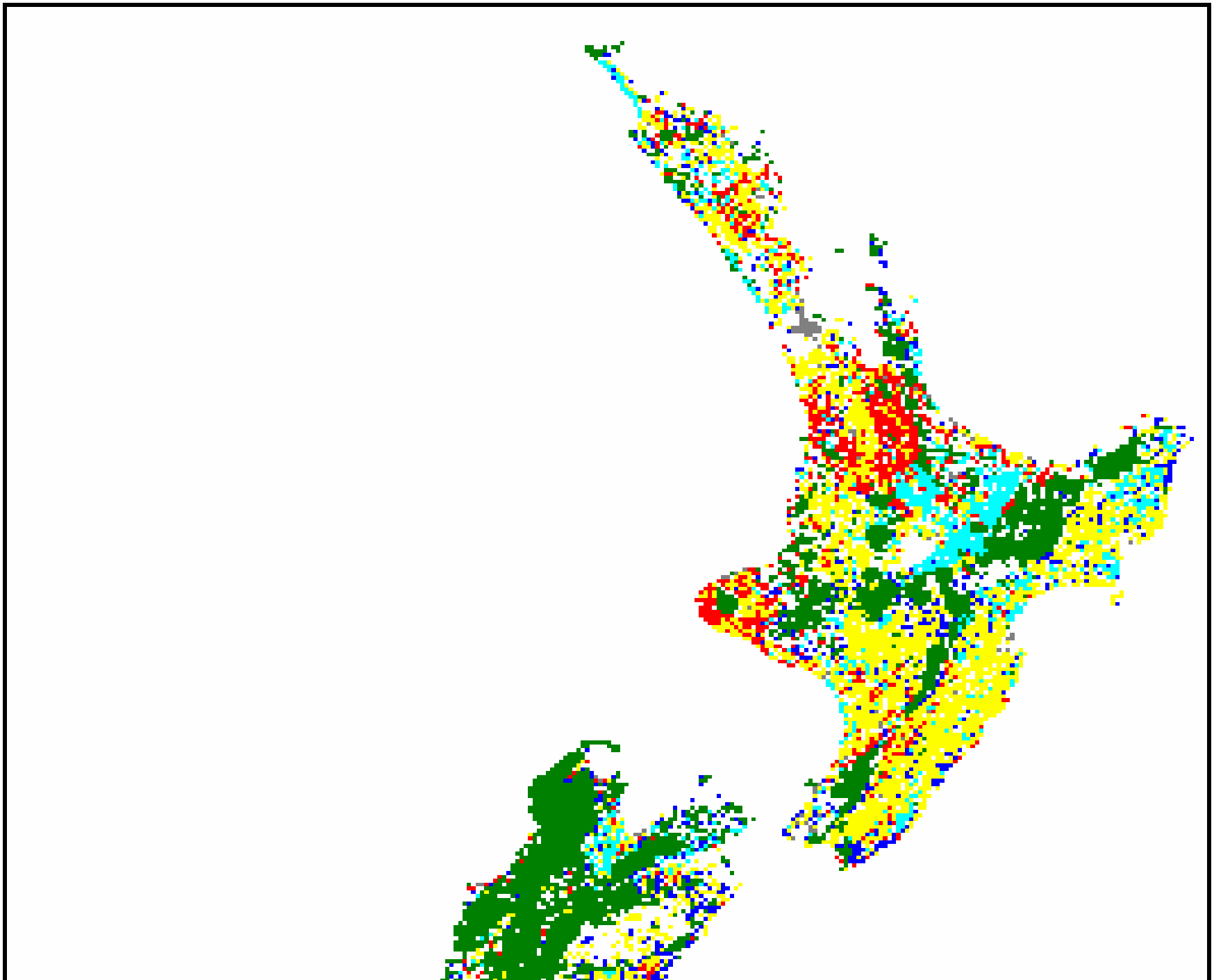
- Natural Capital:
  - Land use capability, LUC 1-8 (Landcare)
  - Agricultural productivity index (Landcare)
  - Exotic forestry productivity index (Landcare)
- Physical/Social Infrastructure:
  - Current land use (LURNZv1 initial map module), on grid cell, on neighbouring grid cells and in territorial authority as a whole

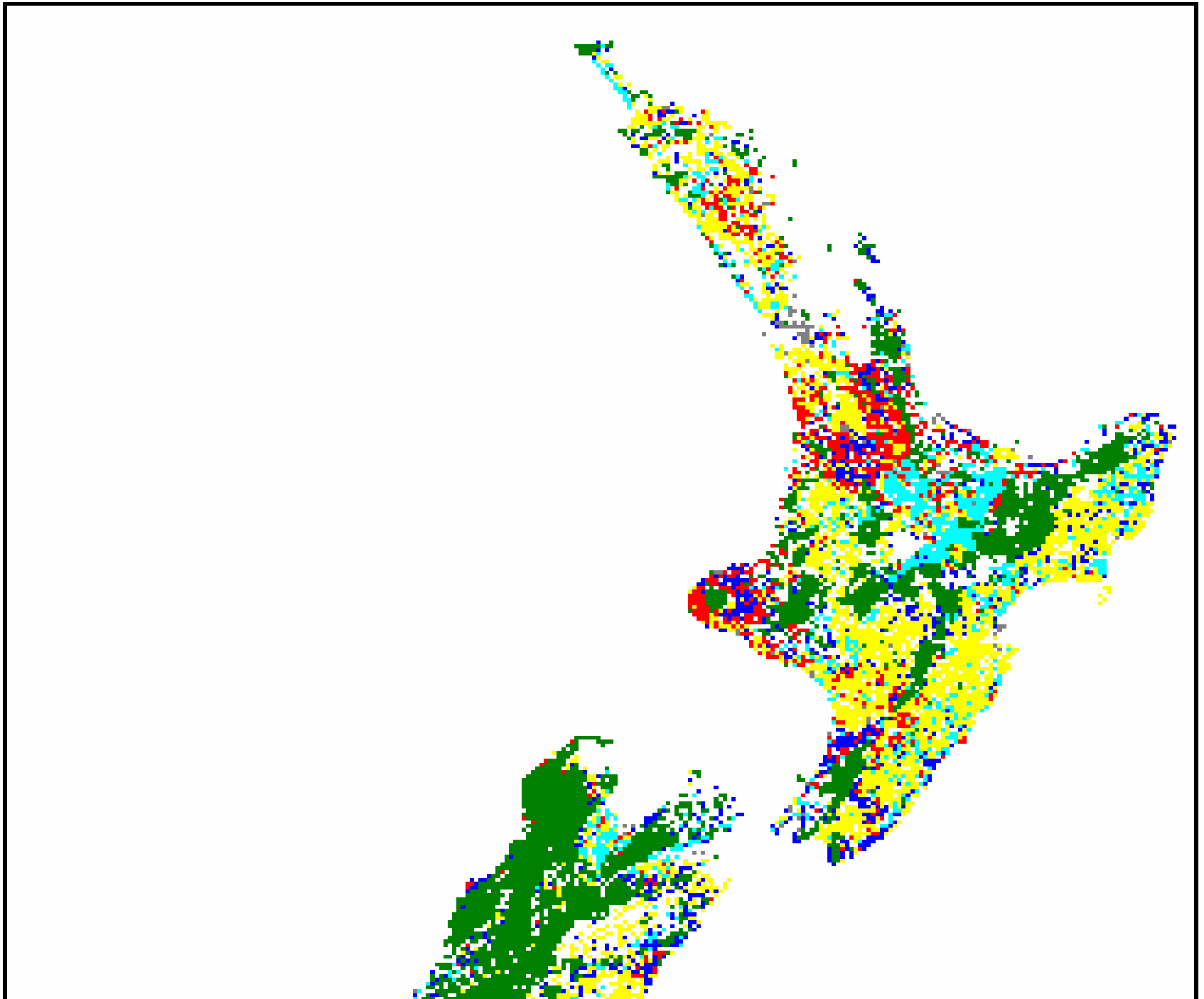
Allocation of changes:





Dairy
Sheep and beef
Plantation Forestry
Scrub
Conservation land
Urban
Other





Enhancements are data intensive!

1 Estimate response to price at disaggregated level

A Need land use data at territorial authority level

Challenges:

- Survey data is collected on inconsistent boundaries – need to downscale data to create concordance but not use variables we will want to use as explanatory variables later
- Survey data 'dirty'
- Missing data because of confidentiality
- Data inconsistent with GIS data – e.g. size of country; land cover

B Need spatial variability in yields and production costs

Different data sources for each land use

Much data not explicitly spatial but can be linked through:

- ‘farm type’ – defined by slope, region, soil fertility, concordance with other data set that is spatial
- Harvesting costs – defined by slope
- Travel costs – defined by distances to ports/processing plants

All data on different spatial boundaries

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Estimate drivers of micro-scale spatial patterns

Need spatial land use map – therefore need to work for government agency.

Product combines land cover with administrative land-use data on parcel boundaries

One ‘period’ only

Want to estimate propensity for each land use so can allocate land use change probabilistically

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Current work: modelling drivers of changes in management practice

- Using farm models to estimate changes in management practices and farm surplus with methane charge for characteristic farm types
  - Data on all inputs, outputs, practices and costs for a range of farms
  - Emissions factors relating to inputs and practices
- Scaling by assuming these are ‘typical’ farms of each type in each region
- Testing variability by using larger sample of farms with simpler methodology

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