Land use change

Modelling the impacts of markets, policy and climate in LURNZ

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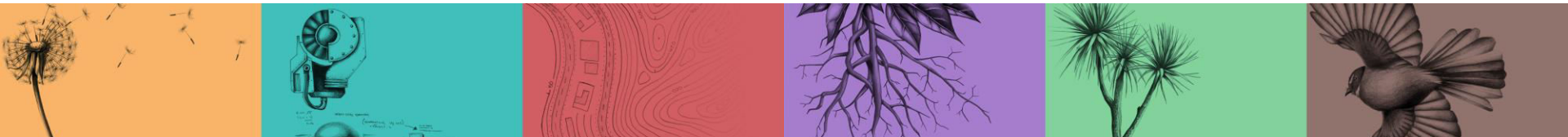


Outline

- The LUNRZ model: key features
- LURNZ structure
  - Land-use change module
  - Land-use allocation module
  - Other modules
- Forestry in LURNZ
- The LURNZ model in action
  - Nutrient leaching
  - Climate change

LURNZ
Land Use in Rural New Zealand

Land-use change module

↓

Land-use allocation module

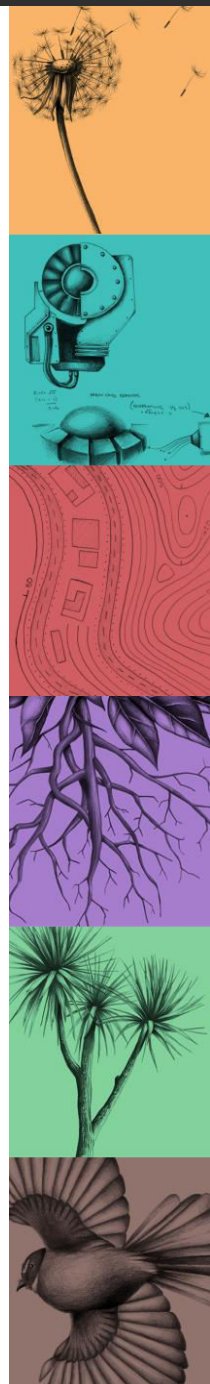
↓

Land-use intensity module

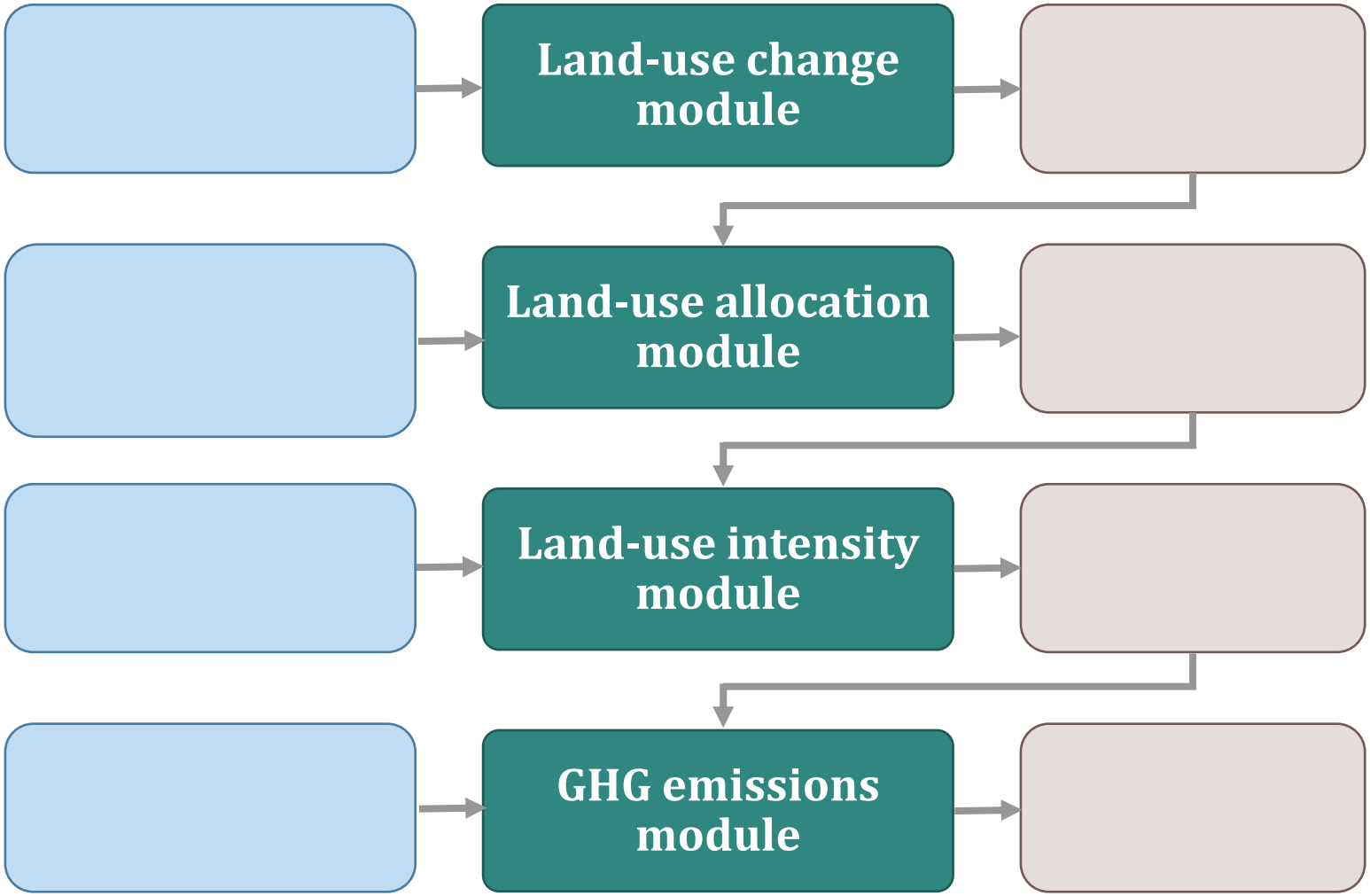
↓

GHG emissions module

- **Spatially explicit econometric model of land use in New Zealand**
- Based on past land-use decisions (data-driven)
- No assumption on motivation of farmers
- Advantages
  - Modest data needs, robust, transparent
- Constraints
  - Flexibility, out-of-sample predictions



LURNZ
Land Use in Rural New Zealand



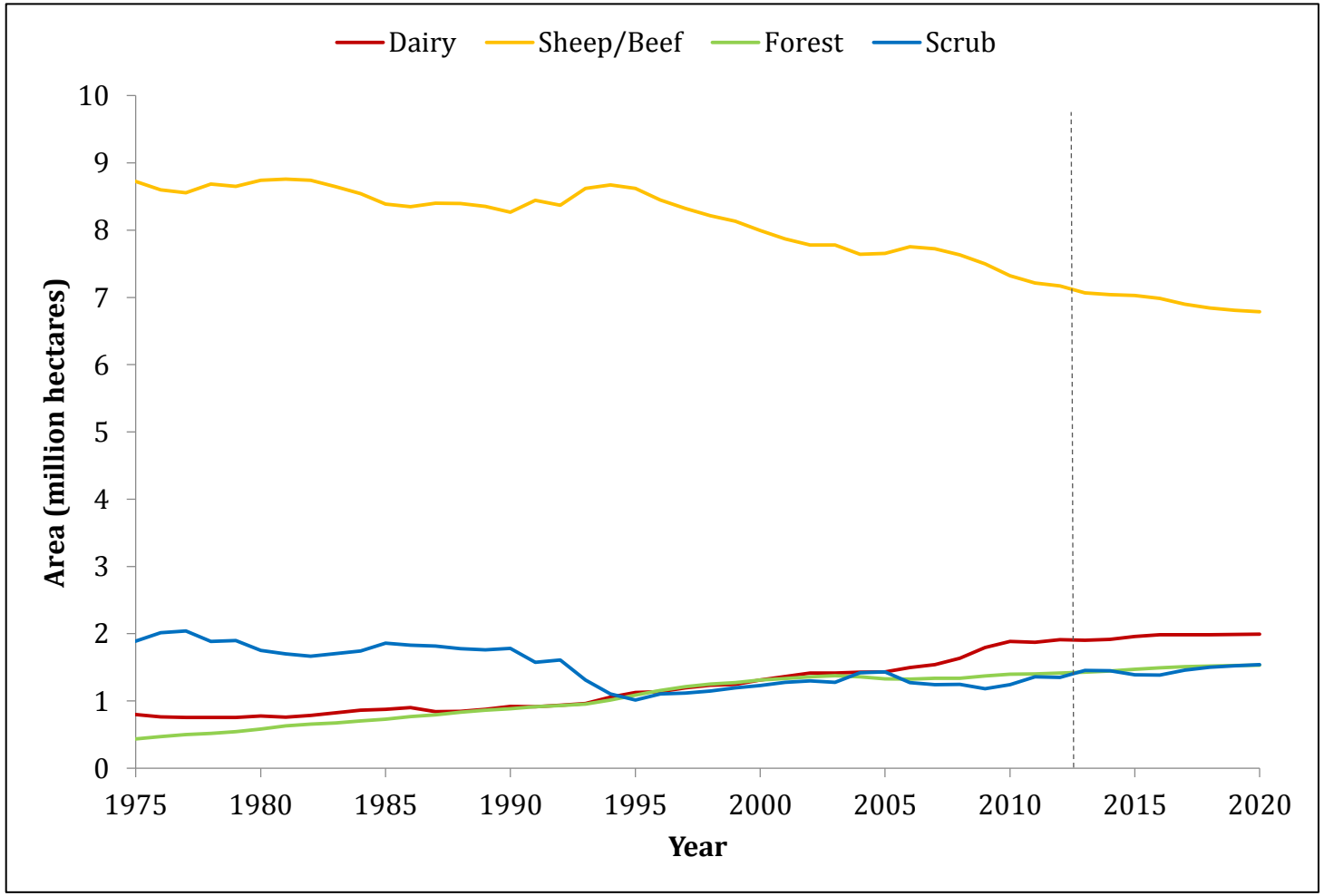
LURNZ
Land-use change module

- Commodity prices
- Carbon price
- Interest rate

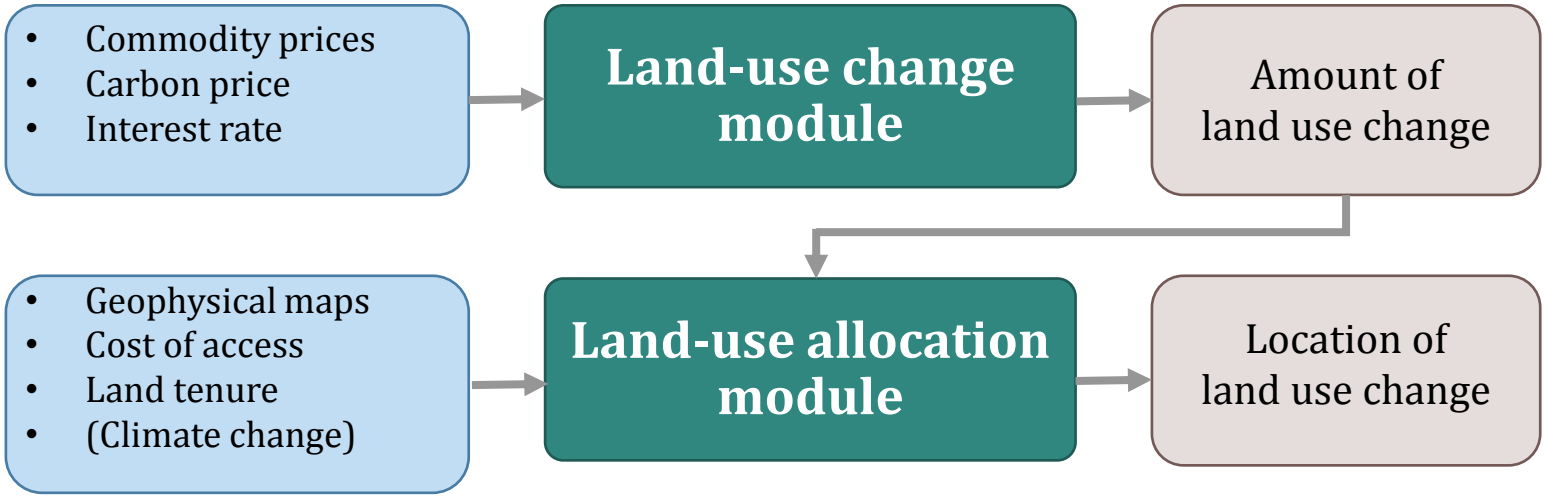
→ **Land-use change module** → Amount of land use change

- *"How much land-use change?"*
- System of regression equations
- Estimates national land-use responses to changes in agricultural commodity prices
  - Data: 1974-2012
  - Dairy, sheep-beef, plantation forestry, scrub
  - Returns to each use affect every other use
- Simulates annual changes

LURNZ
Land-use change module



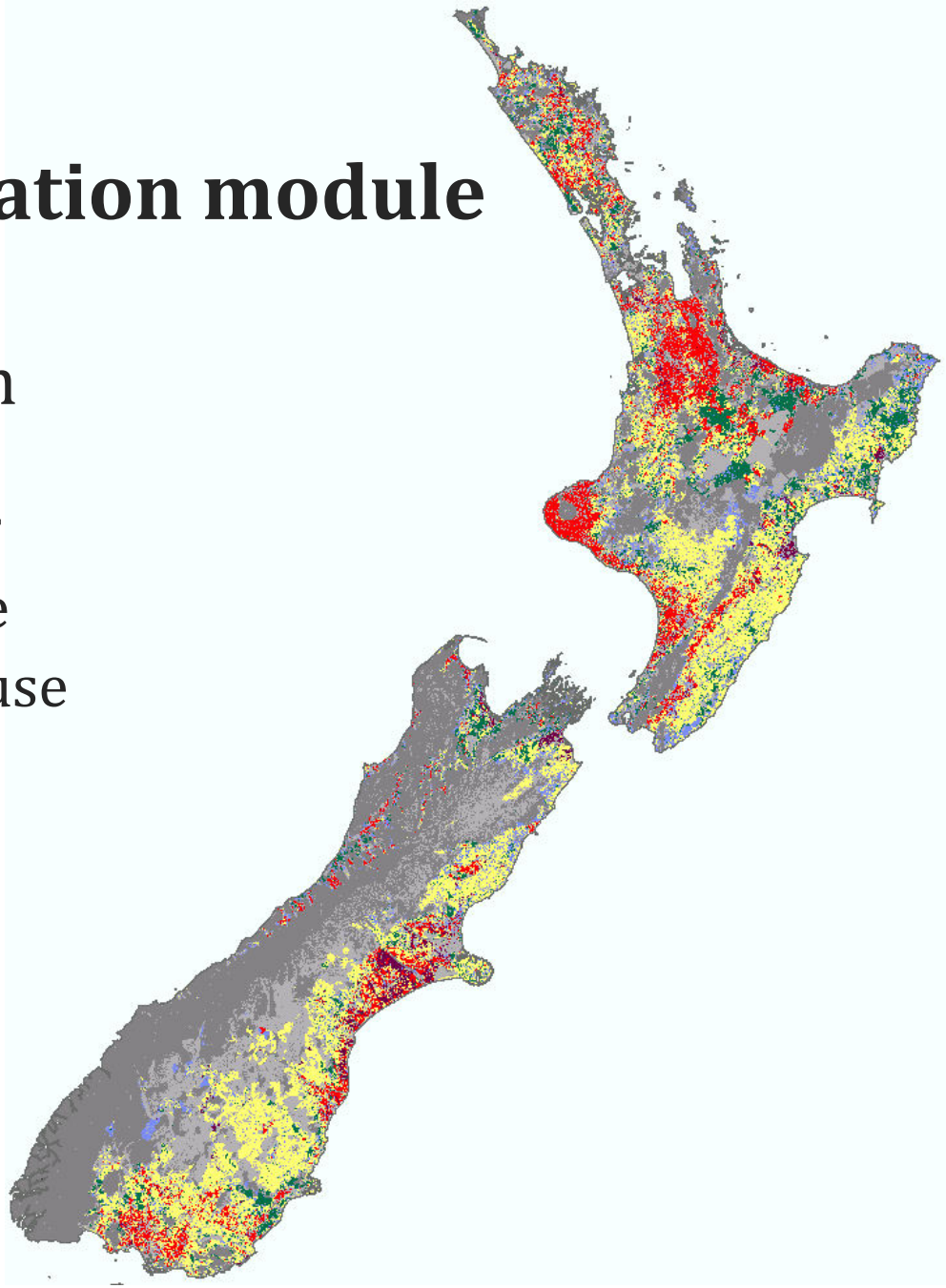
LURNZ
Land-use allocation module



- *"Where?"*
- Multinomial choice model of land use
- Relates geophysical and other attributes of land to observed land-use decisions
- Predicts probabilities for each land-use type

LURNZ
Land-use allocation module

- Spatial allocation based on
  - Total amount of land-use change
  - Modelled land-use probabilities
  - 25 ha or 1 ha resolution



LURNZ
Other modules

- Commodity prices
- Carbon price
- Interest rate

→ **Land-use change module** → Amount of land use change

- Geophysical maps
- Cost of access
- Land tenure
- (Climate change)

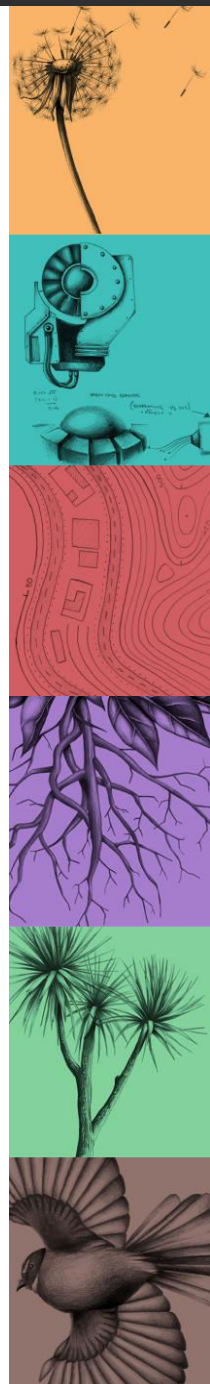
→ **Land-use allocation module** → Location of land use change

- Carrying capacity
- Production trends

→ **Land-use intensity module** → Pastoral production

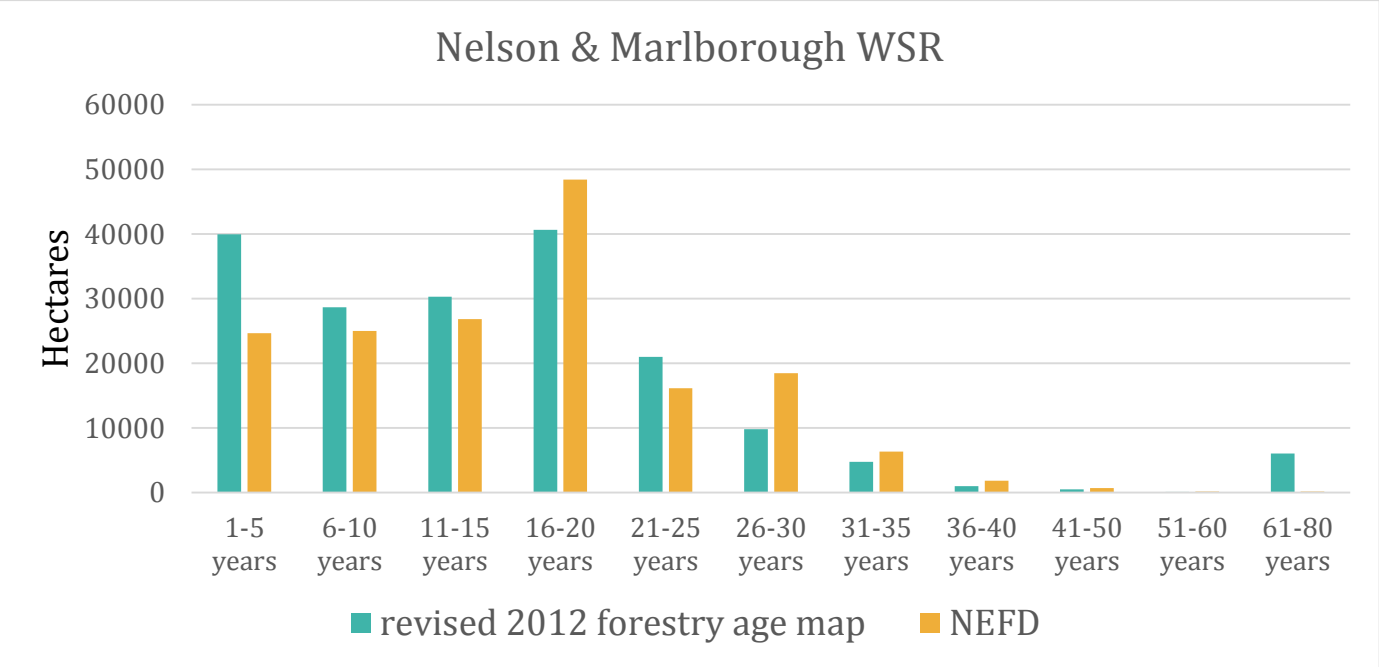
- Emissions statistics
- Forest age
- Sequestration tables

→ **GHG emissions module** → Emissions, Sequestration



Forestry in LURNZ

- Forest age map
  - Four LCDB layers (1996, 2002, 2008, 2012)
  - LUCAS to identify pre-1990 and post-1989 forest
  - TA-level age distribution data from NEFD

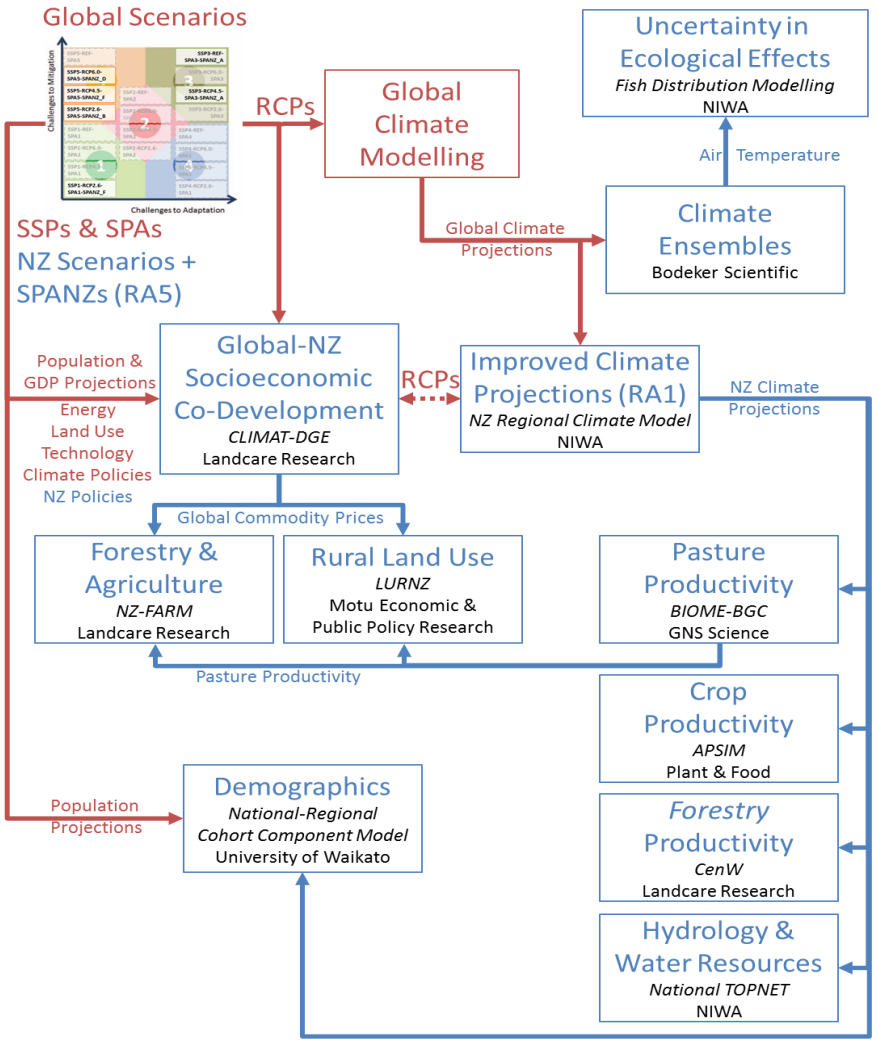


Forestry in LURNZ

- Forest age map
  - Four LCDB layers (1996, 2002, 2008, 2012)
  - LUCAS to identify pre-1990 and post-1989 forest
  - TA-level age distribution data from NEFD
- Tracks afforestation, harvest, deforestation
- Only forests of harvestable age may undergo harvest or deforestation
- Harvested forests retain some residual carbon stock that decays slowly (consistent with the ETS)

LURNZ in action
Climate change

- Global & NZ socio-economic and policy scenarios
  - Commodity prices
  - Carbon price
- Downscaled global climate projections
  - Primary sector productivity

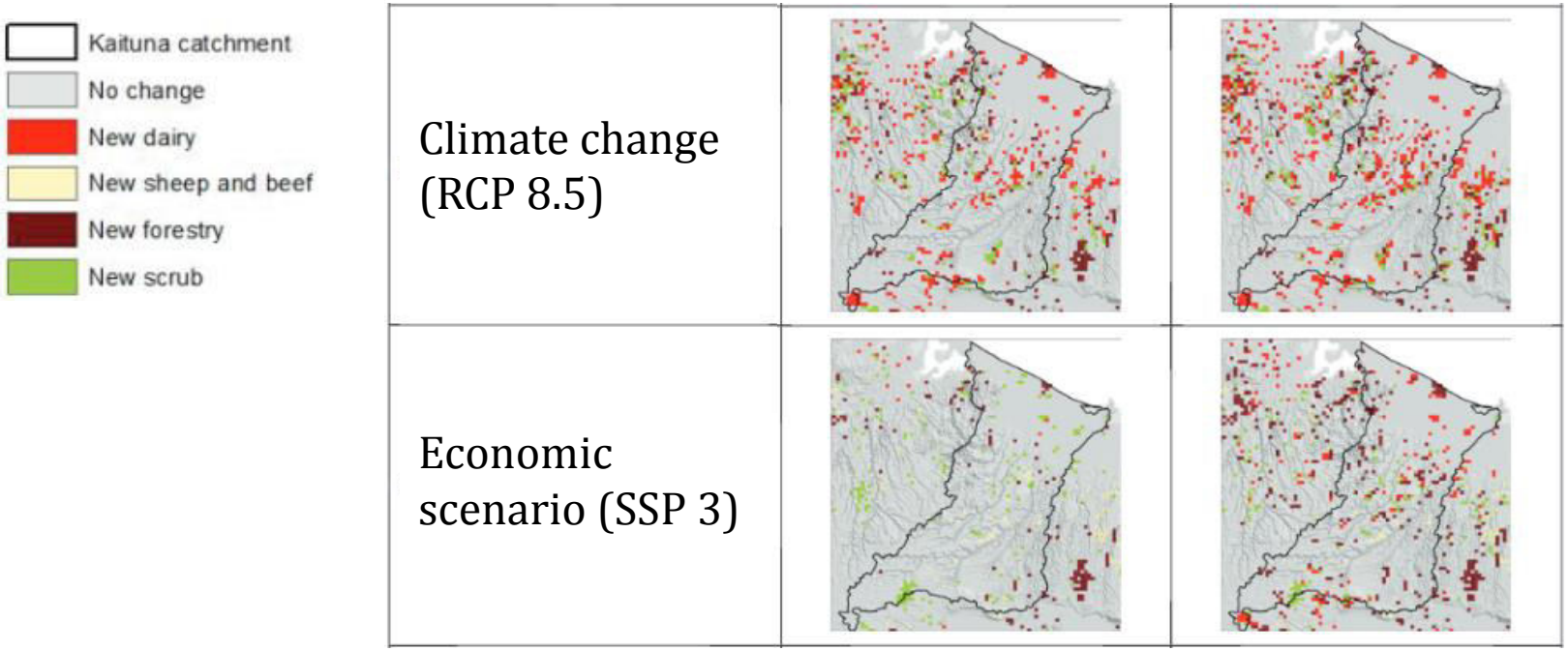


LURNZ in action

Climate change

Land-use change

Mid century | End of century



- Results consistent across all six global climate models
- Effects of economic uncertainty potentially larger

LURNZ in action
Nutrient loss

- Model effects of land-use change and intensification on nutrient loads in NZ streams (2020)
- LURNZ + CLUES (Catchment Land Use for Environmental Sustainability)
- Nationally, taking the predicted increase in N
  - 40% attributed to intensification
  - 60% attributed to land-use change
- In some areas, increased P loads from pastoral agriculture were offset by decreased loads due to afforestation