LAND-USE MODELLING IN NZ: CURRENT PRACTICE AND FUTURE NEEDS

An executive summary of Motu Working Paper 18-16

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SUMMARY HAIKU

Land-use modelling
needs research, data, networks
and sustained funding

INTRODUCTION

Both the public and private sectors face important strategic decisions about future land use. Globally, between 2013 and 2050, the demand for food is expected to increase by 50 percent (Food and Agriculture Organization, 2017). Over the same period, agricultural production systems will be coming under increasing pressure from a changing climate, changing global consumer preferences, and the emergence of potentially disruptive new technologies. The challenge in New Zealand is to use our land in ways that are resilient to future pressures, sustainable for rural communities, and that enhance our natural environment.

The drivers of land-use decisions are complex, and models provide a structured methodology for investigating these. For the public and private sectors to make robust land-use decisions under uncertainty, high-quality modelling tools and data are essential.

Motu convened a workshop in Wellington in April 2018, bringing together some of New Zealand's experts in agricultural and resource economics from government, research institutions and the rural sector. The intent of the workshop was to begin designing a more strategic approach across the land-use modelling community.

This report profiles land-use models and datasets in New Zealand and provides recommendations for strengthening the country's land-use modelling capability to better address key policy challenges. A companion report profiles energy- and cross-sector models relevant to the assessment of climate change mitigation policy options across the economy.

MODELLING IN NEW ZEALAND

While New Zealand is fortunate to have a range of different modelling tools, these have historically been used in a sporadic and ad hoc way, and underlying datasets are deficient in some areas. This report explores priority policy areas where modelling is needed, such as achieving emission reduction targets; managing freshwater, biodiversity and soil quality; and understanding the distributional impacts of policy options as well as climate change.

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WHAT IS A MODEL?

People may think like a modeller when making a decision in a complex situation. They select certain key details, make assumptions about details they have ignored, and apply intuition and judgement to inform their decisions. Scientists make these models more explicit.

A scientific model is a simplified representation of reality that focuses on the key factors and (cause-and-effect) relationships of a phenomenon. Models describe how these factors are related, and the strengths of the different relationships. Constructing a model requires scientists to specify their assumptions explicitly, identify the phenomena they are concerned with, explain their methodology and use data to calibrate the model. By capturing the key agents, elements, processes and decisions, models enable complex systems and situations to be understood and complex problems to be solved.

Land-use models provide a structured way to think about land use and a methodology for investigating land-use change and its impact on key environmental/economic/ecological values. These models are used because the factors and decisions that determine land use and land-use change are complex and interrelated. This complexity arises from the decisions made by individual land owners and from geographic variability, economic uncertainty and interactions among land owners.

Land-use models aim to deepen understanding of how people decide where and how to use land. Some land-use models consider land use only in aggregate. Other land-use models consider also the specific locations and configurations of different land uses and land-use intensities, and how they change over time.

There is a variety of land-use models because different models are required to answer different questions, to model different situations and to work at different levels of detail. These models make different assumptions and use different data and methodologies. As land-use change is too complex for any one model to capture fully, using multiple models in combination can provide a more complete and robust understanding.

Through peer review processes, the quality of a model and the robustness of its conclusions can be tested within the scientific community before results are made available. This helps ensure that modelling upholds rigorous standards.

STOCKTAKE OF LAND-USE MODELLING IN NEW ZEALAND

As shown in Table 1, New Zealand has a range of different models developed to address various land-use-related issues.

One class of models uses an individual decision-maker – or agent-based – method. These attempt to model the learning and preferences of individual agents (farmers). In these models, farmers' decisions may differ from those of their otherwise identical neighbours and may not be economically rational. The final outcome arises as a result of many decentralised decisions.

Another class of models uses an optimisation method, based on an assumption that decision-makers are always making an economically rational decision (and that the modeller can mimic that). In these models, profit or revenue is maximised given that the environmental or regulatory targets must be met.

A third class of models uses a statistical or amalgamated-preferences method. These draw on statistical relationships – identified in historical data – among land use, land-use change and geophysical and economic variables. In these models, the statistical relationships capture the combined decisions of many farmers at a regional or national level.

Table 1: Land-use models

	Catchment	Region	National
Individual agents	ARLUNZ Waikato Multiple Agent Model*	Rural Futures MAS Model	—
Optimisation/best option	NManager*	LUMASS	NZ-FARM
Statistical/amalgamated preferences	—	WISE*	LURNZ

* Models not currently in use

Source: Anastasiadis et al. (2013)

NZ-FARM and LURNZ, the only two models available at the national level, are detailed in the paper. In addition, New Zealand has several time series and computable general equilibrium (CGE) models. In response to scenarios with different economic conditions, these models predict variations in agricultural production and livestock numbers from which changes in land use can be inferred. They do not use or produce spatially-explicit information. The paper includes brief profiles of additional land-use models currently in use.

This report does not profile the full range of models and datasets applied in New Zealand in the areas of biodiversity, water, soil management and climate change impacts. This would be a useful area for future work.

SETTING THE AGENDA

Workshop participants were informed that land-use-related issues are high in the Government's list of priorities. Areas of immediate focus include setting up an independent Climate Change Commission to undertake emission budgeting; setting a 2050 target for New Zealand's GHG emissions; achieving a "just transition" to a low-emissions economy; and improving freshwater management. There is also potential for the development of a national policy statement on soils and another on biodiversity.

During the workshop, participants focused on three key development needs:

- priority policy questions where modelling is needed,
- specific data and modelling development needs, and
- improving the process of modelling in New Zealand.

Workshop participants noted that much of the current modelling work is focused on projections, while there is much less focus on the other kinds of questions that could be interrogated through modelling. Discussion also highlighted the lack of work investigating the sensitivities around decisions and the robustness of different options. In addition to putting uncertainty bounds around projections, we could be using modelling to understand what happens if we take the wrong actions.

In discussion on modelling the impact of a changing climate, a point was made that important insights may be missed if we model purely deterministically. Globally, climate models are good at predicting temperature, but there is large uncertainty when it comes to predicting changes in precipitation, and in addition to this New Zealand has huge climate variability extending over 30-year periods. It is important not to base our decisions solely on an understanding of averages; we need to understand the potential extremes and potential changes in operating regimes.

There is relatively little modelling looking at questions around water quantity, biodiversity, biosecurity/pest control, soil and rural outcomes. For each of these issues, there is a clear need to look at the implications of both changing land use and a changing climate.

The point was also made that work to assess how rural communities respond to policies has tended to be reactive. We could be more proactive, applying a regional development focus and working on alternative rural futures.

Workshop participants highlighted needs for improved data collection and reporting, primary research to inform model development, integration of modelling work across environmental issues, and investment in model maintenance.

IMPROVING MODELLING IN NEW ZEALAND

Workshop participants considered how we could improve the process of land-use modelling in New Zealand, and develop a more strategic approach as a modelling community.

Suggestions include

- Apply consistent data and common assumptions, and increasing transparency,
- Strengthen underlying knowledge,
- Ensure research relevance to decision-makers,
- Enable greater collaboration among researchers, policy-makers and other end users,
- Improve communication of modelling results,
- Invest in maintaining a suite of high-quality models, and
- Consider the impact of domestic policies in a global context.

AN INTEGRATED FRAMEWORK FOR CLIMATE CHANGE MITIGATION MODELLING

Many necessary improvements could be realised by creating an integrated framework for climate change mitigation modelling in New Zealand. This framework would regularly bring together a suite of models and a network of researchers to assess climate change mitigation policies.

Core elements of the framework would include:

- A central repository of data, common input assumptions and scenarios, and
- A "dashboard" that synthesises results from different models, allowing decision-makers to understand and apply the insights from the models more easily.

The framework would also have several other benefits:

- It could be used to improve linkages among models and ultimately allow each model to capitalise on the strength of other models in the framework.
- Enabling modellers to access high-quality datasets and apply consistent assumptions and scenarios would improve transparency and facilitate comparison of model outputs.
- The framework would provide a centralised, formal channel for international collaboration.

CONCLUSION

New Zealand's land sector is an immensely valuable resource, and managing it wisely under competing pressures and a changing climate will require some fundamental improvements in New Zealand's modelling capability. A companion to this report profiles similar issues for energy- and cross-sector models relevant to the assessment of climate change mitigation policy options across the economy.

This capability could be strengthened by collecting and sharing land-use data more effectively; building understanding of underlying relationships informed by primary research; creating more collaborative and transparent processes for applying common datasets, scenarios and assumptions, and conducting peer review; and conducting more integrated modelling across environmental issues. These improvements will require strategic policies and processes for refining model development, providing increased, predictable and sustained funding for modelling activity and underlying data collection and primary research, and strengthening networks across modellers inside and outside of government.

Sustained investment in a modelling framework would create an "ecosystem" for climate change mitigation modelling in New Zealand. It would also help ensure New Zealand's models are fit for purpose and ready to deploy when the policy demand becomes urgent.

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