



Integrated Research on the Economics of Climate Change Impacts, Adaptation and Mitigation

Report to the Foundation for Research Science and Technology Year 2 (July 2008-June 2009)

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1. Key Activities

This research programme has three inter-related objectives: enhance climate modelling capacity; simulate policy scenarios and analyse policy options. We are well on the path to achieving these and contributing to our intermediate outcome: that government will reduce New Zealand's vulnerability to climate change by confidently implementing adaptation and mitigation policies in a more informed policy environment. This year we have produced fourteen publications, all of which are available on our project website. Motu and our subcontractors have given 23 public presentations of work related to our programme to government, private sector and academic audiences here and abroad. In addition, we have run two workshops for researchers in the EcoClimate collaboration.

1.1. Enhance modelling capacity

We are creating a new, more robust and user-friendly version of LURNZ and have created a team of researchers in different institutions (Motu, GNS, Scion, NIWA and MAF) who are all using and contributing to LURNZ. We have continued work to refine our understanding of the drivers of land use change and land management. We have updated our data on land use from Statistics New Zealand both to include the most recent years and also to track the land use history back to the 1800s. We have explored land use change at a farm scale using 1996 and 2002 land cover and 2002 land use. We have confirmed the direction of land use transitions our LURNZ (Land Use in Rural New Zealand) model assumes and gained some insight into the characteristics of land parcels that are most likely to transition between covers/uses. We are developing a new methodology to econometrically estimate probability weights for each transition for each parcel.

We have enhanced our spatial mapping of agricultural emissions. We have also explored the spatial and temporal variation in stocking rates across New Zealand in order to improve our baseline estimates of change in land management. We have developed a database of profitability for three major land uses (forestry, dairy and several different classes of sheep-beef). We have reviewed the literature on the costs of on-farm mitigation and, in collaboration with AgResearch, modelled current options on two types of farm. We are using these to inform new detailed farm

scale modelling of mitigation costs. All of this work has been presented in various research fora and is still in development.

Within the forestry component of our model we have developed a new collaboration with Scion and the School of Forestry at Canterbury University. We have created a stochastic map of forestry age classes to allow detailed spatial modelling of forestry evolution, created a time series of forestry profitability that we will integrate with our spatial profitability layer, have re-estimated our econometric estimates of forestry responses to prices separating deforestation and new planting decisions. These enhancements will allow us to more accurately simulate removal and emissions of carbon in forests and forestry responses to the ETS. Glen Boyle, Lew Evans and Gabriel Fiuza de Bragança (PhD student funded by this programme) at Victoria University participated in the development of real options model applied to forest valuation in the presence of carbon pricing. This work resulted in the publication of the book “Forest Valuation under Carbon Pricing: A Real Options Approach”. We plan to apply these approaches in a stochastic version of our forestry component in an attempt to explain apparent reluctance of farmers to convert to forestry.

We, with Suzie Greenhalgh at Landcare Research, have helped bring together the community of New Zealand general equilibrium modellers to provide more balanced input to the policy process with greater understanding of the similarities and differences between results from different models. This effort has supported higher quality modelling, good communication among modellers and use of a consistent database.

Glen Boyle, Lew Evans and Andrea Lu have developed a model of the NZ electricity market that is calibrated to this market and which has hydro and gas generation; stochastic inflows and lake storage; transmission costs; allowance for various possible situations including spilling; and properly calculates and utilises in generation decisions the real option value of stored water. Lew Evans, Gabriel Fiuza de Bragança, Toby Daghish and Glenn Boyle have also begun to model the electricity auction taking into account uniform price design, risk and market power at a given point in time. We began by establishing an instantaneous relationship between price and state variables for intertemporal pricing purposes and developing a hypothetical one-period model of electricity forward contract decisions. That is, a model where generators take state variables as given and decide forward contracts at the very instant they make production decisions. The effects of risk aversion, short-term demand volatility, market power and demand/cost shifters on the optimal contract decision are then analysed.

1.2. Simulate policy scenarios

As our modelling capacity grows, so does the quality and range of potential policy simulations. This year using LURNZ-climate we have simulated the potential for scrub regeneration in response to the ETS and also the likely potential for land use change to provide wood for biofuel. The latter project linked LURNZ with Adolf Stroombergen’s general equilibrium model ESSAM to produce internally consistent models. We have developed an algorithm using LURNZ-climate and our new profitability database that allows us to estimate the marginal cost of net emission reduction through land use change in two distinct ways. Use of multiple techniques provides a better idea of the uncertainty in outcomes and puts others’ results into clearer perspective. We have also modelled the spatial distribution of direct costs of agricultural emissions trading – assuming no behavioural response and no free allocation of units.

Using general equilibrium techniques and results from international climate change and trade scenarios run using models such as GTAP, Adolf Stroombergen has modelled the effects of climate change on agricultural commodity prices and hence the New Zealand economy. He has also run many scenarios to explore the likely impact of the ETS on NZ.

1.3. Analyse policy options

Our policy design work this year has focused mostly on agricultural emissions trading. The MAF Agricultural Technical Advisory Group finished in January and we produced a report on the distribution of likely impacts of the ETS, likely responses and options for allocation of free units

for that process. Drawing on our parallel work on nutrient trading, which affects very similar actors, we explored the interactions between water quality and climate regulation. We were also involved in the Climate Change Leadership Forum, ongoing discussions about allocation of units in the industrial processes and energy intensive sectors, and the choice between a tax, a pure ETS and an ETS with a temporary price ceiling. We gave evidence before the Select Committee in May that was widely reported in the media. In Australia we contributed to their emerging discussion on agricultural emissions trading and also contributed to a report on auction design for the Australian ETS. In May, we summarised our wider team's new research results in a well attended half-day symposium for private and public stakeholders.

2. Major Achievements to date

The LURNZ-climate model is now functional for producing policy relevant simulations – e.g. scrub pricing and biofuels. We have built a strong modelling team across many organisations and the quality and range of simulations is rapidly developing.

The programme has so far produced four refereed articles.

Kerr, Suzi and Andrew Sweet 'Inclusion of Agriculture in a Domestic Emissions Trading Scheme: New Zealand's Experience to Date' *Farm Policy Journal* 5(4), November, 2008

Pfaff, Alexander; Suzi Kerr, Leslie Lipper, Romina Cavatassi, Benjamin Davis, Joanna Hendy and Arturo Sanchez. 2007. "Will Buying Tropical Forest Carbon Benefit The Poor? Evidence from Costa Rica," *Land Use Policy*, 24, pp. 600-610.

Funk, Jason and Suzi Kerr. 2007. "Restoring Forests Through Carbon Farming on Maori Land in New Zealand/Aotearoa," *Mountain Research and Development*, 27:3, pp. 202-205.

Pfaff, Alexander; Suzi Kerr, Romina Cavatassi, Benjamin Davis, Leslie Lipper, Arturo Sanchez and Jason Timmins. 2008. "Effects of Poverty on Deforestation: distinguishing behaviour from location" in *Economics of Poverty, the Environment and Natural Resource Use*, Rob B. Dellink and Arjan Ruijs, Eds. Wageningen University: Environmental Economics and Natural Resources Group.

Suzi Kerr has given high profile presentations in four conferences in New Zealand and abroad.

Kerr, Suzi 2009. 'How can agriculture be included in an emissions trading scheme? Some thoughts from New Zealand' Invited speaker. Australian Farm Institute Agriculture greenhouse and emissions trading conference, Maroochydore, Australia May

Kerr, Suzi. 2007. 'Emissions trading – the real oil' Invited speaker at NZ Labour Party conference – workshop and panel, November 3.

Kerr, Suzi. 2007. 'Including agriculture and forestry in a domestic emissions trading system: A New Zealand perspective' paper presented at Garnaut Climate Change Review Public Forum, Melbourne, August, 2007.

Kerr, Suzi. 2007. 'The Economics of Deforestation' paper presented at International Economics Association Roundtable, 13 July 2007, Beijing.

3. Major Outcomes to date

The first large trade of forestry credits into the European Union has just occurred. Forestry promises to bring significant gains through carbon sequestration to land and forest owners and to New Zealand as a whole. This is the first time this policy instrument has been used in the world and could have a powerful demonstration effect. While many people contributed to this development, we hope our efforts were also significant.

More broadly we believe that our efforts are raising the level of understanding of climate policy issues in government, private sector, and the media. We believe that Motu is developing a reputation as an independent, objective broker that appreciation for the value of strong analysis in the policy formation process is growing. In some cases, such as agricultural emissions trading, where knowledge is sparse we have mostly exposed the complexity in the issues and the gaps in

our knowledge. In other areas, such as the choice of allocation instruments and tradeoffs between an ETS and a tax we can offer relatively compelling arguments. In the empirical modelling we can indicate where there is relatively strong knowledge and agreement among researchers and where no models are strong enough and any evidence offered by analysts should be regarded as only indicative.

4. Publications in 2008/09

Kerr, Suzi and Andrew Sweet. 2008 'Inclusion of Agriculture in a Domestic Emissions Trading Scheme: New Zealand's Experience to Date' *Farm Policy Journal* 5(4), November

James D. Shephard, M. Anne Sutherland, Ian Payton, Suzi Kerr, Wei Zhang and William Power. 2008. "Nature and Scale of Eligible Post-1989 Non-planted Forests" Landcare Research Contract Report prepared for MAF, October

Smeaton, Duncan and Cecile deKlein. 2008. "Optimum Farming Systems in the Face of GHG Emission Charges," Report written for Motu under a contract to MAF.

Kerr, Suzi and Marianna Kennedy 'Greenhouse gases and Nutrients: The Interactions Between Concurrent New Zealand Trading Systems' in Productivity Commission eds. *Promoting Better Environmental Outcomes, Roundtable Proceedings*, Australian Productivity Commission, Melbourne, 2009.

Stroombergen, A.H. (2009): General Equilibrium Analysis of the Effects of Climate Change on Agricultural Commodity Prices, report prepared for Motu Economic and Public Policy Research.

Stroombergen, A.H., J. Ballingal & C. Schilling (2009): Economic Modelling of NZ Climate Change Policy, report prepared for Ministry for the Environment.

Stroombergen, A.H. (2009) 'General Equilibrium Analysis of Bio-Energy Option', in *Bioenergy options for New Zealand: analysis of large-scale bioenergy from forestry*. Eds. Peter Hall and Michael Jack. Scion Report.

Todd, Maribeth, Wei Zhang and Suzi Kerr. 2009 'Competition for land between biofuels, pastoral agriculture and scrub lands,' in *Bioenergy options for New Zealand: analysis of large-scale bioenergy from forestry*. Eds. Peter Hall and Michael Jack. Scion Report. pp. 122-40

De Klein C.A.M., Smeaton D, and Clark H (2009) The effect of greenhouse gas emission charging on the profitability of New Zealand pastoral farming systems. *Proceedings of the 5th international symposium on Non-CO2 greenhouse gases; Science, Reduction Policy and Implementation*, Wageningen, The Netherlands July 2009. Pp 9

Betz, Regina, Stefan Seifert, Peter Cramton and Suzi Kerr 'Auctioning Greenhouse Gas Emissions Permits in Australia,' *Papers of Peter Cramton 09aghg*, University of Maryland, Department of Economics - Peter Cramton, revised 2009.

Kerr, Suzi and Marianna Kennedy. 2009 'Greenhouse gases and Nutrients: The Interactions Between Concurrent New Zealand Trading Systems' Motu note 09-02, 2009.

Kerr, Suzi and Wei Zhang. 2009 'Allocation of New Zealand Units within Agriculture' Report to MAF, January.

Kerr, Suzi. 2009. "New Zealand ETS: Submission to the select committee," Speaking notes, Monday 11 May, Wellington.

Kerr, Suzi. 2009. "Intensity-based regulation versus output-based free allocation: a clarification of comments to the Select Committee," 17 May.

5. Presentations in 2008/09

5.1. Ecoclimate stakeholder symposium, 18 May 2009

- General equilibrium modelling

- Simulations with the New Zealand Climate-Economy Model (NZCEM): James Lennox (Landcare Research) with Adolf Stroombergen (Infometrics) as discussant
- Equilibrium Impacts of Biofuels from Forestry: Adolf Stroombergen (Infometrics)
- Marginal abatement costs in agriculture and likely response of scrub to the ETS: Suzi Kerr (Motu)
- Agricultural mitigation options, science and farm scale potential:
 - David Whitehead (Landcare Research)
 - Mark Aspin (PGGRC, Meat and Wool Ltd)
- GHG mitigation work within communities:
 - Alison Greenaway (Landcare Research)
 - Carbon sequestration contracts on Maori land: Suzi Kerr (Motu)

5.2. Other public presentations

Kerr, Suzi 2008. 'Interdisciplinary science is greater than the sum of its parts' Provocation at 'Running Hot', Wellington, October

Roson, Roberto 2008. 'Climate Change Feedback on Economic Growth: Explorations with a Dynamic General Equilibrium Model' NZARES Nelson, August

Kerr, Suzi 2008. 'The Economics of Deforestation' NZARES Nelson, August

Zhang, Wei 'The LURNZ (Land Use in Rural New Zealand) Model: Recent climate change simulations and new developments' NZARES Nelson, August

Kerr, Suzi 2008. 'Greenhouse gases and Nutrients: The Interactions Between Concurrent New Zealand Trading Systems' NZARES Nelson, August

Kerr, Suzi 2008. 'Greenhouse gases and Nutrients: The Interactions Between Concurrent New Zealand Trading Systems' Australian Productivity Commission Roundtable 'Promoting Better Environmental Outcomes' Invited speaker. Canberra, August

Kerr, Suzi 2008. 'Report on Cluster B case studies' Climate Change Leadership Forum 6 August

Kerr, Suzi 2008. 'Mitigation and Leakage' Institute of Policy Studies Roundtable, August

Kerr, Suzi 2008. 'Temporal Emission Trading Markets' National Bureau of Economic Research Summer Institute, Environment and Public Policy workshop 'egg-timer' session, Cambridge MA, 21 July

Kerr, Suzi 2008. 'Data challenges in creating LURNZ, an econometrically based model of Land Use in Rural New Zealand' Global Land Project Workshop on Data and model integration for coupled models of land use change, Aberdeen 17th – 19th July

Kerr, Suzi 2008. 'Emissions Trading in New Zealand' EPMU Biennial Conference, Auckland

Kerr, Suzi 2008. 'Greenhouse gases and Nutrients: The Interactions Between Concurrent New Zealand Trading Systems' Phillips Conference / ESAM08, Wellington, July

Kerr, Suzi 2008. 'Emissions Trading in New Zealand' Canterbury Employers Chamber of Commerce Christchurch 2 July

Evans, Lew and Andrea Lu 2009. – presentations on electricity options pricing model calibrated to New Zealand conditions

- Public Seminar through the NZ Institute for the Study of Competition and Regulation
- Meridian Energy Ltd, and
- Contact Energy Ltd

Stroombergen, A.H. (2008): General Equilibrium Analysis of Options for Meeting New Zealand's International Emissions Obligations, paper presented at EcoMod International Conference on Policy Modelling Conference, Berlin, 2-4 July.

Kerr, Suzi 2009. 'Key issues in the design of an emissions trading system for New Zealand', Victoria University, January

Kerr, Suzi 2009. 'How can agriculture be included in an emissions trading scheme? Some thoughts from New Zealand' Invited speaker. Australian Farm Institute Agriculture greenhouse and emissions trading conference, Maroochydore, Australia May

Kerr, Suzi 2009. 'Climate change policy: stepping back and moving forward,' Motu Economic and Public Policy Seminar, May.

Kerr, Suzi 2009. "Environmental Markets: How can they work for water quality and climate change?" Auckland Public Policy Seminar, April.

5.3. Ecoclimate researcher workshops

5.3.1. August 2008

- William Power and Wei Zhang (GNS and Motu) LURNZ Update
- Arthur Grimes (Motu) on irrigation and land values
- Allan Rae (Massey): Approaches to econometric estimation of land use CET parameters for land use modeling in GTAP
- Adolf Stroombergen 'Linking LURNZ to ESSAM – biofuel application'
- Andrea Lu and Gabriel Fiuza de Braganca (Victoria University) Electricity and storage
- NIWA - water availability and electricity (Downscaling of global scenarios)
- Troy Baisden 'Impacts of climate change on productivity'
- Landcare Research - catchment based modelling for the Manawatu catchment
- NIWA: Anthony Clark (Productivity impacts; Drought and floods, extreme events) Spatial modelling of farm impacts.
- Future emission paths for NZ (Adolf Stroombergen)

5.3.2. May 2009

- Border Tax Adjustments (domestic work): James Lennox (Landcare Research)
- Scrub, forestry and pastoral emission modelling: Tom Adams (Scion Ltd)
- Overview of NIWA's climate change research: James Renwick (NIWA)
- NIWA carbon cycle modelling: Sara Mikaloff-Fletcher (NIWA)
- Water balance and pasture production modelling: Anthony Clark (NIWA)
- Water and infrastructure: Arthur Grimes (Motu)
- Impacts on electricity/water and possible response: Lew Evans and Gabriel Fiuza de Braganca (VUW),
- Update on irrigation map: Troy Baisden (GNS Science) and Emily Weeks (Massey University)
- LURNZ developments: Motu Environment team
 - Current status and future development of LURNZ: William Power (GNS Science)
 - Land use transitions: Cleo Ren (Motu)
 - LURNZ application in modelling scrub reversion: Wei Zhang (Motu)
 - National level marginal cost curves for land use change: Stewart Sinclair (Motu)
- Scion's land use modelling: Tom Adams (Scion Ltd)