

V. Conclusion

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The Significance of Analyzing Carbon Farming

New Zealand has taken a progressive step in developing a national trading system for greenhouse gas emissions that includes the land-use sector. The Permanent Forest Sink Initiative (PFSI) creates a mechanism for private landowners to take advantage of carbon sequestration opportunities on their own land, quantify the social benefits of sequestration, and receive income from domestic or international carbon markets as compensation for their efforts. Private landowners will now have an economic incentive to reduce New Zealand's net emissions by changing their land use. If the market works properly, private landowners will begin generating a pool of cost-effective carbon credits that the New Zealand government, private firms, or international buyers can utilize to meet their own commitments to reducing climate change.

Yet, until now, little was known about the potential size of this pool, the profitability of carbon sequestration for landowners, the types of land management they might apply, what areas would be affected by land-use changes, and whether disadvantaged rural communities like Māori would be able to benefit from this policy. In my dissertation, I examined the factors that will affect the adoption of the policy and the resulting changes in land use, including whether the policy creates new income opportunities for indigenous landowners. I evaluated the potential for a land management system using native forest restoration, which I call "carbon farming," to generate revenue from carbon sequestration.

At the heart of this analysis is a conceptual model of decision-making for landowners. This model has four key elements. First, it is underpinned by spatially explicit biophysical information, which determines what is possible for landowners to

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produce under different land management systems. Second, it employs economic decision rules to interpret what is worthwhile for landowners to do, using the net present value of different management systems as the metric for decisions. Third, it incorporates the institutional constraints on decision-making, including the management conditions required by the policy, but also special legal conditions that apply to Māori land, the cultural preferences evidenced by Māori decision processes, and the institutional constraints imposed by different governance structures. The fourth element, the landowner, is at the center of these three elements, applying individual or collective preferences to the decision process. The combination of these elements in the model yields agent-driven, context-specific predictions about the participation of individual land blocks in the PFSI policy.

My research represents an attempt to account for each of these elements and integrate them in a new way. By representing the structure and context of landowners' decisions accurately, I hope to create predictions about their response with greater confidence than other approaches can produce. Beyond predictions, this research has helped identify the points of intervention that can change landowners' decisions, particularly those points that can make carbon farming more attractive. Finally, the tools developed in the process of this research can be used or adapted as tools for intervention. The same information system used in this research could also become a tool for information delivery to landowners and other stakeholders, while the transactional instruments developed in the case studies (process mapping, financial analysis tools, and a legal contract template) could help facilitate adoption of carbon farming. My goal has been to observe and understand the problem, to capture its essential elements and explore potential solutions, and to equip those involved with the means to achieve a better result. In my view, complex environmental problems demand not only a detailed understanding of why they arise, but also the development of transformational pathways to more sustainable outcomes.

Summary of Findings

The research approach I used has led to several new findings and conclusions. First, the system of native forest restoration that I have defined as carbon farming is relatively simple in terms of management activities, but the process for landowner participation is complex. The PFSI policy includes many explicit and implicit conditions, which lead to costs for the landowner. The scale of both the costs and the payoffs is uncertain when landowners undertake a decision about adopting carbon farming.

However, using published analyses and data on land-use capability, climate, soils, forest carbon accumulation, carbon prices, and profitability of livestock production, I developed a model to predict where carbon farming will be economically worthwhile and map the areas likely to convert to carbon farming under a range of conditions. My model uses a decision rule designed to capture the policy-related factors specific to the current formulation of the PFSI.

The non-economic co-benefits of carbon farming may make it more beneficial as a land use than an economic analysis alone would predict. When landowners are rewarded for the social value of these co-benefits, the spatial economic model can be used to predict the impact of these rewards on extent and scale of land converted to carbon farming. The cultural benefits landowners receive from carbon farming are more difficult to quantify, but I saw evidence that such factors played a role in decision-making.

Taking into account the current economic costs and benefits and reasonable predictions about future prices, the model predicts that only about 14% of the eligible area in the Gisborne District would convert to carbon farming. However, if landowners put more weight on the value of future revenues (lower discount rate), carbon farming would be attractive on a much larger area. In my research, I found that Māori landowners are insulated by Māori land law from market forces that would otherwise drive them toward applying market discount rates; in fact, certain Māori cultural norms are expressed as lower discount rates in land-use decisions. These features suggest the potential for Māori to accept carbon farming with greater

likelihood than an economic analysis would predict and to adopt carbon farming on a greater proportion of Māori land.

However, the many uncertain factors in the decision make carbon farming less attractive as a land use to all landowners. Misinterpretation of these uncertainties and their impacts could lead to bad decisions and bad outcomes if landowners do not correctly perceive their importance. One strategy for removing uncertainties at the landowner level is to use a decision support tool for information delivery. Also, well-designed contractual agreements could be a cost-effective way for landowners to mitigate their known risks. In the course of this research, I have developed an example of both of these instruments.

For multiply owned Māori land, land governance structures vary in their ability to carry out the decision process for carbon farming, but the process is often less efficient than it is for individual landowners. As a result, they are disproportionately impacted by the complexity of the decision process to adopt carbon farming. Decision support tools and contractual agreements can mitigate some of the difficulties for some structures, but greater government investment in capacity building to assist these landowners might be needed to secure their participation. Even so, it is possible that such investments would yield public benefits cost-effectively.

Implications of the research, and its limitations

Prior to this research, policymakers and analysts had to rely on generalized information about the extent of eligible land and the carbon sequestration capacity of forests. The information available led some observers to the misleading conclusion that the Gisborne District would be a large source of carbon credits. My research shows that such an outcome is not guaranteed. The heterogeneity in biophysical conditions and opportunity costs in the Gisborne District will strongly affect the response of landowners. Consequently, landowners will respond unevenly to the price of carbon, with minor conversion of land to carbon farming until the expected price rises above \$30 per ton CO₂-e. At that point, the owners of about half of the eligible land in the Gisborne District would find carbon farming the most economically

worthwhile use of their land, if expectations about other land uses do not change. The resulting supply of carbon credits would enter the market slowly, peaking about 20 years after conversion.

This scenario may not be realized, however, if landowners cannot overcome the barriers that are inherent in a native forest restoration system under the PFSI. These barriers originate from uncertainties in their internal and external transaction costs, and from risks of lower payoffs, higher costs, or unexpected losses. As currently framed, the costs of resolving these uncertainties or mitigating risks will fall upon the landowners themselves, reducing the relative attractiveness of carbon farming. Because carbon farming is only slightly more profitable than other land uses under most scenarios, even small costs for each participant could prevent the uptake of carbon farming by a vast number of landowners.

Yet the overall costs for a group of landowners to collect and disseminate information, manage transactions, and mitigate risks could be kept very small for each participant if the program could take advantage of economies of scale and cost-effective tools. In the participatory case studies, I developed two tools that could play a significant role: a land-use decision support tool for District landowners and a contract template designed for Māori landowners, with flexibility in payment options. These two tools can serve as boundary objects that facilitate cooperation of landowners and agencies to attain more sustainable land uses (Cash et al. 2003).

Although some observers realized that the policy could present an opportunity for Māori land, they only intuitively understood that Māori governance structures might play a role in shaping Māori responses to the opportunity. In my case study research, I have captured the details of the decision-making process for different Māori governance structures and identified the potential points of failure in the process of adopting carbon farming. I have also documented points of agreement and conflict between Māori cultural preferences and the practice of carbon farming. Although based on a small number of cases, the consistency of the decision processes with the predictions of organizational theory suggests that the findings might be generalizable to similar structures in the Gisborne District, throughout New Zealand,

and possibly to other countries with multiply owned indigenous land. If these generalizations bear out, this research could become an early step in the development of successful national policies for reducing emissions from deforestation and forest degradation (REDD).

The systemic challenges Māori face in taking up carbon farming, coupled with indications that they may prefer this land use to others for cultural reasons, suggest that targeted actions to overcome or neutralize these challenges could result in larger-than-expected conversion of Māori land. Such actions could be undertaken by government, by Māori themselves, or by entrepreneurs who see potential profits in providing services that facilitate the adoption of carbon farming by Māori. Overcoming the barriers already identified would go a long way toward addressing the challenges, but some structures will need assistance with internal processes if they are going to participate successfully.

These conclusions could not have been reached through any single disciplinary perspective; they are based on an interdisciplinary understanding of the problem. The scientific data on the factors affecting the biophysical capacity of native forests to sequester carbon and for pasture to support grazing were essential for determining what was possible within the landscape. Geographic information on soil quality, climate conditions, parcel boundaries, and land ownership complemented the productivity information and provided the contextual information needed to link the land characteristics to the owners' decision processes. Economic information on the potential price of carbon, the gross margins for livestock, and the policy-related transaction costs of carbon farming made possible the analysis of what was economically worthwhile for landowners. Concepts about institutional decision-making within multiply owned land blocks came from organizational theory and implementation research, which provided a framework for understanding these processes. Participatory research methods from anthropology provided guidance for collecting the necessary data to understand the cultural and institutional factors that influence the decision process. Techniques of policy analysis helped identify and define the implicit and explicit conditions of participation, allowing me to incorporate

them in the decision framework. These methods and concepts helped identify the barriers and opportunities that shape what is acceptable to Māori landowners.

In combination, the outcomes of this research show the breadth of information needed to understand and predict the policy response of landowners to carbon farming. Carbon farming in New Zealand is only one example of a complex environmental challenge that requires a combination of approaches to be addressed successfully. While there will always be a need for disciplinary research to deal with environmental problems, issues like carbon farming will need individuals and teams with interdisciplinary capacities to develop successful solutions.

Unfortunately, even interdisciplinary researchers cannot produce a perfect model of human choices and behaviors – neither in its representation of decision-making nor in the accuracy of its inputs. As a result, we still will face the potential to draw misleading conclusions and create unintended outcomes. In my research, there are many opportunities for incomplete, inconclusive, or even misleading interpretations. For example, events such as a shift in demand for livestock production, a change in New Zealand’s population dynamics, or an alteration in the climate of the Gisborne District could markedly affect the underlying assumptions of the scenarios I have analyzed, making my conclusions irrelevant. Alternatively, my conceptual representation of institutional dynamics and my interpretation of a limited number of case studies might not bear out among a broader sample of land blocks. Finally, my treatment of economic factors in decision-making might not reflect the way landowners weigh these factors in their actual decisions. All of these considerations, if they were realized, would reduce the strength of my interpretation and the effectiveness of my recommendations. Nevertheless, my recommendations are designed to improve the attractiveness of carbon farming, and the considerations above would only affect a policymaker’s assessment of whether such interventions were worthwhile, from a public welfare perspective.

Policy recommendations for using carbon farming as a rural development opportunity for Māori

The outcomes of the case studies suggest ways to target and frame outreach efforts to Maori landowners to increase participation cost-effectively. For instance, the Chairpersons of Māori incorporations are likely to respond favorably when carbon farming is presented as a simple set of management practices. Incorporations may be more capable of responding quickly to fluctuations in market prices for carbon and other commodities. As a result, they may seek flexible contract terms and utilize information services extensively. On the other hand, some incorporations may prefer contract options that provide forward sales or lump-sum advance payments, because they are capital constrained and they can quickly reinvest capital into other profit-generating activities.

Information and cognitive limitations are the most likely constraints on centralized organizations, so government and private agents could likely increase participation by delivering information through appropriate venues and providing detailed knowledge about carbon farming. Providing access to site-specific information about the yield, price, and costs associated with carbon farming, and presentation of simple, specific management rules and potential liabilities in a contract should be sufficient for Incorporations to make land allocation decisions and implement them.

In contrast, for formalized organizations to adopt carbon farming, the processes and parameters of the management practice must be well-defined. Providing access to financially relevant information and contract specifications may not be sufficient to allow these groups to reach quick decisions. They may require time to deliberate the options and to evaluate how carbon farming fits into their overall goals for management. They may apply satisficing criteria to the economic aspects of carbon farming and seek ways to implement the land management so that it will deliver other services. For instance, all else being equal, they may prefer native forest restoration to exotic forests, because of the cultural significance of native forests. On low-quality land that is marginal for most uses, this preference could lead to higher-

than-expected conversion to native forest. Certainty is more important to these groups than a chance for a high reward, which may be reflected in a preference for long-term, stable income streams with low risk and no liability.

Trusts that lease their land will find carbon farming relatively unattractive because of its long time horizon and the fact that financial rewards and liabilities may be split between the two interested parties: a lessee who arranges to sell credits may earn the rewards, but the Trust will be left with the potential liabilities. There are ways to arrange contracts and leases to overcome these issues, but the uncertainties and additional complications of such options seem poorly suited to a structure that favor incremental changes.

Public agents and private entrepreneurs can direct their interventions with these groups to increase their participation in several targeted ways. These Trusts will need all of the financial information and contract options required by the groups described earlier. Moreover, this information will need to be readily available to both lessees and trustees, especially when new leases are being negotiated. Information alone might not be sufficient to trigger adoption. Rental arrangements or forward contracts structured to deliver even annual payments may be the preferred options for these groups, especially if the lessee receives a share (or pays reduced rent). Until lease arrangements can be developed to overcome the constraints of these two parties, they are unlikely to adopt carbon farming at a level that is cost-effective in the long run – they will likely only retire land that has little value in other uses.

The best decision environment for unstructured, complex organizations is one that is complex and stable (Fredrickson 1986). Internally, they will need to work to find ways to allocate management authority to sub-groups, develop and utilize specialized land management skills within these sub-groups, and redistribute the rewards across all shareholders. External interventions to help them improve governance, rather than reach specific decisions, may be the most effective strategy for increasing participation. This strategy will likely require a sustained effort to facilitate change. In this role, agents could provide specialized knowledge of carbon farming and foster specialized skills among land managers. The large amount of

eligible land on these land blocks may eventually lead to a large carbon payoff, if strategies can be found to achieve successful decision processes.

Reducing barriers to participation as far as possible by delivering payments for temporary sequestration in an opt-out format, rather than an opt-in approach, might be a successful policy approach with these groups. **This is the approach used in the provisionally accepted Emissions Trading Scheme (ETS) in New Zealand (Ministry for the Environment 2007).** Under this system, landowners would automatically receive a payment each year they keep their land in continuous-canopy forest; if the forest is removed, payments stop. For groups with no structure, this policy may work best. They can passively accept payments without incurring long-term obligations, though they might eventually decide to accept liability for the stored carbon and sell the accumulated credits.

Recommendations for further research

Research in each of the four areas of the conceptual model – biophysical, economic, institutional, and behavioral – could lead to more effective policies that trigger the swift and large-scale responses needed to effectively address climate change. Biophysical research would help clarify and precisely quantify the plot-level greenhouse gas effects of specific management practices, explain the local and regional effects of soil, ecological, and climatic conditions, and scale up the effects of changes in land management to assess their impact at the global scale.

Economic research, using general equilibrium models, would refine our understanding of the global interlinkages of land-based commodity production systems and help resolve some of the uncertainties about the future price of carbon credits. At the local and national scale, economic research can identify, evaluate, and help develop opportunities for compensating and bundling environmental services, leading to more sustainable land use. At the scale of individuals and groups, behavioral economic research is needed to understand the ways landowners value non-economic benefits, assess risks, and respond to uncertainties.

Several institutional research initiatives could help guide policy development. First, targeted empirical research is needed so that we can better understand how organizational structures shape the land-use decisions of communal landowners. Although Ostrom and others have developed a strong conceptual, theoretical, and empirical foundation for understanding how groups organize themselves to manage resources sustainably (e.g. (Ostrom 2005; Ostrom 2003; Ostrom 1999), a new direction is required if we are to understand how groups will respond to newly emerging environmental markets. A better understanding of the valuation of cultural benefits from different land management systems seems likely to be a key component of any local-scale decision framework. This research effort must combine political science, resource economics, biogeochemistry, management science, and geography to successfully understand the connections between plot-level land-use decisions and global-scale drivers (Geist and Lambin 2002). Policymakers should find this work extremely valuable as they design new environmental policies, especially policies for reducing emissions from deforestation, which will depend upon the participation of communal landowners.

Conclusion

As we move forward with the development of market-based environmental policies, such as the PFSI or other systems, we need to look closely at decision-making structures and their ability to bring opportunities on board, navigate processes, and overcome barriers. The economic assumptions that lead to efficient outcomes do not necessarily apply to these markets because of a number of market failures. As a result, we should think beyond the conceptualization of land as an input for production systems. An addition to this economic view, we should recognize that every land use carries with it transformations of cultural, social, and natural capital. For a significant fraction of land in New Zealand, as well as other countries, there are lands that must meet cultural objectives as well as economic and others. The rules for multi-objective management are not straightforward, in terms of theory, and the way institutions implement such management is not well-understood.

Nevertheless, the outcomes are increasingly important for the planet. Of the many ways we can change from “business as usual” models, one way is to change the institutional structures that manage our resources. Māori land ownership and decision-making provides an example of an alternative that has its own strengths and weaknesses. In some ways, it shares the characteristics of developing lands in other countries and serves as a useful model: lack of capital, alternative forms of tenure, collective decision-making, and marginal quality. These factors can either enhance or impede the responsiveness of these lands, and they may act in conflicting directions on different land or at different times. These factors must be examined in time and space. The implications for biodiversity, climate change, and other environmental issues are of great importance.

Policies to reduce climate change have created global incentives for reducing emissions and increasing sinks. Carbon is becoming a truly global commodity in a global market. Will its benefits reach those who need them the most? The steps of creating the market and quantifying the economic potential are well underway. What remains is to construct local pathways for landowners to participate.

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