

Towards green markets for New Zealand plantations

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Abstract

There is increasing interest in planting trees for benefits other than wood production: for carbon sequestration (Emissions Trading Scheme), for erosion control (East Coast Forestry Project), for water flow regulation (e.g. farm plans in the Manawatu), for reducing nutrient leaching (e.g. into the North Island lakes), and for biofuel production (reduction of fossil fuel reliance). Planted trees also contribute to biodiversity on productive lands (e.g. for Convention on Biodiversity reporting; for forest certification requirements) and provide options of multiple use (tourism and recreation activities). This paper draws together knowledge on the achievable environmental benefits and services of New Zealand plantations, covers the lessons from this research, where the knowledge gaps are, and discusses some of the trends and future issues of markets for these services.

The Changing Environment for Forestry

The nature of production forestry in New Zealand has changed in the last decade. Forest management has moved from a predominant focus on productivity gains to a stronger emphasis on sustainability. In contrast to the regulatory environmental tools that have dominated in New Zealand, there is a rise internationally in the more flexible markets-based approaches, including banking, certification, and credits. Alongside these developments, the government's interest in promoting environmental mitigation and recovery remains and includes regulatory and market-oriented approaches. In this paper the term green market is used for the trade of ecosystem goods and services provided by planted forests, which includes valuing such goods and services.

This paper covers a number of emergent trends for green markets that relate to forestry, recent knowledge gains of the environmental benefits and services of planted forests in New Zealand, and what we believe the future knowledge requirements are for valuing environmental benefits of forestry.

Global Trends in Markets for Environmental Values

The environmental values of planted forests (carbon, biodiversity, soil and water resources, and social benefits such as recreation and tourism) will have an increasingly important influence on opportunities to access value-added markets (US, Europe, and Chinese and Vietnamese exporters to US and Europe, etc.), and the ability to attract investment from the global financial sector. Examples of the growing importance of environmentally sound forest management include:

- i) Growth in the area of commercial planted forest that is environmentally certified (51% in New Zealand, with an even greater proportion of the harvest

certified (pers comm. Chris Goulding, Scion). The certified wood products market is predicted to increase from US\$5 billion per year to US\$15 billion in 2010 and US\$50 billion in 2050 (Bishop *et al.* 2006)

- ii) While certified wood products currently do not attract a price premium (Oliver 2005), in the long term a premium is possible as labelling leads to significant new demand for certified wood products (Sedjo and Swallow 2002)
- iii) All of the forest and pulp and paper companies in the top 250 companies in the Fortune 500 produce Corporate Social Responsibility Reports (KPMG 2005)
- iv) The New Zealand forest industry is actively promoting the environmental credentials (renewable, carbon positive, etc.) of its planted forests through the NZWood programme (www.nzwood.co.nz)
- v) The global trade in carbon certificates is now just under US\$60 billion, and could hit US\$2 trillion by 2020 (Szabo and Wills 2008)
- vi) Emergence of values from ecosystem services, e.g., biodiversity and species conservation banking (Deal 2007, Norton, 2008)
- vii) Wider recognition of non-market benefits of forests is being promoted through mechanisms such as the Montreal Process Criteria and Indicators (FAO 2007).
- viii) Mechanisms to reward forest owners for the production of non-timber benefits (examples include the Permanent Forest Sink Initiative and the Emissions Trading Scheme) are being developed in New Zealand (e.g. FAO 2007).

Environmental benefits from planted forests

Maclaren (1996) summarised the environmental effects of forestry including effects on water yield, water quality, soil erosion, soil quality, global warming and biodiversity. Subsequent research has enhanced our knowledge of the environmental benefits and services provided by planted forest ecosystems (Table 1, after Clinton *et al.* 2006).

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Table 1. Potential benefits of forests

Renewable products
Improved water quality
Moderation of peak flows
Low nutrient inputs
Nutrient sequestration
Carbon sequestration
Improved soil physical structure
Reduce soil erosion
Source of bioenergy, including
- Substitute fuel for reliance on fossil fuel
- Security of energy supply
Biodiversity conservation and enhancement, including:
- Provide habitat for native fauna and flora
- Reduce loss of endangered and threatened species
Enhance rural economies
The green gym
Inspiration for the creative arts
Stock shelter and fodder

Biodiversity

There are a number of examples of the extent to which recent research has contributed to the potential realisation of the benefit of biodiversity from planted forests. It is now widely established that many of New Zealand's exotic forests provide habitat for a wide range of indigenous forest species (e.g. Allen *et al.* 1995; Ogden *et al.* 1997; Brockerhoff *et al.* 2003; Pawson & Brockerhoff 2005), including some threatened species (e.g. Kleinpaste 1990; Brockerhoff *et al.* 2005). Typically, the most common native birds within planted forests are insectivorous species or seed eaters (Spurr and Coleman 2002). Other indigenous fauna known to utilise planted pine forests in New Zealand include long-tailed bats (Maunder *et al.* 2005), Hochstetter's frog (Carter Holt Harvey 1997), and diverse invertebrate communities. Hutcheson and Jones (1999) found that 50-80% of dominant invertebrate species sampled within planted forests were endemic to New Zealand.

The ability of planted forests, once harvested, to provide these biodiversity benefits have also been addressed. Given time, the vegetation of previously clearfelled areas tends to recover to pre-harvesting levels (Allen *et al.* 1995, Brockerhoff *et al.* 2003). Clearfell size has been shown to not be a constraint to recolonisation post-harvest by relatively rich invertebrate communities (Pawson *et al.* 2006). While forest specialist species for which the open habitat of clearfells is unsuitable do disappear from them, on restoration of forest habitats they are reintroduced from adjacent forest and this recolonisation provides for a similar communities to before harvesting (Pawson *et al.* 2006).

Aquatic biodiversity in plantations is no different to that found under indigenous forestry when riparian strips are not felled (Quinn *et al.* 1997, 2004). The diversity of stream invertebrates (Quinn *et al.* 1997), levels of shade



A complex native understorey grows under plantation trees in wetter areas at lower stockings. National Forestry Library

(Davies-Colley and Quinn 1998), litter inputs (Scarsbrook *et al.* 2001), and coarse woody inputs and associated habitat (Baillie and Davies 2002) are greater in planted pine forests compared to pasture. Maunder *et al.* (2005) conclude that there are still some significant gaps in knowledge on the use of planted forests by indigenous fauna, e.g., use by reptiles, and it may still be more utilised than currently recognised.

The greatest factor limiting many threatened native species is their vulnerability to predation by introduced mammals (Craig *et al.* 2000, Atkinson 2001), which can be mitigated by the pest management practised in planted forests, and the less desirable habitat of exotic forests for some of the introduced species (pers comm. W. Shaw, Wildlands Consulting).

Pinus radiata is known to provide conditions suitable for the establishment of an under-storey of native species (Porteous 1993). The extent to which this happens depends largely on the amount of rainfall and the availability of propagules of indigenous species for colonisation. In some of the drier environments in eastern parts of New Zealand, there is limited colonisation by native plants,

particularly when indigenous seed sources are lacking. In other environments, afforestation of pasture (excluding tussock grasslands) with exotic tree species can in fact lead to significant gains in indigenous biodiversity.

Conversely, conversion of planted forests to pasture has been found to lead to substantial losses of indigenous biodiversity (Maunder *et al.* 2005). Such conversions are under way in several parts of New Zealand, mainly in the central North Island, where planted forests contain much indigenous biodiversity, both within planted stands and in the substantial pockets of indigenous vegetation that are embedded in these forests (pers comm. Willie Shaw, Wildland Consultants, unpublished data from numerous field surveys throughout New Zealand). The ongoing conversion of planted forests in Canterbury is a significant concern as Eyrewell Forest contains a greater area of k  nuka remnants, as an understorey, than all the other k  nuka remnants on the Canterbury Plains taken together (Ecroyd & Brockerhoff 2005). In addition, Eyrewell Forest is the only remaining habitat of a critically endangered ground beetle that is endemic to this part of Canterbury (Brockerhoff *et al.* 2005).

Many parts of New Zealand have highly modified landscapes with a high degree of forest fragmentation. Numerous studies from around the world (Murcia 1995, Didham *et al.* 1998, Lindenmayer and Franklin 2002) have demonstrated that forest fragmentation is a significant contributor to biodiversity loss. Fragmentation generally causes an increase in the proportion of forests that suffer from edge effects, which modify the ecological conditions of forests (Pawson *et al.* 2006). Isolation of fragments from other forests negatively influences biodiversity because it reduces the exchange of individuals among populations and it may prevent recolonisation of patches if local populations decline or become extinct. Both fragmentation and isolation of patches can also result in a decline in genetic diversity within species. In this case, planted forests may provide connecting forest habitats (e.g. for kokako, Innes *et al.* 1991) or serve to reduce edge effects.

Soil Erosion

A well-understood benefit of planted forests is the reduction of soil erosion (e.g. Knowles 2006). The benefits of forests in reducing on-site erosion and off-site sediment loss have been widely recognised in New Zealand (Phillips *et al.* 2005) and led to the New Zealand Government through the East Coast Forestry Project providing incentives for afforestation on erosion-prone land (Phillips *et al.* 2000; O'Loughlin 2005).

Possibly of more importance to the wider New Zealand environment is the impact of extreme weather events in areas dominated by steepland pastoral systems. In such situations, the impact of roads, harvesting and forest management on long term catchment sediment yields needs to be considered against the potential long



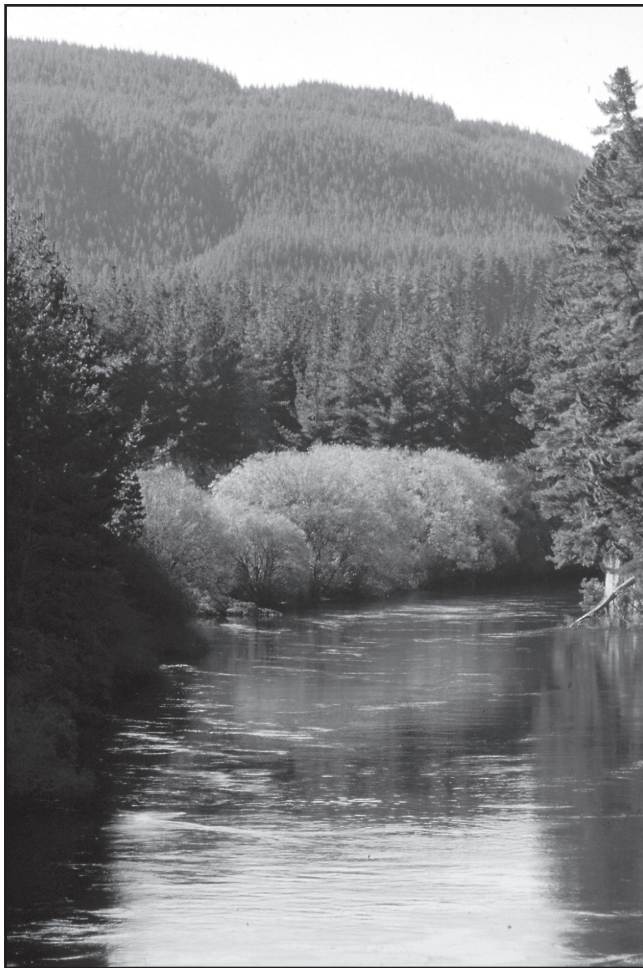
Erosion rates under trees are greatly reduced compared to pasture. National Forestry Library

term impacts of loss of land and sediment generation and transport from land remaining in pasture or scrubland for 30 years or longer. So, although it is well recognised by foresters that trees can strengthen soils through the binding effects of developing root systems in surface soils (O'Loughlin 2005; Marden 2004; Phillips and Marden 2005), examples such as the Manawatu flood damages of 2004 place doubt on whether this lesson has been learned (John Dymond, Landcare Research, pers comm.). Such large scale mass wasting has many implications not only for downstream land owners but also for the national carbon balance (Page *et al.* 2004).

Water quality and quantity

Afforestation may affect low flows but Davie and Fahey (2005) outline the complexity of factors that determine low flows, including the nature and extent of catchment low flow generating areas. Although the benefits of afforestation on catchment flood peak flows under New Zealand conditions is well understood (Davie and Fahey 2005) with forests shown to reduce floods by up to 50% following afforestation (Fahey *et al.* 2004), the focus of public policy in most regions is still on low flows and issues of water supply rather than on the wide ranging benefits of flood reduction and soil protection, water quality, and stream habitats.

Water quality is under pressure from agricultural intensification (e.g. Environment Waikato 2008). Nitrogen is accumulating on New Zealand's grazed pasture and in the aquifers, with excess nitrogen leading to deterioration of water quality such as has happened for the North Island lakes (e.g. Parfitt *et al.* 2006). Of the productive land uses in New Zealand, forestry has the lowest potential for nitrate leaching (Meneer *et al.* 2004) with levels similar to indigenous forests. In the same way, forestry contributes the least amount of phosphorus into waterways. Planted trees as riparian zones are useful for water quality management within catchments (Burt and Pinay 2005) to lower nutrient outputs from the landscape. Similarly regarding sediment yield, a study at Pakuratahi on erodible hill slopes showed



A tree-covered catchment usually results in good quality water. National Forestry Library

a 65% reduction in sediment yields when comparing pasture with mature pines (Fahey *et al* 2003).

Of concern is the effect on water yield and water quality of the recent deforestation in New Zealand where large areas have been or remain at risk of being converted from planted forests to dryland pasture in Canterbury or to dairy farm land in the Waikato and elsewhere. In Canterbury, changing the landuse from planted forests to pasture will increase movement of water, increasing the movement of the associated nutrients into groundwater, raising concerns for water quality (Watson *et al.* 2004). In Waikato there is concern that water quality may further decline with this shift in land use (planted forest to dairy) given that water quality from planted forests is of a greater value than that from pastoral and urban landuses (Larned *et al.* 2004) and nutrient use is lower in planted forests (Davis 2005) and nitrate leaching is lower (Davis 2005; Hamilton 2005).

Carbon storage

Planted forests are an important component of the national carbon inventory and post-1990 planted forests, the so called “Kyoto Forests”, are expected to provide an

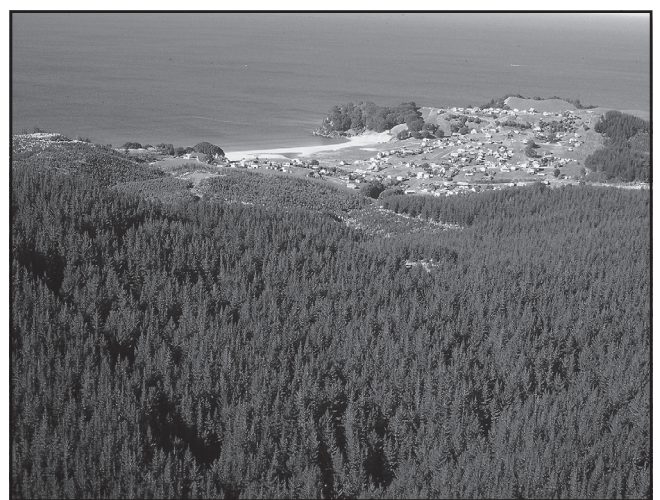
additional 90 -105 million tonnes CO₂-equivalent to New Zealand for the first commitment period of the Kyoto Protocol.

Bioenergy

Unlike fossil fuels, planted forests are sustainable producers of bioenergy (Hall and Evanson, 2007) and form a component of the renewable energy targets for New Zealand (East Harbour Management Services and Scion, 2007). Active investigations are underway on the production of bioenergy from planted trees to replace the reliance on fossil fuels (e.g. Hall and Gifford, 2008).

Other non-timber benefits

Beside employment and the related forestry service industry and the flow on effects of these, planted forests contribution toward social benefits on two levels – one is that through being a more environmentally beneficial productive landuse, planted forests contribute to New Zealand’s clean green image which is important to tourism, while another benefit is through the multiple use opportunities supplied by the forest environment. For example, access to planted forests for mountain biking has grown a multi-million dollar industry benefiting the Rotorua community (e.g. RDC 2006). Ultimately the question needs to be asked (Clinton *et al* 2006) if the wider economic benefit of selling the ecosystem services provided by New Zealand’s forests, such as maintenance of the clean-green image, the ability to continue to sell things like milk products internationally, and the positive effect on tourist numbers because it is safe to fish and swim in the lakes, could in fact benefit the economy of the country more than that from wood products?



Pine trees they may be, but the scenery around certain tourist destinations such as Queenstown, Hanmer and – in this case – Tairua, is arguably enhanced by its forested backdrop. National Forestry Library



Recreational use of plantation forests. National Forestry Library

Technical challenges to achieving benefits from forestry

Achieving the environmental benefits of forests may have its own difficulties. A number of issues are highlighted:

- Carbon – Soil carbon may decline initially following afforestation, however, soil carbon levels may eventually exceed those under grassland (e.g. Paul *et al.* 2003). The effect on trees of higher CO₂ levels in the atmosphere needs to be understood well as there may be levels at which trees reduce growth rather than use the increase for increased growth (Fox, 2007). Thus,

for example, although standing stocks of carbon may not be affected by elevated CO₂ levels, decreasing tree growth could result in the need for increasing rotation age.

- Water flow regulation and erosion – afforestation effects on low flows do need to be taken into account
- Reducing leaching – it takes time for soils with high N leaching rates to decline. While converting pasture to plantations reduces N leaching, it could take more than one rotation to achieve the low leaching levels associated with plantations where the previous land use did not include pasture, as the trees cannot utilise all the available N.
- Biofuel production – marginal lands with the potential for conversion to biofuel production compete with proposals for carbon sequestration (e.g. Whitehead 2006)
- Biodiversity – contributions toward biodiversity in plantations are only beginning to be understood

Towards green markets for forestry

Stakeholder needs, benefits and opportunities from forestry for investment in green markets apply from the farm level, through to catchment, regional, national and international levels (Table 2).

Table 2. Drivers for and potential gains from investing in green markets

Stakeholder	Need	Benefits and opportunities from green market forest investments
Forest owners	Greater returns on investment	Increased revenues, improved market access
Hill country farmers	Pressure to reduce costs and environmental impact	Increased revenues, reduced environmental risk
Maori land owners	Need for sustainable land use for multiply owned land blocks to address intergenerational issues	Increase return on assets Increase social and cultural returns to Iwi Protection of taonga
Catchment	Increase water quality and reduce erosion, increase biodiversity	Improved cultural and social returns
Region	Increase water quality and mitigate high costs of replacing infrastructure, increased biodiversity	Reduced infrastructural risk Improved environmental integrity
National	NZ's clean green image International cost of compliance Carbon sequestration Biodiversity	Maintenance of NZ's clean green image Increased carbon sequestration Bioenergy feed stocks Trade access and increase exports Reduced soil erosion and improved water quality - improved environmental integrity Increase biodiversity
International	Carbon offsets Biodiversity offsets Bioenergy	Security from investing in New Zealand

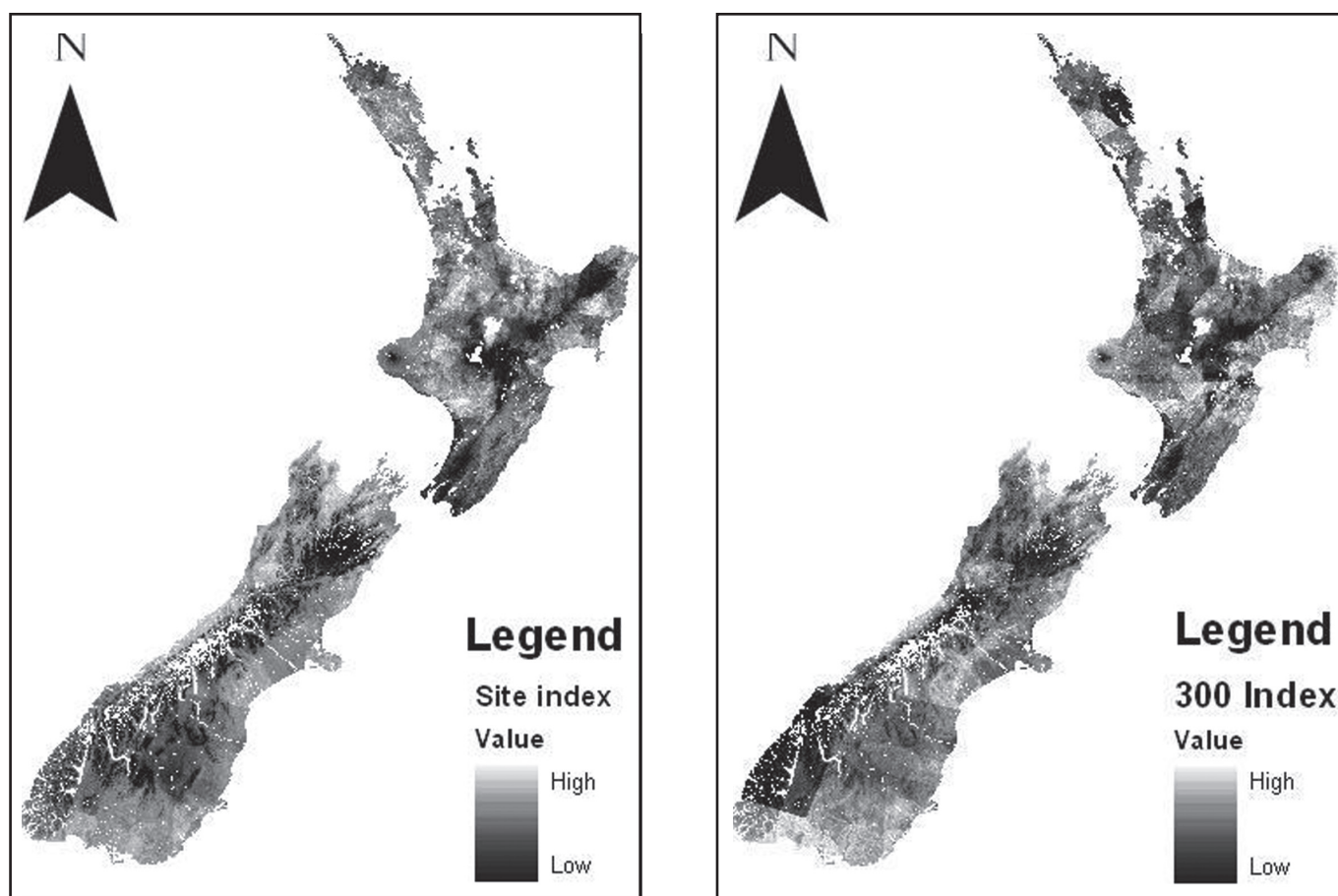


Figure 3. Site index and 300-index productivity surfaces (Palmer 2008)

Approaches to decision making

Models may be as simple as estimating gains in carbon storage by increasing rotation age and tree stocking (Payn *et al*, 2005). Modelling the effects of riparian strips during harvesting has been a research focus over a number of years (e.g. Murphy *et al* 1988), as has modelling the water yield from radiata forests (e.g. Whitehead and Kelliher 1990). Nutrient inputs and losses have been modelled for radiata pine under a range of management regimes and on a number of sites (Payn *et al* 2005). Detailed models are currently being researched for carbon sequestration and biofuel production. To facilitate this, Radiata pine productivity surfaces were developed for New Zealand

(Figure 3). Increased interest may provide the impetus for the development of this knowledge into generally available software products.

Models and their underlying information allow us to develop investment scenarios for new forest plantings based on multiple criteria. There are a number of tools available to assist with this process. The Scenario Planning and Investment Framework (SPIF) tool is a forestry planning and extension application such scenario development (CSIRO 2007). Octopus is a system that searches for an optimum scenario across multiple criteria and values based on people's values (Chikumbo 2008) and has been successfully used in the Rotorua catchment. The types

Table 3 Considerations that could influence investment decisions for multiple value forests

Value	Criteria					
Biodiversity	Land value	Endangered status/scarcity	Ecological environments	Regulatory environment		
Carbon	Sequestration rates	Land value	Disease risk	Regulatory environment		
Water quality	Erosion risk	Nutrient status	Land value	Regulatory environment		
Energy crop	Terrain	Productivity	Distance to plant	Infrastructure	Regulatory environment	
Extreme events	Slope	Soil type	Rainfall	Vegetation cover	Land value	Regulatory environment
Recreation	Quality of environment	Variability	Accessibility	Naturalness	Regulatory environment	

of information that influence green market investment scenarios to be developed is given in Table 3.

Challenges to increasing the provision of environmental services from forestry

Knowledge gaps

Value of goods and services - approaches to valuing services

While numerous studies have estimated the value of ecosystem services (e.g. Kerr 2000, NSW 2004, Krieger 2001) and New Zealand natural forest ecosystem service values (Yao and Kaval 2007, Kaval *et al* 2007, DOC 2006), there have been no estimates of the value of these for NZ planted forests. A Scion review (Dunningham *et al* 2007) identified the services provided by New Zealand plantations and methods for valuing each of these, e.g., replacement cost, hedonic pricing, travel cost, and stated preference (Freeman 2003, Boyle *et al* 2005). The need to consider regional differences in important ecosystem services and data availability was also identified, and the uncertainty in the appropriateness of different valuation methods. The review led to a detailed project plan for valuing the services in case study regions (Barnard *et al* 2007). Work is planned to address these needs through a case study approach. The appropriateness of valuation methods, in terms of relevant data and sources, to different ecosystem services will be assessed, and lessons learned applied to estimating values in other regions.

Availability of data and models

Data and models are patchy and a coordinated approach to model development is required to enable forest managers and investors to take advantage of green market forests. There are a number of research programmes underway within NZ that will assist in the development of these new forestry paradigms (protecting and enhancing the environment through forestry³, diverse forests³, valuing ecosystem services⁴, economic value of erosion⁵, nitrogen trading schemes (Kerr *et al* 2007), Sustainable Land Use Research Initiative New Zealand (SLURI⁶), Intensive Forest Systems⁷), and capability is being developed to push this new area.

A framework to make investment decisions will be necessary in the future as green markets develop. The framework conceptually will be an economic one, though there are many difficulties assigning hard dollar values to less tangible products or benefits that are environmental or social and long term in nature. This economic modelling framework will be one of the most urgent research

³ Foundation for Research Science and Technology programmes (FRST) commenced October 2008

⁴ Scion investment project

⁵ MAF operational research project

⁶ www.sluri.org.nz

⁷ FRST contract programme

challenges, in particular the ability to evaluate investments based on a portfolio of products and services. SPIF goes some way to this, but will require more sophisticated economic approaches as it develops. An approach being explored by the University of Washington is to use auctions where interested groups bid on a variety of forest management plans, which provide different portfolios of products and services (Tóth *et al* 2008). SPIF could be used in conjunction with such auctions to show the alternative management plans and their environmental and social implications

Risk and uncertainty

Investing or paying for ecosystem services is a new concept for many in NZ with few examples that can be referenced, and often with intangible services (lower flood risk, biodiversity maintained for example). This is likely to lead to a reticence by investors to move into these markets. The current delay in implementing the Emissions Trading Scheme (ETS) creates uncertainty and increases investor cautiousness.

Internationally it has often been government initiatives that have kick started the activity, for example the Costa Rican government's initiative to halt deforestation and provide payment for protection of waterways which has had significant national economic and environmental benefits (Castro 2004). Increasing maturity of green markets in other countries may facilitate such markets in New Zealand (for an example of information facilitating, see The Katoomba Group's Ecosystem Marketplace⁸).

The human factor is a critical aspect of this new approach to forestry. Landowners or managers lack of understanding and limited access to useable tools for green market forestry may well be one of the biggest issues facing the New Zealand government's goal of establishing an additional 250,000 ha of planted forests by 2020⁹. The stability of the government's interests in motivating landowners to plant trees and improving all types of ecosystem services is also unknown. Three questions are: (i) How will landowners' land use decisions respond to government initiatives such as the ETS (carbon credits, afforestation grants, deforestation tax)? (ii) How will landowners respond to external market forces (commodity prices, property speculation)? (iii) How do landowner responses reconcile with the levels of environmental quality desired by other stakeholders in the catchment?

Political and Regulatory Environment

Regional variation in regulation

New Zealand land owners and managers are governed by a variety of national and regional regulations. With 17

⁷ <http://www.ecosystemmarketplace.com/>

⁸ <http://www.beehive.govt.nz/feature/fighting+climate+change>

Territorial Authorities, local application of regulations can be highly variable, leading to variability in the investment environment for green market forests.

Attractive regulatory environment

As noted earlier, with new markets developing government led stimulus and creation of an attractive environment is likely to aid uptake of green market opportunities and allow NZ to meet national goals articulate under various strategies such as the Sustainable Land Management and Climate Change Plan of Action or the Biodiversity strategy.

Market environments

Access to market mechanisms

These market opportunities are very limited within New Zealand, though not globally. Currently markets are gradually developing in NZ for carbon, with mechanisms such as the PFSI (Permanent Forest Sink Initiative) or ETS, but do not exist for other ecosystem services in New Zealand. The thinking on nitrate trading is developing (Kerr *et al* 2007, EW 2007, EBOP 2008). Grey market trades are developing ahead of formal markets. However, overseas such markets do exist and often trading is international in its nature so NZ does not necessarily have to develop the market mechanisms itself but will need to market the opportunity. Clear understandings of the expectations will be needed for anyone engaging in such trading. We are likely to see the development of Ecosystem Service brokers.

Commenting on the Future

Forestry by its nature is a low intensity land use that can be of higher value than when viewed for its timber alone. Quantification of the environmental benefits is not without its problems, however. Commodities require standardized measures, while ecosystem service commodities, however, are at best described by indicators of their complex ecological functions (Robertson 2009). The research programmes listed in a previous section include investigations into valuing ecosystem services in NZ. This will at least facilitate the scientific basis for future developments.

Of interest too is how the value of the benefits compares to or, in future with mature green markets, will compare to that of existing products. Issues that will need monitoring while green markets are under development include how the rights to the environmental values (including the market pricing of them) can be developed in a way that is equitable and affordable, including to the rest of the community. Furthermore, should some values prove easier to bring to market than others, how should those too difficult to price be dealt with?

Mixing new forests with other land uses will be critical to give a mosaic of land uses across New Zealand which will diversify and de-risk land management systems and increase overall land system resilience in terms of economic, environmental and social impacts. The question remains how regulators can achieve multiple objectives against competing interests, for example maximising low flow rates versus mitigating floods and protecting steep slopes. Increasingly research is developing more systems-based approaches to provide tools that are useful for such complex problems.

With New Zealand land predominantly in private hands, external economic forces can easily shift land use away from an ecologically balanced mix, particularly where environmental costs and benefits are not valued. Currently New Zealand faces a considerable challenge in balancing economic and environmental objectives from private land. Green market forestry opportunities are emerging for New Zealand on the back of rapid international developments and this has the potential to contribute to a new planting boom. Green market forests that capture benefits other than traditional timber as market values would be highly attractive for New Zealand. A word of caution is needed, however, as green market forests need to be developed under a mix of market and regulation that considers the long term impacts on New Zealand. It is very difficult to balance short term cash benefits from say a high dairy products price, with the long term environmental impacts of intensive land use that currently are not well considered and dealt with. In addition, if capturing the market value of the benefits simply means a transfer from New Zealand residents (who currently enjoy the non-timber values at no cost) to forest owners, many of whom are foreigners, there may be in no benefit for the nation. Only if capturing such values results in a significant increase in tree plantings onto areas that are currently less environmentally beneficial that there will be some gain in total welfare.

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