Final Report

MAF-POL/CP06 DEFOREST-LIABILITIES-01

Deforestation Liabilities – Allocation to Pre-1990 Forests

Prepared for

Ministry of Agriculture and Forestry

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THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

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Under the Emissions Trading System (ETS), land owners with forests that were planted before 1990 must surrender emission units if they deforest their land. This does not apply if the land is reforested, only if the land use changes to some non-forestry use. This is consistent with the rules that apply to New Zealand under the Kyoto Protocol. It passes New Zealand's international obligations onto owners of forests and it provides efficient disincentives to deforestation. The costs that would apply to the land owner are the same as the costs that apply to the nation.

Passing on the full liability has a high potential cost for land owners that do deforest. Typically a mature *Pinus radiata* forest will have an estimated liability for 800t CO_2/ha. At $25/tonne for an emissions unit, deforestation would cost $20,000/ha. This is also the cost to the nation of deforesting. This level of cost would be likely to limit all but the very most profitable land use changes.

Policy Options

In response to the government's proposal, a number of alternative solutions have been proposed that would reduce the burden on land owners wishing to deforest. They are proposed as being more equitable and, to some extent, better long run solutions for the treatment of forests under international agreements. The main one, proposed by PF Olsen and the Flexible Land Use Alliance, would allow land owners to plant trees on alternative sites to avoid a deforestation liability on the original site. Others have been proposed by Ngai Tahu that reduce the level of deforestation liability falling on land owners to less than that faced by the government under the Kyoto rules.

These alternative solutions would reduce the costs for land owners, but the costs avoided would be passed on to the government because of its Kyoto liability. And deforestation rates would be expected to be higher, because of reduced disincentives, so that the total liability increased.

Uncertainty over Treatment of Forestry under International Agreements

Future arrangements for the treatment of forestry under international climate agreements are currently uncertain. In this context, passing the full liability on to land owners can minimise costs and maintain options while we wait to obtain better information about the future.

Specifically, the costs of preventing deforestation may only be the cost of delaying land use change by five years (until after 2012). If during that time the rules that New Zealand will face for the next commitment period change, these can be employed for the ETS in the next period. For land owners, the costs of delaying deforestation by five years may not be that high. Based on estimates of the value of land use change, the costs of delay could be in the order of $3,000/ha compared to the avoided national cost of deforestation of approximately $20,000/ha.

In the presence of future international policy uncertainty, passing the Kyoto obligations on to land owners appears to be the most efficient and least cost option.

Free Allocation as Compensation for Costs

Compensation has been provided for land owners in the form of free emission units. But the number of free emission units is limited and the distribution is untargeted. They are given to all owners of pre-1990 forests, not to those most likely to need them because they are likely to deforest. It means that those land owners that do deforest will receive very few of their unit requirements. However, all options to this approach have disadvantages.

- Giving free emission units only to those land owners that decide to deforest removes (partially or wholly) the marginal signal not to deforest.

- Providing enough emission units to give substantial compensation to those that might deforest, without changing marginal signals, requires untargeted distribution, as with the current approach, but with a much larger numbers of units. This has a high cost to the government and to the nation.

Conclusions

The government is left with a difficult policy choice:

- its current approach, which is an economically efficient outcome but one that results in high costs being passed on to land owners that cannot easily be compensated, or not without high costs; or

- a less efficient outcome that passes lower costs on to landowners but results in increased deforestation and greater national costs.

However, the decision required is not once for all time. The costs for land owners of the current approach are limited to the delay in deforestation for the first commitment period through to 2012. During this time the international rules for subsequent commitment periods will become clearer and a more lasting decision taken about the treatment of liabilities for pre-1990 forests.

1. Introduction

This report analyses the costs and benefits of a number of proposals for the inclusion of pre-1990 forests in the emissions trading system (ETS). Specifically it compares the government's proposal as included in the Climate Change (emissions Trading and Renewables Preference) Bill with those of PFOlsen[1] and two options proposed by Ngai Tahu.[2] An additional proposal by the Flexible Land Use Alliance[3] has not been described by the proposers in the same level of detail as the others, and as it is substantially similar to the PFOlsen proposal it has not been analysed separately.

1.1. Current Proposed Approach under the ETS

The approach proposed by the government and included in the Bill is consistent with the commitments that the New Zealand government faces under the Kyoto Protocol. These are that any change in land use from forestry is treated as an immediate emission equal to the estimated carbon stock on the land at the time of felling. The government must surrender Kyoto units equal to the total net emissions from NZ during the first commitment period (CP1), including those associated with land use change. The ETS makes land owners responsible for the emissions associated with land use change; they must surrender NZUs equal to the estimated carbon stock on the land at the time of felling. This is a substantial impost; at an emissions price of $25/tonne and 800t/ha of CO_2 emissions, the impact is $20,000/ha.

The theoretical basis for the government's approach is clear; by passing on the national obligations directly to land owners who make deforestation decisions, deforestation will only occur where the benefits of doing so are greater than the costs to the nation; using the above example, the benefits of deforestation need to be greater than $20,000.[4]

This approach has significant impacts on existing landowners and reduces the value of their forested land substantially.

Taking these impacts into account, the government has proposed a compensation package for land owners in the form of free allocation of emission units (NZUs). The number of units made available is based on historical annual rates of deforestation. The allocation is not targeted at those most likely to deforest. Rather, the free units are spread across all land owners, recognising that all face a reduction in the value of their land.

1.2. Alternative Solutions

The potential adverse impact on existing land owners has prompted the search by industry for alternative solutions, three of which are analysed in this report. The proposed solutions seek to reduce the impacts on individual land owners while maintaining some restrictions on levels of deforestation and thus the Crown's and New Zealand's liability for surrendering allowances. But the proposed solutions also take a stand on principle; they

[1] Clark PD (2008) Pre-1990 Forests and the ETS – a Solution? Ver 3 23rd January 2008
[2] Ngai Tahu Property Limited (2008) NZ ETS Forest Sector – Alternative Solutions. 18th February 2008
[3] http://www.flexiblelandusealliance.org.nz/proposals.html
[4] Although, note the deforestation decision has a dynamic element – it can happen this year or be delayed

suggest that the existing Kyoto framework is wrong and that it is unsustainable as a long term solution. They suggest that the proposed alternatives would be more sustainable and thus provide a better preparation for long run policy settings that might be adopted in a future international agreement.

This is difficult to analyse as the future is uncertain. In contrast, we are certain what the rules for CP1 are and of the obligations they place on the New Zealand government; we can analyse impacts in the presence of these rules. And the other element of context is that forestry is a long term investment and deforestation can be delayed or brought forward; this affects potential costs and raises the potential of delay in the presence of an uncertain future.

There is a further suggestion that, if New Zealand adopts a different approach and demonstrates its workability, this can influence the international negotiations and make it more likely that the international rules will change in the future. Here short term pain is offset by longer run benefits. This might be so but is almost impossible to analyse. It is highly uncertain whether New Zealand's actions would have influence, and whether alternative policy in place would have more influence than persuasive arguments. We have been unable to include these arguments in the formal (quantitative) assessment of options.

1.3. Treatment of Other Sectors under the ETS

The treatment of emissions from deforestation needs to be compared with the treatment of other sectors under the ETS. The ETS introduces a new requirement to surrender emission units for all emitting sectors. This requirements is staggered over time, with the final sector included being agriculture, in 2013. In all cases, from the date of entry, participant firms face a requirement to surrender emission units equal in number to their emissions in any year. The requirement mirrors the requirement that the government faces under the Kyoto Protocol; the liability is passed on fully.

It is intended that some sectors will be compensated for the increase in costs that will result. This includes participants responsible for agricultural emissions and trade-exposed firms that face increases in costs associated with stationary energy use and industrial process emissions. The compensation will be in the form of free gifts of emission units.

The details of this allocation are still being examined, but the intention is to limit the size of the total pool of free allowances to 90% of direct and indirect emissions from the eligible firms in 2005.[5]

The key difference from deforestation emissions is that the emissions from any one source are relatively constant over time. In contrast deforestation emissions from any one source (ie area of land) occur once only. There are no 2005 emissions with which to compare. There are historical rates of emissions from the sector as a whole, but rates of deforestation will reflect changes in the relative value of land and land use over time and the age structure of forest plantations.

[5] In the case of electricity, which is regarded as an indirect emission, the intention is to compensate firms for some percentage of the increase in price of electricity.

The main lesson from the treatment of other sectors is the rationale for compensation, which has been largely to protect against economic regrets from plant closure, ie

1.4. Approach to Analysis

Our analysis takes a cost benefit approach to examining the different options.

The starting point for cost benefit analysis of government policies is the assumed objective that policy should result in an improvement in the overall welfare or well-being of society. To assess this, cost benefit analysis measures total costs and benefits, whoever they fall on, and then compares one policy or project with another; wellbeing-improving projects or policies are those for which the total benefits exceed the total costs. Analysis is not concerned primarily with whether projects or policies have effects that differ across society, for example, if a decision has a net benefit for the nation but results in net negative impacts on some people and net positive impacts on others. The theory is that these distributional issues can be tackled separately and society is better able to tackle them if the overall level of wellbeing is higher.

Consistent with this, the analysis of the options focuses initially on whether the options provide incentives for:

- Land to be allocated to the best possible use, taking account of all costs and benefits, including the costs of emission units;

- Reducing CO_2 emissions by absorption by sinks or avoiding deforestation, where it is lower cost than the international price of emission units.

The analysis will go further to quantify the differences between the total costs and benefits of the options.

2. The Options

In this section we set out a brief description of the different options that have been proposed. We compare these with the requirements under the Kyoto Protocol and the ETS.

The options are summarised in Table 1.

2.1. Kyoto Protocol

The Kyoto Protocol treats forestry in the following way.

- Forest land is split into pre-1990 and post-1989 forests.
- Emissions from pre-1990 forest land are counted at the time of land use change only. When land under forest is converted to another land use there is a requirement to measure the carbon stock on that land prior to deforestation; this is treated as an instantaneous emission at the time of felling. No absorption from pre-1990 forests is counted, eg a forest planted in 1989 would be 19 years old in 2008 and still growing and absorbing carbon, and no emissions are calculated for land that is felled but then replanted, and thus retained in forestry.[6]
- For post-1989 forests net changes in carbon stocks are counted as annual net emissions or net absorptions from any given land area.
- Total net emissions or absorption from land use, land use change and forestry are counted in estimating New Zealand's total obligation in the first commitment period (CP1). This includes the sum of emissions from pre-1990 land use change and net emissions/absorption from post-1989 forests. Where there is net absorption of emissions, New Zealand is issued with removal units (RMUs) after the end of CP1 equal in number to its net absorption during CP1; where there is a net emission from LULUCF, this is counted in estimating the total national obligation to hold Kyoto units.

2.2. Emissions Trading System

The emissions trading system as currently formulated introduces rules that are consistent with the Kyoto Protocol. This includes:

- A requirement for all[7] land owners of pre-1990 forests that change land use away from forestry (ie they deforest), to surrender NZUs equal in number to their calculated emissions. There is no requirement for land owners to surrender NZUs if they harvest and replant (or allow to revert) within a short period of time.

[6] New Zealand had two options for how pre-1990 forests were accounted for. The alternative approach, not chosen by New Zealand, was one which used carbon stock change accounting, ie any change in carbon stocks—positive or negative—was counted in estimating annual emissions or absorption.

[7] Land owners with less than 50 hectares of pre-1990 forests can apply to be exempt from the obligations associated with deforestation

Table 1 Summary of Proposals

	Kyoto Protocol	ETS	PFOlsen	Ngai Tahu 1	Ngai Tahu 2
Liable party	NZ government	Land Owner for Pre-1990 deforestation and Joint Owners[4] for Post-1989 afforestation and harvesting	Land Owner	Land Owner for deforestation and Forest Owner[6] for planting and harvesting	Land Owner for deforestation and Forest Owner[6] for planting and harvesting
Pre-1990					
Participation	Compulsory	Compulsory	Compulsory	Planting & Harvesting: Voluntary Deforestation: Compulsory	Planting & Harvesting: Voluntary Deforestation: Compulsory
Replanting	na	na	na	Forest Owners[6] receive 100NZUs/ha for replanting	Forest Owners[6] receive NZUs for net absorption (less than 1:1 ratio)[3]
Harvesting	na	na	na	Forest Owners[6] must surrender 100NZUs/ha at time of Harvest	Forest Owners[6] surrender NZUs for net emissions (with liability limited to previously earned credits)
Deforestation	Surrender Kyoto units equal to carbon deforested when land use changes[1] No requirement if land is replanted	Land Owner surrenders NZUs equal to carbon held in the crop prior to harvesting/removal. No requirement if land is replanted	Plant trees to offset deforestation: 1 ha to 1 ha Surrender NZDUs equal to carbon deforested	Land Owner must hold a "Contestable Deforestation Permit" (CDP) or surrender NZUs equal to the Net Carbon[5] held in the crop prior to harvesting/removal. No requirement if land is replanted	Land Owner must hold a CDP OR an auctioned NZ Deforestation Permit or NZUs equal to the Net Carbon[5] held in the crop prior to harvesting/removal. No requirement if land is replanted
No of Deforestation units	The government has access to any Kyoto units	Land owners have access to NZUs and all Kyoto units. 55Mt of NZUs given to potential deforesters including 21Mt in CP1	NZDUs issued based on deforestation intentions	Limited by an annual cap (5-6,000 ha pa) equating to 21 Mt in CP1	Limited by an annual cap (5-6,000 ha pa) equating to 21 MT in CP1
Deforestation Allocation approach	Government is given RMUs for net absorption from LULUCF. There is no initial allocation based on emissions in 1990	Free allocation to existing land owners on a pro rata (or possible some other) basis	NZDUs auctioned by the government. All land owners that have fulfilled the offset requirement are eligible to bid	No Free Allocation; Land Owners submit applications for CDPs that are assessed against criteria or cost benefit analysis	No Free Allocation; a) CDPs: as for NT1; b) NZDPs: annual auction; c) NZUs awarded to Forest Owners for net absorption (less than 1:1 ratio)[3] or NZUs purchased

	Kyoto Protocol	ETS	PFOlsen	Ngai Tahu 1	Ngai Tahu 2
Post-1989					
Participation	Compulsory	Voluntary	Voluntary	Planting & Harvesting: Voluntary Deforestation: Compulsory	Planting & Harvesting: Voluntary Deforestation: Compulsory
Afforestation / Replanting	Obtain RMUs on the basis of net absorption across LULUCF as a whole. Afforestation contributes on the basis of net carbon storage during commitment period	Joint Owners receive NZUs on the basis of net absorption during commitment period	As for ETS	Forest Owners receive 100NZUs/ha for afforestation and replanting	Forest Owners receive NZUs for net absorption (less than 1:1 ratio)[3]
Harvesting	Net carbon loss estimated and this results in reduced RMU eligibility or increased total national emissions	Joint Owners required to surrender NZUs on the basis of carbon loss during commitment period (with liability limited to previously earned credits)	As for ETS	Forest Owners must surrender 100NZUs/ha at time of Harvest	Forest Owners surrender NZUs for net emissions (with liability limited to previously earned credits)
Deforestation	As above	As above	As for ETS	Land Owner must hold a "Contestable Deforestation Permit" (CDPs) or surrender NZUs equal to the Net Carbon[5] held in the crop prior to harvesting/removal.	Land Owner must hold a CDPs OR an auctioned NZ Deforestation Permit or NZUs equal to the Net Carbon[5] held in the crop prior to harvesting/removal.
Deforestation Allocation approach	na	na	na	As for Pre-1990	As for Pre-1990

[1] New Zealand's obligation relates to the net contribution of LULUCF, but within this, deforestation is all negative and one more tonne deforested results in NZ requiring one more Kyoto unit or missing out on one more RMU;

[2] These would be specified on a hectare basis but could be on a carbon basis;

[3] the number is limited to the ratio of total number of RMUs earned by the NZ government and the total absorption by pre-1990 and post-1989 forests, both of which will be eligible to receive NZUs:

[4] Joint Owners means both the Forest Owner and Land Owner must agree (if they are not one in the same) to receive NZUs and become liable;

[5].Net Carbon means carbon held in the crop harvested prior to deforestation less any NZUs surrendered by the Forest Owner upon prior harvesting.

- Landowners of post-1989 forests can opt to receive NZUs on the basis of net absorption of carbon during the commitment period. Felling of trees in post-1989 forests (reductions in net carbon) are liable for associated emissions only to the extent that they have earned NZUs for those forests, so that a post-1989 forest felled on 1st January 2008 would have no emissions liability.

- Landowners of post-1989 forests who do not opt to receive NZUs may deforest without incurring an emission liability.

Land owners that are required to surrender units because of changed land use (pre-1990) or reduced carbon stocks (post-1989) can use any valid units they obtain on the market, and this includes NZUs issued by the NZ government and Kyoto units.

The government will make some NZUs available for free to land owners of pre-1990 forests. A total of 55 million tonnes of NZUs will be allocated for free, including 21 million tonnes in CP1. The initial proposal was for all relevant land owners to be allocated free units on a pro rata basis; available units would be divided equally across all affected pre-1990 forest on the basis of area as at 1 January 2008.[8] Subsequently the government has signalled that it is open to considering alternative approaches.

2.3. PF Olsen

The PF Olsen proposal criticises the ETS for basing its rules so rigidly on the Kyoto Protocol. The arguments included:

- the arbitrariness of the 1990 split into different forest types, with the consequent arbitrary cost impacts on some land owners and rewards for others;
- the unsuitability of some land under forest for forestry and the way in which the proposed system entrenches existing land uses;
- the treatment of deforestation of plantation forestry as an emission, when it is emitting carbon that was absorbed relatively recently.

PF Olsen recommends an alternative solution for the treatment of deforestation of pre-1990 forests. There are two elements that apply to land owners of these forests:

- a requirement for all deforestation to be offset by planting, either on the same piece of land or elsewhere;

- a requirement to surrender NZ Deforestation Units (NZDUs). It is not stated in the proposal, but NZDUs might be specified on a CO_2 or a hectare basis.[9] NZDUs would be placed on the market through auction and the number put up for auction would be determined by a survey of deforestation intentions.

  NZDUs would be non-tradable and land owner-specific. Eligibility for participation

[8] Forestry in A New Zealand Emissions Trading Scheme. Engagement Document. September 2007. P 27.
[9] 1 tonne of CO_2 emitted through deforestation would require 1 tonne of NZDUs or 1 ha deforested requires 1 ha NZDUs

in the auction will be limited to "forest landowners who were prepared to establish new forest on non-forest land."[10]

2.4. Flexible Land Use Alliance

The Flexible Land Use Alliance (FLUA) proposal is substantially similar to that of PFOlsen. It proposes an offset scheme that requires planting of land to compensate for any deforestation. We have not analysed this proposal separately but presume that the results of the analysis of the PFOlsen proposal apply to the FLUA proposal also.

2.5. Ngai Tahu

Ngai Tahu provided a critique of the ETS proposals and two alternative solutions. The criticisms include the risks associated with existing policy settings, including over NZUs awarded for afforestation. The suggestion is that the risk-weighted discounted cash flow from future credits would be low. The proposal includes a lower up front award of NZUs for planting new forests.

The proposals include elements relating both to the treatment of pre-1990 and post-1989 forests. They are discussed in turn below.

2.5.1. Option 1

Option 1 is focussed on promoting afforestation. It includes the following elements:

- a requirement for all landowners that deforest to hold "contestable deforestation permits" (CDPs). To obtain CDPs (land) owners would need to apply to the government to obtain a permit to deforest a specific site. The government would assess all sites against a set of criteria, which might be (or include) a cost-benefit test; the highest ranked sites would be granted CDPs. The number of CDPs would be limited to 21 million tonnes in CP1, consistent with the ETS proposals.

- those that replant or afforest would receive 100 NZUs/ha and those that harvested (or otherwise destroyed their forests) after receiving 100NZUs/ha would face an obligation to surrender 100NZUs/ha. Landowners that deforest post harvest would still require a deforestation permit.

2.5.2. Option 2

Option 2 introduces a wider set of obligations on deforestation. The components of this option include:

- Obligations on pre-1990 and post-1989 landowners that deforest to hold CDPs (with a process as described above) and/or surrender NZ Deforestation Permits (NZDPs). A limited number of NZDPs would be made available each year (5-6,000 pa is suggested in the proposal); they would be placed on the market through auction.

[10] It is not clear how this would be defined

- NZUs would be awarded to forest owners for absorption. This would apply equally to pre-1990 and post-1989 forests, despite the fact that New Zealand does not obtain additional Kyoto units for additional absorption by pre-1990 forests. However, the amount awarded to forest owners would be based on the total number of RMUs awarded to New Zealand under the Kyoto Protocol, divided by the quantity of CO_2 absorbed by both pre-1990 and post-1989 forests. This results in an award ratio estimated by Ngai Tahu as approximately 0.4 NZUs per tonne of CO_2 absorbed.

- Harvest (or destruction) of pre-1990 and post-1989 forests would result in a requirement to surrender NZUs, but this would be limited to the number already earned for that area of land. Thus it is limited in the short run to an approximate 0.4:1 ratio.[11] Landowners that deforest post harvest would still require a deforestation permit.

[11] Over time a greater portion of forest land will be post-1989 forest and thus eligible to receive RMUs under the Kyoto Protocol (assuming that the rules continue as are). Thus the ratio of NZUs awarded to CO_2 absorbed will trend over time towards 1:1

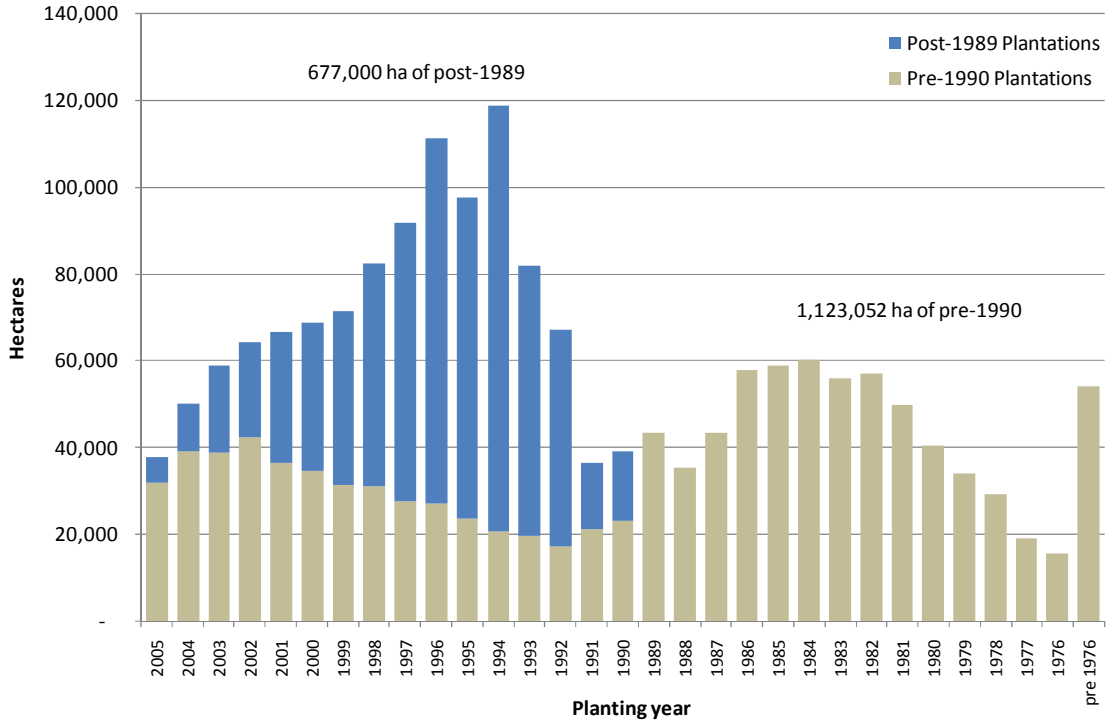
3. Analysis of Options

In this section we set out the analysis of the different options. The starting point is the business as usual projections of deforestation/land use change. We discuss issues relating to land use economics and we elaborate further on the analytical approach adopted. We then analyse the expected levels of deforestation under the different options and the consequent impacts on national costs and benefits.

3.1. The Baseline Numbers

The area in plantation forest is shown in Figure 1. It shows the split into areas that were planted pre-1990 and post-1989. The pre-1990 forest includes areas that were first planted pre-1990 but have been replanted since 1990. The areas of concern are the approximately 1.1 million hectares of pre-1990 forests.[12]

Figure 1 Plantation forests (as at 1 April 2006)



Source: MAF National Exotic Forest Description 2006

Not all of this is at risk of deforestation, at least in the short run. Some will continue under forest until it reaches an optimal age for harvesting and some land will be replanted. But some land is more suitable for other uses on the basis of current land use economics and, in the absence of climate change policy, it would be deforested. Estimates of areas 'at risk' have been made by MAF and are currently estimated to be in the order of 280,000 hectares.[13] Most of this is non-Kyoto forest (ie that planted before 1990).

[12] MAF estimate is 1.2 million ha

[13] Smith B and Horgan G (2006) Area of forest 'at risk' from deforestation. MAF Policy

Historical rates of deforestation are somewhat difficult to estimate from the available data. MAF estimates are given in Table 2.

Table 2 Historical Deforestation Rates

	2001	2002	2003	2004	2005	2006
Harvest area (ha)	38,000	40,700	49,000	40,800	39,000	38,800
Estimated area of deforestation (ha)	1,790	1,120	1,748	1,732	7,000	12,900
Deforestation rate (%)	4.8%	2.8%	3.6%	4.2%	18%	33%

Source: MAF

The government's proposed level of allocation is based on 100% of the estimated rate of deforestation over the 10 years from 1996 to 2005 inclusive (estimated at being 5.2% of the area harvested per annum); 55 million tonnes of CO_2 is the emissions that would occur if 5.2% of the pre-1990 forest area was deforested at maturity in the period to 2020.

An alternative source of data on deforestation is a survey conducted by Dr Bruce Manley.[14] This survey asked large-scale forest owners (companies with more than 10,000 ha of plantation forest) whether they would be likely to deforest, and how much, under three different scenarios: (1) with the ETS as currently specified; (2) with an amended version of the ETS that had a reduced (but unspecified) deforestation liability; and (3) with no climate change policy applying to deforestation (Table 3). The stated intentions under no policy are in the order of 7,400 ha per annum in 2008-12 but fall to an estimated 2,400 ha per annum under the ETS as understood by forest owners.

Table 3 Deforestation Intentions ('000 hectares)

	2008-12	2013-20
ETS Policy (Large scale owners)	8	3
ETS Policy (all owners)	12	12
Amended ETS Policy (Large scale owners)	24	23
Amended ETS Policy (all owners)	31	35
No Policy (Large scale owners)	29	28
No Policy (all owners)	37	45

Source: Manley B (2008) 2007 Deforestation Survey Final Report. University of Canterbury.

These data need to be interpreted with some caution as they will include deforestation of both pre-1990 and post-1989 (Kyoto) forests. They also include forests that will be exempt under the ETS, particularly land holdings of less than 50 ha. So, for example, the difference between the 2008-12 intentions of large scale and all owners (4,000 ha) can be assumed to be small areas of land that will be deforested under the ETS because they do not face a financial penalty.

We estimate the implications below.

[14] Manley B (2008) 2007 Deforestation Survey Final Report. University of Canterbury.

3.2. Forestry Economics

The economics of forestry land use, as with all land uses, are determined on the basis of the discounted cash flow, ie the stream of future costs and revenues. For forestry this includes the costs of land, planting and maintenance set against the value of the timber crop at harvest. These factors determine the value of the investment. And the value of forestry land is the land cost that could be paid while still enabling the investor to achieve a return equal to its cost of capital on the future use of that land. The same kind of analysis for other land uses determines defines the value of the alternative use.

3.2.1. Optimal harvesting

Forestry has an additional dynamic that reflects the long term nature of the investment. This is the timing of harvest. Figure 2 shows the rate of growth for a forest; it is exponential growth under a limit.

The growth rate determines the optimal timing of harvest. Figure 3 illustrates using the same data as used in Figure 2; it shows the rate of growth of the forest (the accumulation of volume). The growth rates starts rapidly but slows as the volume approaches the limit (the maximum volume). Assuming a constant value of timber in real terms, the optimal harvest is when the growth rate equals the discount rate, or the private cost of capital (here it is set at 10%). After that time, the forest owner is better to reinvest the timber sales revenue elsewhere rather than retain capital in the forest. In the hypothetical example below the rate of growth equals the cost of capital at 28 years; this is the optimal harvest date.

Figure 2 Forest tree growth

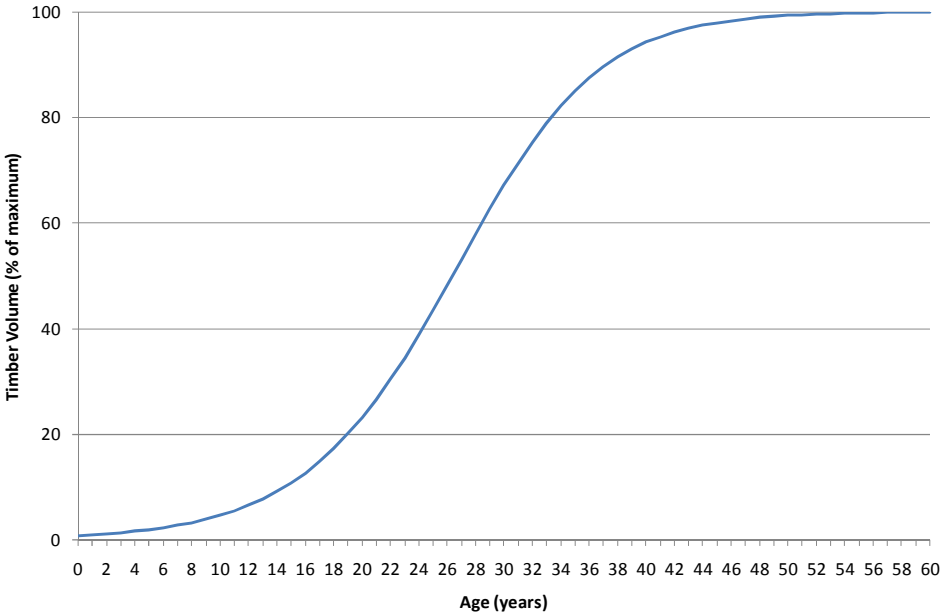
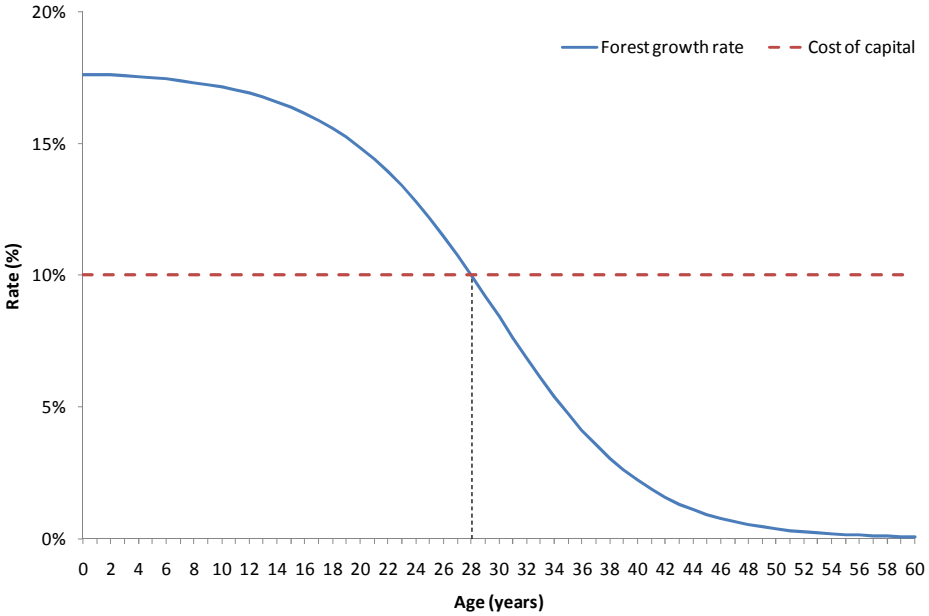
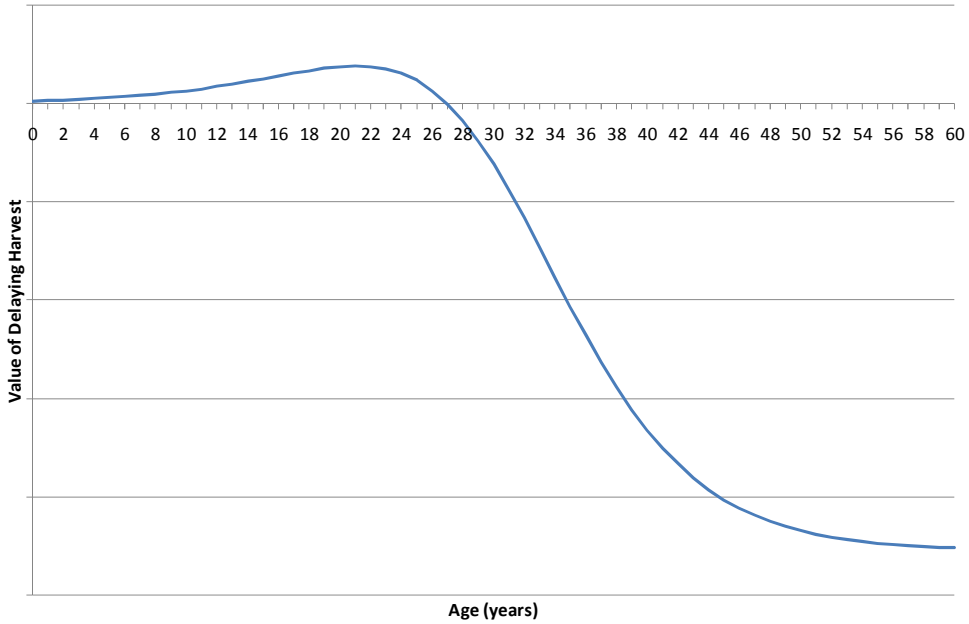


Figure 3 Optimal harvest time



The information is shown as the value of delay in Figure 4. This uses a hypothetical value of timber[15] and shows the discounted value of the harvest in one year's time less the value of the harvest this year. It is the value of delaying harvest by one year. By year 28 this has become negative, ie at that stage there is a cost to not felling now.

Figure 4 Value of harvest delay



[15] and thus does not include a y-axis label – the shape of the curve is the same regardless of the timber value

The cost of delay reaches a maximum when there is effectively no tree growth; the cost of delay is simply the loss of a normal return on the value of the timber, ie the value of the timber could have been invested to obtain this return.

Thus there is an optimal timing of harvest for a forest.

3.3. Economics of Land Use Change

The economics change when an alternative land use is introduced to the equation. The deforestation issue arises because, for many areas under forest, there is now a more profitable alternative land use. The cost of continuing in forestry is the opportunity cost of not being in dairy (or whatever the better alternative is). We explore this issue initially in the absence of a price on emissions and then consider the implications of the emissions price.

Under this new analysis the opportunity cost of not harvesting is the difference between the value of the lost growth in tree volume and the returns in the alternative land use.

3.3.1. Economics of Alternative Land Uses

Smith and Horgan made a number of estimates of the value of land use change from forestry to alternative land uses.[16]

On the basis of anecdotal information they estimated a value of bare forest land of $5,000/hectare and its value in alternative uses varying from $15,000 to $20,000 per hectare. This provides a surplus of $10,000 to $15,000 per hectare, against which the costs of conversion itself would need to be netted off; conversion costs were estimated to be $6,000 to $9,700 per hectare, resulting in a net value of conversion of $5,000 - $14,000 with an average of $9,650.

Smith and Horgan also included the results of an analysis of sales data (Table 4). They estimate a mid-point (median) estimate of the net benefit as $8,000/hectare.

Table 4 Benefits of land conversion using sales data

Item	Value/cost ($/ha)
Dairy land	$20,000 - $22,000
Forestry only land	$3,000
Conversion costs	$4,000 – $8,000
Other infrastructure	$5,000 – 9,000
Net benefits	$0 - $10,000

Source: Smith B and Horgan G (2006) Area of forest 'at risk' from deforestation. MAF Policy

These values have undoubtedly changed since this time. Updating these would change the absolute value of the costs of the different policy options, but will not change the relative rankings.

[16] Smith B and Horgan G (2006) Area of forest 'at risk' from deforestation. MAF Policy

A third stream of analysis used the annual net incomes from different farm management systems, assumed that these extended to infinity and discounted them back to produce a net present value, ie a difference in the estimated land value. The results are shown in Table 5.

Table 5 Benefits of land conversion using expected net income gains

Land use switch	Net benefit ($/ha)
Forestry to sheep & beef – extensive	$150
Forestry to sheep & beef – medium	$2,500
Forestry to sheep & beef – intensive	$5,200
Forestry to dairy – standard	$8,200
Forestry to dairy – intensive	$19,200

Source: Smith B and Horgan G (2006) Area of forest 'at risk' from deforestation. MAF Policy

These do not take account of the costs of switching itself which they estimate as being in the order of $2,500 to $10,000 per hectare. This results in switching being limited largely to dairy farming, with some potential for switching to intensive sheep and beef. They also do not take into account the impacts of emission unit costs on the value of agricultural land, ie the requirement from 2013 to surrender emission units to cover emissions from agriculture. The impact will depend on the approach taken to free allocation of emission units to agriculture, in addition to emission rates and prices.

Table 6 shows the expected impacts of emission costs on the value of agricultural land under two emissions prices: $15/tonne and $30/tonne. At $30/tonne, the emission impact may be over $2,500/ha for dairy land and up to $3,000/ha for intensive beef land. However, these impacts are estimated on the basis of the reduction in future profits and these effects may be compensated substantially through free gifts of allowances. This will mitigate these price effects substantially.[17]

Table 6 Impacts of Agricultural Emissions on Land Prices

	Stocking rate animals/ha	kg/animal/yr	t CO2/ha/yr	kg Urea/ha	kg DAP/ha	t CO2/ha/yr	t CO2/ha/yr	$/ha/yr	$/ha @ $15/t	$/ha @ $30/t
sheep – intensive	14	330	4.62	27.4	22.3	0.1	4.7	69	693	1,386
beef – intensive	6	1700	10.2	27.4	22.3	0.1	10.3	153	1,530	3,060
dairy – standard	2	2500	5	200	50	0.6	5.6	75	750	1,500
dairy – intensive	3.5	2500	8.75	300	55	0.8	9.6	131	1,313	2,625

For a number of reasons we have ignored these effects in the analysis:

- The time before agriculture is included in the ETS;

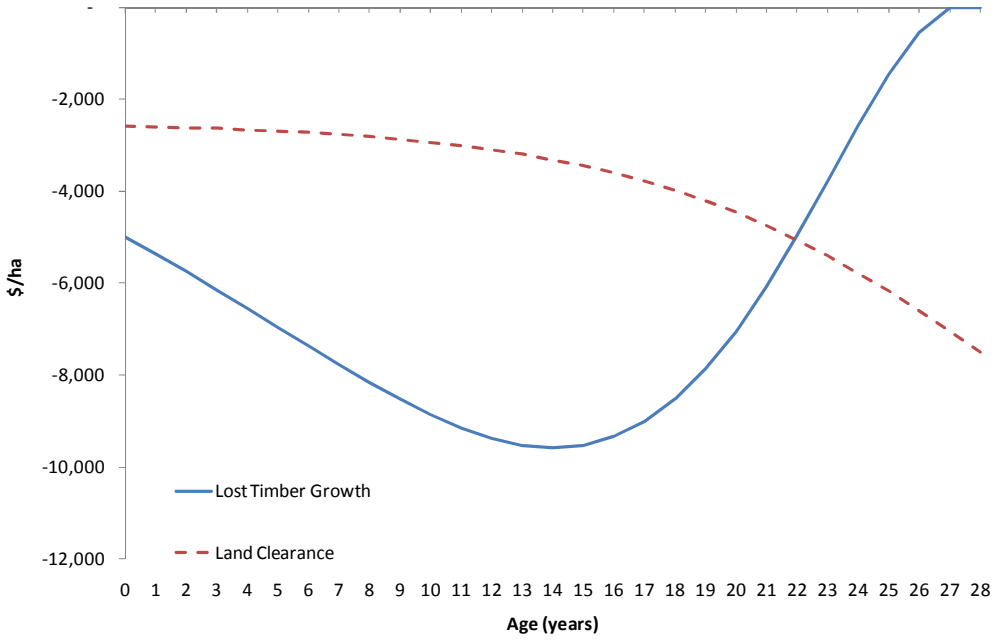
[17] Assuming free gifts of allowances equal to 90% of emissions in 2013 falling linearly to zero in 2025, the emission impacts on dairy land prices would be approximately $500/ha in 2012 at $15/tonne and a 10% discount rate

- The expected high level of gifting of free allowances to agriculture which will mean the impacts on farm profits will be significantly mitigated;
- Current high levels of dairy returns (pay outs) that would further compensate for emission costs.

3.3.2. Deforestation Choice

Figure 5 shows the costs of deforestation over the life of the forest, ignoring, for now, any benefits of doing so. The costs include the lost future growth in timber volume and the costs of felling/land clearance itself. The cost of lost future growth increases initially but then falls to zero by the time of optimal felling; the shape of this curve reflects the impacts of discounting. The costs of land clearance are assumed to have a fixed cost element ($2,500) and an amount that differs with the volume of timber removed; they increase to a maximum ($7,500) at the time of optimal harvest.

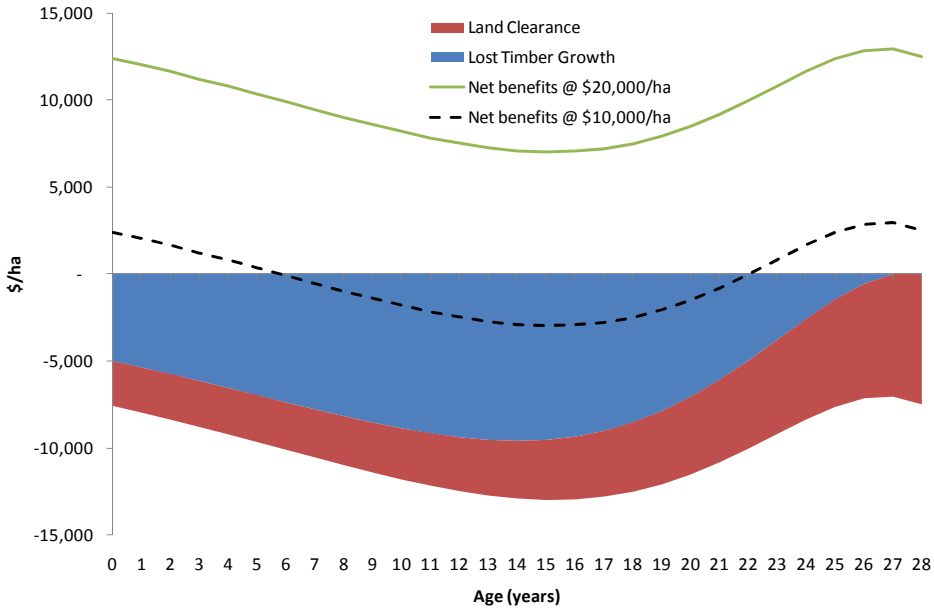
Figure 5 Costs of Deforestation



In Figure 6 these two costs are added together; an assumed value of an alternative land use is included also; two values are used: $10,000 and $20,000 per hectare. Under this analysis, the net effects of deforestation are always positive if the alternative land use is worth $20,000 per hectare but vary over the life of the forest at a value of $10,000/hectare. They are initially positive (there is a net benefit of deforestation), become negative over a range of years and then become positive as the optimal harvest date is reached.

Next we add NZU costs into the equation. Doing so is complicated by the way that the government has chosen to pass on the costs. Original pre-1990 forests would be expected to be at least 18 years old; however, areas that are harvested and then replanted remain pre-1990 forests and there is no liability to surrender emission units. However, if the land is deforested soon after replanting, landowners face the full liability for emissions, as if they were from a mature forest, but after this initial period the liability is reduced to the carbon stock only.

Figure 6 Net benefits of deforestation



The New Zealand government has chosen to pass the liability on in a way that, strictly speaking, is different from the Kyoto rules. The international rules that New Zealand has negotiated[18] are silent regarding liabilities for landowners that reforest and subsequently deforest. In contrast, New Zealand government has introduced a rule that applies full liability for felling pre-1990 forests up to 8 years of age, whereas after this time, the liability is limited to the carbon stock on their land. The reason is that the government perceives that, if land was permanently deforested after replanting and at an early age, this would be regarded as at odds with the spirit of the agreement that they have signed, although not the written rules. This is difficult to interpret for analysis and we examine the implications below.

Figure 7 shows the analysis based on an interpretation of the Kyoto rules and an allowance price of $30/tonne. These change the decision from that without an emissions price. At a land value of $20,000/ha in an alternative land use there is a value of deforesting if the forest is less than approximately 19 years of age,[19] but thereafter the decisions would be not to deforest. This would apply to reforested areas. At an alternative land value of $10,000/hectare the decision to deforest becomes optimal only very briefly and this effectively eliminates the desirability of deforestation for pre-1990 forests. The decision changes somewhat at a lower emission unit price. If the expected price of units is only $15/tonne, it becomes worthwhile deforesting throughout the forest's life at $20,000/ha but has little impact on the decision for alternative land uses valued at $10,000/ha.

[18] And note, New Zealand has agreed to be bound by an alternative set of rules rather than full carbon accounting for pre-1990 forests

[19] This takes account of the value of the timber and the costs of emission units, both of which vary with the age of the forest and thus the volume of timber and weight of carbon

Figure 7 Net Effects of Deforestation including NZU Costs

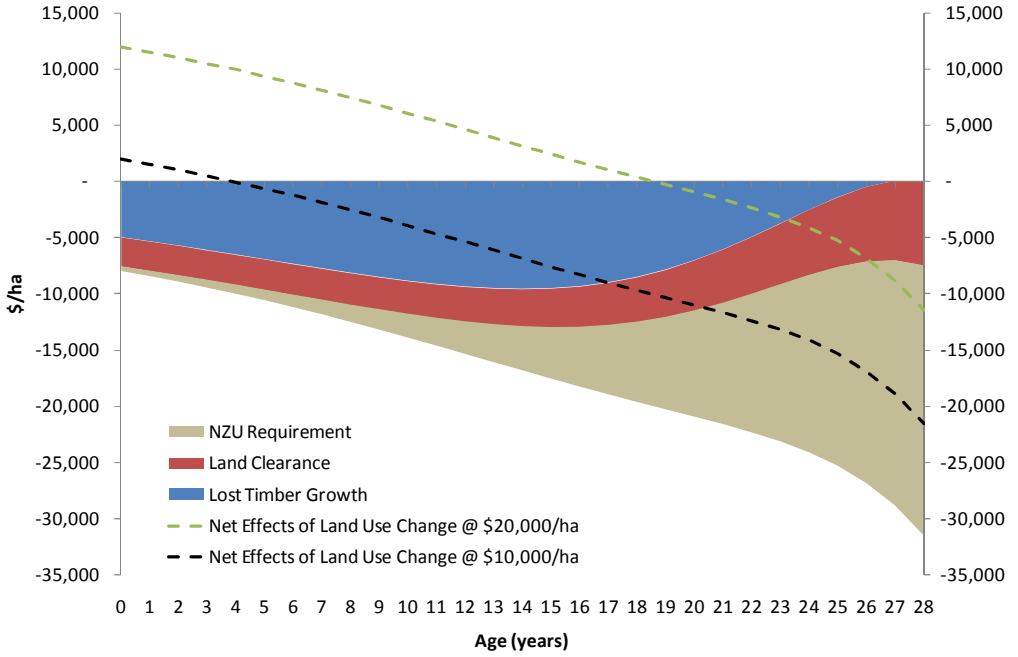
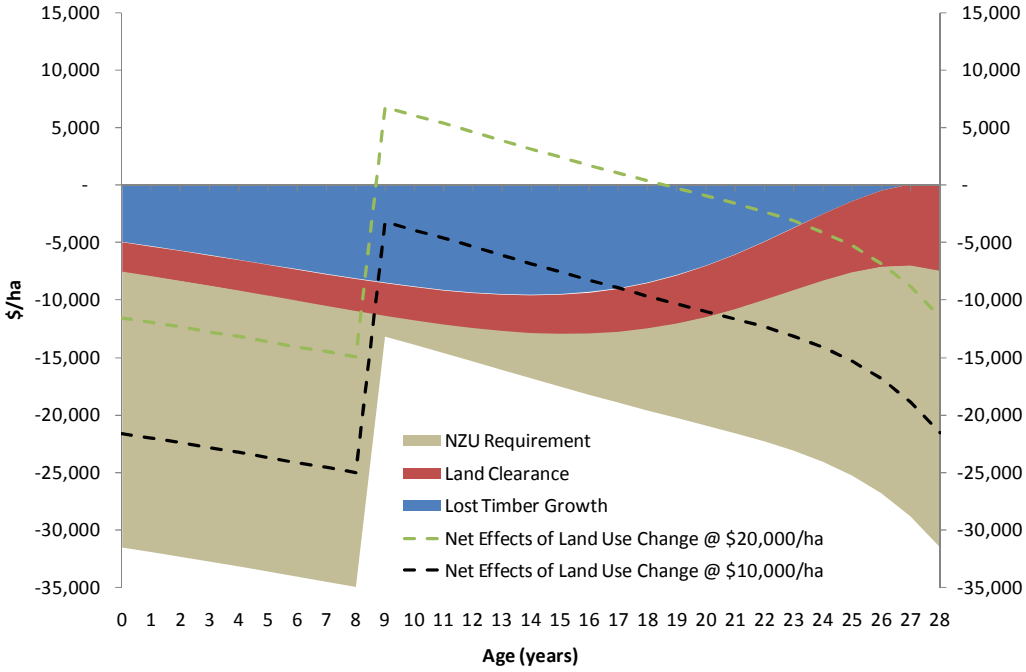


Figure 8 changes the analysis to that based on the current New Zealand regulations. The most significant impact is on the desirability of deforesting before age nine. Under the NZ-specific rules deforestation at these ages becomes unattractive. And to the extent that some deforestation is prevented as a result, this is a cost to the nation. However, the government has introduced this rule differently from the Kyoto rules, largely because it perceives that there would be a net cost of simply meeting the Kyoto rules. We do not have sufficient information to analyse if this is so; this would involve knowledge of the likely diplomatic response and possible implications for future international agreements to which New Zealand may be bound.

Figure 8 **Net Effects of Deforestation including NZU Costs**



Significantly, if the government is convinced of this position, and would intend to act in a way that was consistent with it under whichever policy option is chosen, then these are real impacts that need to be taken into account in the analysis. That is, if adoption of an alternative mechanism to the ETS led to some deforestation of pre-1990 forests aged less than nine years old, then the government would be expected to purchase additional emission units to cover emissions, as though they were emissions from a mature forest, ie it would over-comply. If this is so, then this does not become a point of differentiation between the policy options. We have no way of knowing this, but suggest that this would be a logical government response to this perceived international threat.

At $30/tonne the requirement to surrender emission units changes the deforestation decision to one in which, unless it occurs early, there is not an incentive to deforest. This will be so up until the time that the forest begins to deteriorate and there is a then a decision which resolves around whether the rate of deterioration of the value of the timber is greater than the reduction in the emissions liability.

These costs are estimated as private costs to the landowner making the deforestation decision, but they also represent costs to the nation.

3.4. The Analytical Perspective

3.4.1. Assumptions

A number of points need to be made about the underlying assumptions.

Firstly, the perspective taken is that of the nation. We are concerned about the total costs and benefits that accrue to New Zealand. This includes:

- The number of Kyoto units that are needed to meet Kyoto obligations as a result of decisions made in land use, land use change and forestry; and
- The value of land in production, ie the return to land use. This includes the opportunity costs that result from using land in sub-optimal uses.

However, the costs do not include the costs of any compensation packages, including gifts of NZUs. These are simply transfers from the government to the forestry sector; they are costs to the government and benefits to the forest industry. The national costs and benefits arise from the changes in behaviour and land use. This assumes that the wealth transfers are retained by the nation and not appropriated by foreign owners.

Secondly, and following from the first assumption, we take the Kyoto Protocol as a given; it is not a policy variable. This means the costs of surrendering units as a result of deforestation apply, regardless of the domestic policy settings. It also means that the requirement to surrender units is part of the real resource costs of land use options.

This has important implications for the study. Regardless of whether the Kyoto Protocol's approach to forestry is the best way to deal with the issue, and clearly there are significant criticisms, it is now part of the policy landscape; New Zealand cannot avoid the resulting

costs unless it goes out of compliance. We assume that it will not do this; we also assume that the decision to stay in Kyoto is not subject to cost benefit analysis, or not within this study at least, or that the benefits of being in are substantial. The cost of emission units from other countries is a real resource cost to the nation because there is an opportunity cost of the financial transfer; the money is no longer available to purchase something else.

There is a complicating factor that does affect the analysis. That is the expectation of the requirements on New Zealand after the end of CP1. If the rules change after 2012 to one that gives greater flexibility, then the costs of not deforesting in CP1 may be limited simply to the costs of delay for up to five years rather than the full opportunity costs of not switching to an alternative land use. We assess three options for the period post-2012:

1. Continuation of the CP1 rules;
2. Treating planting another area in the same way as replanting;
3. Forestry removed from the international agreement

3.4.2. Possible Limitations of Partial Equilibrium Analysis

Cost benefit analysis is a partial equilibrium analysis. It does not take account of all the effects in the economy; rather the analysis is restricted to the markets that it examines. Thus we assume that if agricultural land is valued at $20,000 this is the discounted sum of future profits available from its use and that the difference between this and the value in some other use (viz forestry) represents a surplus to the nation. But notably we assume this is the full extent of the surplus.

Other commentators have suggested that there are additional benefits. For example, Brian Fallow in a NZ Herald article argued recently "...if the policy effectively locks some forested land into a second-best use there is an opportunity cost. Export receipts, incomes, jobs, profits and taxes will all be lower than they might otherwise be. The importance of land-based industries to the economy argues powerfully against reducing flexibility of land use."[20]

The question is the extent to which these effects are fully captured in an analysis that looks at changes in land values only. The argument for general equilibrium analysis is that the effect of deforestation will have flow on effects in the economy. Take labour as an example; if there is less labour employed per hectare in forestry than in dairy, then demand for labour in the economy might be lower if land was retained in forestry, and wage rates will similarly be lower.[21] Thus the restriction on deforestation has flow-on effects into labour markets that are not captured by simply using an analysis based on existing land prices and labour rates. At the margin, ie for very small changes in land use (a single hectare or a single block of land), these effects will be unnoticeable. And if there are no changes in factor prices as a result of the marginal changes in land use, then the change in the land market can be assumed to fully reflect the impacts in the economy as a whole.

The question is whether these effects become material when more significant changes occur.

[20] Brian Fallow. "Can't See Wood for Trees" NZ Herald Thursday February 14 2008

[21] Although existing labour shortages in the agricultural sector more widely would mitigate this effect.

The extent of the difference in land use change suggested above (Table 3) is in the order of 25,000 hectares in the period 2008-12 (CP1), or approximately 5,000 hectares per annum; 5,000 ha is 0.24% of the total land area currently in dairy (25,000 ha is 1.2%).[22] Assuming that employment is proportional to area, deforestation in favour of dairy farming would result in an increase of 247 people in dairy farming,[23] and there may be additional increases in employment in dairy product manufacturing.[24] However, this is not the size of the net increase in national employment as there will be a decrease in forestry labour use that offsets these, at least to some extent.

These effects are small in the context of the economy as a whole. It is extremely unlikely that a 25,000 ha change in land use will have any long run effect on total levels of employment in the economy, or on the other macro-economic indicators of interest.

The effects beyond the land use values appear insignificant for the analysis and we have ignored them.

One dynamic effect that might be more significant is the potential reputational risk to New Zealand of introducing the deforestation liability to existing landowners in a way that significantly reduces asset values. The concern is that this action by the government might have flow-on effects to other sectors if there is a perceived risk that similar actions might be taken elsewhere in the economy. If this is perceived to be a systematic increase in risk to investments in New Zealand it might result in an increase in the cost of capital for investment projects.

Set against this argument is the suggestion that the New Zealand government is behaving consistently with the way it responds in other markets, eg through not providing protection to firms and the removal of subsidies. Risk is reduced when the government acts predictably. Such consistency does not reduce all risk, and specifically does not protect firms from unexpected risk.

We are unable to quantify the systematic effect on investment risk but note its potential; it provides some justification for compensation of affected landowners.

3.4.3. The Counterfactual

For analysis of options, it is essential to have a counter-factual. This is a statement of what would happen in the absence of intervention. In some ways the choice is arbitrary, as all the options will be analysed relative to this one point, and the rank order should still be the same.

For analysis we have assumed a counter-factual, our base case, in which New Zealand is in the Kyoto Protocol but does not pass any obligations on to landowners or foresters. It means that forestry activity carries on as it would with no Kyoto Protocol and the relative

[22] The area in dairy farming was estimated as 2.1 million ha at June 2005. Statistics NZ Agricultural Production Survey 2005

[23] 20,880 people employed in dairy cattle farming in 2007. NZ Stats.

[24] Currently 10,090 employed. NZ Stats

economics of forestry and agriculture determine the extent of land use change. And the extent of land use change determines the costs that New Zealand faces for having to purchase additional Kyoto Units.

3.5. The Base Case

The base case, as noted above, assumes that

- The Kyoto Protocol is in place;
- The government retains the liability and does not pass any obligations on to landowners;
- Land use changes at the same rate as it would in the absence of any climate change policy, ie is determined purely by the relative economics of different land uses, ignoring emission costs.

There are two decisions involved in changing land use: whether to change and when to change.

The decision on whether to change is based on the long term comparison of returns under forestry versus agriculture (or other land use), and this is reflected in the value of land in these different uses. It also needs to take account of the cost of switching, which will include the land clearance costs plus any other set up costs associated with the alternative use. Switching is worthwhile if:

$$V_{AU} > V_F + C_S \quad (1)$$

Where: V_{AU} = Value in an alternative use
V_F = Value in forestry
C_S = Costs of switching

The data for this decision was discussed above (Section 3.3.1).

The decision on when to change depends on the annual rate of return on investment in forestry versus the alternative land use. As explained above, there is an optimal time to harvest timber when the annual growth rate slows to less than the cost of capital. This is brought forward in time if the annual financial return ($/ha) is greater in some other land use than the annual increment available from continued forest growth.

The costs under the base case arise because equation (1) above does not take account of the costs of emission units arising from deforestation. Whenever land use changes there is a requirement for New Zealand to purchase (or not sell) sufficient emission (Kyoto) units to cover the estimated emissions. This cost accrues to the government and is a real resource cost to the nation. It will need to be covered through additional taxation, costs applying to other sectors (eg that otherwise would have been given emission units) or reduced government expenditure.

Assuming that land use change occurs in the base case when it is economically rational to change land use, the costs to the nation are the sum of:

$C_{KU} - S_{LUC}$

Where: C_{KU} = costs of Kyoto Units
S_{LUC} = surplus from land use change which is estimated as:
$S_{LUC} = V_{AU} - V_F + C_S$

There are three components required to estimate these costs:

- The relative value of the different land uses
- The area that is likely to switch
- The costs of Kyoto Units

These factors are somewhat inter-related.

Initially we estimate the number of hectares that might switch on the basis of the deforestation intentions survey. The results are shown in Table 3 on page 11. It suggests, based on the current perceptions of the costs of switching, that 37,000 hectares would switch land use in the first commitment period (CP1). The 37,000 hectare estimate is highly uncertain, as it is based on the aggregation of stated preferences which might be biased by perceived incentives for over- or under-estimation and by uncertainties over future prices of inputs or outputs. This results in turn in uncertainties in the estimates of the total costs and benefits of the different options. However, it does not affect the relative ranking of the different options.

The alternative land uses to which forestry land would switch following deforestation were also identified in the survey of intentions (Table 7), although the results do not include the estimates of what would happen in the absence of any ETS. The table shows the estimated switch in land use from forestry under the ETS compared with an amended ETS with reduced liabilities on land owners; the figures are for the period 2008-20.

Table 7 Land use to which deforested area would be converted (2008-20)

	ETS Area (ha)	%	Amended ETS Area (ha)	%
Dairy	2,700	24	29,600	63
Sheep & beef	4,900	45	13,600	29
Lifestyle	3,100	28	3,300	7
Grapes	300	3	500	1
Total	11,000	100	47,000	100

Source: Manley B (2008) 2007 Deforestation Survey Final Report. University of Canterbury

The amended ETS is unspecified in detail but is expected to include a lower cost of deforestation for landowners. Compared to the "amended ETS", the ETS is expected to result in a 91% reduction in the area going to dairy and a 64% reduction in the area going to sheep and beef. There is a much lower reduction in the land going to lifestyle units or grapes. These estimates appear to conflict with the analysis of alternative land uses by Smith and Horgan (see Section 3.3.1) which suggests that it is more likely that switching to

dairy farming is retained as an option than switching to sheep and beef. However, the outcome is also determined critically by the size of land holdings. A large proportion of land that would go to sheep and beef farming is in holdings of less than 50ha and is therefore exempt from the ETS liability.

3.6. ETS

Under the ETS, the full Kyoto obligations are passed on to landowners, with the exception of exempted areas or post-1989 forest areas not voluntarily entering the ETS. The landowner faces the costs of deforestation as depicted in Figure 7. Few land owners will choose to deforest. Table 3 above suggests that close to a third of those originally intending to deforest would do so under the ETS, ie approximately 12,000 hectares.

It is likely that the land use changes that will be displaced by the ETS will be the lower value changes. In that sense, it does not matter that we do not know the actual land use change (Table 7); we just need to make assumptions about the lost value of the avoided change. For simplicity, we assume a uniform (average) loss of value of $8,000/hectare (see Section 3.3.1).

We undertake the analysis initially from the perspective of the nation. We compare the case of the ETS with the base case. The main impact will be the land which is now not converted to alternative land uses. For analysis the:

- Costs are the reduced value of the land use
- Benefits are the reduced requirements for purchase of Kyoto Units to cover deforestation emissions.

We estimate these in turn below.

3.6.1. Reduced Value of Land Use

The cost to the nation of the ETS is that we now continue forestry on land that, without an emissions cost, would be better used for another purpose. However, the cost may not be the whole value of the land; the ETS is fixed only for CP1 and thereafter could be changed. Thus the lost value may be simply for the five years of CP1.

To take account of this we examine the options as noted in 3.4.1 above, ie

1. Continuation of the CP1 rules;
2. Treating planting another area in the same way as replanting;
3. Forestry removed from the international agreement

The costs may differ also depending on whether the land not deforested is not felled or is felled and then replanted. Figure 6 above suggests that a landowner that has replanted will still have an incentive to deforest, regardless of the fact that it has trees in a strong growth period.

Under Option 1, the cost of the ETS system is the ongoing loss of land value; land being retained in forestry when it would be better suited to some other purpose. The cost is the difference in land value.[25]

Under Option 2, the costs of the ETS are five years of less than optimal land use. We assume that, under this option, if the forest owner replants another area it is relieved of all obligations relating to is current forest land, regardless of whether it harvested and replanted in CP1 or retained its forest.

Under Option 3 the costs are the same as Option 2.

The results are summarised in Table 8. The analysis assumes a discount rate of 10% and a difference in land value of $8,000/ha (dairy over forestry). It assumes that 25,000 hectares of deforestation no longer occurs. Under options 2 and 3, we annualise the $8,000 over 30 years and then take a present value over a five year period.

This is a simplification of the cost analysis as the value used for forestry is based on the value of bare land suitable for forestry. The value of forest land will be different at different ages of the forest(s) (Figure 6). Table 8 shows a different opportunity cost of avoided deforestation, depending on the assumption over the CP2 regime.

Table 8 Costs of the ETS - Land Use Opportunity Costs

Option	Cost ($/ha)	Total Cost ($ million)
1	-$8,000	$200
2	-$3,222	$81
3	-$3,222	$81

3.6.2. Benefits

The benefits are estimated from the area of land on which deforestation is avoided, times the emission liability. We take the area avoided initially from the deforestation intention survey. This was based on landowners' estimates of the price of allowances in CP1 and this ranged from $12-25/t.

Current estimates of prices in CP1 cover a wider range, ie NZ$15-50/t with a mid-estimate of approximately $30/t. We make a number of assumptions on the benefits building on the estimates in the deforestation intention survey, despite its considerable limitations. In the analysis, the key outcome is the relative, rather than the absolute levels of deforestation.

It is assumed that the initial estimates (12,000 hectares) were based on an emissions price in the order of $15/tonne and that, at higher unit prices, more deforestation would be avoided. However, there are limits to avoided deforestation because of the exemption of land area of

[25] Note, in saying this we have treated the land use economics equation as though the economics were determined in the absence of any price on emissions. It would be equally valid to include emission (NZU) costs as an integral cost of land use change. Rather than having a cost to weigh up against a benefit, there is simply a net benefit of an avoided detrimental land use change, ie the ETS has prevented change from forestry to agriculture which would have been a poor land use decision.

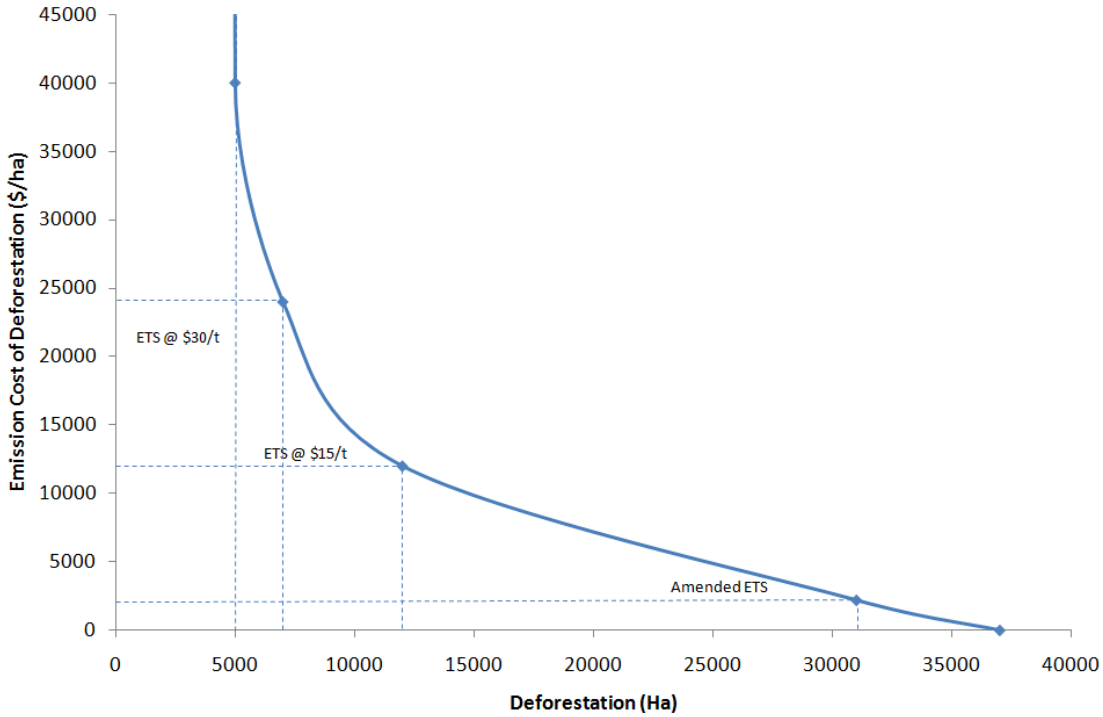
less than 50ha. We assume that the estimated quantity of deforestation under the ETS (12,000 ha) is above the minimum, which we assume to be 5,000 ha. This level of deforestation would occur under any emissions price. The assumptions and their impacts are shown in (Table 9). The effective demand curve for deforestation based on these assumptions and the deforestation survey is shown in Figure 9.

Table 9 Benefits of ETS impacts on Deforestation

Unit price	Deforestation (ha)	Deforestation avoided (ha)	Benefit ($M)	Land use opportunity costs ($M)	Net Benefit ($M)
$15/t	12,000	25,000	300	$81 – 200	$100 – 219
$30/t	7,000	30,000	720	$97 – 240	$480 – 623
$50/t	5,000	32,000	1,280	$103 – 256	$1,024 – 1,177

The net benefits depend on the estimated future international policy regime, but we estimate the net benefits of the ETS to the nation, over an approach that has no domestic climate change policy applied to forestry, as in the order of $480 to $623 million at an emissions price of $30/tonne.

Figure 9 Estimated Demand Curve for Deforestation



3.6.3. Cost to the landowners

The costs to the landowners that do not deforest are the costs as shown in Table 8 above. In addition, to those that do deforest, the cost is the requirement to surrender NZUs at a cost in the order of $20,000/ha. It is assumed that those who do deforest only do so when the

benefits to them exceed this cost, ie that they still earn a surplus from deforestation. For the estimated 12,000 hectares of deforestation, this totals $240 million.

3.7. PF Olsen

The analysis of this option is presumed to apply also to the Flexible Land Use Alliance (FLUA).

The main impact of the PFOlsen proposal, relative to the ETS, is to increase the amount of deforestation that occurs. However, the actual impact is unclear. The PFOlsen proposal suggests that deforestation is constrained by two factors: the requirement to offset elsewhere and the need to surrender deforestation units. We explore the likely costs of these below.

3.7.1. Offset Requirement

The offset requirement is that land elsewhere is planted when deforestation occurs and that the government: (1) takes on the liability for the emission unit requirement associated with deforestation and (2) retains ownership of the resulting emission units created from absorption . The net cost of this is highly uncertain. The economics of afforestation on the alternative land area changes when it is used for offsetting purposes, because the owner gives up the right to the emission units that result from sequestration.

Currently owners of post-1989 forests can choose whether to opt in to receive emission units. If they opt in, they are subsequently faced with the liability for surrendering allowances when the forest is felled. Amongst those that intend to harvest the trees later many would choose not to opt in, because the value of the emission units earned is matched by the later liability to surrender emission units. Whether one is greater than the other depends on what happens to the price of emission units in the interim and whether this is greater or less than the cost of capital of the forest owner, but in simple terms, those that opt in are more likely to be landowners that intend not to deforest.

Given that the PFOlsen proposal has a liability on later felling, the cost of the offset requirement is most easily estimated as the value of the emission units. What is given up is the discounted sum of the value of future earnings from the sale of emission units. If we assume that emission units start at $30/tonne and stay the same price in real terms (increase with inflation), the discounted value to maturity (800 tonnes of CO_2) at a 10% discount rate is approximately $4,000; this drops to $2,000 at a price of $15/tonne and rises to close to $9,000 if e assume the price increases from $30/tonne at 5% per annum (in real terms). These are significant costs and will deter some shifts in land use. But they are not as large as the cost of the surrender of emission units required under the ETS. Thus there will be some deforestation and it is expected to be more than occurs under the ETS.

3.7.2. NZ Deforestation Units

NZ Deforestation Units (NZDUs) would be made available equal in number to the deforestation intentions of landowners as revealed in an updated survey. There are a number of issues here.

- If NZDUs are made available at a level equal to deforestation demand at no cost of emissions (37,000 ha), this will be greater than demand at a small positive cost (the cost of the offset requirement). And if supply exceeds demand, it is expected that costs will be low (close to or equal to zero).

- There is little incentive in a survey to provide accurate estimates of deforestation intentions. Indeed, given the use that will be made of the results, the incentive is likely to be to inflate estimates of deforestation intentions.

The expectation is that the number of units will be less than the full 37,000 ha requirement but that the price of NZDUs will be low.

3.7.3. Estimates of Deforestation

Peter Clark's estimate is that the deforestation level might be quite low, in the order of 10-12,000 ha.[26] However, this is the same as the maximum estimated level of deforestation under the ETS above, and would imply that deforestation is inelastic to the price of emission units; if this were so there would be little economic benefit from passing the emission unit costs on. However, we do not believe this to be the case, ie the emission unit costs make a substantial difference to the economics of deforestation and have a direct impact on levels of deforestation as suggested by the results of the survey of a wide range of forest industry participants. More significantly, in comments on a draft version of this paper, Peter Clark suggested that levels of deforestation under the current proposed ETS would be expected to be very low, and significantly less than the 12,000 ha assumed. This raises questions over the absolute values in the analysis but not the rank ordering, ie the extent to which a policy leads to greater levels of deforestation than is optimal, based on a comparison of national costs and benefits, there is a cost to the nation. Importantly, however, the level of this net cost is of interest also; the eventual policy dilemma is to balance efficiency and equity concerns. If equity concerns can be allayed at a low total cost then this is a significant result. At this stage we note only that there is considerable uncertainty regarding these expected levels of deforestation.

The deforestation survey results suggest a higher amount, ie 31,000 hectares of deforestation occurs under an amended ETS in which the requirement on land owners is reduced but there is still some cost.

We use a range of values to understand the potential impacts.

3.7.4. Analysis of Costs and Benefits

Using the same approach as above, the results in terms of costs of the policy are expressed below. We take a base assumption of an avoided deforestation of 6,000 hectares, ie 31,000 hectares will be deforested in CP1 as suggested in the deforestation intentions survey for an amended ETS. As an alternative we take Peter Clark's upper bound (12,000 hectares of deforestation and thus 25,000 hectares of avoided deforestation), with an intermediate position also (15,000 hectares avoided). The results are shown in Table 10.

[26] Clark PD (2008) Pre-1990 Forests and the ETS – a Solution? Ver 3 23rd January 2008

Table 10 Benefits of PFOlsen Proposal impacts on Deforestation

Unit price	Deforestation avoided (ha)	Benefit ($M)	Land use opportunity costs ($M)	Net Benefit ($M)
$15/t	15,000	$180	$48 – 120	$60-132
$30/t	6,000	$144	$19 – 48	$96 – 125
	15,000	$360	$48 – 120	$240 – 312
	25,000	$600	$81 – 200	$400 – 519
$50/t	15,000	$600	$48 – 120	$480-522

There are positive net benefits compared to our base case, but the level of the net benefits is less than under the ETS.

3.8. Ngai Tahu Option 1

Ngai Tahu's Option 1 proposal limits the rate of deforestation through selling a limited number of deforestation units: 21 million tonnes in CP1; this is estimated to be equivalent to 5-6,000 ha per annum or 25-30,000 hectares over CP1. This level of deforestation determines the net costs and benefits of the proposal.

For analysis we assume a mid-point of 27,500 hectares of deforestation, ie an avoided level of deforestation of approximately 10,000 hectares. The results are shown in Table 11

Table 11 Benefits of Ngai Tahu Option 1 Proposal impacts on Deforestation

Unit price	Deforestation avoided (ha)	Benefit ($M)	Land use opportunity costs ($M)	Net Benefit ($M)
$15/t	10,000	$120	$32 – 80	$40 – 88
$30/t	10,000	$240	$32 – 80	$160 – 208
$50/t	10,000	$400	$32 – 80	$320 – 368

The proposal differs from the PFOlsen proposal through the quantitative restrictions that it introduces on deforestation in addition to a price disincentive. We estimate that it may lead to a higher level of deforestation.

The Ngai Tahu proposal also includes a reward for afforestation alongside the requirements for deforestation. This is not the primary interest of this analysis, or it is only to the extent that it has feedback effects on levels of deforestation. Such effects do not seem significant. However, we note that the effect of the proposal as a whole is a reduced incentive for afforestation.

3.9. Ngai Tahu Option 2

Ngai Tahu's Option 2 proposal limits the rate of deforestation through selling a limited number of deforestation units. The limits are the same as in Option 1. This dominates the analysis of impacts and means that the net benefits of this option are the same as estimated for Option 1.

3.10. Comparison of Options

The different options are compared in Table 12. The values are based on a number of assumptions and, critically, on the survey estimates of deforestation intentions under different policy scenarios. While this means that the absolute level of the results is thus subject to considerable uncertainty, it does not change the rank ordering of the proposals.

Table 12 Net Benefits (Costs) of Policy Options

Unit price	ETS	PF Olsen/FLUA	Ngai Tahu 1	Ngai Tahu 2
		Relative to Base Case		
$15/t	$100 – 219	$60 – 132	$40 – 88	$40 – 88
$30/t	$480 – 623	$240 – 312	$160 – 208	$160 – 208
$50/t	$1,184 – 1,361	$480 – 522	$320 – 368	$320 – 368
		Relative to ETS		
$15/t	-	- $40 – 87	- $60 – 132	- $60 – 132
$30/t	-	- $240 -311	- $320 – 416	- $320 – 416
$50/t	-	- $832 - 956	- $704 - 809	- $704 - 809

Another assumption is that of the value of the alternative land use to which land might shirt. This again affects the overall level of the results but not the ranking; the ranking of options is always proportional to the quantity of land deforested. The closer to the optimal level of deforestation, the lower are the costs (higher the net benefits).

4. Conclusions

4.1. Comparison of Net Benefits

The analysis of the different options from a national cost benefit perspective suggest that the emissions trading system (ETS) as currently specified has greater net benefits than the other options. This result occurs because the ETS ensures that deforestation occurs only when the net benefits are greater than the costs of the emission units that need to be surrendered as a result of the deforestation. Surrendering emission units is a real cost to the nation that the other proposals do not pass on to landowners. The other options result in a greater level of deforestation, and the additional area deforested has higher costs than benefits.

This result is unsurprising. The other options had an objective of passing a lower level of cost on to forest owners.

The level of national cost is not directly related to the costs charged to forest owners; it is a result of the quantity of deforestation. If the alternative proposals could produce the same amount of deforestation, on the same land as the ETS, the net national benefit (or cost) would be the same as the ETS.

In Figure 9 above we provided an estimated demand curve for deforestation. The quantity of deforestation is determined by the price of emission units. If an alternative mechanism was introduced that required deforesters to hold or surrender deforestation units, and if the number on the market were the same as the estimated level of deforestation under the ETS, the price of these deforestation units would be expected to be the same (on a hectare equivalent basis) as emission units.

The costs to the landowners are opportunity costs. And a different policy that resulted in the same amount of deforestation would be equally costly to landowners because it would be restricting their land use choice to the same degree. There is thus an obvious and irreconcilable trade-off:

- The landowners' costs are only reduced by increasing land use flexibility, and allowing more deforestation.

- The nation's costs are minimised when deforestation is restricted to that area for which the net benefits of switching are greater than the emission unit costs.

It is this trade-off that leads to the ETS approach of passing on the full cost so that the national benefit is greatest but designing a compensation package to offset landowner costs.

4.2. Longer Term Context

The short term result needs to be placed in the longer term context. Specifically, some of the proposals have been produced in the expectation that the government is seeking to

negotiate a different set of rules for forestry in the future. The Flexible Land Use Alliance suggests that:

> "it makes no sense to introduce environmentally and economically destructive policies in New Zealand based on perverse wording in the Kyoto Protocol that the New Zealand Government itself is working hard to change. Nor does it make sense to introduce one set of domestic rules for the First Commitment Period of the Kyoto Protocol, knowing that those rules will need to be changed when the Bali negotiations deliver refined international rules for the Second Commitment Period."[27]

This raises serious points that are echoed in the other proposals. But the downside risks it suggests depend crucially on the land use decisions being irreversible. In contrast it appears that the impact could simply be a five year delay in deforestation and land use change. This is undoubtedly a cost, our estimate is approximately $3,000/ha where the difference in land value is $8,000/ha; on many sites the costs will be substantially less than this. This contrasts with a national cost that might be in the order of $20,000/ha.

If the rules governing forestry are going to change in the future, the most beneficial thing to do now is to delay deforestation until that occurs, and not to press on with deforestation as though there are no current rules.

4.3. Are the Compensation Mechanisms Appropriate and Adequate?

The ETS has introduced new costs for owners of pre-1990 forests that did not exist before. This reduces the value of land that is in pre-1990 forest. The current proposal is to provide compensation through the allocation of free emission units. However, the allocation is not directed at those most likely to be affected. Rather, emission units are spread across all owners of pre-1990 forests.

Those that face costs as a result of the introduction of the ETS include:

- those that do deforest and thus face the cost of emission units; and
- those that do not but would have done without the ETS. They face an opportunity cost of not using their land for a different, higher value use.

If there is a desire to compensate, then the ideal approach is to provide lump sum compensation to those that are most likely to face costs, and for the level of compensation to any individual landowner to be independent of the decision to deforest. This ensures that it does not reduce the effective emission price faced by landowners.

The difficulty faced by the government is to identify these participants. It is easy to identify deforesters, after they have deforested. But ex-post compensation of those that do deforest (and presuming that they know compensation is coming) is equivalent to these landowners not facing the full price of emissions—rates of deforestation would rise and the nation

[27] www.flexiblelandusealliance.org.nz/proposals.html

would face higher net costs. The compensation needs to be lump-sum and this is what the proposed regime seeks to achieve.

The problem is, it is poorly targeted. But the targeting problem is not easily resolved. The only way to be sure of providing adequate compensation is to increase total compensation levels. However, in the absence of a clear way to target compensation, this would need to be spread widely thus increasing total costs to the government substantially.

The government is left with a difficult policy choice:

- its current approach, which is an economically efficient outcome but one that results in high costs being passed on to land owners that cannot easily be compensated, or not without high costs; or

- a less efficient outcome that passes lower costs on to landowners but results in increased deforestation and greater national costs.

However, the decision required is not once for all time. The costs for land owners of the current approach are limited to the delay in deforestation for the first commitment period through to 2012. During this time the international rules for subsequent commitment periods will become clearer and a more lasting decision taken about the treatment of liabilities for pre-1990 forests.