Carbon economics of natural regeneration at scale

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Abstract

Natural regeneration on eligible post-1989 land is a carbon project where nature establishes the forest for free. Converting marginal farmland to natural regeneration and registering this free gift from nature in the New Zealand Emissions Trading Scheme (NZETS) would be an ideal way to finance carbon sequestration. This could deliver on our Paris Agreement target alongside considerable biodiversity and sustainable land management co-benefits. Similarly, managing natural regeneration on existing pre-1990 indigenous scrub and forest land induces additional carbon sequestration that (in theory) could also be traded in a voluntary carbon market and contribute to our national climate change mitigation goals.

This paper presents a practitioner perspective on these two aspects of natural regeneration for carbon management, with a particular emphasis on operating at a scale that has a meaningful impact on national carbon sequestration goals.

A discounted cash flow (DCF) analysis was undertaken for four approaches to forest carbon sequestration projects commencing in 2024, at a scale of 100,000 ha:

Scenario 1: Natural regeneration on eligible post-1989 land (a 'shut the gate' approach).

Scenario 2: Indigenous afforestation planted at 2,000 stems/ha.

Scenario 3: Exotic afforestation transitioned to indigenous forest over a 60-year period.

Scenario 4: A combination of exotic afforestation transitioning to indigenous forest (70,000 ha) plus indigenous afforestation at 2,000 stems/ha (30,000 ha).

Results showed that (under Scenario 1) natural regeneration starting in 2024 would contribute zero carbon sequestration towards the 2030 Paris Agreement target, cost $650 million in investment (assuming no land purchase costs) and not be financially viable (i.e. unlikely to gain access to investment capital and not be financially self-sustaining). Indigenous afforestation planting 2,000 stems/ha (Scenario 2) would deliver approximately 800,000 carbon credits towards the Paris Agreement target, require $1.5 billion in investment and also not be financially viable. In contrast, a project that used exotic afforestation (Scenarios 3 and 4) would deliver between 2.77 million and 3.5 million tCO_2e by 2030 (respectively), is financially viable, and could therefore be delivered at no cost to the taxpayer.

Pre-1990 indigenous forest regeneration was also examined using an additionality lens consistent with international forest carbon standards. 'Additionality' is a measure of whether a project is delivering carbon benefits to the atmosphere that resulted from human intervention that is additional to: (a) what nature would do anyway; and b) what humans would do anyway. Pre-1990 natural regeneration is not additional unless there is a change in forest management (project scenario) that causes a measurable change in carbon benefits compared with business-as-usual (baseline scenario). This can be delivered through avoided logging of commercially viable timber volumes (via land-use change from productive to permanently protected forest) and/or enhancing carbon sequestration through (for example) enrichment planting.

Introduction

National and global climate change mitigation requires a change from the current situation where greenhouse gas (GHG) emissions from sources are running at a higher rate than GHG removals by sinks. The shift of this dynamic ratio to avoid dangerous climate change requires a significant reduction of emissions from sources (beyond what is currently occurring) combined with a significant increase of emission removals by sinks.

Forests are one form of carbon sink and the lowest hanging fruit in the carbon sink world. Forest carbon stock change is relatively easy to measure, and interventions that cause this change are relatively easy to attribute to a causal agent (e.g. someone planted the forest on non-forest land).

For this reason, the first phase of global carbon sink management has been dominated by forest carbon sequestration. Subsequent phases of global and domestic carbon sink management will likely have a greater emphasis on non-forest systems, including soils, wetlands, saltmarsh and grasslands. But forests are also likely to remain a key component in climate change mitigation due to the technical and logistical suitability of forests to function as carbon sinks and reservoirs.

The Climate Change Commission (CCC) has made recommendations for carbon emissions reduction and carbon sequestration targets to enable Aotearoa New Zealand to meet its Paris Agreement obligations. The emission reductions and removals required between 2021 and 2035 are listed in Table 1.

Table 1: Climate Change Commission emissions reductions and removals targets for the period 2021–2035. Source: 2021 Draft Advice Scenarios Dataset (CCC, 2021)

Emissions sector	GHG reductions 2021–2035
Transport	−43%
Buildings	−33%
Heat, industry & power	−49%
Agriculture	−14%
Waste & hydrofluorocarbons	−26%
Forestry	+135%

These sector targets include the assumption of the Government purchasing ~100 million tCO_2e of climate change mitigation from offshore. If the nation fails on any of these targets, we will need to either buy additional offshore mitigation, or plant more forests (or both).

As such, GHG removals by forests plays a central role in meeting national emissions targets. Since 2022, there has been considerable controversy over the policy settings for carbon sequestration in the forest sector. Of particular interest to the public debate is the relative roles of exotic and indigenous forestry, with special reference to the permanent forest category of the New Zealand Emissions Trading Scheme (NZETS).

The Government asserted a desire for a much greater role for indigenous forests in its public announcements during 2022. This included a proposal to exclude exotic forests from the NZETS permanent forest category (MPI, 2022). The Government backtracked on this proposal (Radio NZ, 29 July 2022), but then set in motion consultation with relevant stakeholder groups to establish rules for the use of exotic species in the permanent forest category.

At the core of this policy debate are the economic realities of indigenous carbon forestry and the impact this reality will have on the effectiveness of policy settings. Practitioners in the NZETS have asserted that the high cost of indigenous forest establishment, the slow-carbon sequestration rates of indigenous forest and price sensitivity among carbon buyers means that carbon-financed afforestation using solely indigenous species is often not financially viable (Weaver, 2021, 2022; Weaver et al., 2022). Situations where indigenous afforestation can be financially viable include:

- Natural regeneration (where nature planted the forest without charge)
- Transitioning exotic forests to indigenous forests (through active management)
- When indigenous afforestation projects are financed jointly with exotic afforestation projects as part of an indigenous and exotic investment portfolio (Weaver, 2022, op. cit.).

Because natural regeneration has very low forest establishment costs, it is plausible to consider that this approach to afforestation could play an important role in meeting national sequestration targets while: (a) reducing reliance on exotic forests; and (b) substantially contributing to biodiversity conservation. This includes project activity types undertaken inside the carbon accounting boundary of the NZETS (post-1989 forestry) and outside the NZETS (pre-1990 forestry).

This study has two parts:

1. Financial viability analysis for post-1989 natural regeneration at scale.
2. Additionality analysis for pre-1990 natural regeneration.

Post-1989 natural regeneration at scale

A discounted cash flow (DCF) analysis of carbon-financed natural regeneration at scale has been undertaken to test the ability of this approach to contribute to national climate change mitigation targets. It does so by comparing four project scenarios undertaken at the scale of 100,000 ha.

Scenario 1: Natural regeneration on eligible post-1989 land (a 'shut the gate' approach).

Scenario 2: Indigenous afforestation planted at 2,000 stems/ha.

Scenario 3: Exotic afforestation transitioned to an indigenous forest over a 60-year period through strip/patch harvest and replanting. This scenario delivers 100% indigenous forest by year 60 with harvest and replanting interventions starting in year 15.

Scenario 4: A combination of exotic afforestation transitioning to an indigenous forest in the manner of Scenario 3 (70,000 ha) plus indigenous afforestation at 2,000 stems/ha (30,000 ha). A 70:30 ratio of exotic forest to indigenous forest was the highest ratio of indigenous afforestation possible while delivering a financially viable project venture at the carbon prices modelled.

This analysis uses 100,000 ha as a benchmark to provide an indication of the extent to which natural regeneration can be used to meet the potential identified by the CCC (e.g. 740,000 ha of marginal land that could revert to native forest) (CCC, 2022).

The regeneration scenario modelled the termination of grazing at the initiation of the project intervention and then letting natural regeneration take place thereafter. This scenario assumed that it would take 12 years for the pasture to be populated. It also assumed sufficient native tree species to meet the forest definition in the NZETS, and during those 12 years the landowner would need to receive a land rental payment (modelled at $150/ha/yr being the same rate used in financial scenario modelling by local government entities that the author works with) to compensate for the loss of pastoral revenue from the land in question.

It is assumed that such land rental payment is not required for years when the project is issuing carbon credits and receiving carbon revenue. In reality, the time it would take for closed pasture to eventually meet the forest definition of the NZETS would vary, depending on factors such as rainfall, aspect and proximity to seed sources.

Another approach that could be tested is natural regeneration where the regeneration started in the past where the native forest is already present now having established (e.g. 12 years ago). The problem with this approach is that although it is undertaken routinely in the NZETS now, it does not occur at the scale under consideration. To come close to achieving the scale envisioned by the CCC (i.e. hundreds of thousands of hectares), new natural regeneration on land that is currently non-forest land will be required.

Methodology

A DCF analysis was employed to generate key financial indicators, including investment required, internal rate of return (IRR) and net present value (NPV). The analysis is designed to shed light on the scale of investment required, risk and expected return. These are key financial attributes to consider when attempting to secure investment funding and before considering the non-financial costs and benefits accruing to the investor or society.

Key assumptions and inputs used:

1. Cashflows are unleveraged (no debt), before-tax and real (no inflation)
2. Project is undertaken by a landowner on their own land
3. Project development starting year (e.g. recruiting land) – 2023
4. Project intervention start year (e.g. shut the gate and/or plant forest) – 2024
5. Starting carbon price in 2024 – $90 – aligned to the mid-range of the Treasury shadow carbon prices (The Treasury, 2021)
6. Annual average real carbon price increment (three scenarios) = CP1 $1.50; CP2 $4.75; CP3 $8
7. Fencing/tracking costs = $0
8. Average native seedling price = $2 each
9. Average exotic seedling price = $0.50 each
10. Indigenous forest carbon sequestration rate = 80% of the Ministry for Primary Industries (MPI) Lookup Tables, to realistically align with field measurement results from forest carbon projects. Some have argued that carbon sequestration rates in natural forest are higher than the MPI Lookup Tables. This is not supported by the experience of forest carbon projects in practice, which typically deliver carbon sequestration rates considerably lower than the MPI Lookup Tables. The latter experience aligns with the national average carbon sequestration rate for indigenous forest of 3.5–3.7 tCO_2e/ha/yr (Payton, 2007)
11. Exotic forest carbon sequestration = 100% of MPI Lookup Tables for ‘other softwoods’ (to be conservative)
12. Exotic planting density = 1,000 stems/ha
13. Native planting density = 2,000 stems/ha
14. Cashflow period = 25 years
15. No terminal value
16. Discount rate = 6% (the assumed required rate of return for the investor)
17. Carbon accounting method = stock change
18. Exotic management regime = continuous cover forest management transitioning to native forest through harvest and replacement with harvest strips or patches never exceeding NZETS forest definition for any given hectare
19. Forests established over two years when planted (2024 and 2025).

Results

The DCF results are shown numerically in Table 2, and graphically in Figures 1–5 below.

As shown in Table 2, the different carbon price scenarios are material to the financial viability, with increasing returns as the carbon price increases from CP1 to CP3.

Internal rate of return (IRR)

The IRR is an indicator of the financial viability of a project. Different investors will require different rates of return, depending on their investment preferences and the amount of real or perceived financial risk in the project venture. The IRR reflects a discount rate where the NPV of a cashflow equals zero.

Table 2: Discounted cash flow results (red numbers indicate negative numbers)

	IRR CP1	IRR CP2	IRR CP3	Capex	Investment	Investment/ha
Regeneration	−2.3%	0.1%	1.7%	$5,750,000	$650,000,000	$6,500
Native	−1.9%	0.7%	2.5%	$1,262,815,230	$1,500,000,000	$15,000
Exotic transition	8.9%	12.3%	14.8%	$357,880,000	$550,000,000	$5,500
Exotic & native	4.6%	7.7%	9.9%	$628,670,615	$800,000,000	$8,000

	NPV CP1	NPV CP2	NPV CP3		Total credits	Credits by 2030
Regeneration	($512,783,022)	($437,851,757)	($362,289,805)		23,600,000	0
Native	($1,052,439,632)	($837,749,049)	($622,639,680)		25,736,000	796,000
Exotic transition	$208,346,868	$563,742,446	$919,138,024		42,858,300	3,550,000
Exotic & native	($127,534,095)	$187,744,269	$503,022,633		37,848,010	2,775,400

Note: IRR = internal rate of return of the project; NPV = net present value to the investor; Capex = capital expenditure; Total credits = carbon credits delivered across the 50-year cashflow period; Credits by 2030 = carbon credits delivered by 2030; CP1, CP2, CP3 = three different carbon price change scenarios listed in the methodology bullet points

The respective IRR results for the different afforestation scenarios are shown in Figure 1.

Negative and marginally positive IRRs tend to fail to gain access to investment capital due to the low projected returns when considered alongside the financial risk involved (i.e. losses arising from unforeseen events). Higher returns (e.g. those towards the right-hand side of Figure 1) increase the probability of gaining access to investment capital.

Net present value (NPV)

NPV is a more reliable measure of the financial viability of a project as it provides a measure of a project's level of profitability, including 'not-for-profit' ventures that need to break even to be financially viable. It is calculated as the sum of all discounted costs and revenues for a project over the investment period where the discount rate applied is consistent with the investor's required rate of return. In this analysis, the discount rate applied is 6%. Results of the NPV for each afforestation scenario are shown in Figure 2.

The NPVs for natural regeneration and native afforestation (Scenarios 1 and 2) are negative at all carbon price scenarios. In contrast, the exotic transition to indigenous forest (Scenario 3) and the 70% exotic afforestation transitioning to indigenous forest and 30% indigenous afforestation (Scenario 4) both show predominantly positive NPVs, with the exception of Scenario 4 under the lower CP1 carbon price projection. In each scenario the carbon project NPVs can be compared with the NPV of same land receiving a land rental of $150/ha/yr instead of a carbon project.

Investment required

The investment required is the amount of capital needed to fund project establishment and any negative operational cashflows in early years when the project is running at a loss. This is presented in Figure 3 for each scenario.

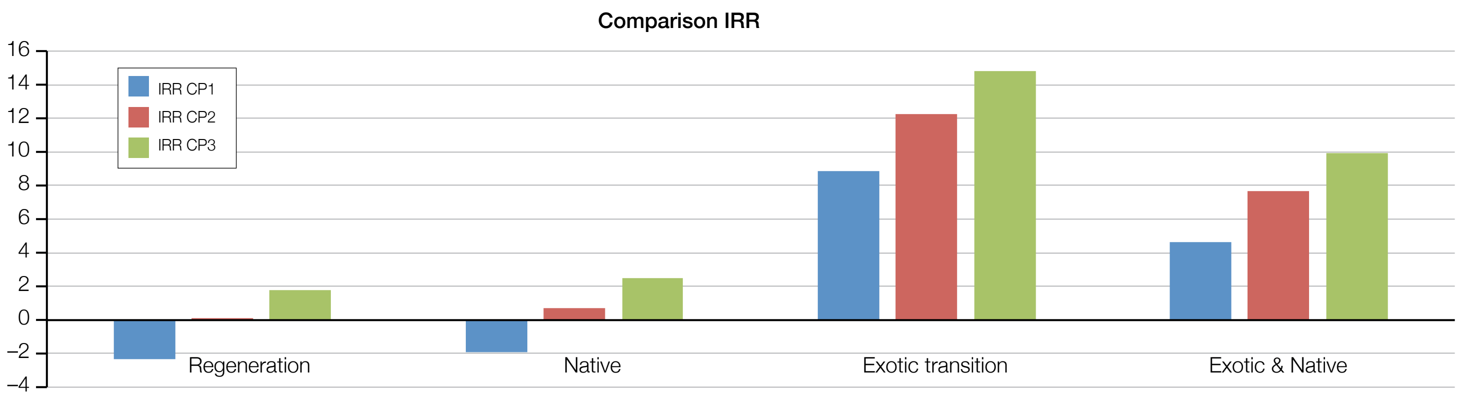

Figure 1: IRR for the four forest establishment scenarios showing the three different carbon price change scenarios (CP1, CP2 and CP3) for a 25-year investment period

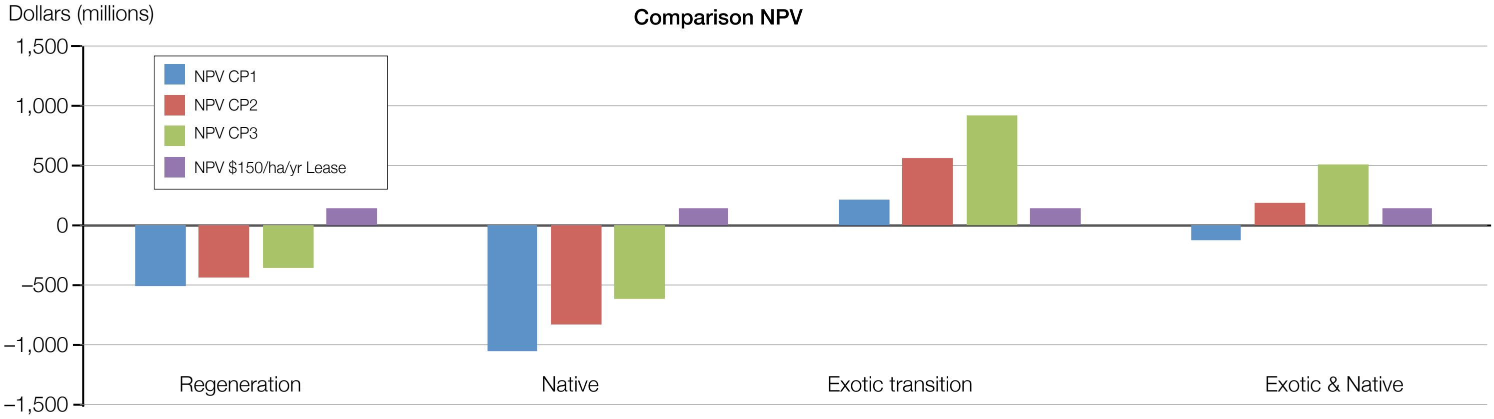

Figure 2: NPV for the four forest establishment scenarios showing the three different carbon price change scenarios (CP1, CP2 and CP3) and for leasing out the same land at $150/ha/yr for the investment period (i.e. instead of a carbon project)

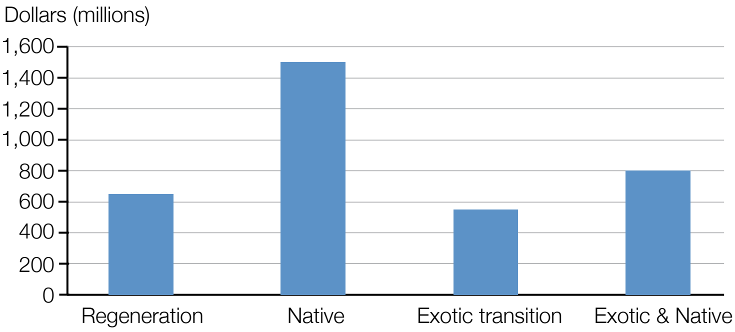

Figure 3: Investment required for the four forest establishment scenarios for a 25-year investment period

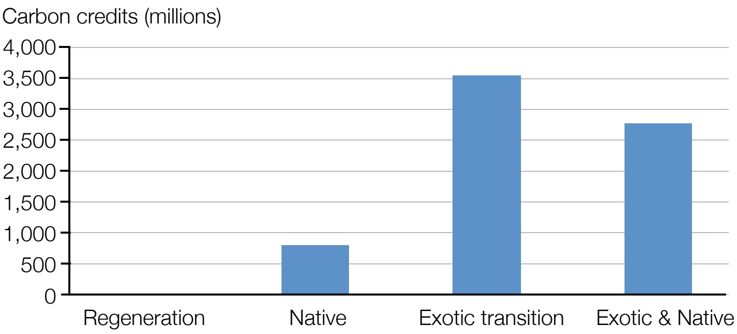

Figure 4: Carbon credits delivered by the four forest establishment scenarios by 2030

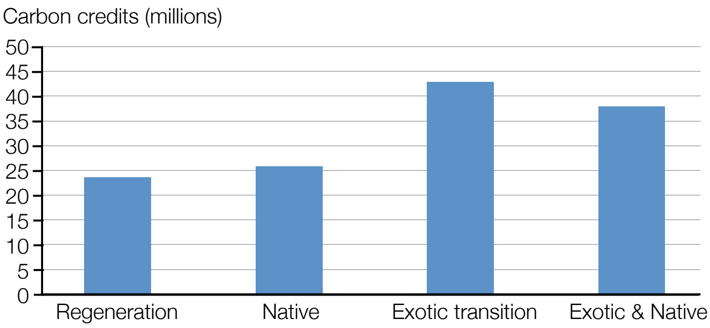

Figure 5: Carbon credits delivered by the four forest establishment scenarios by 2050

Figure 3 shows that Scenario 2 (indigenous afforestation) requires the greatest capital investment at $1.5 billion ($15,000/ha). Scenario 4 (70% exotics/30% indigenous) requires $800 million ($8,000/ha). The lowest capital investment required is for Scenario 3 (exotic afforestation transitioning to indigenous forest) at $550 million ($5,500/ha).

Notable also is the relatively high amount of investment required for Scenario 1 (natural regeneration) ($650 million), which may seem an anomaly because nature did the planting for free. While this is true, this project type also needs to fund the land rental costs of $150/ha/yr for the 12 years when no carbon credits (and no carbon revenue) can be delivered to the landowner (i.e. the period of natural forest establishment). While there may be some landowners willing to forego a land rental payment when no carbon revenue is being received, most rural landowners need to make a living from their land and cannot afford to forgo revenue from such land for 12 or more years while nature gets the forest established.

Also, because of the relatively low volume of carbon credits delivered in the first 25 years, it is difficult for this project type to support debt funding and/or deliver the necessary dividends to the investor in a manner that enhances liquidity (the ability for an investor to exit the project at any time during the project investment period).

Limited initial cashflow revenue is a common attribute of all four scenarios. This extends the period of investment and has the effect of increasing the perceived project risk for both investors and debt funders.

Carbon credits delivered

A key purpose of forest carbon sequestration at scale is to help the nation deliver its Paris Agreement obligations by 2030. Figure 4 shows the volume of carbon credits delivered by each project type by 2030.

As can be seen in Figure 4, Scenario 1 (natural regeneration) delivers zero carbon credits as a contribution to the Paris Agreement by 2030. As such, this option can at best be seen as a component of a long-term carbon management strategy. To this end, carbon credits delivered by 2050 have also been modelled, with results shown in Figure 5.

As shown in Figure 5, indigenous forests can make a significant contribution to carbon credit supply over a longer timeframe, but still deliver less than an exotic forest that transitions to indigenous forest, and a forest including 70% of exotic forest transitioning to native forest and 30% indigenous afforestation.

Analysis and discussion

Trade-offs

Financial analysis provides an opportunity to weigh the merits of different project types in relation to what they also do not allow (trade-offs). Trade-offs come into play when considering the purpose of carbon forestry in the context of a national obligation to the Paris Agreement, an aspiration to be a net-zero carbon nation by 2050 and a climate emergency response. When viewed through a climate change mitigation lens, indigenous forests perform slowly and take opportunities away from other more cost-effective options. This is because those other options cannot be resourced with land or capital that has been used by indigenous afforestation and/or natural regeneration.

Because the volume of carbon credits delivered by natural regeneration is zero by 2030, this afforestation approach cannot help Aotearoa New Zealand deliver on the Paris Agreement target. This means that the $650 million in investment required for 100,000 ha of natural regeneration will deliver a zero return to the 2030 Paris target. If, on the other hand, the same investment was allocated to an exotic forest transitioning to indigenous forest the return to the Paris target will be in the order of 43 million tCO_2e.

Another problem is that natural regeneration at scale is not financially viable. The NPV for this activity type is negative for all three carbon price scenarios, meaning that this project type is unlikely to gain mainstream investment funding. One could remedy this by means of a taxpayer subsidy to lift the returns to private investors. The subsidy required to deliver a positive NPV at carbon price change scenario CP2 (starting at $90 and rising annually on average at $4.75) is $450 million for every 100,000 ha reforested. In contrast, project scenarios (3 and 4) incorporating exotic afforestation would deliver 3.5 million tCO_2e and 2.77 million tCO_2e by 2030, respectively, at no cost to the taxpayer.

With the challenges facing society (COVID-19 recovery, high inflation, a cost-of-living crisis, a supply chain crisis, a human resources crisis in health, education, policing and across the private sector, and a climate change emergency), society needs a cost-effective climate change solution. New Zealand requires an affordable approach that can be delivered at least cost to the taxpayer now and into the future. Least cost now means avoiding taxpayer subsidies for forest establishment. Least cost in the future means reducing the need to buy more offshore carbon credits due to failure to deliver emission reduction and carbon sequestration targets under the Paris Agreement.

Taxpayer and philanthropic funds are not limitless, and if we are to succeed as a nation at avoiding dangerous climate change, we need these finite financial resources to be allocated to an urgent set of 'must-haves' in the form of investment in low-carbon transportation, agriculture, buildings and clean energy. In the meantime, the private sector can fund the carbon sequestration element of the national climate change emergency response using a combination of exotic and indigenous afforestation without the need for taxpayer or philanthropic funding. If well designed, this private sector afforestation contribution will also comprise much-needed climate resilience and adaptation through permanently reforesting erosion-prone landscapes.

Sitting in the background are farmers who do not want the forest sector to multiply its land area needs by a factor of three or four, as required for indigenous regeneration in comparison with blended approaches that employ exotic and indigenous afforestation.

Pre-1990 natural regeneration additionality analysis

Methodology

This analysis examines the definition of 'additionality' in international carbon standards and as applied by the New Zealand Ministry for the Environment (MfE) in the context of natural regeneration in pre-1990 indigenous forests. It then uses these definitions to identify legitimate ways to pass an additionality test in a pre-1990 indigenous forest setting. This analysis is designed to inform public policy in preparation for potential future changes to the Climate Change Response Act 2002 (and NZETS) to include pre-1990 indigenous forests. It also provides a context for evaluating the validity of voluntary carbon market activities in pre-1990 forests.

Additionality analysis

The CCC has indicated that recognition of carbon stock change in pre-1990 forest has the potential to assist in meeting New Zealand's 2030 Paris targets. According to the CCC, accounting for carbon stock change in pre-1990 forests involves estimating additional emissions and removals in pre-1990 forests above or below 'business-as-usual' due to changes in forest management (CCC, 2022, p. 202). This echoes the United Nations Framework Convention on Climate Change (UNFCCC) definition of climate change mitigation, which 'involves human interventions to reduce the emissions of greenhouse gases by sources or enhance their removal from the atmosphere by sinks' (UNFCCC, 2009).

A key principle (MfE, 2022; Verified Carbon Standard, 2022; Gold Standard, 2020) in international carbon markets relating to carbon sequestration is that sequestration eligible to be used to offset GHG emissions must be derived from:

1. A human intervention, and
2. Be additional to what nature would do anyway (e.g. additional to sequestration by natural forests and the oceans), and
3. Be additional to what humans would do anyway (e.g. additional to activities already required by law, regulation or common practice).

In carbon projects there are two main components of additionality:

- Project additionality – the carbon credits issued may only be those arising from the project as a result of human intervention
- Financial additionality – the human intervention in the project would not occur in the absence of revenue derived from the sale of carbon credits. In this way, the purpose of carbon credit sales revenue is to fund an activity that could not happen without that revenue.

Without 'financial additionality' the so-called 'carbon credits' would be a fiction and potentially fraudulent, as they would have happened naturally or did not need carbon revenue to occur. Their use to offset real and additional GHG emissions may give the impression (to a third party) that something beneficial to the atmosphere is occurring when in fact no additional carbon sequestration or removal has been delivered. This would potentially breach the Environmental Claims Guidelines of the Commerce Commission (Commerce Commission, 2020 p. 11):

> *Carbon-offsets are credits for emission reductions gained by projects such as tree planting or energy efficiency. The offsets can be used to cancel out the negative environmental impact of carbon emissions, by achieving lower emissions elsewhere. Businesses might use carbon-offset claims to promote themselves and/or their good or service, or they might allow customers to participate in carbon-offsetting (i.e., by purchasing carbon credits as part of the sales process).*
>
> *Carbon-offset claims should clearly inform consumers about what is being offset and how it is being offset.*

In some indigenous forest management activity types such as habitat enhancement, biodiversity benefits are being delivered that are additional (i.e. the benefits would not occur without money spent on biodiversity conservation activities such as pest and weed control). But for such activity to be traded in a carbon market, as opposed to a biodiversity market or philanthropy, the project must pass the minimum requirements for carbon benefit delivery (i.e. comprise additional carbon benefits). This coalescence of carbon and biodiversity benefits delivered through the same project actions has been recognised by international carbon standards such as the Plan Vivo Standard, the Gold Standard and the Verified Carbon Standard. The biodiversity benefits, however, remain secondary to the carbon benefits required by these standards.

Where an activity type delivers biodiversity benefits, but not carbon benefits, the project would fall outside the ecosystem accounting boundary of the carbon market and outside the scope of a carbon market financing instrument. This by no means suggests that there is anything inferior about biodiversity conservation in comparison with carbon benefits. It simply recognises that the carbon market was designed for carbon outcomes as the core deliverable to be traded.

This potential alignment of biodiversity and community co-benefits with carbon projects has led many actors in the carbon market domestically and internationally to focus carbon project and programme development on delivering a range of non-carbon co-benefits alongside the carbon benefits. Examples include the multitude of nature-based solutions projects already certified to the Plan Vivo Standard and the combination of the Verified Carbon Standard and the Climate, Community and Biodiversity Standard.

When the non-carbon co-benefits of a forest conservation project cannot be accommodated in the carbon project (e.g. because the beneficial carbon stock change is marginal or non-existent), such a project has the opportunity to pursue other (non-carbon) market-based financing instruments and approaches. Such market-based financing instruments and approaches to biodiversity conservation internationally include the:

- Business and Biodiversity Offsets Programme (BBOP, 2016)
- Plan Vivo Biodiversity Standard (in development) (Bohannon, pers. comm)
- Ekos Sustainable Development Units programme developed by the author (World Economic Forum, 2022)
- Sustainable Development Verified Impact Standard (SD VISta) (Verra, 2019)
- Gold Standard for the Global Goals (Gold Standard, 2019)
- DHF Model (Environmental Finance, 2021)
- EcoAustralia credits
- Wallace Trust biodiversity credit methodology (World Economic Forum, op. cit.)
- Biodiversity credit initiatives of ValueNature, Terrasos, Qarlbo Natural Asset Company, the Scottish Wildlife Trust and the Biodiversity Credits Alliance (BCA) – the author is a founding committee member of the BCA.

There is also a range of sustainable financing revenue streams and modalities for biodiversity conservation (Weaver et al., 2022b), including (but not limited to):

Sustainable revenue streams, including:

- Taxes, levies fees and fines
- Results-based payments
- Payment for ecosystem services
- Voluntary surcharges
- Environmental trust funds.

Sustainable financing modalities, including:

- Impact investment
- Blended finance
- Impact bonds
- Pooled funds
- Partnerships for public purpose (PPP)
- Crowdfunding
- Catalytic capital
- Debt-for-Nature Swaps.

Non-additional 'carbon credits', even if they deliver considerable non-carbon co-benefits, make the atmosphere worse off rather than better off for the following reasons:

1. Money spent on these carbon credits could have been spent on genuinely additional carbon benefits to the atmosphere (e.g. investing in emission reductions like installing a solar photovoltaic system, or purchasing legitimate carbon offsets from planting a new permanent forest).
2. The seller and buyer of those carbon offsets has made a carbon-related claim that is fictional (i.e. claimed to have offset their fossil fuel emissions when they have not). This threatens the integrity of the carbon markets and can impede investment flows and consumer demand for carbon market solutions for a low-carbon economy.

Table 3 provides examples of different aligned definitions of additionality by different carbon market standards and integrity initiatives.

The only legitimate way for a carbon credit seller and buyer to maintain integrity in a carbon credit transaction is for the carbon credits used for carbon offsetting to be: (a) certified to an internationally recognised carbon standard (to safeguard additionality); and (b) issued and tracked by an internationally recognised carbon credit registry (to safeguard against double counting).

According to the MfE Interim Guidance for Voluntary Climate Change Mitigation (2022), for voluntary climate change mitigation to be considered credible it must take account of these principles:

- Information on the mitigation must be transparent, clearly stated and publicly available
- Mitigation must be real, measurable and verified by a third party to a reputable, and publicly disclosed, carbon standard (including the NZETS)
- Mitigation must be additional to business-as-usual activity
- Mitigation must not be double used*
- Mitigation must not result in leakage of emissions elsewhere
- Mitigation must be permanent.

In this guidance double use does not refer to mitigation claimed at the organisation and country level. Units representing voluntary climate change mitigation used towards a country's Nationally Determined Contribution should be transparently disclosed in the claim made by the organisation (see Weaver et al., 2022).

At the time of writing MfE had not released its 2023 guidance on the voluntary carbon market.

The MfE Interim Guidance for Voluntary Climate Change Mitigation (2022) lists several types of New Zealand Units (NZUs) that cannot legitimately be used for voluntary carbon offsetting. These are units freely allocated by the Government that were not earned by undertaking specific emissions reduction or removal activities. These units include:

- Emissions-intensive, trade-exposed allocation (NZU_EITE)
- Pre-1990 forestry allocation plan (NZU_FA)
- Fishing allocation (NZU Fishing)
- NZUs sold by auction (NZU_AUC).

Voluntary carbon market

Project types not eligible to register in the NZETS can potentially deliver legitimate carbon offsets through the international voluntary carbon market. This market functions by means of international carbon standards and international carbon credit registries.

Internationally recognised carbon standards include:

- Verified Carbon Standard
- Gold Standard
- Clean Development Mechanism
- Plan Vivo Standard
- Climate Action Reserve
- Joint Implementation
- American Carbon Registry
- Emissions Reduction Fund (ERF) of the Australian Government.

* In this guidance 'double use' refers to: multiple organisations using the same units representing voluntary climate change mitigation to meet their own organisational targets; or an organisation using the same units representing voluntary climate change mitigation for their mandatory compliance obligations and making a claim of voluntary action.

Table 3: Additionality definitions by different carbon standards and programmes

Carbon standard	Additionality definitions/guidance
Verified Carbon Standard Methodology Requirements (2022)	A project activity is additional if it can be demonstrated that the activity results in emission reductions or removals that are in excess of what would be achieved under a 'business-as-usual' scenario and the activity would not have occurred in the absence of the incentive provided by the carbon markets. Additionality is an important characteristic of GHG credits, including VCUs, because it indicates that they represent a net environmental benefit and a real reduction of GHG emissions, and can therefore be used to offset emissions. Methodologies shall set out a procedure for demonstrating additionality using a project method or a standardized method (i.e. performance method or activity method). Source: Verified Carbon Standard, 2022
Plan Vivo	The benefits from a Project Intervention are considered to be additional if they would not be achieved in the absence of the Project. Source: Plan Vivo Standard, 2022
Gold Standard	Additionality is a defining concept of carbon-offset projects. To qualify as a genuine carbon offset, the reductions achieved by a project need to be 'additional' to what would have happened if the project had not been carried out (e.g. continued as business as usual). The concept of additionality is important as only carbon credits from projects that are 'additional to' the business-as-usual scenario represent a net environmental benefit. Without the 'additionality' requirement, there is no guarantee that the emissions reduction activities will lead to a reduction of GHGs into the atmosphere. Therefore, in simple terms, if carbon credits are awarded to activities that would have happened anyway, emissions are allowed to rise without a corresponding cut elsewhere, making the process meaningless. Any business or individual considering purchasing carbon credits to ask questions to ensure that the standard or system backing the credits require proof of additionality. Source: Gold Standard, 2020
CDM	Project additionality The first requirement is that the project activity is not a 'null' activity (i.e. it achieves real 'net anthropogenic GHG removals by sinks' relative to the 'business-as-usual' scenario – called the 'baseline scenario'). Financial additionality The second requirement is that the project activity must be in need of additional resources and it should be possible to cover this resource gap with the expected Clean Development Mechanism (CDM) revenue (i.e. the financial incentives expected from carbon credits under the CDM must be demonstrated to be both necessary and sufficient for the project activity to be implemented). The difference made by the financial incentives expected from carbon credits must therefore be shown to be a decisive factor in enabling the project activity. Source: UNFCCC, 2013
Integrity Council for the VCM	The GHG emission reductions or removals from the mitigation activity shall be additional (i.e. they would not have occurred in the absence of the incentive created by carbon credit revenues). Source: Integrity Council for the Voluntary Carbon Market, 2022
ICROA	Project-based emission reductions and removals shall be additional to what would have occurred if the project had not been carried out. International Carbon Reduction and Offset Alliance (ICROA) members shall demonstrate the project would not have occurred without the availability of carbon finance. Source: ICROA, 2019
Ministry for the Environment	The GHG emissions reductions or removals are due to a specific intervention and would not have occurred under business-as-usual. This means the voluntary climate change mitigation cannot be an action or activity that was going to happen anyway, something that is already required under existing regulation, or incentivised by other policy measures. Business-as-usual management of a pre-1990 forest is likely to sequester carbon. Only measurable carbon benefits in a pre-1990 forest that result directly from a specific new action could be considered additional. Source: MfE, 2022

Each of these carbon standards is listed as an eligible offset type by the International Carbon Reduction and Offset Alliance (ICROA). Note that the ICROA endorsement of the Plan Vivo Standard occurred after publication of its 2019 Code of Best Practice.

Natural regeneration in the international voluntary carbon market

To date, there is only one forest carbon project registered in the international voluntary carbon market in Aotearoa New Zealand – the Rarakau Forest Carbon Project on Māori land in western Southland. This project is certified to the Plan Vivo Standard (Weaver, 2018a, 2018b) and applies an improved forest management methodology. It has passed two additionality tests through two international validation and verification audits (2013 and 2018), issues carbon credits in the Markit Environmental Registry (New York) and has traded carbon credits since 2014.

The carbon accounting methodology for the Rarakau project involves avoided conventional logging of tall indigenous forest. The baseline (business-as-usual) situation was low impact logging under the Forests Act 1949 and the Resource Management Act 1991 (RMA). The landowners had been logging the forests until the 1990s and during a pause in the logging cycle in the mid-2000s agreed to permanently give up the property right to log their forests and instead transition to a forest carbon project to earn revenue from carbon credit sales instead of indigenous timber.

The carbon benefits from the project are delivered through a combination of avoided emissions from logging (one-off small carbon benefit), plus enhanced carbon sequestration caused by the change in land use from production forestry to long-term protection and the ability of the measured natural regeneration to continue uninterrupted by periodic logging for a limited period. The total carbon benefits to the atmosphere are modest, averaging 3.3 tCO_2e/ha/yr (i.e. approximately half of the 50-year average indigenous carbon sequestration rate in the MPI Lookup Tables) (MPI, 2017).

Avoided emission carbon project activities in the forest sector has provoked controversy internationally in recent times (Verra, 2023). Avoided emissions in the energy and forest sectors are conceptually challenging because they are preventing harm from happening rather than causing something new and desirable to happen. 'Harm avoidance' involves effort and cost to ensure that nothing (bad) happens. Similar public policy challenges are common, such as preventing disease from tobacco, preventing road accidents and preventing fires, through to preventing dangerous climate change.

Projects that prevent or reduce harm face the problem of not knowing exactly when the harm would have happened without the intervention. Yet carbon markets have successfully supported renewable energy and energy efficiency projects for many years, despite no-one knowing for certain the extent to which such projects slowed down the rate of fossil fuel extraction and burning globally.

As such, 'avoided harm' project types need to be treated slightly differently to 'causing good' project types. Additionality tests in avoided harm projects need to examine the plausible level of emissions that would occur without the intervention, based on a detailed examination of local drivers across time. The alternative is to not do the climate change equivalent of fencing swimming pools until we can prove that this fence will save the life of this child. The trouble with climate change and child drownings is the permanence of the harm that results from a failure to prevent or reduce the risk of that harm.

The other main activity type eligible in principle for carbon project development in pre-1990 indigenous forest land is enhanced carbon sequestration from improved forest management of land that does not have any commercially viable timber and cannot be otherwise cleared for farming (i.e. is protected under the RMA). Enhancing the carbon sequestration rate in such forest could conceivably be delivered through one or more of the following interventions:

- Herbivore control at such a level that a significant increase in carbon sequestration is demonstrated through measurement in comparison with a reference (control) area
- Enrichment planting of tree species that will lift the carbon sequestration rate from the baseline rate (baseline: 'business-as-usual' or 'without intervention')
- Invasive herbaceous weed control (e.g. eliminating *Clematis vitalba*) to enhance woody vegetation growth rates.

While each of these interventions could conceivably deliver carbon benefits in comparison with a baseline, in practice the annual volume of carbon benefits will need to generate sufficient carbon credits to cover project costs, including the cost of capital/borrowing.

Simply declaring that natural regeneration is occurring in pre-1990 indigenous forest land is not sufficient for issuing and trading carbon credits for the purpose of carbon offsetting. This is because natural regeneration is a baseline (business-as-usual) activity (i.e. it is happening anyway), in the same way that natural carbon sequestration into the oceans is a natural occurrence (taking place in the baseline) and is therefore not additional (i.e. not a human intervention that needs to be funded through the sale of carbon credits).

For carbon projects to pass an additionality test, the project activity (i.e. the human intervention) needs to deliver carbon benefits that are not delivered in the baseline. The volume of carbon benefits that can legitimately be turned into carbon credits is equal to the sum project carbon benefits minus the baseline carbon benefits.

To illustrate this concept in a natural regeneration setting on pre-1990 forest land one can imagine the following contrasting carbon scenarios:

1. Baseline = natural regeneration without human interventions to speed it up.
2. Project = enhanced natural regeneration with human interventions that speed up the rate and amount of carbon sequestration.

Subtracting the baseline carbon benefits from the project carbon benefits delivers the net carbon benefits delivered by the project. This concept is illustrated in Figure 6.

The annual difference between the carbon benefits delivered by the natural regeneration (green line) and the enrichment planting (blue line) amounts to the annual additional carbon benefits delivered by the project intervention and that can be legitimately issued as carbon credits.

Note also that the total carbon benefits delivered by the project is not equal to the carbon credits that can be traded from a project in the voluntary carbon market. This is because such projects are required by international carbon standards to self-insure by means of allocating a percentage of 'buffer credits' that are issued but which cannot be sold. Such buffer credits are used to 'make good' on any carbon credits damaged in the case of a reversal (e.g. fire). The buffer credits are typically held and owned by the carbon standard in a pooled buffer. The volume of buffer credits required for a project is calculated by means of a detailed risk assessment – the higher the risk the larger the buffer.

Conclusion

Despite my own preferences for indigenous forests as a climate change solution, including a career in indigenous forest conservation that runs back to the late 1980s, my experience working with indigenous forest carbon projects at scale has revealed a set of economic realities and public policy trade-offs.

Naturally regenerating indigenous forest carbon projects can and do work well at a small scale and/or where landowners are wealthy enough to not need to replace pastoral revenues on reforested lands. But at a scale sufficient to have a material impact on national carbon sequestration targets, economic and public policy realities come into play that cannot be ignored. These realities include: (a) the need to cover forgone income (e.g. replacing pastoral revenues and/or covering land rental costs); (b) the slow delivery of carbon credits (missing the Paris Agreement deadline); and (c) the much larger land area required to deliver the same volume of carbon sequestration that could be delivered in a much smaller area when exotic forests are included in the carbon sequestration portfolio. This is at a time when there is considerable political pressure from the agricultural sector to avoid turning good farmland into forests amid high inflationary pressures on the economy.

If the taxpayer were asked to fund the forgone income mentioned in (a) above, trade-offs to consider include: (i) deciding what domestic public spending budgets to cut; and/or (ii) the impact of reallocating public funds earmarked for the acquisition of international carbon credits to domestic forest carbon through natural regeneration. During a cost-of-living crisis in the wake of a global pandemic the public will rightfully demand a cost-effective solution to climate change. Any public spending on carbon sequestration internationally or domestically will need to deliver a cost-effective outcome – otherwise climate change policy will fail politically.

The inconvenient truth elaborated in this paper shows that indigenous regeneration at scale is a far less cost-effective option compared with other regenerative options at scale, including continuous cover exotic forestry (e.g. the kind that gets sustainable forest management certification), continuous cover exotic

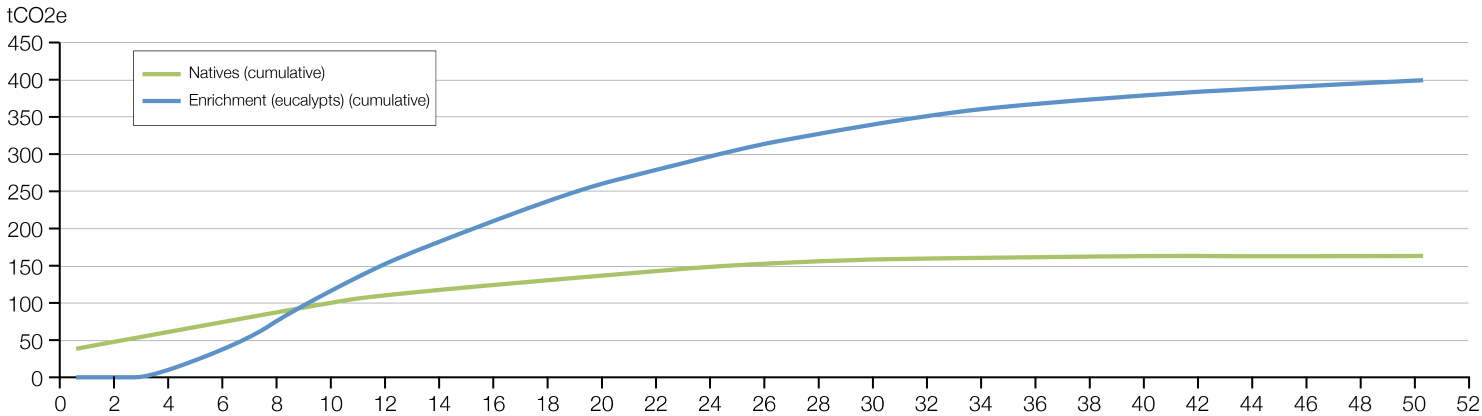

Figure 6: Cumulative baseline (green line) and project (blue line) carbon benefits in natural regeneration that has been enrichment planted with widely-spaced eucalypt

forestry transitioning to indigenous forest (through careful management including harvest and replacement), combined with indigenous afforestation plantings. The latter combination can deliver a high-carbon sequestration outcome, in time for the Paris Agreement deadline, at no cost to the taxpayer. This approach can also include indigenous regeneration wherever possible, but as part of a climate change strategy that does not rely on this practice as the core solution.

Indigenous regeneration will deliver high biodiversity benefits. But so too will indigenous afforestation that has been funded by exotic continuous cover forestry, and such forestry that transitions through to indigenous forest across several decades. Moreover, biodiversity conservation costs money in the short and long term (pest and weed control in perpetuity).

A forest carbon project focused on biodiversity conservation needs to fund that biodiversity conservation effort. If the financial viability of that forest carbon project is negative or highly marginal, there will be little or no funds available for pest and weed control now and into the future. This is for the hundreds of thousands of hectares that need reforesting to meet our Paris Agreement obligations, our biodiversity conservation goals, our net-zero carbon nation aspirations, and to get our landscapes ready for the intense ex-tropical cyclones that will become the norm in a warmer climate.

Improved forest management of pre-1990 indigenous forest is worthy of inclusion in a national forest carbon strategy. But this activity will need to demonstrate additionality through either being included in the Climate Change Response Act 2002, with appropriate additionality safeguards, or being certified to the additionality requirements of internationally recognised forest carbon standards. To do less would create a flawed carbon market and leave the door open to fraudulent carbon trading activities that are both not benefiting the atmosphere and are degrading the integrity of the carbon market itself.

If project proponents want to pursue biodiversity conservation in situations that are not delivering additional carbon benefits to the atmosphere, they have the option to pursue biodiversity conservation financing pathways including (but not limited to) philanthropy and biodiversity markets. Such philanthropy could include the funds no longer needed for native afforestation because the carbon markets are delivering this at scale in a blended exotic and indigenous approach.

If an activity cannot be funded, it will not happen. We are in a climate emergency and this demands open-minded innovation, extraordinary responses to an extraordinary situation and an acceptance that, according to the Italian proverb La Bégueule 'le meglio è l'inimico del bene' – the perfect is the enemy of the good.

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