The Interwoven World
Te Ao i Whiria

Toward an Integrated Landscape Approach in Aotearoa New Zealand

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AUT

About this discussion paper

This discussion paper is part of an ongoing series on urgent contemporary policy issues in Aotearoa New Zealand. This series is action-oriented and solutions-focused, with an objective of bringing academic research to bear on the economic, social and environmental challenges facing us today.

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>
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>
> **§4.3: The resilience principle:** which dictates that landscapes ought to have the capacity to absorb change and shocks while still providing the same functions.
>
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6: The Landscape Approach: in which I recommend the emerging framework of the *landscape approach* as a way to reorientate ourselves toward the Interwoven World, to steer a path between people's diverse and conflicting expectations for the land.

7: Tweaking Systems: in which I touch upon the question of implementation, especially how to overcome barriers to a more integrated landscape. I argue that a systems approach is required, which incorporates the many factors that influence forest outcomes, whether supply- or demand-side factors, or features of the enabling environment, or the intermediaries and instruments that implement change. (Further detail is included in the Appendix.)

8: Summary: in which I summarise my argument once again, imploring New Zealand to suppress the influence of trinary thinking, and to embrace the ample opportunities for a more prosperous, integrated landscape.

1: Overview

> *I suspect no landscape… can be comprehended unless we perceive it as an organization of space; unless we ask ourselves who owns or uses the spaces, how they were created and how they change.*
>
> —John Brickerhoff Jackson, landscape writer[1]

It is common for New Zealanders to have a binary view of forests. Either they are *native conservation forests*, which are managed under the principle of 'look but don't touch'. Or they are *exotic commercial forests*, which usually means *Pinus radiata* managed under a clear-cut system on a nearly thirty-year rotation. Obviously, this is an oversimplification. But anyone involved in debates over forestry will know that this binary thinking has a strong grasp on many people's minds.[2]

If we step back and look at land use more generally, a trinary view appears: it's either native conservation forests, exotic commercial forests or *pastoral agriculture* with nary a tree in sight. Again, an oversimplification: what about orchards or shelterbelts? Still, drive through places like Southland, Mid Canterbury and the Hauraki Plains and you might notice (as I have) that trees are less frequent than they were. In such places, our rural land appears to be becoming more compartmentalised: this patch of land for that purpose, that patch of land for this purpose, and never the twain shall meet.

I call this the *Siloed World*, where particular land uses come to dominate particular sites without being permitted to merge or mingle. This is an oversimplification, as I've already emphasised, but it is not without its truthfulness. It captures something of where the New Zealand landscape appears to be headed.

But this siloed approach to rural landscapes defies a longstanding wisdom, as well as a growing corpus of scientific evidence, that managing our land in this compartmentalised way is suboptimal. By 'suboptimal' I mean that the Siloed World is not prosperous over the long run, because short-term gains in profit and productivity are offset by mid- to long-term environmental harms that, in turn, create economic burdens. I discuss these threats to prosperity in Section 4.

[1] John Brickerhoff Jackson. (1984). *Discovering the vernacular landscape*. New Haven & London: Yale University Press, p.150.

[2] This distinction was noted years ago by the Parliamentary Commissioner for the Environment (PCE), who observed a 'conservation–production divide' in New Zealanders' views about the landscape, revolving around dichotomies of 'nature and culture (society); public and private; indigenous and exotic; conservation and production; protection and exploitation.' See Parliamentary Commissioner for the Environment. (2002). *Weaving resilience into our working lands: Recommendations for the future roles of native plants.* Wellington: PCE, p. 16.

By way of contrast, this discussion paper will endorse an alternative, the *Interwoven World*, where a wide palette of land uses are spliced, merged and intermingled in order to enhance prosperity over the long run, especially by mitigating and obviating some of the negative impacts caused by siloed approaches to land use. These interwoven land uses include agroforestry and silvopasture, which combine forest and pastoral land; and forest systems that go beyond the conventional reliance upon monocultures and clear-cutting to create more diverse and more continuous forests that are nevertheless still economically viable.

It is *not* the purpose of this paper to suggest that native conservation forests, exotic commercial forests and pastoral agriculture have no role to play in a prosperous future for Aotearoa New Zealand. For particular sites, these may well be the most appropriate land use. It is always a question of *which* land use *where* – and to *what* effect for *whom*. In other words, questions of land use cannot be answered in isolation from the wider context, especially how land uses affect surrounding landscapes and the communities that call these landscapes 'home'.

More broadly, it is not the purpose of this paper (except for a few general observations) to prescribe which land use systems ought to be implemented where. To make geographically-specific recommendations would require a localised analysis, as well as stakeholder engagement, which goes well beyond the scope of this paper. Such an analysis would include (and not be limited to) the geological and climatic properties of particular land sites, the land expectation value and opportunity costs of alternative land uses, the non-financial preferences of landowners and the constraints they face, and the needs and aspirations of the communities that they belong to.

What, then, is the purpose of this paper? *It is simply to disrupt these binary and trinary ways of thinking*, to demonstrate that there is a rich palette of options that combine and cross over those familiar categories of native conservation forests, exotic commercial forests and pastoral agriculture.

As the new Government rolls out its Billion Trees Programme, it is useful to think in terms of an *integrated landscape* approach whereby different land uses are entwined in ways that complement the land, its inhabitants and adjacent land uses. What I call the Interwoven World is an ideal that derives from these principles. It also consciously echoes the Māori tradition of raranga (or flax weaving), where the strength of the weave comes from the binding together of individual strands. Consequently, the whole is greater than its parts. Analogously, through the interweaving of different land uses in Te Ao i Whiria – at the scale of the farm and the landscape – New Zealand could adopt a land use strategy that creates long-term prosperity by striking an optimal balance between financial, social and environmental outcomes.

Many farmers and foresters already think this way: this won't be news to them.[3] Plenty of landowners live by the refrain: 'Look after the land and the land will look after you.' This paper is primarily intended to encourage policy makers and the wider public to think beyond the Siloed World, to better understand the realities and potentialities of the landscape. Because continuing along the path of compartmentalisation creates risks and liabilities that – for the sake of New Zealand's long term prosperity – we would do well to avoid.

2: The Siloed World versus the Interwoven World

Alice: Would you tell me, please, which way I ought to go from here?
The Cheshire Cat: That depends a good deal on where you want to get to.

—Lewis Carroll, Alice's Adventures in Wonderland[4]

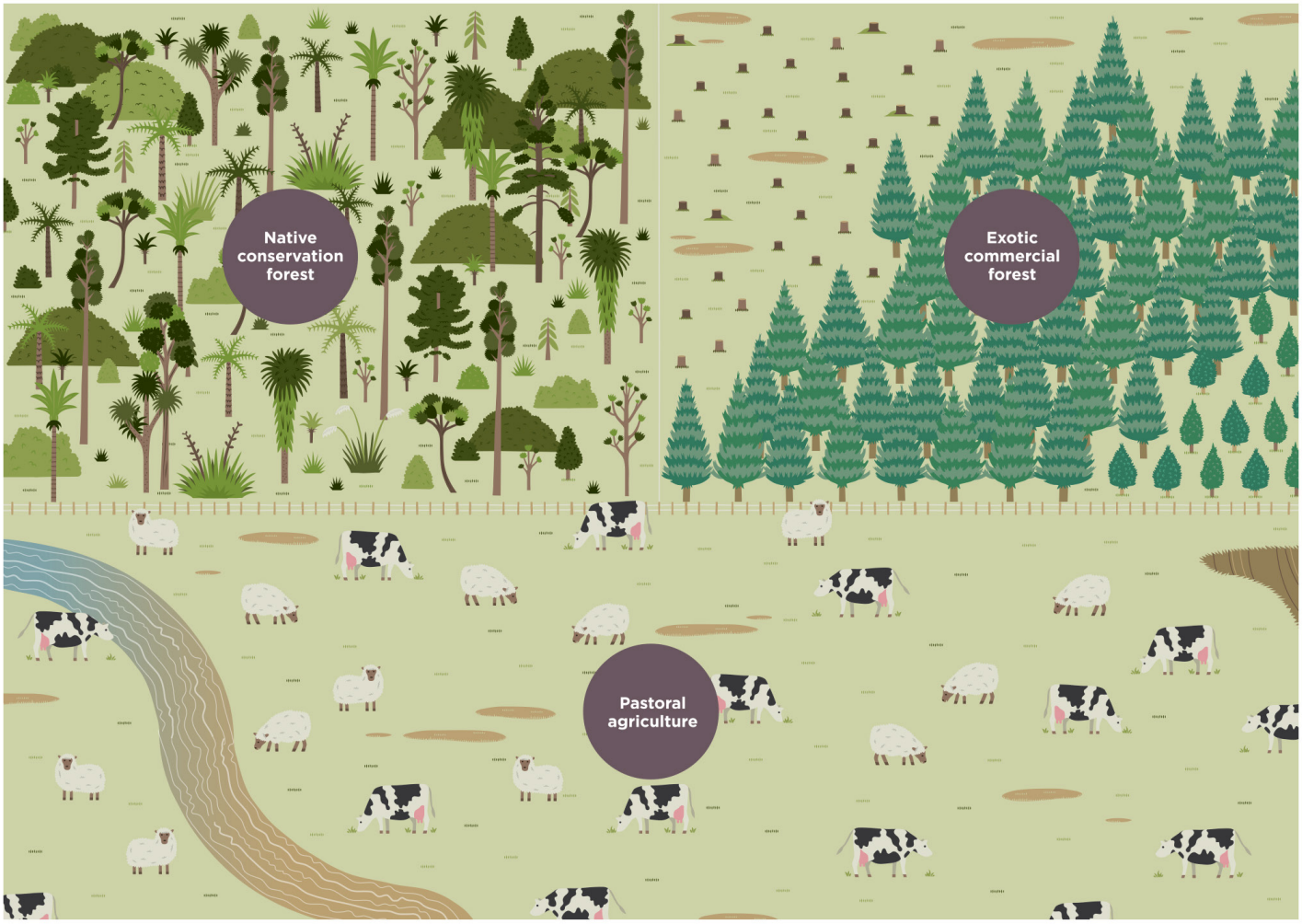
Below is a visualisation of the Siloed World (see Figure 1). It shows native conservation forest on the upper left, a clear-fell forest system of *Pinus radiata* on the upper right, and pastoral agriculture in the lower portion.

By 'native conservation forest', I mean roughly New Zealand's conservation estate; that is, forest that is dominated by indigenous species and under some form of legal or regulatory protection, or active management regime, to preserve this character.[5] By 'exotic plantation forest', I mean forest that was established by human intervention with the intention to harvest for commercial purposes. By 'pastoral agriculture', I mean grasslands that are used as pasture for livestock. Generally speaking, dairy farming has come to dominate highly productive grasslands, while the high country's less productive grasslands are dominated by beef, lamb and wool production.

Such is the trinary view of the New Zealand landscape. It is an oversimplification but, as I discuss in Section 3, it corresponds loosely to reality. First, however, I shall provide a glimpse of the alternative that I advocate in this paper: *the Interwoven World.*

[3] I'll take this opportunity to acknowledge the longstanding work done by the New Zealand Farm Forestry Association <http://www.nzffa.org.nz/> in championing the diverse land uses that I discuss here.
[4] Lewis Carroll. (1869). *Alice's adventures in wonderland.* Boston: Lee and Shepard, p.89.
[5] Formally, this is pre-1990 natural forests which are protected as conservation areas under the Conservation Act 1987, or scenic and nature reserves under the Reserves Act 1977. It also includes forests protected by the Local Government Act 2002 as regional parks, such as the Belmont Regional Park in Wellington, Waitākere Ranges in Auckland, and Papamoa Hills in the Bay of Plenty; or protected areas under local plans, such as the significant ecological areas (SEAs) identified by the Auckland Unitary Plan.

Figure 1: The Siloed World



As shown in Figure 2, the Interwoven World blurs the boundaries of the Siloed World, creating a diverse mosaic of land use systems that landowners can choose from, given their circumstances. I discuss these different systems in further detail in Section 5, but below I offer an overview.

Figure 2: The Interwoven World

In the Interwoven World, we see a diversification of forest systems for commercial forestry, in order to strike a different balance between the various economic, environmental and social outcomes of forest land uses. So, we have not only *clear-cut systems* – which is the dominant system for intensive production forests in New Zealand – where the entire forest is planted, felled and restocked on a rotation cycle. We also have *retention systems* where portions of forest are left in the ground, in order to provide environmental benefits such as erosion control, habitat provision, or to accelerate natural regeneration. Or *selection systems* where individual trees are felled according to specific criteria, such as size or quality. If selection felling is minimal enough that the integrity of the forest canopy is maintained, then the forest may fulfil the definition of *continuous cover forestry*, which consists of an uneven-aged stand of trees where the gaps are occupied by new trees, either self-seeded or planted deliberately. Even further along the spectrum, we see *close-to-nature* forestry where the integrity of a natural ecosystem is maintained to the greatest extent possible, while still extracting trees for commercial forestry.

We have not only *exotic plantation forests*, but also *native plantation forests*, where indigenous species are planted for commercial uses. On the flipside, we see the use of fast-growing exotic trees for *carbon farming*, managed in a way that resembles conservation management, in order to create permanent forest ecosystems that maintain their carbon stocks into perpetuity. We also see *native restoration projects,* where trees and vegetation are established with the intention of emulating original indigenous forest ecosystems. Or sites where land is retired to facilitate *regeneration,* either *natural* or *assisted* by humans, potentially also accruing carbon credits in the process. More innovatively, we see *mixed exotic/native systems*, where fast-growing exotics (such as tree lucerne, poplars, willows or even pine species) are planted as a nursery crop, then interplanted with native trees which eventually take over on a longer timeframe. Such systems strike a middle road between the functions of rapid carbon sequestration and native biodiversity outcomes.

Finally, we see all these forest land uses interweaving with pastoral agriculture – and doing so across multiple scales. At the farm level, this integration of forestry can occur as small forestry blocks, such *as wood lots* for timber, or diversification into *horticulture and cropping*, or permanent forest reserves for carbon farming. But this can also occur in a more thoroughly integrated fashion through agroforestry and *silvopasture* where trees are incorporated into pastures or crop fields, often to exploit synergies and complementarities that increase productivity and reduce environmental damage. At the landscape level, this interweaving of discrete land uses can be undertaken strategically to strike an alternative balance between land functions across a region or rohe. A salient example in the New Zealand context is integrated catchment management, whereby

we consider land use strategy across the entire hydrological catchment area for rivers or lakes with the intention of improving water quality.

This is the interwoven utopia that I advocate in this paper, to be contrasted with the dystopia of the Siloed World. But is the Interwoven World actually a utopia? After all, these diverse land uses are already visible in the New Zealand landscape. Are we not, in a sense, already there? Section 3 discusses how these 'worlds' correspond to reality.

3: Worlds and Realities

> *I will not be describing the world of any concrete human beings. A world is something which people inhabit. It gives the shape of what they experience, feel, opine, see, etc.… [W]e can gain insight into the way two people or groups can be arguing past each other, because their experience and thought are structured by two different pictures.*
>
> —Charles Taylor, political philosopher[6]

So far I have asserted a contrast between the Siloed and Interwoven Worlds, and implied that the New Zealand landscape is overly aligned to the former. It is time to justify this assertion.

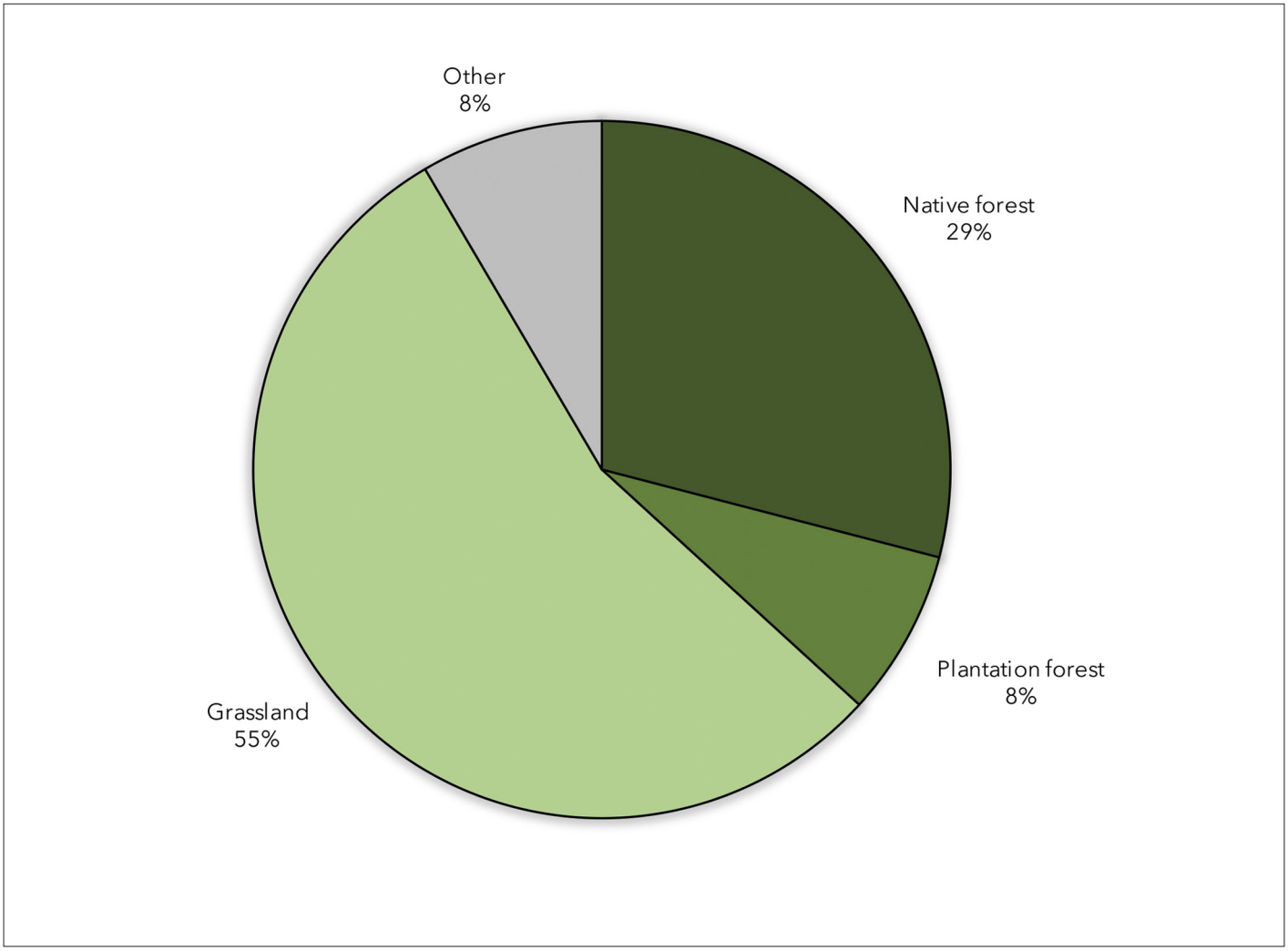
After all, one immediate response to my argument so far is that the Siloed World is not an accurate reflection of reality in New Zealand. What about shelter belts, wood lots and poplar pole planting? What about horticulture and cropping? What about other land classifications, such as wetlands or urban settlements? The Siloed World (as I've already alluded to) is a drastic oversimplification which obscures the complexities of the New Zealand landscape. At worst, it's a straw man argument, a distortion of empirical reality. Why set out my argument in this way?

The crucial point is that the Siloed World is *a way of seeing the landscape*, a worldview more than it is a description of the world we live in. To put this more formally, the Siloed World is a normative vision, more an assertion of *how things should be* than how things *actually are*.[7] It is, moreover, a vision that is shared by many New Zealanders (not all New Zealanders, by any means, but *many*). As a consequence, the Siloed World exerts a real, if incomplete, influence on the landscape. This occurs either directly via the choices of landowners, or indirectly via the choices of planners, policy makers, lenders, financial officers, and others. In short, a siloed vision brings about a siloed reality.

[6] Charles Taylor. (2007). *A secular age*. Cambridge MA; London, UK: Belknap Press, p.557.
[7] For further elaboration, see Charles Taylor. (2004). *Modern social imaginaries.* Durham; London: Duke University Press, chapter 2.

This is why the Siloed World has some resemblance to the world we live in. As Figure 3 shows, grassland, native forest and plantation forest cover 92 per cent of the country. Although the trinary view of land use is not *entirely* true, it is still *massively* true.

Figure 3: Land Use in New Zealand in 2016



Source: Ministry for the Environment. (2018). *New Zealand's greenhouse gas inventory 1990-2016.*

Grassland is by far the largest land classification, covering 55% of New Zealand's total land area. Native forest, most of which belongs to New Zealand's conservation estate, amounts to 29% of the total land area. Meanwhile, plantation forests are estimated to cover 8% of the country.[8] According to the New Zealand Forest Owners' Association (NZFOA), this planted forest is dominated by just two exotic species: 89.9% in *Pinus radiata* and 6.1% in Douglas fir.[9] The remainder includes other exotic hard- and soft-woods, such as eucalyptus and cypress species respectively. Native commercial planting of indigenous species such as tōtara and kauri is not large enough to be captured in the NZFOA survey.

Of course, we can add more nuance to this breakdown (see Figure 4 below). Grasslands, for instance, can be broken down into high- and low-producing grasslands, which favour different land uses. High-productivity, usually exotic, pasture species (22.1% of New Zealand's total land area) are dominated these days by dairy agriculture, whereas the low-fertility grasslands and tussock grasslands of the high country (27.5%) are predominantly used for sheep, beef and wool. A further category is 'grassland with woody biomass', where we start to see an interweaving with trees and forests, either due to human intervention or simply because nature abhors a fenceline. This includes shrubland, where shrub and scrub species like mānuka, kānuka and matakoura have encroached onto once-cleared land. It also includes sparse plantings of trees that don't meet the forest definition, such as riparian and erosion control plantings, silvipasture, golf courses, large shelterbelts and so on.[10] This is a hint of the Interwoven World, but at only 5.1% of New Zealand's total land area, it is a minor theme.

We can also tease out the further land classifications from the 'Other' category in Figure 4 below. These include croplands, wetlands and urban settlements, then a further collection of uncommon land uses like scree slopes, quarries, glaciers, sand dunes and so on. However, in terms of space, these land classifications are relatively small. For example, annual and perennial croplands cover only 1.8 per cent of New Zealand's total land area. There are good reasons for wanting to increase this proportion: two pivotal reports by Vivid Economics and the Productivity Commission have argued that increased cropping could better align the land sector to a low-emissions future while still preserving economic productivity.[11] But this remains aspirational: presently, horticulture is a minor theme in the New Zealand landscape.

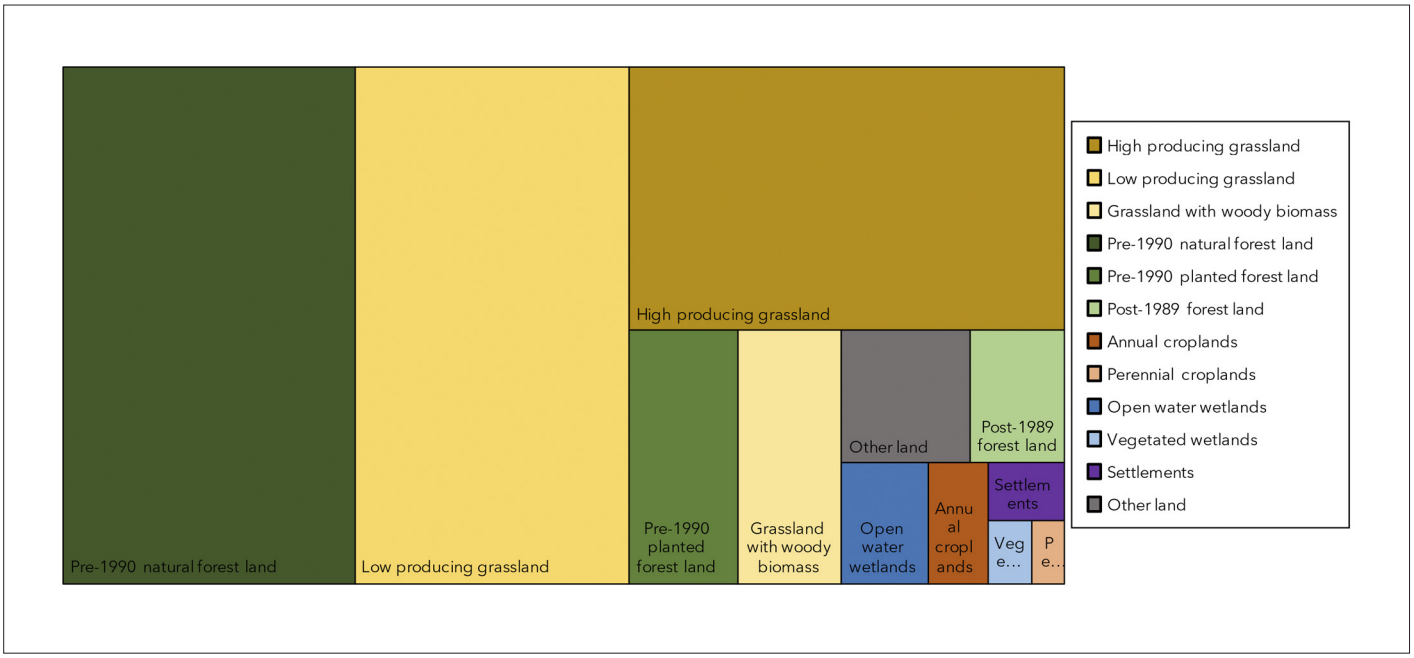
[8] The source is *New Zealand's greenhouse gas inventory 1990-2016* (Ministry for the Environment, 2018). I acknowledge that different land classifications will generate a different picture; for comparison, see the land cover charts in Ministry for the Environment & Statistics New Zealand. (2018). *New Zealand's environmental reporting series: Our land 2018, p.39.*

[9] New Zealand Forest Owners' Association. (2018). *Facts and figures 2016/2017*. Wellington NZ: NZFOA & MPI.

[10] The forest definition for the New Zealand's Emissions Trading Scheme (NZ ETS) requires that forest is at least one hectare in size; with an average width of at least 30 metres; have (or will have) tree crown cover of more than 30% in each hectare; and constituted by forest species that can reach at least 5 metres in height at maturity.

[11] See Vivid Economics. (March 2017). *Net zero in New Zealand*. Report prepared for GLOBE-NZ, p.50; Productivity Commission. (April 2018). *Low-emissions economy: Draft report.* Wellington: Productivity Commission.

Figure 4: Land Use in New Zealand in 2016



Source: Ministry for the Environment. (2018). *New Zealand's greenhouse gas inventory 1990-2016.*

Any explanation of the predominance of pastoral agriculture, and hence grassland, must begin with profitability. Agriculture is generally regarded the highest and best use for productive land. But this is a product of circumstances that warrant explanation, such as the absence of prices on certain kinds of pollution,[12] the perceived lack of risk and uncertainty relative to other land uses such as forestry,[13] the presence of soft subsidies for agriculture such as public investment into irrigation schemes, the weak enforcement of environmental compliance,[14] the terms under which bank loans and mortgages are provided, and so on (see Section 7 for further discussion).[15] So why is the land sector set up in this way, with these financial, economic and regulatory circumstances? A part of this larger story would involve culture – and this is where the Siloed World is relevant, as a worldview that shapes the landscape in its own likeness.

[12] Juan J. Monge, Sandra J. Velarde, Richard T. Yao, & Stefania Pizzirani. (November 2015). *Identifying complementarities for the dairy and forestry industries in the central North Island*. Technical report. Rotorua: Scion.

[13] Juan J. Monge, Warren J. Parker & James W. Richardson (2016). Integrating forest ecosystem services into the farming landscape: A stochastic economic assessment. *Journal of Environmental Management 174* (1), pp. 87-99.

[14] Marie Brown. (2017). *Last line of defence: Compliance, monitoring and enforcement ofNew Zealand's environmental law*. Auckland: Environmental Defence Society (EDS).

[15] Specifically on the question of agriculture versus horticulture, Andy Reisinger, in his submission to the Productivity Commission's *Low-emissions economy* report, notes: 'On paper, horticultural enterprises appear to have higher profitability than dairying in parts of New Zealand, but horticulturalists are not buying out dairy farms in large numbers. This is likely to be influenced by hidden costs, skills barriers, infrastructure, investment costs, risks, along with more systemic influences in terms of attitudes of banks, international markets, export and training mechanisms.' See Productivity Commission. (2018). *Low-emissions economy: Draft report.* (sub. 28, p.2), p.254.

This has deep historical roots. The British scientist Sir Reginald George Stapledon, who toured New Zealand and Australia in 1926–27, concluded that 'probably grass land, equally with the sea, is to be regarded as one of the corner-stones on which the greatness of the British Empire has been built.'[16] This colonial commitment to agricultural productivity had a profound effect on land cover in New Zealand, especially in the rapid conversion from forest to pasture. Pastoral land increased from less than 70,000 hectares in 1861 to 1.4 million hectares by 1881 to 4.5 million hectares in 1901. The flipside was dramatic deforestation, mostly by fire. Between 1890 and 1900, an especially intensive decade, 27 per cent of New Zealand's existing native forest was cleared.[17] A common saying of the time was 'one blade of grass is worth two trees'. This attitude influenced the thinking of Prime Ministers William Ferguson Massey and Gordon Coates who strongly advocated for the expansion of exotic grasslands. Government subsidies for pastoral farming in the 1970s and early 1980s incentivised the clearing of forest and scrubland. In short, land use choices in New Zealand, like other colonial societies, were shaped by an 'ideology of improvement': 'These choices produced relatively straightforward landscapes... aimed to simplify the environment and standardise production techniques.'[18]

That isn't to say that everyone went along with this. In 1922, Wellington's *Evening Post* declared: 'Are there not already enough object-lessons of the consummate stupidity of the policy of growing one blade of grass where two trees grew before?'[19] For Māori, these radical changes to the landscape were particularly agonising, because they were inseparable from land alienation and the inability to exercise kaitiakitanga. However, some Pākehā and Europeans also opposed deforestation, even while it was occurring, such as the German naturalist Ernest Dieffenbach, politican Thomas Potts, artist Alfred Sharpe, historians J. P. Grossman and Guy Scholefield, and others. Later, the soil conservation movement, spearheaded by figures like Lance McCaskill, Kenneth Cumberland and Lindsey Poole, emphasised the importance of forest for fixing soils and 'holding this land'.[20] Finally, there have been various attempts to diversify land use over past decades, including through farm forestry and the establishment of woodlots, both as market-driven exercises and through public grants and subsidies. The Interwoven World has always had its believers.

[16] As Tom Brooking writes, the 'broad-based consensus [of colonists]… incorporated the simple idea that no one, whatever their race or class, had a moral right to own land unless they used it productively.' See Tom Brooking. (1996). Use it or lose it: Unravelling the land debate in late nineteenth-century New Zealand. *New Zealand Journal of History, 30* (2), p.145.
[17] Ministry for the Environment. (1997). *The state of New Zealand's environment 1997.* Wellington: NZ Government, chapter.8, p.30.
[18] Tom Brooking & Eric Pawson. (2010). *Seeds of empire: The environmental transformation of New Zealand.* London; New York: L. B. Taurus, p.206.
[19] Tom Brooking & Eric Pawson. (2010), p.209.
[20] Lance McCaskill's history of the soil conservation movement is (1973) *Hold this land: A history of soil conservation in New Zealand.* Wellington: A.H. & A.W. Reed.

Nevertheless, to an overwhelming degree, we have acquired a regulatory framework, a research funding regime, and an investment ecosystem that is significantly oriented toward a siloed approach to the land (see Section 7 for further discussion). Attempts to realise a more interwoven approach cut against this grain. Even though the Interwoven World is an attractive ideal to many New Zealanders – both in the past and the present – our institutions are not set up well to help landowners achieve these outcomes, even when they wish to do so. What is more often affordable, or practicable, or feasible, is to simplify and standardise the land and to maximise its financial functions. Even for those who desire it, the Interwoven World is difficult to achieve.

In Section 6, I introduce the landscape approach as a way to coalesce public and political support for the Interwoven World. But in the following two sections I will make the case for why it needs achieving, for why the Siloed World is misaligned with long-term prosperity (Section 4) and why the Interwoven World could do better (Section 5).

4: Five Principles of Prosperity

> *Our human landscape is our unwitting autobiography, reflecting our tastes, our values, our aspirations, and even our fears, in tangible, visible form. […] Grady Clay has said it well: 'There are no secrets in the landscape.'*
>
> —Pierce F. Lewis, geographer[21]

Why resist the Siloed World? Why not embrace it? The Siloed World is clean, orderly and uncomplicated. Why embrace the messiness and variability of the Interwoven World?

The simple answer is that, while the Siloed World is well-aligned with short-term economic growth, it is in many ways misaligned with a long-term prosperity that is founded upon a favourable balance of social, environmental and economic outcomes. The relevant considerations are too numerous to cover comprehensively in this paper. Instead, I shall refer to five principles which crisscross this terrain, overlapping at times but also emphasising distinct aspects of the foundations of prosperity. These are summarised here, then spelled out in greater detail below (although readers familiar with these issues might like to skip forward to Section 5).

[21] Peirce F. Lewis. (1979). Axioms for reading the landscape: Some guides to the American scene. In D.W. Meinig (Ed.), *The interpretation of ordinary landscape: Geographical essays* (pp.11–32). Oxford University Press.

- **The climate-alignment principle:** which dictates that agriculture, forestry and land use more generally need to support climate mitigation and adaptation activities.
    - The Siloed World is not optimally aligned with the climate-alignment principle, because siloisation tends to go hand-in-hand with intensification of land uses, which means increased agricultural emissions and increased use of clear-cut plantation forests whose harvesting schedules could misalign with climate targets.
- **The sustainability principle:** which dictates that land use choices have a responsibility to meet the needs of the present without compromising the ability of future generations to meet their own needs.
    - The Siloed World is not optimally aligned with the sustainability principle, because intensified, high-input systems in forestry and agriculture produce environmental harms that undermine the sustainability of natural resources, and undermine the social license for these land uses to continue.
- **The resilience principle:** which dictates that landscapes should cultivate the capacity to absorb change and disruptions in order to provide the same functions.
    - The Siloed World is not optimally aligned with the resilience principle, because it works against diversity through the homogenisation of land uses, thereby reducing the capacity of landscapes to adapt to change and shocks.
- **The mauri ora principle:** which dictates that the wellbeing of people is strongly correlated with the wellbeing of the land, because of the complex interdependencies between them.
    - The Siloed World is not optimally aligned with the mauri ora principle, nor with integrated accounting approaches, because it focuses on private choices on private land blocks, thereby failing to properly account for the wider impacts of land use decisions on surrounding communities and future generations.
- **The biodiversity principle:** which dictates that the preservation of diverse, native species of flora and fauna has both instrumental and intrinsic value.
    - The Siloed World is not optimally aligned with the biodiversity principle, because when land is optimised for its financial functions rather than its conservation functions, biodiversity considerations are excluded or minimised.

§4.1: The climate-alignment principle

This principle dictates that agriculture and land use, land use change and forestry needs to support climate mitigation and adaptation outcomes. I discuss adaptation below in §4.3 on resilience, but climate mitigation refers to reducing total emissions of greenhouse gas emissions or creating negative emissions, especially through carbon sequestration. Ultimately, the aim is to reduce concentrations of atmospheric carbon that contribute to global warming; but the more immediate aim is to satisfy international obligations and expectations under the United Nations Framework Convention on Climate Change.

As a signatory to the Paris Agreement, New Zealand has adopted a target of reducing emissions to 30 per cent below 2005 levels by 2030. The current Government is also committed to reaching net zero emissions by 2050, which would situate New Zealand favourably in regard to the Paris Agreement's collective agreement 'to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century'.[22] Achieving these targets will involve some combination of (i) domestic emission reductions, (ii) growing trees to remove carbon dioxide from the atmosphere, and (iii) purchasing international emission reductions.[23]

The Siloed World presents a variety of risks to climate alignment which include:

§4.1.1. Continued intensification of pastoral agriculture

Nearly half of all of New Zealand's greenhouse gas emissions (49.2% of gross emissions in 2016) come from agriculture. These emissions have increased by 12% since 1990, primarily driven by the intensification of dairy agriculture. The size of the national dairy herd increased by 92% since 1990, while the use of synthetic fertiliser containing nitrogen increased by about 600%.[24] This expansion has also involved conversions from forestry, particularly in the Waikato region, which not only means the loss of forest carbon stocks, but also the transition from a negative emissions activity to a positive emissions activity.

There are multiple opportunities to reduce these domestic emissions through new technologies and farm-management practices. Individually, these can be small, but collectively can make a significant impact. Still, the scope of these reductions is limited.

[22]United Nations. (2015). *Paris Agreement,* Article 4(1). Retrieved from https://unfccc.int/sites/default/files/english_paris_agreement.pdf

[23]For the Government position, see Ministry for the Environment. (2016). *National interest analysis: The Paris Agreement.* Wellington, NZ: New Zealand Government. For more detailed analysis of climate mitigation opportunities, see Royal Society of New Zealand. (2016). *Transition to a low-carbon economy for New Zealand.* Wellington: RSNZ; Vivid Economics. (March 2017). *Net zero in New Zealand*. Report prepared for GLOBE-NZ, p.50; Productivity Commission. (April 2018). *Low-emissions economy: Draft report*. Wellington: Productivity Commission.

[24] Ministry for the Environment. (2018). *Greenhouse gas inventory 1990–2016.* Wellington: NZ Government, p.10.

In the absence of transformative disruption,[25] any major reduction in agricultural emissions will need to involve deintensification of agriculture through reduced stock numbers, carbon offsetting through the creation of negative emissions, or both. These courses of action create opportunities for more integrated land uses, because deintensification may involve diversification into forest land uses such as woodlots or carbon farming, and carbon offsetting will require the creation of forest sinks, either on-farm, domestically via New Zealand's Emissions Trading Scheme, or internationally through future carbon trading arrangements.

§4.1.2. Harvesting schedules for clear-cut forest systems

When a forest is clear felled, this registers on current carbon accounting frameworks as an instant emission of almost all the carbon stored throughout the forest's growth. This results in the classic 'saw tooth' pattern for carbon stocks in clear-cut forest, where carbon is accumulated over the course of the rotation cycle, then 'lost' when harvested.[26] This creates complications for meeting emissions targets, especially if forest planting has occurred in spurts, rather than being evenly spread over the years.

This is a problem for New Zealand. The spate of planting that occurred in New Zealand in the mid-1990s means that a bulge in harvestable wood supply will occur in the early- to mid-2020s. If these forests are clear-felled when they reach optimal harvestable age (the average age of Pinus radiata at harvest is currently 29.1 years), then this entails a commensurate bulge in emissions as forests are converted from carbon stocks to carbon sources, at least under the current carbon accounting framework. Troublingly, from a climate-alignment perspective, this 'bump' in net emissions is due to occur in the lead up to New Zealand's 2030 target. The Billion Trees Programme, which would involve reaching similar planting rates to those of the 1990s, could create a further bump in the years leading up to 2050.

However, this is *only* a problem if we manage, as we do, nearly all of our commercial forests as clear-cut systems.[27] Other forest systems, such as continuous cover forestry,

[25]Three such potential disruptions come to mind: (1) a significant change to international carbon accounting methodologies which minimises the climate forcing potential of agricultural methane in comparison to carbon dioxide (2) the substitution of traditional agriculture by non-greenhouse gas-emitting alternatives through technological breakthrough, such as laboratory-grown meat; and (3) a cessation of traditional pastoral agriculture, presumably to be substituted by cropping and horticulture, driven by a massive consumer shift from meat to vegetable products.

[26] In reality, of course, a tree's carbon is not *immediately* released into the atmosphere, even if this is the presumption of carbon accounting frameworks. Carbon accounting does factor in that some carbon remains below the ground, thus not all carbon credits need to be surrendered on felling. Also, New Zealand is in the process of trialling a modified framework that recognises the carbon stored in durable wood products.

[27] This contrasts with Geoff Bertram and Simon Terry's (2010) influential analogy that: 'Growing trees in production forestry plantations offers only a temporary respite [for net emissions], akin to buying the groceries on a credit card. When in due course the trees are harvested, the debt must be paid off' (see *The carbon challenge: New Zealand's Emissions Trading Scheme.* Wellington, NZ: Bridget Williams Books, p.78). But this is only true of clear-cut systems. Continuous cover forests are more like assets - that is, durable carbon stocks that generate income through controlled timber extraction. As such, Bertram and Terry reiterate siloed thinking by not thinking beyond clear-cut systems. They also take only a short-term view, because, over multiple forest rotations, this land carries a long-term average of carbon that is much greater than pasture, although much less than permanent forest.

maintain the majority of their carbon stocks into perpetuity (see Section 5), thereby smoothing out these irregularities in carbon stocks and timber supply.

§4.1.3. Loss of forest carbon through catastrophic shocks

Forest carbon can be released into the atmosphere as a consequence of catastrophic events such as fire, disease, pests or extreme weather events. I discuss these risks in §4.3 on the resilience principle, but it is worth highlighting here how these two principles interact. In short, a failure of resilience carries implications for climate alignment, because mass forest loss can create positive feedbacks by contributing to atmospheric carbon levels, which in turn accelerates global warming and further forest degradation.[28]

§4.2. The sustainability principle

In the Brundtland Report from 1987, sustainability was defined as economic activity that 'meets the needs of the present without compromising the ability of future generations to meet their own needs.'[29] The focus of this report was *environmental sustainability* – that is, how we consume resources, especially non-renewable resources that are made more scarce through consumption. However, this concern for inter-generational outcomes can also be applied to other challenges facing an economy or organisation, which include *fiscal sustainability* – that is, the long-term solvency of its balance sheet or budget; and *social sustainability* – that is, the ability to maintain public support or stability over the long run.[30] It is this richer multi-faceted sense of sustainability that I wish to capture here.

§4.2.1. Environmental sustainability

The Siloed World, by giving priority to singular functions on certain sites, encourages the intensification of land uses. As such, we see examples in the New Zealand landscape of intensive dairy farming and intensive commercial forestry, which create environmental harms that undermine the future prosperity of the landscape. The basic problem is the prioritisation of short-term financial gain to the detriment of environmental systems, especially over the long run. This is not necessarily about extending profit margins; for many landowners, the more pressing challenge is to remain solvent in a challenging economic environment. The tragedy is that these immediate financial exigencies can

[28] See, for instance, Dominik Thom, Werner Rammer & Rupert Seidl. (2017). The impact of future forest dynamics on climate: Interactive effects of changing vegetation and disturbance regimes. *Ecological Monographs, 87* (4), pp.665-684.
[29] United Nations. (1987). *Our common future: Report of the World Commission on Environment and Development.* Transmitted to the General Assembly as an Annex to document A/42/427 - Development and International Cooperation: Environment. Geneva: UN, chapter. 2, para. 1.
[30] Given that organisations and economies are necessarily socially and environmentally embedded, it is likely that these different kinds of sustainability will reinforce each other over the long run. However, we should remain open to the possibility that tradeoffs are possible; for example, an organisation might maintain its fiscal sustainability by exploiting resources in a way that undermines environmental sustainability.

undermine economic prosperity over the long run, by degrading the natural assets (soil fertility, freshwater, biodiversity and so on) that underpin farm productivity and profitability.

Any land use delivers a range of impacts – some positive, some negative, some involving trade-offs between different kinds of public value. In this section, §4.2.1, I focus only on negative environmental impacts of intensive production. High-input intensive dairy farming is associated with:[31]

- pollution of surface and groundwater by excess nutrients, particularly nitrogen and phosphorous;
- extraction of water for irrigation to the detriment of other water users;
- indirect damage to freshwater and estuarine habitat through contamination and extraction;
- soil erosion, soil contamination, and damage to soil structure;
- destruction of wetland and native lowland forest for farm development;
- loss of native biodiversity through damage or destruction of native habitat; and
- discharge of greenhouse gases, especially methane and nitrous dioxide.

Intensive commercial forestry – in particular, exotic monoculture forests that are densely planted for rapid growth and managed under a clear-cut system – are associated with:[32]

- degradation of soil organic matter and soil nutrient loss;
- discharge of sediments from harvesting and roading;
- reduction of water yield and flow in associated catchments;
- disturbance of flora and fauna, especially during harvest or pesticide;
- contamination of soil and water from discharge of chemicals such as pesticides, herbicides, fungicides, and timber preservation treatments.

[31] Parliamentary Commissioner for the Environment. (2004). *Growing for good: Intensive farming, sustainability and New Zealand's environment.* Wellington: Parliamentary Commissioner for the Environment; D.A. Clark et al. (2007). Issues and options for future dairy farming in New Zealand. *New Zealand Journal of Agricultural Research, 50* (2), pp. 203-221; Henrik Moller et al. (2008). Intensification of New Zealand agriculture: Implications for biodiversity. *New Zealand Journal of Agricultural Research, 51 (3)*, pp.253-263; R. Collins et al. (2007). Best management practices to mitigate faecal contamination by live-stock of New Zealand waters. *New Zealand Journal of Agricultural Research, 50*, pp.267-278; M. Jay & M. Morad. (2007). Crying over spilt milk: A critical assessment of the ecological modernization of New Zealand's dairy industry. *Society and Natural Resources, 20*, pp.469-478; Ramesh Baskaran, Ross Cullen & Sergio Colombo. (2009). Estimating values of environmental impacts of dairy farming in New Zealand. *New Zealand Journal of Agricultural Research, 52* (4), pp. 377-389.

[32] For discussion, see Grant Rosoman. (1994). *The plantation effect: An ecoforestry review of the environmental effects of exotic monoculture tree plantations in Aotearoa/New Zealand.* Report prepared for Greenpeace New Zealand; Piers Maclaren. (1996). Environmental effects of planted forests in New Zealand: The implications of continued afforestation of pasture. *FRI Bulletin.*

There are important caveats here. Impacts depend on the specifics of the site (soil type, local climate, topology, etc.) and management strategy, as well as the degree of intensification. Moreover, even when negative impacts occur, these are balanced against positive impacts, which include supply of food, provision of timber and other wood products, regional employment opportunities, export goods, lifestyle opportunities, and so on.[33]

These positive impacts can be unexpected and underappreciated, such as the relationship between exotic plantation forestry and indigenous biodiversity, where plantation forests can become an unlikely home to a wide range of native flora and fauna. This extends the scale of potential habitats for native species to survive and flourish in. Even where these forests are eventually felled, the use of retention systems, where forest features are preserved after harvest, can prolong these habitats.[34]

Nevertheless, being clear-eyed about negative impacts enables landowners and regulators to put in place measures that control, minimise or compensate for their effects; or to adopt less harmful technologies and management practices; or to pursue propitious trade-offs with other land uses and functions. In other words, there is scope for pragmatism. But the Siloed World is limited in its capacity to be pragmatic, because it lapses back to a trinary choice: native conservation forests, exotic commercial forests and pastoral agriculture. By contrast, the Interwoven World has a palette of land use options to choose from, each of which strikes a different balance between economic, environmental and social functions. There is, therefore, a greater capacity to manage the landscape in an integrated way, especially to harmonise various land uses so that (where possible) negative impacts are offset, remediated or diverted.

§4.2.2. Social sustainability

Land uses need to have a degree of social license or legitimacy from wider publics in order to be sustainable. Without this, unpopular land uses are vulnerable to boycott by consumers and investors, or subjected to regulatory changes that voters call for via their political representatives. Alternatively, if regulation itself is the cause of an unpopular land use – perhaps because of zoning or planning rules – then there is a chance for noncompliance or electoral backlash. (For more on community sentiment, see §4.4, the mauri ora principle.)

A salient example is the question of using fast-growing exotic trees, such as *Pinus radiata*, for creating carbon sinks. If a government forced landowners to establish such forests through regulatory measures, even though those landowners preferred native species, then these forests are likely to be poorly managed or removed in future. In other words, these forests would be unsustainable because of the absence of social

[33] For discussion, see John Dymond (ed.). (2013). *Ecosystem services in New Zealand.* Lincoln, NZ: Manaaki Whenua Press, especially chapters 1.4, 1.5 and 1.6.
[34] See E.G. Brockerhoff, H. Jactel, J.A. Parrotta, C.P. Quine & J. Sayer. (2008). Plantation forests and biodiversity: Oxymoron or opportunity? *Biodiversity Conservation, 17*, pp. 925–951.

license. This is also a risk if the forest is incentivised not through 'sticks' but 'carrots', such as subsidies and grants, because present and future generations might not have any affinity for the forests that were funded. However, forest sinks that enjoy a sense of legitimacy and affection from local communities are likely to be well managed and protected over the long run. In Aotearoa New Zealand, perhaps especially among Māori landowners, it is more likely that permanent forests of native species will enjoy that social license. Hence the need to think more creatively about carbon sinks, not just to take a siloed approach that aims to maximise carbon yield to the detriment of other considerations or functions.

It is also worth noting that the question of social sustainability is global as well as local, particularly when it comes to transnational supply chains. The Siloed World, in its pursuit of intensification and higher productivity, tends toward high-input systems that rely upon synthetic fertilisers, supplementary feedstocks, and so on. This can involve highly contentious relationships, such as the import to New Zealand of phosphate for fertilisers from politically contested territory in the Western Sahara,[35] or the purchasing of palm kernel extract as a supplementary feedstock which can incentivise deforestation of tropical rainforests in South East Asia.[36] Intensive land use systems that rely heavily on such inputs are vulnerable not only to shocks in supply, but also to consumer backlashes, regulatory controls and/or international conventions.

§4.2.3. Fiscal sustainability

It is vital also that land use systems are financially viable over the long-run, and do not make landowners or their inheritors insolvent. It is in regards to this principle that the Interwoven World, at least under current regulatory and economic circumstances, is less well-aligned than the Siloed World. If this were not so, then the New Zealand landscape might look more like the Interwoven World than it currently does.

This is not to say that the diverse land uses of the Interwoven World (see Section 5) are uniformly uneconomic. On the contrary, there is evidence that, even under current conditions, less intensive systems in agriculture and forestry can be profitable, potentially even competing with intensive systems.[37] But other land use systems may subordinate profitability by promoting the social and environmental functions. This might be acceptable to landowners with deep pockets, who can afford to make land use decisions based on extra-monetary considerations like aesthetic preference or environmental aspirations. But for most landowners, these land use systems – no matter how desirable – will be fiscally unsustainable, either because they will make landowners

[35] See Gerard Hutching. (2018, March 2). The ethical element to fertiliser - push for NZ co-ops to stop buying phosphate from Morocco. Stuff. Retrieved from: https://www.stuff.co.nz/business/farming/101920354/nz-fertiliser-coops-under-growing-pressure-to-stop-buying-phosphate-from-morocco

[36] See Gerard Hutching. (2017, June 12). Fonterra farmers have a year to adapt to palm kernel changes before penalty. *Stuff.* Retrieved from: https://www.stuff.co.nz/business/farming/93586066/fonterra-farmers-have-a-year-to-adapt-to-palm-kernel-changes-before-penalty

[37] Tony Benny. (2017, September 21). Demonstration dairy farm cuts nitrate leaching 30 per cent and stays profitable. *Stuff.* Retrieved from: https://www.stuff.co.nz/business/farming/97071476/demonstration-dairy-farm-cuts-nitrate-leaching-30-per-cent-and-stays-profitable

bankrupt, or impose an intolerable risk of this occurring. The Siloed World, for all its faults (and indeed for all its own challenges in maintaining fiscal sustainability), at least provides a predictable schedule of revenue and expenses. For the Interwoven World to become fiscally sustainable, or to overcome perceptions that it is fiscally unsustainable, a systems change is required to adjust the wider economic and regulatory conditions. I explore the possibilities for reform in Section 7.

Suffice to say here that one dimension of the Siloed World does appear to be more directly misaligned with fiscal sustainability: native conservation forest. Our conservation estate is managed as a public good and protected as a matter of statutory obligation. Biodiversity, recreational value and national identity are among the key dimensions of value. Also, from a climate perspective, forest conservation is vital for preventing the carbon dioxide emissions through forest loss and degradation. In 2015, it was estimated that New Zealand's mature indigenous forests stored about 1.706 billion tonnes of carbon, at about 257.7 tonnes per hectare, which entails an enormous liability in the event of catastrophic forest loss.

Nevertheless, for many years, funding for conservation has been insufficient and declining; for example, it was recently claimed that only about 12.5% of public conservation land receives pest control.[38] One response would be to simply increase public funding – yet this is one of many demands upon public funds and there are genuine disagreements over what should take priority. This raises the possibility that a siloed conception of conservation is an obstacle to alternative management strategies that are more financially sustainable and less vulnerable to the changing priorities of consecutive governments. Indeed, debates of this nature have already occurred in relation to Māori-owned forest, such as Waitutu forest, where Ngāi Tahu were looking to harvest native forests sustainably, yet were prevented by conservation laws and activists that upheld a preservationist approach to native forest.[39]

It is doubtful that the public would support a dramatic shift away from the current preservationist model of conservation management for New Zealand's old-growth forests. However, for future forests, it is possible that a more financially sustainable management system would permit selective felling under a close-to-nature forestry system. When combined with carbon revenue, such forests could create enough income to self-sustain the costs of forest maintenance, as well as pest and predator control. But this would require a rethink of regulations, especially local District Plans that impose blanket bans on the felling of native species, even recently planted trees, thereby relegating native species to conservation siloes.

[38] Marie Brown et al. (2015). *Vanishing nature,* p.42.

[39] See Michael J. Stevens (2012). Settlements and 'Taonga': A Ngāi Tahu commentary. In Nicola R. Wheen and Janine Hayward (Eds.), *Treaty of Waitangi Settlements* (pp. 106-118). Wellington: Bridget Williams Books.

§4.3: The resilience principle

Resilience is typically defined as the capacity of a system to absorb disruptions and to adapt to change in order to provide the same functions.[40] In terms of the New Zealand landscape, resilience is a desirable property for land use systems, whether in forestry or agriculture, but also for the land itself and its underpinning geophysical and biological systems. For example, climate adaptation policy is centrally concerned with building resilience to prepare for the increased risk of extreme weather events and other unexpected shocks, such as the changing distribution patterns of parasites or pests. However, building resilience is also vital for preparedness to disruptions in the global economic system.

The Siloed World creates or perpetuates aspects that undermine the resilience of the land sector. Two major issues stand out:

§4.3.1. Reforesting erosion-prone land

A major deficiency of land resilience in New Zealand is the substantial proportion of highly erosion-prone land in pasture. A recent analysis of the New Zealand Land Cover Database from 2012/2013 found that the scale of suitable land for afforestation that is severely to extremely erosion-prone is 695,566 hectares. Moderate to extremely erosion-prone land was 1.131 million hectares. Slight to extremely erosion-prone land was 2.923 million hectares.[41] Much of this land is in Manawatū and the East Coast of the North Island, and remains highly vulnerable to terrestrial erosion during major rain events, which are expected to increase as a consequence of climate change. For example, the June 2015 'weather bomb' that struck Taranaki/Horizons regions was estimated to have cost $70 million in damage to public and private property, with about 460 farms affected and thirty farms facing over $500,000 damage each.[42] In addition, there are the continued annual costs from soil loss and the associated effects of sedimentation in waterways. New Zealand is estimated to be losing 192 million tonnes of soil into the ocean every year, with an estimated cost in 2015 from erosion and landslides at $250–300 million annually.[43]

Establishment of forest on this land will, typically, reduce sediment loss and vulnerability to terrestrial erosion. Moreover, the opportunity cost for other uses is usually low or negligible, because this erosion-prone land is minimally productive for pastoral agriculture, and also marginal for commercial forestry because of the added transport and operational costs from steep, remote land. The recent increase in carbon price

[40] B. Walker, C.S. Holling, S.R. Carpenter & A. Kinzig. (2004). Resilience, adaptability and transformability in social–ecological systems. *Ecology and Society, 9* (2), p.5.

[41] Walsh et al. (2017). *Valuing the benefits of forests: Final report.* Report prepared for the Ministry for Primary Industries. Wellington: New Zealand Government.

[42] Ministry for Primary Industries. (2015). *June 2015 Taranaki and Horizons regions storm*. MPI Technical Paper. Wellington, New Zealand: Ministry for Primary Industries. Retrieved from https://www.mpi.govt.nz/news-and-resources/media-releases/june-floods-cost-the-primary-sector-70-million-says-mpi/.

[43] Ministry for the Environment & Statistics New Zealand. (2018). *New Zealand's environmental reporting series: Our land 2018*, pp.75–6. Retrieved from www.mfe.govt.nz and www.stats.govt.nz.

has made carbon revenue more feasible, and carbon farming could be encouraged through greater knowledge of the opportunities and removing administrative barriers. However, high land prices work against the financial viability of carbon sinks. The lack of regulatory certainty in the past, especially over the Emissions Trading Scheme, remains a perceived risk. Upfront costs for establishing forest, or even for fencing off land for regeneration, are prohibitive. And for some landowners, there remains a culture of resistance to returning land to forest, especially when earlier generations worked to clear scrub from the hills.

§4.3.2. Enhancing forest resilience in a warming, globalising world

Another issue is the vulnerability of forest ecosystems to a changing climate. One of the Intergovernmental Panel on Climate Change's reasons for concern about global warming is the increased incidence of extreme weather events. In the New Zealand context, this is expected to lead to: (1) more frequent and longer droughts; (2) higher incidence of extreme weather events that might damage forest through windthrow or landslides; and (3) expanded ranges for pests, diseases and parasites.[44] Both native conservation forests and exotic plantation forests are vulnerable to these effects; however the latter are especially vulnerable because most are managed as monocultures for rapid growth rates rather than longevity.

A key contributor to resilience is heterogeneity – that is, the presence of diversity and redundancy in a system, which enhances its capacity to adapt to change and disruption.[45] This is encouraged in the Interwoven World, yet not in the Siloed World, which works against complexity to create monocultures. As Nocentini et al. argue:

> Conventional forest management, aimed at maximizing wood production and based on a command & control approach has simplified the structure and composition of forest ecosystems. This simplification, reducing response diversity, makes these systems fragile, more vulnerable to stress, such as parasites, climate change etc. and thus more prone to collapse because unable to respond in an adaptive way. [46]

The predominance of even-aged, single-species stands among New Zealand's non-conservation forests – both at the national and the plantation level – means that our forest assets are vulnerable to catastrophic loss from such hazards. In particular, the heavy reliance on Pinus radiata for production forests, as well as carbon farming, is mitigated somewhat by encouraging genetic diversity. However the uptake of clonal forestry, where trees are cloned, reduces such diversity and hence increases the risk of species-specific pests and disease.

[44] A. Reisinger, R. L. Kitching, F. Chiew, L. Hughes, P. C. D. Newton, S. Schuster, A. Tait, & P. Whetton. (2014). Australasia. In V. R. Barros et al. (Eds.), *Climate change 2014: Impacts, adaptation and vulnerability. Part B: Regional aspects. Contribution of Working Group II to the Fifth assessment report of the Intergovernmental Panel on Climate Change* (pp. 1371-1438). Cambridge University Press: Cambridge, UK and New York, USA; Royal Society of New Zealand. (2016). Climate change implications for New Zealand. Wellington: RSNZ.

[45] S. A. Levin et al. (1998). Resilience in natural and socioeconomic systems. *Environment and Development Economics, 3* (2), pp.225–36.

[46] Susanna Nocentini et al. (2017). Managing forests in a changing world: The need for a systemic approach. A review. *Forest Systems, 26* (1), p.3.

Consider, for example, the recent mountain beetle outbreak in North America. It is estimated that the cumulative impact in British Columbia, Canada during 2000–2020 will involve the loss of 270 million tonnes of carbon, enough to convert this forest from 'a small net carbon sink to a large net carbon source both during and immediately after the outbreak.'[47] The British Colombia Government has estimated that, by 2020, the infestation will have killed an estimated 55 per cent of the province's mature merchantable pine, just under 740 million m^3.[48] Given the impact on the forestry industry, this is a combined financial, social and environmental loss.

Forest diversity – again, at the national and the plantation level – is an insurance against such risks. As James Scott writes:

> Monocultures are, as a rule, more fragile and hence more vulnerable to the stress of disease and weather than polycultures are… A diverse, complex forest, however, with its many species of trees, its full complement of birds, insects, and mammals, is far more resilient – far more able to withstand and recover from such injuries – than pure stands. Its very diversity and complexity help to inoculate it against devastation: a windstorm that fells large, old trees of one species will typically spare large trees of other species as well as small trees of the same species; a blight or insect attack that threatens, say, oaks may leave lindens and hornbeams unscathed.[49]

This excerpt comes from the opening chapter of *Seeing Like a State*, Scott's famous critique of administrative rationality. He uses forestry as a foundational example, discussing the 'scientific forestry' movement in late eighteenth-century Prussia and Saxony, whereby forests were managed strictly on the function of increased yield. However, this involved monoculture forests that eventually succumbed to soil degradation, outbreaks of pest and disease, and disruptions to the nutrient cycle. As Scott writes, 'A new term, Waldsterben (forest death), entered the German vocabulary to describe the worst cases.' This had flow-on effects for local communities, already alienated from their traditional lifeways, now faced with the collapse of their new forest economy. However, this contributed to new thinking in German forestry, such as Karl Gayer's (1822–1907) work on mixed forest structures, then the development of Dauerwald (continuous cover forestry) by Alfred Möller in the early 1920s, then close-to-nature forestry by Arbeitsgemeinschaft Naturgemäße Waldwirtschaft in the 1950s, and finally the establishment of the pan-European Pro Silva movement in 1989. These innovations are discussed below in Section 5 and point to options for more resilient forest assets.

[47] W. A. Kurz et al. (2008). Mountain pine beetle and forest carbon feedback to climate change. *Nature 452* (7190), pp.987-990.
[48] British Columbia Government. (2018). Mountain Pine Beetle Projections. Retrieved from: https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/forest-health/forest-pests/bark-beetles/mountain-pine-beetle/mpb-projections
[49] James C. Scott. (1999). *Seeing like a state: How certain schemes to improve the human condition have failed.* New Haven: Yale University Press.

§4.4: The mauri ora principle

The mauri ora principle refers to the interconnectedness of people and the environment. It relates to the concept of *mauri*, which in te ao Māori is conceived as a lifeforce – 'the spark of life'[50] – that permeates the universe. Mauri belongs not only to people and animals, but also to features of the environment such as water, water bodies, the land, the soil, and so on. A further concept is *whakapapa*, which recognises the interdependencies and interrelatedness of things, including between people and place. Accordingly, a decline in mauri in one domain can upset the balance of mauri elsewhere, producing a state of mauri mate where wellbeing is negatively affected. A state of mauri ora, by contrast, underlies good health, reflecting a state of balance or harmony between people and the environment.

In recognition of this interrelatedness, Māori frameworks of well-being, such as those developed by Mason Durie, include an environmental dimension, because the health of the land is regarded as intrinsically connected to the health of tangata whenua, the people connected to a place by way of whakapapa.[51] Similarly, the Mauri Model devised by Kepa Morgan recognises that an adequate planning assessment ought to consider the implications for mauri across four interrelated spheres: 'the mauri of the whanau or family (economic), the mauri of the community (social), the mauri of the hapu (cultural), and the mauri of our ecosystem (environment) respectively.'[52]

These are uniquely Māori concepts that operate within uniquely Māori frameworks of thinking. However, there are affinities and echoes with some strands of Pākehā thinking. This includes long-standing traditions of systems thinking that focus on the interrelatedness and dynamism of complex systems.[53] It also includes the present shift toward integrated approaches to accounting and reporting that take a holistic view of social, environmental and economic value. A prominent example at the national level is the Living Standards Framework by the New Zealand Treasury, which emphasises the interrelatedness of the four capitals – economic, natural, social and human capital – in determining national wellbeing.[54] At the project level, Total Value Analysis is emerging as a potential framework for capturing the wider sense of value created by particular projects, especially for infrastructure projects that deliver significant public benefit.[55]

[50] Hirini Moko Mead. (2003). *Tikanga Māori: Living by Māori values.* Wellington: Huia, p.57.

[51] Mason Durie. (1998). *Whaiora: Māori health development*. Auckland: Oxford University Press; Durie, M. (1999). Te pae mahutonga: A model for Māori health promotion. *Health Promotion Forum of New Zealand Newsletter, 49*. Retrieved from http://www.hauora.co.nz/resources/tepaemahutongatxtvers.pdf; Mason Durie. (2001). *Mauri ora: The dynamics of Māori health.* Melbourne: Oxford University Press.

[52] T. K. K. B. Morgan. (2006). An indigenous perspective on water recycling. *Desalination*, 187, p.130.

[53] This is a theme in Anne Salmond. (2017). *Tears of Rangi: Experiments across worlds.* Auckland: University of Auckland Press, especially pp.36–37 & 406–415.

[54] Treasury. (February 2018). *The Treasury approach to the living standards framework.* Wellington: New Zealand Government.

[55] Ernst & Young (EY). (2014). *Integrated reporting: Elevating value.* EY Climate Change and Sustainability Services; Ernst & Young (EY). (2016). *Total value: Impact valuation to support decision-making.* Netherlands: EY; Ernst & Young (EY)/Tahi. (2016). *Total value reporting: How to articulate and measure progress against all of the Kaupapa your organisation pursue*. Auckland: EY.

Yet the Siloed World tends to work against this interrelatedness. It allocates discrete land uses to particular sites, then sets out to intensify activities on those sites. This intensification is enabled, in part, by land use decisions that account *only* for immediate costs and benefits. Meanwhile, negative impacts that occur beyond the fenceline – such as deteriorating water quality, air pollution, or emission of greenhouse gases – are neglected or minimised by decision makers. To use the economic parlance, these are *negative externalities*, where costs are borne by neighbouring property owners, or local communities, or national taxpayers, or the global community, or future generations. However, precisely because these costs are borne by others, in ways that are unfair or unjust, there is every possibility that these externalities will not remain external over the long run. Egregious polluters are likely to eventually face consequences for their actions, which might take the form of public resentment, or calls for remediation or compensation. If this public pressure is successful and prompts a regulatory response from Government, or a voluntary response from landowners themselves, then the externalities will become internalised, as landowners face pollution charges, or carry the costs for remediation and/or mitigation, and so on.

In other words, the Siloed World perpetuates a vision of landowners operating in perfect silos, where private choices on private land have no implications for wider publics. But this vision alone cannot remove landowners from our interwoven reality where social, environmental and economic factors are entangled with one another. This is a consequence of the mauri concept, but also Western traditions of systems thinking that treat the landscape as a complex adaptive system that is entwined with other complex systems at the local or global scale, such as local ecosystems, geological systems, hydrological systems, global climate systems, or economic systems that landowners participate in by selling their products and purchasing goods and services (see further discussion below Section 6 on landscape approaches).

The concept of mauri provides a uniquely Māori perspective on this interconnectivity: it recognises that, by undermining the wellbeing of the land, the wellbeing of surrounding communities will be undermined, which will eventually undermine the wellbeing of the landowner also. Integrated frameworks, such as the Living Standards Framework or Total Value Analysis, can also transcend these siloed ways of thinking by internalising those impacts that were otherwise external to cost-benefit analysis. Incorporating these more holistic frameworks into our present-day decision-making would advise against the Siloed World, which outsources environmental costs to others, and instead would recommend the Interwoven World.

§4.5: The biodiversity principle

The biodiversity principle recognises that there is both intrinsic and instrumental value to the unique flora and fauna of New Zealand.[56] Among New Zealand's native plants, nearly 40% are threatened or at risk. Among native lizards, 85% are threatened or at risk. Among native freshwater fish, 74% are threatened or at risk. Among New Zealand's 417 bird species, over 40% are threatened or at risk, with 56 species already extinct.[57]

This is not only a consequence of land use changes – introduced predators are a major cause – but land use decisions do impact upon biodiversity, both directly and indirectly. This includes the direct destruction or removal of ecosystems through land use change (for example, the clearing of forest ecosystems to make way for pastoral agriculture). It also includes the disruption or destabilisation of an ecosystem as a secondary effect from land use change on adjacent sites (such as changes to freshwater ecosystems as a consequence of nutrient runoffs from agricultural intensification in the surrounding catchment).

Any land use change can have these effects, whether in pursuit of the Interwoven or Siloed World. However, the latter is especially disruptive, because its mandate is to manage a site in order to maximise some singular function, such as agricultural productivity, timber yield, or preservation of nature. The Interwoven World, by contrast, gives priority to the mixing, mingling and co-existence of land uses. This can include land use strategies that have the deliberate purpose of supporting native biodiversity while also permitting other functions.[58]

One concrete example is the creation of green corridors or wild links in urban settings that enable biodiversity functions to co-exist with economic development. Similarly, the creation of riparian margins or buffer zones in agricultural areas create opportunities for habitat restoration, thereby enriching local biodiversity as a co-benefit of reducing the environmental impact of agriculture. Finally, plantation forests, which already support biodiversity outcomes, can maximise these positive impacts through practices such as retention forestry, where individual trees or forest patches are retained at harvest.[59] So, while the Interwoven World does not rule out the disruption of native biodiversity through land use changes, it nevertheless enables land uses that strive to balance biodiversity functions among others.

[56] For example, see National Research Council (US) Committee on Noneconomic and Economic Value of Biodiversity. (1999). *Perspectives on biodiversity: Valuing its role in an everchanging world.* Washington (DC): National Academies Press (US), especially chapters 3 and 4.
[57] Marie Brown et al. (2015). *Vanishing Nature*, pp.2-3.
[58] See Parliamentary Commissioner for the Environment. (2002). *Weaving resilience into our working lands.*
[59] Katja Fedrowitz et al. (2014). Can retention forestry help conserve biodiversity? A meta-analysis. *Journal of Applied Ecology, 51* (6), pp.1669–1679.

For Colin Muerk and Simon Swaffield, this potential shift away from our siloed landscape would be socially transformative, a break from our colonial legacy: 'New Zealand is at a crossroads, one that is historically unusual in that we are now conscious of our culture-forging decisions. We can collectively decide to integrate indigenous nature into our productive landscapes, or we can allow reinforcement of the historical dichotomy of nature and culture and continue the ambivalence and uneasy sense of displaced identity it brings.'[60]

5: The Many Strands of the Interwoven World

Whiria he kaha tua tini mōu, whiria he kaha tua manomano mōu, he koutu whenua, he take whenua e kore e taea

—Marumaru[61]

In order to strike a more prosperous balance between economic, environmental and social functions, New Zealand should – where possible – shift toward more integrated land use systems. These could be applied at a range of scales – from the farm level, to the catchment level, to the national level. To be clear, the Interwoven World *does not exclude* the trinary framework of exotic plantation forests, native conservation forests, and pastoral agriculture. It includes these as among the threads that might create the tapestry of the landscape. But the Interwoven World encourages and incentivises a more diverse palette of land use options. These could include – and are not limited to – the following:

- **Carbon farming:** This is already a well-established, if still underutilised, land use. In carbon farming, forests are grown for the primary function of carbon sequestration to accrue carbon credits to be sold in voluntary or compliance carbon markets. In regards to the latter, carbon sinks registered under the Emissions Trading Scheme (ETS) or the Permanent Forest Sink Initiative (PFSI) earn one NZU (New Zealand Unit) for each tonne of carbon sequestered (at the time of writing, $21 per NZU). Carbon farming in the ETS and PFSI can involve native species but also exotics. If the only function is carbon yield, then exotic species are preferable given their fast growth rates; for example, *Pinus radiata* is commonly used for carbon farming. It is worth noting, however, that when we include sustainability and resilience as expected forest functions, then diversity of species for carbon sinks is crucial. Firstly, diversity is a way to manage the risk of catastrophic forest loss (see §4.3.2) and therefore the loss of sequestered carbon. Secondly, a forest sink that includes at least some native species will deliver multiple functions (such as biodiversity values) that are likely to be highly valued in the future, which de-risks the forest somewhat from future land use change.

[60] Colin Meurk & Simon Swaffield (2000). A landscape ecological framework for indigenous regeneration in rural NZ-Aotearoa. *Landscape and Urban Planning, 50* (1), p.142.

[61] 'Plait a many cord belt for yourself. Plait a thousand cord belt for yourself. Land is the substance, land is the foundation.' Cited in Murdoch Riley. (2013). *Wise words of the Māori: Revealing history and traditions*. Paraparaumu: Viking Sevenseas NZ Limited, p. 860.

- **Mixed native/exotic systems:** This is the use of a nursery crop of fast-growing exotic species (such as tree lucerne, polar, willow, or pine species) that is interplanted with a successive generation of slow-growing native species. The exotic trees could be left to die out naturally or by human intervention, or selectively felled and extracted to create interim revenue as timber, chip or pulp. In this way, the native understorey comes to dominate the forest ecosystem sooner than it would by natural regeneration. There are multiple considerations about the appropriateness of certain species for particular sites. There are also major knowledge gaps about mixed native/exotic systems (although research is emerging, such as forest ecologist Adam Forbes' work on using *Pinus radiata* plantations as nurseries for native forest restoration).[62] But mixed systems provide an opportunity to strike a favourable balance between climate alignment and biodiversity outcomes. On the one hand, it enables more rapid carbon sequestration and hence greater economic viability.[63] On the other hand, it creates a clear pathway to native forest outcomes, which is critical for landowners who have personal or cultural preferences for native forest (such as Māori landowners).

- **Continuous cover forestry:** This refers to the use of commercial silvicultural systems that maintain the forest canopy at one or more levels without clear felling.[64] One strategy is selection systems, which involve the removal of trees or groups of trees according to certain criteria. Such systems are designed to create and maintain an uneven-aged stand structure, which, depending on the proportion of trees removed, preserves the continuity of canopy cover. This can be contrasted with clear-cut systems, where the entire forest is felled and restocked at roughly the same time, which has environmental implications in the 'window of vulnerability' when the land is unforested (see §4.1.2). But continuous cover forestry minimises these environmental effects, because only a proportion of trees are removed, thereby maintaining a continuous forest ecosystem (albeit not without disruption). This not only reduces environmental damage, it also minimises future irregularities in the forestry sector's contribution to national net emissions, because it would elongate felling schedules, rather than causing bulges in harvestable wood supply and therefore coincident bulges in emissions. This is potentially a financially viable system: a recent investment analysis by asset manager SLM Partners estimated an internal rate of return of about 6% before inflation, by modelling a Sitka spruce-dominated plantation in Ireland.[65] The New Zealand Farm Forestry Association

[62] Adam Forbes. (2015). *Non-harvest* Pinus radiata *plantations for forest restoration in New Zealand.* PhD thesis for New Zealand School of Forestry. Christchurch: University of Canterbury; Adam Forbes, David Norton & Fiona Carswell. (2015). Underplanting degraded exotic Pinus with indigenous conifers assists forest restoration. *Ecological Management & Restoration, 16* (1), pp.41-49; Adam Forbes, David Norton & Fiona Carswell. (2016). Artificial canopy gaps accelerate restoration within an exotic *Pinus radiata* plantation. *Restoration Ecology, 24* (3), pp.336-345.

[63] A preliminary investment analysis by Sean Weaver of Ekos modelled an internal rate of return of 13.9% for a mixed native/exotic scenario for a project modelled to 2040. Sean Weaver. (2017). *Hawke's Bay climate resilience programme: A framework for the climate change component of the Hawke's Bay Long-Term Plan.* Consulting report to the Hawke's Bay Regional Council. Ekos Consulting Reports 2017/008. Takaka, New Zealand, pp.81-83.

[64] Ian Barton. (2008). *Continuous cover forestry: A handbook for the management of New Zealand Forests.* Tānes Tree Trust, Hamilton, NZ. 104 pp.

[65] See Paul McMahon, Darius Sarshar, & Paddy Purser (2016). *Investing in Continuous Cover Forestry.* White Paper for SLM Partners.

recently received a Sustainable Farming Fund grant to explore the feasibility of continuous cover forestry for small forest blocks in New Zealand, drawing upon the system trialled by Dr John Wardle in Oxford, North Canterbury.[66] This can also occur within the Permanent Forest Sink Initiative, which allows forest owners to harvest on a selection basis,[67] thereby combining carbon and timber revenue. Although operational costs for continuous cover forestry could be higher, given the public value created, there are opportunities for public and/or private investment (see Section 7).

- **Close-to-nature forestry:** This involves the selection harvesting of trees while otherwise maintaining the integrity of a native forest ecosystem as much as possible. This has international precedents, such as the Pro Silva movement in Europe, but also aligns with Māoritanga in certain forests, where trees are removed for timber but the forest remains intact. There would likely be strong public resistance to introducing these management systems to old-growth forests in New Zealand's conservation estate, but there are opportunities for forests under Māori authority, or for increasing the financial sustainability of future forests.

- **Native commercial forestry:** This is the use of native species in conventional commercial systems in order to derive a timber yield of premium value. Such forests will likely grow slower than exotic forests, which may misalign with short-term emissions targets (i.e. 2030), but generate other benefits such as biodiversity, social license, premium timber value, and longer-lasting carbon flows (i.e. 2050 and beyond).[68]

- **Natural and assisted regeneration:** Natural regeneration is the most cost-effective route to afforestation/reforestation of retired land.[69] However, regeneration can take decades, especially if seed sources are remote, so assisted regeneration could be deployed to accelerate carbon sequestration and environmental co-benefits. This could include the creation of nearby 'seed banks' that facilitate seed dispersal by birds, the use of drones for seed dispersal and weed control, the planting of nursery species to provide cover, and so on.

- **Riparian planting:** This refers to the creation of riparian buffers along waterway margins in order to reduce excess nutrients or contaminants from entering the water, and also to restore native habitat that creates shade, cools water, and supports native biodiversity. Riparian planting is an increasingly familiar concept, but not necessarily well-aligned with the existing regulatory framework. For example, most

[66] Harriet Palmer. (March 2018). Assessing the feasibility of a continuous cover forestry system for radiata pine in small-scale forests. *Farm Forestry New Zealand.* Retrieved from http://www.nzffa.org.nz/article-archive/assessing-the-feasibility-of-a-continuous-cover-forestry-system/

[67] 'Under the PFSI, harvesting operations must retain a minimum of 80 percent of the pre-harvest basal area on each hectare for the first harvesting operation. For subsequent harvests, either a minimum of 80 percent of the existing pre-harvest basal area on each hectare or 80 percent of the previous pre-harvest basal area on each hectare (whichever is the greater) must be retained.' Ministry for Primary Industries. (February 2015). *Guide to the Permanent Forest Sink Initiative*. Wellington: NZ Government.

[68] For example, see the literature developed by Tāne's Tree Trust (last accessed 6/3/2018): http://www.tanestrees.org.nz/resource-centre/publications/

[69] Thomas Carver & Suzi Kerr. (2017). *Facilitating carbon offsets from native forests*. Motu Research Working Paper 17-01. Wellington NZ: Motu Economic and Public Policy Research, p.9.

riparian margins are less than 30 metres, hence not eligible for accruing NZUs through the Emissions Trading Scheme.

- **Horticulture and cropping:** This refers to orchards, vineyards and croplands for fruit, vegetables and flowers. Although horticulture is not currently within the Emissions Trading Scheme and fruit trees are not eligible for carbon credits, the transition from livestock to crops nevertheless reduces greenhouse gas emissions. However, it doesn't mean no emissions at all; most horticultural emissions come from nitrates in fertilisers.
- **Agroforestry:** This refers to the integration of trees on farms and agricultural landscapes to diversify and sustain production through delivering environmental and economic benefits.[70] This could include:
    - **silvopastoral systems** that strategically combine trees with pastoral agriculture and livestock, thereby delivering carbon sequestration benefits that offset, or exceed, on-farm emissions, as well as creating further environmental benefits (shade for stock and streams, erosion prevention, nutrient sequestration, etc.);
    - **tree intercropping systems** that combine trees with crops, increasing on-site carbon sequestration and providing additional environmental benefits;
    - **multistrata agroforestry systems** that combine perennials, annual crops and livestock (usually in tropical environments).
- **Urban forestry:** This refers to the integration of trees and vegetation into urban settings, especially as 'green infrastructure' that provides material benefits such as rainwater interception and regulation of stormwater, filtration of pollutants and contaminants from air and water, food as urban orchards, and so on.[71] Some examples are:
    - **green corridors and wild links:** A series of interlinked habitats that enable the movement and flourishing of native biodiversity in urban settings;
    - **street trees, green streets and green spaces:** The establishment of trees in order to produce benefits for local communities, including general effects on wellbeing and community health, but also specific benefits such as shade and temperature regulation, UV protection, air filtration, increased aesthetic value with subsequent increases to property value and retail expenditure, and so on.

[70] Stephen Briggs. (June 2012). Agroforestry: A new approach to increasing farm production. Nuffield Farming Scholarships Trust Report. Stratford Upon Avon, UK: NFU Mutual Charitable Trust; Eric Toensmeier. (2016). *The carbon farming solution: A global toolkit of perennial crops and regenerative agriculture practices for climate change mitigation and food security.* White River Junction, VT: Chelsea Green Publishing.

[71] C. Boyle et al. (2014). *Greening cities: A review of green infrastructure.* Report prepared by Transforming Cities: Innovations for Sustainable Futures, University of Auckland.

- **bioretention systems, bioswales and constructed wetlands:** The use of trees and vegetation as 'green infrastructure' to intercept rainwater and relieve strain on the 'grey infrastructure' of wastewater systems, and to filter contaminants and pollutants that would otherwise enter waterways, estuaries or harbours.
- **urban orchards and community gardens:** The combining of trees, typically exotic species, to provide community food sources, in addition to delivering environmental benefits cited above.

6: The Landscape Approach

[Forest and landscape restoration] is not just about trees. Trying to put the forest back the way it was is one possible restoration strategy, but there are many others that sometimes have to be woven together to tailor a solution that's right for the setting and for all those with a stake… The goal, in each case, is to revitalize the landscape so that it can meet the needs of people and the natural environment, sustainably.

—Global Partnership on Forest and Landscape Restoration.[72]

New Zealand is torn between two worlds, the Siloed and the Interwoven. The latter is attractive in many ways, and it is already partially expressed in the landscape. But how do we promote it further? How do we steer New Zealand toward the ideal of the Interwoven World, where integrated land use systems are strategically deployed to strike a better balance between social, environmental and economic outcomes?

I would argue that the Interwoven World is not a model to be imposed from above by planners and regulators. Planning and regulation has a role in creating an enabling environment for more integrated land use, but it is crucial that land use change retains the consent and social license of landowners and local communities. A less hierarchical, bottom-up approach is needed, not only to generate public support and legitimacy, but also because this may shed light on the financial and regulatory barriers that landowners face in implementing more diverse land uses.

The Interwoven World is best pursued through a *landscape approach*, which can basically be defined as a way of working *with*, rather than *against*, the highly complex challenges of land use. More formally, the landscape approach is 'a framework to integrate policy and practice for multiple competing land uses through the implementation of adaptive and integrated management systems'.[73] Although this an emerging concept, the ideas and practices that belong to landscape approaches have a longer, deeper history.

[72] Global Partnership on Forest and Landscape Restoration. (2013). *Our approach: The landscape approach*. Washington D. C., USA: GPFLR.
Retrieved from: http://www.forestlandscaperestoration.org/tool/our-approach-landscape-approach

[73] James Reed et al. (2016). Integrated landscape approaches to managing social and environmental issues in the tropics: Learning from the past to guide the future. *Global Change Biology, 22* (7), p.2544.

Indeed, landscape approaches are really a consolidation of diverse and often long-standing traditions in land management, supported by growing scientific evidence about the environmental and economic costs of siloed sectoral approaches, as well as contemporary thinking about how to govern for 'wicked problems' like climate change, food security and global development.[74]

What is a landscape approach?

'A landscape approach is a framework to integrate policy and practice for multiple land uses, within a given area, to ensure equitable and sustainable use of land while strengthening measures to mitigate and adapt to climate change. It also aims to balance competing demands on land through the implementation of adaptive and integrated management systems. These include not only the physical characteristic features of the landscape itself, but all of the internal and external socio-economic and socio-political drivers that affect land use, particularly related to conservation, forestry and agriculture. In short, landscape approaches seek to address the increasingly complex and widespread environmental, social and political challenges that transcend traditional management boundaries.'[75]

Literature reviews of landscape approaches have identified a diverse array of definitions and understandings that operate under this label. Nevertheless, these have been synthesised by Sayer et al into ten principles:[76]

1. **Continued learning and adaptive management:** Landscape processes are dynamic and ever-changing, shaped by geophysical, economic and socio-political systems whose effects cannot always be adequately explained or predicted. Accordingly, the working assumption is that there is always something to learn, and that strategies will need to continually adapt to accommodate changing circumstances.

2. **Common concern entry point:** It is assumed that the stakeholders associated with a particular landscape will have diverse concerns and values. Accordingly, a landscape approach strives to create a common entry point by way of shared negotiation processes and short-term objectives that build trust and confidence.

[74] Ecoagriculture Partners. (2013). *Defining integrated landscape management for policy makers*. Ecoagriculture Policy Focus, No. 10.

[75] James Reed et al. (2014). What are 'Integrated landscape approaches' and how effectively have they been implemented in the tropics: A systematic map protocol. *Environmental Evidence, 4* (2).

[76] Jeffrey Sayer et al. (2013). Ten principles for a landscape approach to reconciling agriculture, conservation, and other competing land uses. *Proceedings of the National Academy of Sciences of the United States of America (PNAS), 110* (21), pp.8349-8356.

3. **Multiple scales:** Landscape processes occur at a range of scales, from the molecular to the global level and everything in between: the farm, the catchment or watershed, the region, the nation, the international market, and so on. A landscape approach is attentive not only to these multi-scalar influences, but also to the interactions between these various systems: the external demands and drivers, feedbacks, synergies, and other interactions.

4. **Multifunctionality:** Landscapes have diverse uses and purposes, each of which are differently valued by different stakeholders. A landscape approach recognises this diversity in order to more effectively navigate the disagreements, tradeoffs, compromises and compensations that follow.

5. **Multiple stakeholders:** By recognising the diverse interests of affected parties, landscape approaches strive to engage these stakeholders in a fair and equitable manner, especially through iterative processes, effective communication, mutual respect, recognition, and cultivation of trust.

6. **Negotiated and transparent change logic:** Whatever course of action is chosen needs to understood by all stakeholders, in terms of its general logic, legitimacy, and risks and uncertainties. Building and maintaining consensus through transparent and open negotiations is vital for maintaining the trust of parties.

7. **Clarification of rights and responsibilities:** It is important for all stakeholders to be clear about the rights and responsibilities of various actors. In the New Zealand context, this will necessarily involve clarifications around the Treaty of Waitangi | te Tiriti o Waitangi. In the event of conflict, which is assumed to be highly likely, there needs to be an accepted process for arbitration, reconciliation and recourse.

8. **Participatory and user-friendly monitoring:** It is assumed that valid information can derive from a variety of sources; hence, no single stakeholder has a unique claim to all relevant knowledge. Information processes should be open and accessible, and should accommodate distinct forms of knowledge, such as the integration of traditional Western science and mātauranga Māori.

9. **Resilience:** Given the working assumption that landscapes are dynamic and interconnected with other complex systems, resilience is treated as a virtue. Resilience can be defined as the capacity to absorb, avoid, deflect or recover from unexpected shocks or disruptions (see §4.3).

10. **Strengthened stakeholder capacity:** Landscape approaches should not only permit stakeholder engagement, but also create the conditions by which such engagement can take place. In particular, the stakeholder process should help to cultivate the skills and provide the resources by which stakeholders can improve their capacity to participate and engage.

What would this look like in New Zealand? Perhaps the simplest point of reference is the Land and Water Forum (LAWF). Operationally, LAWF embodied key elements of a landscape approach, notably (Principle 5) the inclusion of multiple stakeholders from industry, recreation, environmental advocacy, iwi and science, along with observers from local and central government. It also focused on (Principle 2) an entry point of common concern – the issue of deteriorating water quality in New Zealand – which led to (Principle 6) the negotiation of a transparent 'change logic', in particular the identification of national standards to be incorporated into the National Policy Statement for Freshwater Management in 2017. Furthermore, in its own recommendations, LAWF advanced the spirit of a landscape approach through its recommendation of *integrated catchment management* in its Fourth Report.[77] Although this focused on the catchment level, rather than the landscape more broadly, this proposal has many affinities to a landscape approach, which include: a recognition of complexity; an emphasis on the dynamic nature of catchments; a commitment to adaptive management and anticipating unintended consequences; a priority on high quality information which includes mātauranga Māori as well as scientific data, research and modelling; and a recognition of the importance of co-governance and collaborative planning among diverse stakeholders.

In sum, LAWF provides a sense of the direction of travel for an integrated landscape approach in New Zealand, albeit applied to hydrological catchments and not the entire landscape. But there is much to be learned from LAWF's shortcomings as well as its successes. For example, the neglect of wider community engagement, beyond engagement with key stakeholder organisations, was a serious limitation. As Reed et al. note: 'Without commitment from rural communities, landscape approaches are unlikely to succeed'.[78] An audit of the LAWF process suggests that limited resourcing resulted in suboptimal outcomes in regards to (Principle 10) strengthened stakeholder capacity. Yet the audit also identified an issue that isn't explicitly captured in the above principles – that is, the greater influence of powerful parties at the expense of others.[79] These power imbalances played out in the LAWF process, but also more decisively in LAWF's relationship to central government, which held the authority to implement LAWF's recommendations (and did so only selectively).

Put starkly, although landscape approaches are a promising way to build agreement around a shared vision for the land, there remains a challenge in implementing this ideal. For all the attractiveness and desirability of the Interwoven World, land use change away from the Siloed World can be unattainable, at least in existing economic and regulatory circumstances. It may be too unaffordable, impracticable or risky to

[77] Land and Water Forum. (November 2015). *Fourth Report of the Land and Water Forum.* Land and Water Trust.

[78] Reed et al. (2016). *Integrated landscape approaches to managing social and environmental issues in the tropics: Learning from the past to guide the future*, p.2545.

[79] A review of the Land and Water Forum process noted that, among participants, there were 'clear concerns about representation of the wider community in discussions, and the power differentials as a result of both differential resourcing and the impact of powerful others (eg. politicians and shareholders) on the success of the collaborative process'. See James Baines & Marg O'Brien. (2012). *Reflections on the collaborative governance process of the Land and Water Forum*. Research report prepared under sub-contract for Ecologic for the Ministry for the Environment, CR 122, Wellington: Ministry for the Environment, p.46.

convert land uses, even when there are social and environmental benefits. What is necessary, then, is to change the economic and regulatory circumstances. I discuss this below in Section 7.

7: Tweaking Systems

Lose the object and draw nigh obliquely.
—Lancelot 'Capability' Brown, landscape gardener.[80]

A landscape is a system of a kind. This system is connected to other systems. Some are biophysical systems, such as local ecosystems, soil systems and the global climate system. Others are social systems, such as local regulatory frameworks and the global economy. All these systems interact, and all exert an influence on the form and function of the landscape. These systems govern what land uses are possible, viable, feasible, and likely to prosper.

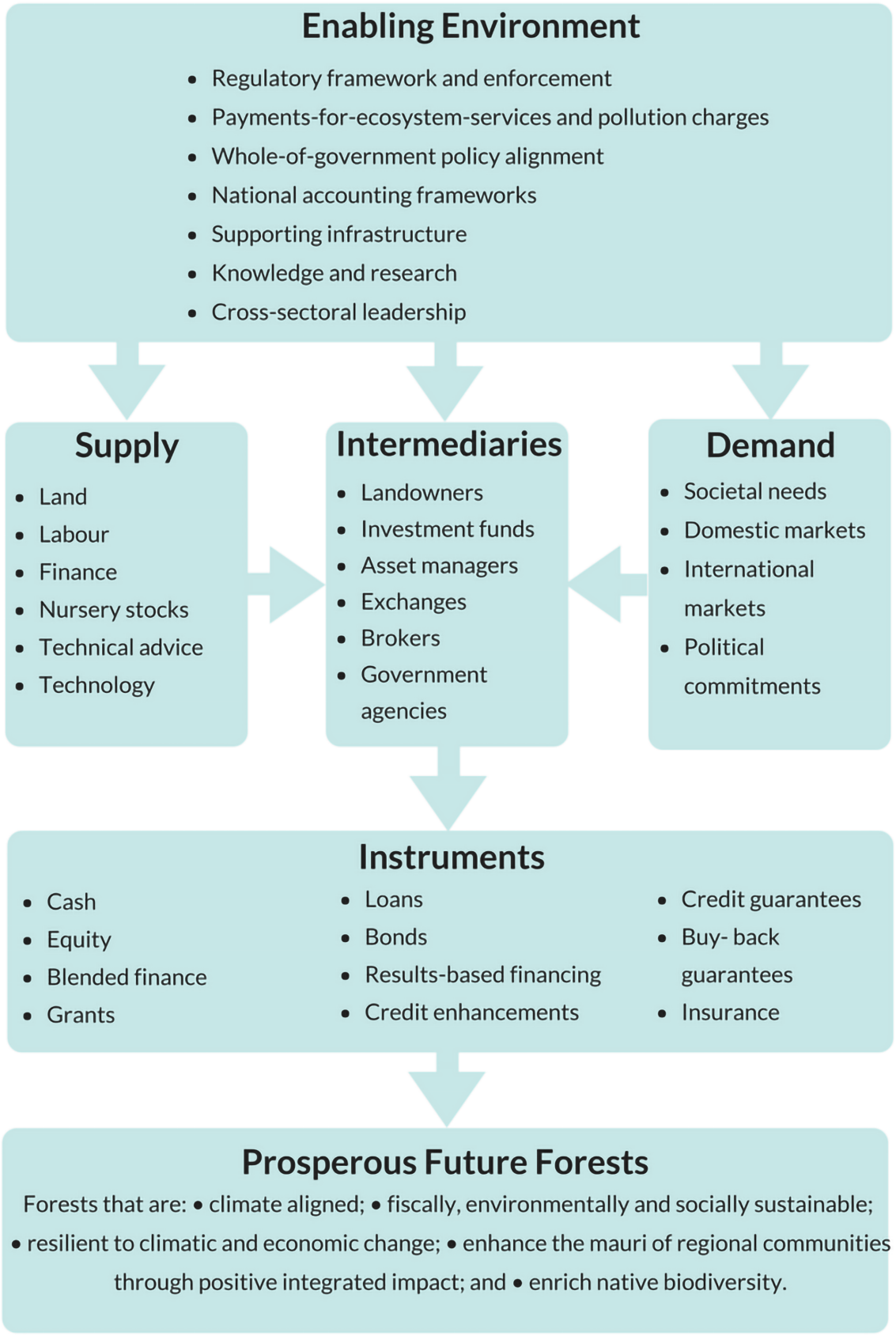
This should force us to be subtle in our thinking about how to effect land use change. To understand why a piece of land is used in one way and not in another, it is necessary to look beyond the individual motivations of the landowner (although these are relevant too) and to think about the systems that landowners are operating within. What is the regulatory environment, both at the national and local level? How do these regulatory levels interact? What activities are incentivised by regional, national and global economies? What barriers are there for accessing finance? What are the technological gaps? If we don't like the outcomes that the landscape is manifesting, it pays to ask how we can tweak these systems to generate a different set of outcomes.

Figure 5 below provides an example of systems thinking, as applied to the New Zealand landscape.[81] It is not intended as a comprehensive systems analysis, but a selective systems approach toward the challenge of advancing the diverse forest systems described in Section 5. This is not because forest is all that matters in a landscape, but because (1) the expansion and diversification of forest systems are vital for a more integrated landscape in New Zealand, and (2) there is a trend toward net forest loss in New Zealand which needs to be halted and reversed. A similar diagram could be designed for, say, sustainable agriculture or horticulture.

[80] This quote from famous eighteenth-century English landscape gardener, Lancelot 'Capability' Brown, suggests that the optimal approach to a destination may be indirect, rather than head-on. The authors of the Hartwell Paper identify this as sage advice for addressing the wicked problem of climate change, whereby the ultimate objective (decarbonisation) can be pursued obliquely via other more immediate challenges. See Gwyn Prins et al. (May 2010). *The Hartwell paper: A new direction for climate policy after the crash of 2009,* p.9.

[81] This analysis draws on a multitude of forest-related conversations that I've had over the last two years – on forestry, climate finance and impact investment. See also Rosemary Addis, Sally McCutchan & Sabina Curatolo. (2017). *Impact Investing: Submission to the Australian Government on Social Impact Investing.* Discussion Paper. Melbourne: Impact Investing Australia and Australian Advisory Board on Impact Investing; Padraig Oliver, Bella Tonkonogy, David Wang & Xueying Wang. (2018). *Supporting the Momentum: A Systems Approach to Accelerating Climate Finance*. Synthesis Paper. San Francisco: Climate Policy Initiative.

Figure 5: A Systems Map for Prosperous Future Forests in Aotearoa New Zealand



A detailed analysis of these system factors is provided in the Appendix. Below I discuss this system in general terms.

The *enabling environment* is the broad economic and regulatory context within which land use decisions are made. More formally, this can be defined as a set of interrelated conditions – such as legal, bureaucratic, fiscal, informational, political, and cultural conditions – that impact on the capacity of actors to adopt sustainable, climate-aligned land use practices in a sustained and effective manner.[82] As I have suggested, the Siloed World is a cultural influence at this level, but a more concrete factor is the regulatory framework, which for forests includes the Climate Change Response Act 2002 (CCRA), Resource Management Act 1991 (RMA), the forthcoming Zero Carbon Act (ZCA), and the National Environmental Standards for Plantation Forests (NES-PF). What is also important is that these regulatory instruments are adequately enforced, evenhanded in their impact, and create long-term certainty. In this respect, there are lessons to be learned from the management of the New Zealand Emissions Trading Scheme, which created significant uncertainty for forestry by being amended, and also applied unevenly across the land sector through the exclusion of agriculture. (I discuss other factors of the enabling environment in the Appendix.)

Decisions to convert land into forest are determined by various supply- and demand-side factors. In regards to *supply*, successful forest planting requires affordable land, availability of skilled labour, access to finance, nursery stocks prepared in advance of planting, provision of technical advice for establishing forests successfully, and access to technologies to make certain forestry systems safe and feasible. In regards to *demand*, there are societal needs and expectations for forests and their benefits (as described in Section 4), market demands for forest products and sustainable sourcing, and political commitments for afforestation, forest and land restoration, and climate mitigation that support the expansion of forest land uses.

Crucially, though, it is people who bring supply and demand together. There are a variety of parties who could play the role of *intermediary*. This could simply be landowners themselves, if they can independently bring together demand and supply. However, depending on the scale of forests or the barriers to afforestation, this may involve larger organisations, such as traditional investment funds, green investment funds, or impact-oriented funds or brokers who see an opportunity in afforestation and landscape restoration to combine financial returns with positive social and environmental impact. Government agencies can also play an intermediary role when implementing schemes and programmes that promote land use change.

[82] This definition is paraphrased and adapted from Jeff Thindwa. (2001). *Enabling environment for civil society in CDD projects*. World Bank Social Development Family, CDD Learning Module. Washington D.C.: World Bank.

Finally, there are a range of different *instruments* to be deployed to enable land use change.[83] Some of these are conventional, such as loans, equity, cash, and government grants to overcome market barriers, such as the Afforestation Grant Scheme or the Erosion Control Funding Programme. Yet there are other less well-known or more innovative instruments that could also be deployed to overcome barriers. For example, if beneficiaries of future forest are reluctant to invest because of risks of failure, then *results-based payments* (also known as *outcomes-based funding*) could unlock investment by de-risking propositions. Similarly, if an investable proposition requires a first-mover, or needs to achieve greater scale by crowding-in investors, then *blended finance* that combines public and private investment could be appropriate. Other relevant instruments include debt instruments such as *green bonds, climate bonds* and *impact bonds;* or *credit enhancements* to reduce the risk on forest-related debt; or kinds of insurance such as *credit guarantees* and *buy-back agreements*.

Bringing forward these instruments is what I have previously described as 'a smorgasbord of funding': an array of financing options that landowners could turn to in light of their unique circumstances and preferences, and the specific b arriers that they face.[84] As the Food and Agriculture Organization of the United Nations has identified, such instruments can be used to 'provide fi nancial viability to alternative [land use] practices… overcome resistance to innovation… [to] finance external and specialized input into the design of better and locally adapted practices… [and] finance an information and monitoring system for measuring the costs and climate benefits associated with [land use change].'[85]

To summarise, when we create the whāriki or tapestry of an integrated landscape, we should use many strands, and many combinations of strands, in our weave. This means that if a mistake occurs, if our tapestry buckles or ripples, there are many strands that we might pull on or loosen to make things right. Moreover, as Lancelot 'Capability' Brown observed, the best way to create a particular effect (such as net forest gain) isn't always the most direct way. To use a timely example, the One Billion Trees Programme could plausibly be achieved by providing grants for tree planting, but this is unlikely to be a durable solution: forest planting will retreat if grants are retracted, or if wider circumstances shift. Hence, a more holistic approach is required. The real opportunity of the One Billion Trees Programme isn't so much meeting the target, but *creating the conditions by which this target can be met sustainably.* A systems change could deliver forest outcomes without needing to use, say, grants to swim against the tide of prevailing land use choices.

[83] For more on forest- and climate-finance instruments, see Food and Agriculture Organization of the United Nations (FAO) & Global Mechanism of the UNCCD. (2015). *Sustainable financing for forest and landscape restoration: Opportunities, challenges and the way forward. Discussion Paper.* Rome: FAO & Global Mechanism-UNCCD; David Hall & Sam Lindsay. (2018). *Climate finance landscape for Aotearoa New Zealand: A preliminary survey.*

[84] David Hall. (2016). *Our forest future*. Report Prepared for Pure Advantage. Retrieved from: http://pureadvantage.org/news/2016/04/22/our-forest-future/

[85] FAO & Global Mechanism-UNCCD. (2015). *Sustainable financing for forest and landscape restoration,* pp.32-33.

In doing this, it is also important to note that it isn't the above factors *per se* that promote afforestation, but the right expression and combination of these factors. For example, it isn't enough to have land: what is needed is affordable land, because land value is a key determinant for the profitability of rural land uses. When land prices are high, as they are these days, dairy agriculture is attractive as the 'highest and best use', also serving as leverage for debt to finance farm operations. This, in turn, contributes to speculative pressure on land prices, further pricing out less siloed, integrated land uses such as forestry or agroforestry. Additionally, it is plausible that land prices are further elevated by subsidies such as payments-for-ecosystems, or the carbon credits awarded through the New Zealand ETS, which is a perverse consequence that could become decisive if carbon prices rise. While this issue is highly complex,[86] this also means that the potential solutions are numerous, which includes ensuring that regulatory checks on the land sector are even-handed, revising the terms on which rural finance is provided, revisiting the tax system and its impact on land price, investing in infrastructure to support premium-quality exports, and so on. What is needed is adaptive decision making, supported by rigorous monitoring and evaluation that can identify unanticipated outcomes and adjust strategy accordingly.

8: Summary

> *People will not change [the] landscape unless they are under very heavy pressure to do so. We must conclude that if there is really a major change in the look of the cultural landscape, then there is very likely a major change occurring in our national culture at the same time.*
>
> —Pierce F. Lewis, geographer [87]

My hope is that this short paper creates a sense of possibility, that it disrupts the trinary thinking that constrains our view of the land use options that are available to us.

I have argued that the prevalence of trinary thinking – in terms of exotic plantation forest, native conservation forest, and pastoral agriculture – has set us on the path toward a Siloed World. I have further argued that this Siloed World is misaligned with five principles of long-term prosperity: (i) climate alignment, (ii) sustainability, (iii) resilience, (iv) mauri ora, and (v) biodiversity. The intensification of agriculture and the harvesting schedules for clear-cut forestry systems create potential obstacles for meeting international obligations in the Paris Agreement. The environmental effects of intensive land use, in both agriculture and forestry, incur costs on future generations that undermine sustainability. The perpetuation of pastoral land uses on erosion-prone land, and the predominance of monocultures in commercial forestry (and even

[86] For discussion, see Phil Journeaux. (2015). *The effect of environmental constraints on land prices.* Waikato: AgFirst.

[87] Peirce F. Lewis. (1979). *Axioms for reading the landscape. Some guides to the American scene*.

carbon farming), undermines land resilience and the capacity to adapt to shocks. The siloed emphasis on private choices on private land neglects the effects on surrounding communities and ecosystems. Finally, our trinary view tends to confine biodiversity to our conservation estate, bypassing the opportunities to enrich biodiversity and its benefits on non-conservation land.

The Interwoven World, by contrast, pushes beyond this trinary thinking and considers land uses as threads in a multi-functional tapestry to be woven in various ways at various scales, from the farm level to the landscape level. In doing so, the Interwoven World has the potential to better align with the five principles of prosperity. It encourages more permanent forest systems, even for commercial crops, that would smooth out the 'saw tooth' pattern of carbon stocks in clear-cut forestry. By encouraging agroforestry, silvopasture and wood lots, the Interwoven World increases carbon stocks on agricultural land, some of which will offset agricultural emissions under the compliance regime. The Interwoven World enhances sustainability by entwining land uses, to create a combination of sinks and sources for nutrients and greenhouse gases that reach a state of balance. By being environmentally sustainable, the Interwoven World is also more socially sustainable, securing social license from landowners and the communities they belong to. All this contributes to mauri ora, to a state of general wellbeing among people and place that can be reflected through well-designed frameworks for integrated value at the national and project level. Finally, the Interwoven World creates multiple opportunities for biodiversity, not only in conservation estates, but throughout the rural and urban landscape. By operating outside of the conservation estate, these nodes of biodiversity can rely on alternative financing models, thereby enhancing the financial sustainability of New Zealand's biodiversity.

The emerging framework of landscape approaches provides a promising pathway toward the Interwoven World. By working with the diverse and conflicting expectations of stakeholders, landscape approaches are disposed to deliver more nuanced, localised and elegant solutions to land use dilemmas. This includes the use of integrated land use systems that respond to the particularities of a site, striking an optimal balance between financial, social and environmental outcomes.

But implementing these land use changes will be challenging. It will require a systems approach to the landscape, which considers the complex factors that shape the landscape, the multitude of barriers that impede greater long-term prosperity, and the variety of tweaks or interventions throughout the system that could make land use change more viable for landowners. This could require regulatory adjustments, a well-designed payment-for-ecosystem-services, or even the issuance of a financial instrument to overcome fiscal constraints. Above all, it will require adaptive decision making, which monitors the effects of systemic changes and adjusts policy accordingly. There is substantial work to be done on these questions, not only through research, but by well-studied interventions in the landscape itself.

Appendix

Please note that entries within square brackets are not yet implemented in New Zealand, but are speculative or in development.

Enabling environment		
Factors	*Examples*	*Comments*
Regulatory framework and enforcement	• Resource Management Act 1991 (RMA) • Climate Change Response Act 2002 (CCRA) • New Zealand Emissions Trading Scheme (NZ ETS) • National Environmental Standards for Plantation Forests (NES-PF) • [Zero Carbon Act]	• Inadequate enforcement of the RMA provides a tacit advantage to polluting activities • Regulatory uncertainty can disrupt confidence in forestry, such as the legislative and regulatory changes made to the CCRA and NZ ETS • Evenhandedness in regulation across a sector is important; for example, the exclusion of agriculture from the NZ ETS functions as a subsidy that disadvantages forestry
Payments-for-ecosystem-services (PES)	• Carbon credits (NZUs) through the NZ ETS • Carbon credits from voluntary markets • [Biodiversity payments] • [Payments for hydrological services]	• PES requires a clear line of sight to beneficiaries who are willing and able to pay • Compliance markets like the NZ ETS, where emitters have obligations to surrender credits, overcome lack of demand
Pollution charges	• Carbon price (obligation to surrender credits) • Fuel taxes or levies • [Nitrate levy]	• Pollution charges can have implications for land value, which impact non-polluting activities as well as polluting
Whole-of-government policy alignment	• Tax system • Migration policy • Biosecurity policy • Bioenergy	• Whole-of-government perspective and joined-up policy needed to identify and remedy misalignments in adjacent policy sectors
National accounting frameworks	• System of Environmental-Economic Accounting (SEEA) • [Living Standards Framework (LSF)] • Natural capital • Gross domestic product (GDP)	• Need to incorporate natural capital accounting and valuation into options analyses and instruments that reflect these valuations
Supporting infrastructure	• Roads, railways and ports • Sawmills and processing plants	• Transport costs a key determinant in profitability for forestry • Domestic processing capacity is critical for value-add

Knowledge and research	• National Science Challenges (Our Land, Our Water) • Sustainable Land Management and Climate Change Research Programme (SLMACC)	• Research investment into *Pinus radiata* has contributed to path-dependency, because timber and carbon yields are highly determined, thus perceived as less risky
Cross-sectoral leadership	• Political leadership • Business leadership • Community leadership (iwi, churches, etc.) • Advocacy groups and environmental NGOs	• In light of complexity, adaptive leadership is needed to respond to change and shocks
Supply-side factors		
Factors	*Description*	*Comments*
Land	Land for sale or lease	• Land is key determinant for profitability, so availability and affordability of land are vital
Labour	Rural workers available for site preparation, planting, maintenance, extraction, transport and processing	• Degrowth in regions means that forest expansion might require migrant workforce
Finance	Access to finance (see Instruments below)	• Equitable access to finance is important, so the terms on which finance is provided to agriculture and forestry respectively is vital
Nursery stocks	Stable supply of seedlings	• Nurseries need a lead-in to prepare stocks for following year, so credible orders need to be placed
Technical advice	Reliable forestry consultants to advise on forest establishment and profitable outcomes	• Carrots and sticks (economic incentives and regulations) cannot overcome a knowledge gap, especially when landowners shifting from familiar to unfamiliar land use (i.e. farming to forestry) • Forest failure is not only discouraging for landowners, but also local communities
Technology	Forest technology such as cable yarding systems and mechanised extraction.	• Continuous cover systems and steep slope forestry can have higher operational costs, especially due to safety standards; but existing and emerging extraction technology can make these systems viable
Demand-side factors		
Factors	*Examples*	*Comments*
Societal needs	• Basic human rights • Public health benefits of forest • Cultural rights (e.g. kaitiakitanga)	• Refers to both tangible and intangible, quantifiable and unquantifiable human goods

Domestic and international markets	• Market for harvested wood products • Markets for non-timber products such as carbon credits, honey, biochemical, and so on • Markets for waste products (biofuels)	• Accreditation schemes like the Forest Stewardship Council's can influence market demand • Trade policy also shapes markets; for example, prohibitions on unsustainable timber imports can create opportunities for domestic alternatives • Public entities can 'make markets'; for example, Rotorua Lakes Council's 'wood first' policy for new council developments
Political commitments	• One Billion Trees Programme • Paris Agreement targets • Sustainable Development Goals, especially Target 15.3 to reach land degradation neutrality by 2030	• Creates project pipelines to coordinate planning and investment around
Intermediaries		
Factors	*Examples*	*Comments*
Landowners	• Small-scale farm foresters • Iwi and Māori trusts • High net worth individuals	• Limited by cash reserves • Forestry requires significant upfront capital, with delayed returns,
Investment funds and asset managers	• NZ Super Fund • Impact Investment Fund • [Green Investment Fund]	• Internationally there are growing number of funds and asset managers that focus on equity stakes in sustainable forests, such as SLM Partners, or the Moringa Fund for agroforestry in Latin America
Exchanges	• NZX • ForestX • CommTrade	• Potential to promote corporate sustainability through listing rules, ESG reporting, climate risk disclosure, and regulatory initiatives
Brokers	• Forestry investment managers • Carbon brokers • Impact investment entrepreneurs	• Internationally some forest managers are turning to sustainability as a competitive advantage, such as Lyme Timber Company (US) • Aboriginal Carbon Fund (Australia) leverages carbon revenue to finance indigenous land management practices
Government agencies	• Ministry for Primary Industries (sustainable land use grants) • Regional and local councils	• Governments are limited in their intermediary capacity due to principal role as regulator and political liabilities

Instruments		
Factors	*Description*	*Examples*
Cash	Direct payment for forest outcomes	• Savings • Balance sheet financing
Equity	Shares in a forest or forest-related company, which return dividends to the shareholder	• Forest shares • Company shares
Blended finance	Blending of finance from different sources, especially where concessional, public and/or philanthropic funding is used to mobilise private capital, typically by occupying a first-loss position	• Joint ventures • Public-private partnerships (e.g. Althelia Climate Fund, Africa)
Grants	Typically a one-off financial support with no repayment	• Afforestation Grant Scheme • Erosion Control Funding Programme
Loans	Debt issued with repayment obligation and interest carried	• Market-rate loans • Concessional loans at below market rate • Micro-finance for small-scale projects
Bonds	Instrument of indebtedness of the bond issuer to the holder or purchaser	• Green bonds • Certified climate bonds (Climate Bonds Initiative) • Forests Bond (BHP Billiton and IFC) • Forest Resilience Bond (in development by Blue Forest Conservation, US)
Results-based financing	Programmes or schemes that reward the delivery of one or more outputs or outcomes by one or more incentives, financial or otherwise	• Sustainable Land Bond (Nature Conservancy, global) • Green Infrastructure Bond (issued by Quantified Ventures, US) • Native Forest Bond Scheme (in development by Mōhio, NZ)
Credit enhancements and credit guarantees	An external mechanism that aims to increase the credit rating of project (credit enhancement), commonly by providing an insurance to mitigate lender risk by absorbing a proportion of a lender's loss, typically in return for a fee (credit guarantee)	• A credit enhancement scheme, such as a partial credit guarantee, could improve access to finance for forestry and agroforestry by mitigating actual and perceived risk of default, especially relative to dairy agriculture as 'highest and best use'
Buy-back guarantees and contract agreements	Binding contracts to purchase products which guarantee viable markets for forest products, especially to create confidence for small or niche providers	• Guarantees to purchase timber or other forest products • Guarantees to purchase carbon credits, including the Reforest Trust's proposal for forward contracts for carbon to reduce future liabilities

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About The Author

Dr David Hall is a Senior Researcher with The Policy Observatory, AUT. He has a D.Phil in Politics from the University of Oxford and B.A. in Geography from the University of Otago. His research interests cover political philosophy, public policy, environmental policy and migration. In a 2016 report for Pure Advantage, *Our Forest Future*, he advocated for 1.3 million hectares of new forest in Aotearoa New Zealand. Subsequently, he advised The Tindall Foundation on the conceptual design for the Trees That Count initiative, and consulted on Auckland Council's strategy for urban ngahere. In collaboration with Sam Lindsay, he also prepared the 2018 report, *Climate Finance Landscape for Aotearoa New Zealand: A Preliminary Survey*, for the Ministry for the Environment. With support from Foundation North, they are currently co-designing an innovative financial instrument – the proposed Native Forest Bond Scheme – to mobilise public/private investment for establishing continuous native forest on erosion-prone pastoral land.

About The Policy Observatory

Based at Auckland University of Technology, The Policy Observatory provides a lens on public policy in Aotearoa New Zealand. We both conduct and commission research on economic, social and environmental policy issues, with the intention of publishing results in a form that is accessible to the general public. We work in a collaborative, networked way with researchers across institutions and in the private sector. Ultimately, we are concerned with how policy advances the common good.