

Integrated land use options for the Aotearoa New Zealand low-emissions ‘careful revolution’

Abstract

The Climate Change Response (Zero Carbon) Amendment Act 2019 is a welcome start on the path towards a low-emissions future for Aotearoa New Zealand, but it is not much more than a set of targets and some tools. There are also so many potential alternative tools and processes now on offer that we face the additional significant risk of an unsystematic effort, without enough focus to secure an optimal pathway. Most of the needed tools and processes involve decisions about land use. This article outlines various options for well-integrated land use policies for Aotearoa New Zealand that in

sum attempt to address the land use-related low-emissions challenge in a coherent way. The analysis is built around seven key integrative themes: an Aotearoa New Zealand world view and identity; sustainable low-emissions dietary and nutrition policy; integrated lower-emissions farming, forestry and freight transport; natural capital’s contribution to wellbeing; integrated catchment approaches; resilient cities; and meta-integration. Without significant effort on the integration of these and many other components of the required ‘careful revolution’, the revolution will be neither careful nor successful.

Keywords land use, New Zealand, environmental integration, catchment scale, just transition, carbon emissions reduction

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With the passage of the Climate Change Response (Zero Carbon) Amendment Act 2019 (the Zero Carbon Act), Aotearoa New Zealand is now hopefully on a pathway towards a low-emissions future. But the act does not provide a map for the journey; it is not much more than a set of targets and some tools. The recent book *A Careful Revolution: towards a low-emissions future* (Hall, 2019) offers much useful guidance on aspects of the changes required, coming from a refreshingly wide range of contributors and perspectives. Principles of intersectoral and intergenerational justice permeate the contents, especially the concept of a 'just transition',¹ as does an appreciation of the many types of risk and disruption that must be addressed. Partly because of this welcome diversity of approach, however, its messages are not comprehensive and not always clearly coherent.

A plethora of government and private initiatives, including several national policy statements under the Resource Management Act (RMA), reform of the RMA itself, the One Billion Trees programme, the Emissions Trading Scheme (ETS), the 'Action for healthy waterways' plan, post-Treaty of Waitangi settlement programmes, a new national Biodiversity Strategy and more, offer a superabundance of potential policy and implementation vehicles to assist the journey. The current government's wellbeing agenda and the Treasury's Living Standards Framework represent further approaches to a more sustainable and resilient future. In fact, there are so many potential vehicles and guidance systems now on offer (many of them untested and seemingly not integrated) that we face an additional significant risk on this critical journey: a scattering of effort, without enough focused intellectual, political or financial resource available to ensure an optimal pathway.

Most of the initiatives mentioned involve decisions about land use. I offer here a personal commentary on some options for land use policies for Aotearoa New Zealand that in sum attempt to address our critical low-emissions challenge in a consciously integrated way. Without significant effort on the integration

of the components of the required 'careful revolution', the revolution cannot be considered careful, nor will it be successful. An additional reason for a land use focus is that this sector (especially agriculture, forestry and nature conservation) is among the most politicised in Aotearoa New Zealand and most vulnerable to interest group lobbying. There is a real need, therefore, to take a carefully integrated approach which anticipates the likely kinds of social pushback to transition policies.

The background to this commentary is the legacy of colonial and post-colonial changes in land use that have led to the current land use pattern.

A need for integration in land use policy has been long recognised, but is not handled well in the RMA despite it being specifically required under several sections (Bührs, 2009; Resource Management Review Panel, 2019). Given that the RMA is our main statute for planning land use, this is a serious obstacle to better integration.

The theme of environmental integration related to land use has been discussed by Bührs (2009) and Perley (2018). Bührs calls this type of integration 'green planning', which he regards as an overarching, mainly national-scale policy framework to guide the development of all kinds of policies that may have a significant impact on the environment. Bührs' focus helps to promote a systems approach to environmental policy applied to wicked problems such as the climate crisis. It also reflects the realisation that humans and human institutions are a part of nature and

operate within planetary boundaries. Perley uses a landscape systems framework to illustrate his assertion that 'if we want to understand and act wisely, we need to synthesise as much as we analyse'.

The background to this commentary is the legacy of colonial and post-colonial changes in land use that have led to the current land use pattern. Although our per capita fossil fuel emissions are somewhat lower than those of comparable OECD countries,² our total per capita emissions are much higher than the global average because of unusually high biogenic emissions (Ministry for the Environment, 2019), as discussed below. The recent pattern is of agricultural intensification but continued dependence on commodity production, leading to a desperately concerning failure to reduce greenhouse gas emissions. We are also experiencing persistent biodiversity losses in all types of environments, and high levels of freshwater pollution, soil loss and sedimentation.³

As this article was being finalised, the Covid-19 pandemic was still rapidly expanding worldwide, and Aotearoa New Zealand was in the early stage of its Level 4 lockdown. Comment was beginning to emerge on the recovery phase,⁴ including the need for the economic recovery to be planned and supported in a way that builds in less carbon-intensive growth, and at the same time is equitable and offers support to people in declining sectors. The needs of 'just transition' mentioned above will be equally critical for the required Covid-19 recovery. In the conclusion I offer a brief postscript highlighting some aspects of a low-carbon Covid-19 recovery phase in the land use sector.

What could constitute a 'careful land use revolution' in Aotearoa New Zealand? Seven strands of integration

Aotearoa New Zealand world view and identity

Any appropriate integrated response to the low-emissions challenge requires an integrated and evidence-informed world view, outward-looking but shaped to the history and environment of Aotearoa New Zealand in the 21st century. An excellent basis for this is provided by the seminal Waitangi Tribunal Wai262 report concerning ownership of and rights to

mātauranga Māori (Māori knowledge systems) (Harmsworth and Awatere, 2013), in respect of indigenous flora and fauna (Waitangi Tribunal, 2011). Over a protracted hearing period, the Tribunal's inquiry widened from the traditional resource management and conservation sectors into many intersecting sectors such as health, education, intellectual property and commerce. It thereby became the Tribunal's first whole-of-government report, recommending wide-ranging reforms to laws and policies affecting Māori culture and identity and calling for the Crown–Māori relationship to move beyond grievance to a new era based on partnership.

Essential concepts traversed included the interpretation of land and sea 'resources' as taonga, and the viewing of humans as integrally bound to and part of the environment, as vividly expressed by the whakatauki 'Ko au te awa, ko te awa ko au' ('I am the river, the river is me').⁵ This report and its recommendations provide a vivid, integrated and sustainable view of how our land and water taonga could best be used.

Notably, there has been no government response to the report in the years since it was issued.⁶ The report has been hugely influential nevertheless, its ideas and recommendations permeating landmark partnership settlements such as for Te Urewera and Te Awa Tupua (Whanganui), both incorporating the concept and legal right of personhood conferred on elements of the environment.

Aotearoa New Zealand-appropriate technology and knowledge

Appropriate knowledge is required in order to develop the means of expressing the world view referred to above and shaping it towards the low-emissions challenge. Mātauranga is an integral part of such knowledge and can be used productively in conjunction with Western, Aotearoa-adapted scientific knowledge. For example, mātauranga incorporates ecosystems and ecosystem service concepts (Harmsworth and Awatere, 2013), as well as intimate knowledge of taonga species not expressed within Linnean nomenclature. These productive relationships are increasingly underpinning recent environmental

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research programmes such as the New Zealand Biological Heritage National Science Challenge, Ngā Kōiora Tukuiho.

An example of where integrated Aotearoa-specific knowledge is particularly relevant is within the new forestry agency Te Uru Rākau. Te Uru Rākau is positioned within the Ministry for Primary Industries, so that forest policy is developed within a broader land use framework. Aotearoa-specific technical knowledge is required, for example, for feasible wood processing options, end uses of tree products and responses to invasive species, including soil pathogens. Technical knowledge must be integrated with social and economic research to ensure effective outcomes. Such integrated knowledge is necessary for developing forestry-related emissions offsets with a high degree of permanence, including possible end uses of timber. All this requires innovation in both knowledge acquisition and implementation into land use systems. The whole journey from knowledge to technology to implementation is an iterative social process of engagement and knowledge transfer.

Sustainable low-emissions diet and nutrition policy

A very large reduction in Aotearoa New Zealand agriculture-related emissions is needed. This must be achieved while people's dietary and health needs are equitably met and there is food security (IPCC, 2019). It is a critical component of a just transition towards a low-emissions future (Huggard, 2019).

A large and increasing body of research indicates important human health co-benefits from a diet that is richer in foods produced with a lower fossil fuel input (such as most fruits, vegetables and pulses), compared with foods produced with a higher fossil fuel input (such as meat and dairy products). From both an environmental and a health perspective, these principles imply that New Zealanders should eat much less meat than we do currently on average, but not necessarily no meat. Meat products are not the only high climate-impact foods, and not all meats have a high climate impact (e.g. poultry) (Drew et al., 2020). Food production systems that require high levels of water input (mainly through irrigation) can also have a large climate impact and in turn become highly vulnerable to climate change impacts.

How closely should food exports mirror domestic food production and consumption? Thinking about Aotearoa New Zealand's international trading position as a significant food exporter, as well as global food security and equitable global nutrition considerations, there is a continuing requirement for animal-based and dairy-based protein; and in some cases it is environmentally, as well as culturally and/or nutritionally, appropriate for this to be meat protein.

From a climate response perspective, if there is a role for food exports these must be high-value and relatively low climate-impact (Saunders and Barber, 2008). The higher emissions of our long-distance transport costs must be offset by lower climate-impact production systems. Exports to countries closer rather than further away should be favoured: for example, Asian Pacific Rim countries. It is hard to see a large future role for air-transported food exports.

Technology and knowledge have a critical role in achieving low-emissions diets and food production. Aotearoa New Zealand has been a significant exporter of innovation for many agricultural sectors, and its role in researching greenhouse gas reductions in pastoral agriculture has also been significant,⁷ with potential for further large reductions. Integrated reduction of food waste at points of production and consumption, for both domestic and export agricultural produce, is also an important component of reducing agriculture-related greenhouse gas emissions (Drew et al., 2020), closely tied to reductions in the transport sector (see below).

Farming, forestry and freight transport in the low-emissions economy

Agriculture, forestry and associated freight transport should be considered together because transport emissions associated with agricultural and forest production and processing are large but not incorporated into those sectors in Aotearoa New Zealand's emissions inventory system (Ministry for the Environment, 2019).

Some form of meaningful price for all primary production greenhouse gas emissions is fundamental to lowering those emissions, as now recognised in the Zero Carbon Act and the ETS.⁸ The bottom line in these sectors is that, overall, many more trees are needed, both native and introduced, because of their potential for greenhouse gas storage and erosion reduction, and the need to halt native biodiversity decline. To achieve these higher-level aims, the One Billion Trees programme and Te Uru Rākau slogan 'the right tree in the right place for the right purpose' are complementary.

Commercial forests, including those using native species, have a role in the ETS. Exotic tree plantations⁹ can have a valuable role for employment, trade, building and erosion control, subject to adequate and well-enforced environmental controls, especially in the harvesting phase. An integrated production landscape will include various types of longer-term continuous and discontinuous canopy, including conservation areas, farm woodlots, shelter belts and agroforestry systems, covering steep as well as rolling

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and even flat land (Meurk and Swaffield, 2006).

Contributory measures would include the provision of efficient renewable energy for all possible agriculture and transport uses, both road and rail (through greater use of electric vehicles, including for freight,¹⁰ and rail electrification); and reduced overall sector transport demand, initially and urgently to no net growth. The objective should be that fossil fuels are reserved for heavy freight transport and essential infrastructure needs during the transition period.

Farming and forestry: carbon targets

A feature of the Zero Carbon Act is the split in the emissions target between biogenic methane and other greenhouse gas (mainly fossil fuel-derived) emissions targets.¹¹ Although the split target appeared to be largely a political response in order to gain greater consensus for the act, there are also valid environmental reasons to support a split target, as discussed by the parliamentary commissioner for the environment (2019). The commissioner's discussion takes account of necessary scale considerations for an integrated landscape approach. For example, the 'ideal' balance between farming and forestry for equitably reducing emissions would range in scale from the local to the national depending on many factors, including: the nature of the land resource (see next section); projected economic returns on different land use options; proportions of animal

numbers; distance from markets or ports; labour and infrastructure requirements for each potential land use; and social and cultural factors. Landowners in specific localities remain the best placed to take all these considerations into account, but need to face an environmentally realistic price on emissions.

The parliamentary commissioner for the environment also considered the potential roles of carbon offsets, recommending that access to forest sinks as offsets be allowed 'only for biological emissions'. In his view they should be used as a temporary last resort measure to offset fossil emissions, and only those sinks with a high degree of permanence, including timber end uses, should be counted. Essentially, however, all offsets in the sector are trade-offs and not in themselves problematic as a means to an end if they result in an overall reduction in net emissions in a well-integrated manner – for example, to take account of regional social needs and avoid inappropriate whole-farm conversions. Overall, by considering the purposes of split targets, the appropriate uses of offsets and the importance of scale considerations, the commissioner's report achieves a rare degree of integrated systems thinking for this sector.¹² His conclusions reinforce the 'right tree, right place, right purpose' principle again. The principle makes a direct contribution to sustainability and resilience in its immediate land use context, as well as contributing to carbon sequestration. Landscape-integrated woody vegetation serves many purposes.

Natural capital's contribution to wellbeing

Protecting natural capital as the basis for economic and societal resilience is a fundamental tenet of an integrated sustainability framework, and this must be maintained during and beyond the transition to a low-emissions future. The focus here is not just on the land component of natural capital, but on all the components of the environment: land, water, soil, plants, animals and microbes, mineral and energy resources.

Economists have long grappled with how to express and make real the values of ecosystem services.¹³ Markets do not adequately provide for these values, so there is a case for statutory approaches,

such as land or water management standards, or a zoning approach that enables recognising and protecting diverse ecosystem services.

As noted earlier, an adequate price on emissions is fundamental not only to enable a low-emissions transition, but also to maintain natural capital in the low-emissions future. This economic tool could lead to a revival of 'old' land uses that generate lower emissions while providing high-value or niche products, such as wool, manuka and honey bee crops, and plantation trees for timber construction as opposed to log exports.

Incentives for development, such as the Provincial Growth Fund, must be shaped to value natural capital and enable appropriate capital investment. Disincentives for unproductive capital investment, such as a capital gains tax, may be necessary even if unpopular. The insurance and investment sectors have a vital role to play to channel investment, providing low-cost capital to enable landowners to invest in new assets and management systems, and informed market signals of emissions-related risk (Whineray, 2019).¹⁴

We must also consider how tourism will be positioned in the transition, as it is a land use driver in its own right as well as a key economic sector. To continue this role in a low-emissions future, tourism must be at appropriate scale, and may contract under the Zero Carbon Act. International tourism, in particular, may move to become a niche high-value product for those who can afford the carbon charges of international travel when aviation fuels eventually attract a charge or levy (Parliamentary Commissioner for the Environment, 2020). This is true also for the outward tourism of New Zealanders, so the counterpart of less international tourism is likely to be more domestic tourism, with lower net emissions.

Overall, a wellbeing approach is highly integrative and implies a quadruple bottom line: recognition of natural, cultural and social capital and performance alongside economic capital and performance. To expand on a conventional triple bottom line approach, value is derived for all the components of people, planet, prosperity

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and purpose (including spiritual and cultural components).

Integrated catchment approaches: ki uta ki tai (mountains to sea)

A catchment-based approach to land use planning and management is a logical basis for integrated management because it recognises the principle that all landscape processes occur in natural catchment systems (Perley, 2018), and that human management that recognises this physical setting is more likely to achieve integration.

In Aotearoa New Zealand our often steep catchments are visible and intuitive units of land management. This realisation makes easier the objective of matching land use and land management to land capability while adapting land use to a lower-emissions framework. Farming according to land capability is a further expression of the 'right tree in the right place' approach, which should be extended to the notion of 'right crop and animal in the right place'. Aspects of integrated catchment-based management still exist in local government organisations; these can be built on and extended to current or future developments to enable low-emissions land management to be widely adopted. For example, in the Wellington region, Whaitua implementation programmes¹⁵ are being developed by catchment-based community groups in order to implement water management objectives in regional plans.

A catchment-based approach and the matching of land use and land capability is the key to adapting to climate variability, now and into the future. In many regions,

climate adaptation will include more attention to and preparedness for increased fire hazards. The catchment scale is also appropriate for recognising the inclusion of nature conservation as a land use: managing threatened ecosystems and species and integrating many local or regional biodiversity programmes and projects with land management in a catchment, all planned with a view to a low-emissions future. All these aspects can powerfully come together in an integrated catchment management plan methodology (Marshall, Blackstock and Dunlinson, 2010).¹⁶

Catchment-based soil conservation, which has a relatively long history in Aotearoa New Zealand, is a key implementation methodology for matching land use to land use capability (Roche, 1994). Maintenance of intact soils and soil quality is essential to maintaining farming use and food-producing potential in the face of variable and changing climate. Soil conservation during forest establishment and harvesting is also a key requirement of any wood production system. Generally, production management on our very widespread mountain and hill lands is sustainable under only very light and conservative land uses everywhere.

Avoidance of soil erosion and sedimentation is also the key to mitigating many water quality problems currently experienced in Aotearoa New Zealand, as sediment is among the worst and most pervasive pollutants in waterways. Freshwater quality and availability are intimately linked to land management. In spite of some initiatives under the National Policy Statement for Freshwater Management, systematic problems for freshwater remain, including a lack of clear goals and the need to integrate potentially conflicting goals.

A suite of methods under the rubric of 'regenerative agriculture' offer conservative, low-input methods for maintenance of soil quantity and quality, as well as retaining the ability of intact soils to sequester carbon. A regenerative agriculture approach is also essentially integrative in character in requiring soils, vegetation and animals to be managed within a land systems framework. Relatively low-input farming was the norm in Aotearoa New Zealand farming systems until recent

decades, and elements of regenerative farming are still common,¹⁷ but an increase in intensity and accompanying fossil fuel dependence has been evident for some time (Parliamentary Commissioner for the Environment, 2004). As the parliamentary commissioner for the environment pointed out in 2004, low-input farming is not necessarily inefficient or unprofitable. Nevertheless, in an era of high land values and capital servicing costs, more explicit valuation of natural capital and the environmental cost of high-emissions farming may be required in order for its efficiency to be profitable.

Resilient cities

Why should urban areas, with less than 1% of Aotearoa New Zealand's total area, be a focus of integration? Urban areas and their more extensive peri-urban surrounds provide the habitat and most of the food, ecosystem and wellbeing benefits for nearly 90% of the national population; most of our gross national domestic product is produced in cities; and they are growing rapidly in extent. Denser urban populations offer generally easier low-adaptation opportunities and more resources available to implement these opportunities. Urban land uses must therefore be included among the integrated land use mosaic for a low-emissions future.

Extensive rural areas occur around and even within the boundaries of many Aotearoa New Zealand city council administrative areas and provide rural uses and services. Peri-urban areas offer critical transitions between urban and rural environments; they are also an important focus area for horticulture, currently around 1.5% of total land area. This land, if not lost to urban expansion, offers potential to maintain or expand horticulture, including products with high value and relatively low volume, and thus potential export priorities in a low-emissions future. But development of this potential must be linked to the retention of the high-value soils on which growth of these crops depends.

Some of these rural and peri-urban areas also contain significant natural 'areas, e.g. regional parks'. Hence, they offer spatially close opportunities for integration of production and natural values, with the

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added benefit of proximity and fewer travel-related emissions for the urban-based recreation and nature seekers who visit. The use of these green and blue spaces for recreation offers important health and wellbeing benefits to large numbers of urban dwellers (Roberts et al., 2015).

Cities function best if there are limits to spatial growth (i.e. sprawl), which are also necessary for low-emissions outcomes. Total urban emissions footprints of urban areas are much higher than their land area share,¹⁸ so emissions transitions need to take place in cities even more so than in rural areas. Urban transport emissions (including from transport between outer suburbs, city centres and employment hubs) need to reduce urgently; there is emerging evidence that intensification of cities can play a useful part over time in reducing these transport emissions (Chapman et al., 2017). Alongside this, some policy measures to achieve urban emissions reductions are relatively straightforward technically, but require political will to implement (Hasan et al., 2019). Integration of urban and rural land uses also require efficient low-emissions city/hinterland connections, both public and private.

In short, there is much potential for the careful revolution to occur in and around our cities as well as rural areas, through decarbonised transport systems, energy efficiency and conservation, building and manufacturing technology, waste management, etc. Many of these sectors use

significant areas of land within or adjacent to our cities. For this potential to be realised, the functional relationships between urban, peri-urban and rural areas are critical, and some significant land use changes would need to be accepted by urban residents.

Conclusion: meta-integration at the core of a low-emissions wellbeing economy

The last strand briefly addresses land use components of meaningful whole-of-government and whole-of-society integration towards a low-emissions future (Waitangi Tribunal, 2011; IPCC, 2019). This will obviously involve many sectors; all those referred to above and more. 'Whole-of-government' refers to an integrated and holistic systems-oriented, cross-agency approach (Boston, 2017), but also includes an integral partnership approach as embodied in *Ko Aotearoa Tēnei* (Waitangi Tribunal, 2011). The governmental approach currently being developed towards an integrated response to that report could turn out to be highly relevant to whole-of-government approaches to the climate crisis, not just to bicultural governance issues.

Land use is a vital part of our economy and society. A fully integrated land use response will need to embrace all aspects of carbon farming and low-emissions initiatives discussed above, including native and exotic trees, animals and urban land use. As well as government policy and regulatory initiatives, it will build on diverse current examples of best practice ranging from farm environmental award winners to innovative multi-sector production sector NGOs and stakeholder organisations. It must also include large corporate farming organisations (Carden and McKenzie, 2018). It must see biodiversity conservation in its widest sense as an integral part of our land use responses, making full use of nature-based solutions (Cohen-Sacham et al., 2016; Roberts et al., 2015). A well-integrated, nature-based solution recognises that as well as our precious native biodiversity, introduced species within plantations, agro-ecosystems, and all kinds of novel ecosystems and mixtures of native and introduced species can provide elements of nature-based solutions to climate change and biodiversity decline. Novel or

enriched ecosystems within extensive areas of production, 'fallow' or stewardship land can be habitats for native biodiversity recovery (Parliamentary Commissioner for the Environment, 2002; Forbes et al., 2020), as well as for climate responses.

Some of the social and economic parameters for land use transitions are in themselves whole-of-society integrative responses. The concept of 'just transition' (Huggard 2019)¹⁹ is in itself integrative by involving many sectors, including the land use sectors. So is the notion that carrots as well as sticks will be needed to change behaviours, with at best fiscal neutrality being achieved from the financial mechanisms used. For example, the Provincial Growth Fund is being used for many social and economic development projects as well as the One Billion Trees programme and other environmental sustainability and resilience projects. Emissions charge revenues can be used in the same redistributive way.

Climate change adaptation is of course a critical part of the low-emissions transition (Lawrence, 2019) and provides opportunities for integration. The Zero Carbon Act provides for systematic risk assessment across sectors to be a key input to an integrated multi-sector national adaptation plan spanning central and local government. Many adaptation responses will be short-term, but need to be framed in the context of longer-term mitigation goals.

Examining potential integrative planning and policy vehicles for the low-emissions wellbeing economy is beyond the scope of this article.²⁰ The Climate Change Commission has some key roles that can clearly be integrative. Some of these, such as the provisions for national adaptation planning, have already been set down in the Zero Carbon Act. There are many potential but underused vehicles within the Resource Management Act which could receive consideration under the current reform of that act.

Taken together, it is hoped that these land use themes as discussed here will provide some useful options and suggestions for the integrated low-emissions transition so vital in the years and decades to come. Most of the principles mentioned are not new, and there are many past and current

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examples of sustainable and integrated land use management for Aotearoa New Zealand. Better and more equitable human wellbeing outcomes are needed, as well as averting the worst impacts of the climate crisis. For both sets of outcomes to be achieved, more focused thinking on the role of land use in the integration of the two linked sets will be essential.

Postscript: aspects of a low-carbon Covid-19 recovery phase in the land use sector

As mentioned in the introduction, a brief recap of aspects of the previous commentary relevant to economic and social recovery after the Covid-19 pandemic is relevant.

- Tourism may be very restricted for some time, and in a low-emissions future cannot recover its former high-growth characteristics. As discussed earlier, domestic and limited short-haul international tourism would be more appropriate than long-distance tourism.
- Continuation of agriculture and production forestry for domestic and export markets will be critical for economic recovery, but more local food production (especially plant-based and in peri-urban areas) would provide lower-carbon food alternatives. Continued tree planting and the early achievement or exceedance of the One Billion Tree targets would provide short-term employment and longer-term low-emission opportunities.
- More local renewable energy sources for rural and peri-urban areas would

help low-emissions resilience and can also help in managing demand peaks if well designed and integrated (Transpower New Zealand, 2020). Development of such sources would require the development of smart grids and local energy distribution networks.

- Policy and implementation tools are needed for the continued development of low-emissions, resilient urban and peri-urban forms during the recovery phase, as well as continued housing growth. This will be critical for halting urban transport emissions growth and protecting high-quality soils while maintaining good access for rural and urban populations.
- Sustainable land use projects for recovery workforce opportunities could include (among many others): urban and rural infrastructure projects, especially water quality improvements; renewable energy development (as above); rail and electric vehicle infrastructure to service more primary producers (e.g. recharging facilities to enable more light commercial e-vehicle deliveries); pest-free and other biodiversity initiatives in and off the conservation estate, including in freshwater habitats.

1 Defined by the International Trade Union Confederation as an 'economy-wide process that produces the plans, policies and investments that lead to a future where all jobs are green and decent, emissions are at net zero, poverty is eradicated, and communities are thriving and resilient'. Its two key components are planned economic diversification away from fossil fuel industries, and integrated planning of workforce change. It also requires anticipating and compensating for injustices that are a consequence of taking action.

2 Largely because of our generous endowment of renewable energy sources, rather than from planned emissions management.

3 See various chapters in Ministry for the Environment and Statistics New Zealand, 2019. In 2017, emissions from the agriculture sector decreased slightly (by 0.1%) from 2016. This decrease was due to a small fall in the sheep and dairy cattle populations (0.4% and 1.5% respectively). It was mostly offset by a 2.1% increase in the population of non-dairy cattle. See <https://www.mfe.govt.nz/sites/default/files/media/Climate%20Change/snapshot-nzs-greenhouse-gas-inventory-1990-2017.pdf>.

4 For example, see commentary from Williams, 2020, and report from Greenpeace New Zealand, 2020.

5 This concept is not uniquely Māori. It was articulated for example by the Canadian-Japanese environmentalist David Suzuki as: 'There is no environment "out there" separate from us. The environment is embedded in us. We are as much a part of our surroundings as the trees and birds and fish, the sky, water and rocks' (Suzuki, 2014).

6 A response is now being slowly developed, led by the Minister for Maori Development, with promising signs of an integrated whole-of-government approach being adopted. See <https://www.tpk.govt.nz/en/a-matou-kaupapa/wai-262-te-pae-tawhiti#head2>.

7 Largely through the Agricultural Greenhouse Gas Research Centre allied with the Global Research Alliance on Agricultural Greenhouse Gases.

8 A charge on methane and nitrous oxide is still not recognised within the ETS and will not be until 2025.

- 9 Including *Pinus radiata* stands which currently account for a very high proportion of forest production. Diversification away from this dependency on one species is necessary but cannot be expected to be achieved any faster than on a decadal scale.
- 10 The capacity for higher power delivery and greater capacity of vehicle batteries is improving rapidly and could be expected to enable a much greater use of renewable energy within the next decade.
- 11 Aotearoa New Zealand's national emissions profile is unusual among OECD countries because of its very high proportion of biogenic emissions, principally methane from our large national herd of ruminant animals (especially cows and sheep). The national cow herd's total greenhouse emissions (approx. 600 Mt CO₂-e) currently total nearly three times that of the national sheep herd (approx. 218 Mt CO₂-e), and is trending upward while greenhouse gas emissions from sheep are trending downward.
- 12 For example, one of the commissioner's recommendations is to 'Develop the tools needed to manage biological sources and sinks in the context of a landscape-based approach that embraces water, soil and biodiversity objectives'.
- 13 A comprehensive analysis of ecosystem services in Aotearoa New Zealand, including their valuation, is provided in Dymond, 2013.
- 14 The Aotearoa Circle (see <https://www.theaotearoacircle.nz/>) is a recent partnership of public and private sector leaders which aims to pursue sustainable prosperity and reverse the decline of New Zealand's natural resources. One of its first projects was an interim report from its Sustainable Finance Forum setting out principles and characteristics of a sustainable economy and financial system for Aotearoa New Zealand.
- 15 See <https://www.gw.govt.nz/whaitua-committees/>.
- 16 The integrated catchment management plan approach in Aotearoa New Zealand is best exemplified by work in the 2,170km² Motueka catchment west of Nelson. This was a multi-disciplinary, multi-stakeholder research programme which provided valuable information and knowledge to improve the management of land, freshwater and near-coastal environments in catchments with multiple, interacting and potentially conflicting land uses. The understanding and knowledge gained from the programme is impressive, especially its integrative approach linking community resilience and ecosystem resilience. However, nine years after the programme ended, specific implementation outcomes are elusive, perhaps showing the length of time required to acquire and implement the understandings gained (Phillips et al., 2010; Fenemor et al., 2011).
- 17 Including outdoor grass-based pastoral production systems and low-tillage practices. These are relatively low-input compared to very mechanised industrial farming systems practiced in much of the Northern Hemisphere.
- 18 Even though per capita urban footprints are generally lower than rural ones (Newman, 2006; Ombler et al., 2017).
- 19 Huggard's chapter is among a number of relevant chapters in *A Careful Revolution* (Hall, 2019) along with those already

cited; especially those of Bargh concerning a 'tika' revolution (that which is right or just) that addresses Treaty obligations and Maori world views, Nissen concerning intergenerational equity, and Frame concerning the political and democratic requirements for accepted change.

- 20 Some options for integrated planning within the RMA regime have been presented recently by the Resource Management Review Panel (2019), with a strong focus on spatial planning options.

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