Chapter 14: Environment and ecology

There could be positive and negative environmental and ecological impacts of the climate transition for Aotearoa. In addition to reducing our emissions, using low carbon technologies and changing land practices could have broader environmental impacts, including on biodiversity, water quality and air quality.

This chapter looks at the environmental and ecological impacts from reducing emissions in the transport, heat, industry and power and land sectors.

Contents

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This chapter looks at the environmental and ecological impacts from reducing emissions in the transport, heat, industry and power and land sectors.

14.1 Introduction

This section looks at the environmental and ecological impacts of the climate transition. In addition to reducing our country's emissions, using low carbon technologies and changing land practices would have broader environmental impacts, such as the effects on biodiversity and water quality as well as on the atmosphere. This section specifically looks at the environmental and ecological impacts from reducing emissions in transport, heat, industry and power and the land sector.

14.2 Environmental and ecological impacts of actions to reduce emissions from transport and heat, industry and power

The changes made to reduce our country's emissions in transport, heat, industry and power could bring positive or negative environmental and ecological impacts. This section looks more closely at the impacts from reducing emissions from electrification, such as moving to EVs and switching to low carbon fuels, such as biomass. Although building new hydroelectric dams is not explicitly included in our pathways, we have also considered its environmental effects given their scale and significance.

14.2.1 Air quality benefits from moving to electric vehicles and improved fuel efficiency

Vehicle exhaust is a significant source of air pollution in Aotearoa, particularly in heavy transport areas. Vehicle exhaust emits a range of pollutants, including nitrogen oxides and fine particulate matter that is less than 2.5 micrometres wide. Fine particulate matter has greater health impacts than coarser particulate matter as it can get deeper into the lungs, causing respiratory issues.[1]

Moving to EVs from petrol and diesel would reduce air pollution and would reduce particulate matter that is less than 2.5 micrometres wide. EVs would continue to generate some air pollution as the weight of the vehicle wears down the road pavement, tyres and brake pads. However, these particulates tend to be coarser and have less health impact.[2]

Measurements show that as vehicles have become more emissions- and fuel-efficient over time in Aotearoa, air pollutants concentrations have decreased.[3]

[1] (Ministry for the Environment & Statistics NZ, 2018)
[2] (Ministry for the Environment & Statistics NZ, 2018)
[3] (Bluett et al., 2016)

In addition, studies in Aotearoa and internationally on the lifecycle assessment of EVs found they produce significantly fewer emissions than conventional petrol or diesel vehicles.[4]

14.2.2 Land and water implications from low carbon fuels

There are environmental effects from using low emission fuels, such as biofuels or hydrogen, which would depend on how the fuels are supplied and distributed.

Although liquid biofuel use in Aotearoa is currently very small (an estimated 0.1% of total transport fuels), increased demand for biofuels would have implications for land-use. For example, growing crops for biofuel feedstocks may compete with other land uses, such as food production. Using land to produce biofuels, may also generate other environmental benefits, such as erosion control and reducing freshwater nutrient loads.[5] It is important that biofuel production is economically and environmentally sustainable in order to maximise these benefits.

Green hydrogen produced from renewable electricity is a potential low emissions option for transport or industry. Producing green hydrogen at-scale can be extremely energy intensive and require significant build out of new renewable electricity generation as well as hydrogen distribution infrastructure. The environmental implications of hydrogen production and use would depend on whether it is produced via electrolysis (water) with renewable electricity (green hydrogen) or via fossil fuels with carbon capture and storage (blue hydrogen).

14.2.3 Mining, recycling and disposal of minerals and metals for low emission technologies

Many technologies that would be important in the transition to a low emissions economy – including wind turbines, solar panels and batteries – require mineral and metal inputs. How these minerals and metals are sourced, recycled and disposed of could have environmental impacts.

There are environmental, social and supply chain concerns around the international mining of minerals, such as lithium or cobalt, which are used in the production of batteries for EVs. Studies have concluded that there are sufficient reserves of these critical metals to meet increased EV demand.[6] Further innovations in battery technology would also help to reduce the use of these metals. Sustainable management of supply chains is required to reduce the adverse social and environmental impacts.[7]

Repurposing or reusing batteries – either as storage or recycling materials – would also extend their lifecycle. Work is underway in Aotearoa on the recycling and disposal of EV batteries. Through the Ministry for the Environment’s Waste Minimisation Fund, the Battery Industry Group (BIG) was set up in early 2020 to research and develop a co-designed framework for a product stewardship scheme for large batteries of all types used in Aotearoa.[8]

Disposing of the materials for renewable energy technologies, such as solar panels or wind panels, requires the necessary infrastructure and skills. For example, although the materials of solar panels

[4] (Elkind et al., 2020; Life Cycle Strategies, 2015)
[5] (Suckling et al., 2018)
[6] (Transport & Environment, 2017)
[7] (Elkind et al., 2020)
[8] (Battery Industry Group, 2019)

are recyclable, Aotearoa does not currently have the capacity for recycling solar panels.[9] Facilities for recycling and disposing of solar PVs is expected to increase as recycling infrastructure grows in Aotearoa.

Although wind turbines produce energy without any emissions, the turbine blades can be difficult to recycle or dispose of when turbines are decommissioned. This is because turbine blades are made of composite materials and it is costly to separate the materials for recycling. Internationally, most wind turbine blade waste is currently sent to landfill. However, the wind energy industry is working to find novel new methods for recycling composite waste.[10]

14.2.4 Environmental impacts from replacing fossil fuel boilers

The environmental impacts of replacing fossil fuel boilers would depend on what they are replaced with. Electrode boilers and heat pumps can be used for producing lower temperature heat and reducing greenhouse gas emissions and improving energy efficiency. These boilers and pumps also do not emit particulate matter and other pollutants that contribute to localised air pollution.

However, moving to biomass boilers – which can be used to produce low to high temperature heat – would be associated with emissions of some air pollutants. Canterbury District Health Board has replaced a coal fired boiler at Burwood Hospital with biomass and diesel fired boilers. In addition to reducing emissions, an assessment by BECA suggests this change would also reduce particulate matter and sulfur dioxide but increase nitrogen dioxide. However, it found that concentrations of these air pollutants would still be below air quality limits.[11]

The ash or biochar produced by most biomass boilers can also be used by horticulturalists to lift the productivity of agriculture and as a bioremediation tool for contaminated soils.[12]

14.2.5 Ecological consequences of new renewable electricity sources

Our modelling does not show that new hydroelectric power plants would be needed to meet emissions budgets and the targets. However, building new hydroelectric dams could be part of the response. In addition, a pumped hydro scheme, such as that proposed on Lake Onslow, could help to reduce electricity emissions while providing flexible capacity to meet daily peaks in electricity demand as well as demand in dry years where hydro lake levels are low.

However, such schemes can have substantial impacts on the landscape and carry ecological consequences. Hydro schemes require a large area of land to be flooded for water storage and can impact water flows downriver of the scheme, to the detriment of nationally significant wetlands, habitat for endemic bird and fish species and in some cases endangered or threatened species.

Hydro dams can also obstruct native freshwater fish from migrating up and down rivers. More than half of our native freshwater fish migrate up rivers from the sea to suitable habitats and food sources and return to the sea at the end of their life.[13]

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[9] (Ecotricity, 2020)
[10] (Cefic et al., 2020)
[11] (BECA, 2015)
[12] (Biochar Network New Zealand, 2019)
[13] (Ministry for the Environment & Statistics NZ, 2017)

Any proposed scheme would need to assess the environmental and ecological impacts, in particular on our endangered or threatened species and be consented under the resource management framework. In addition, given the freshwater implications, attention would also need to be paid to the commitments within Te Tiriti o Waitangi settlement legislation and other forms of statutory obligations or non-statutory agreements with iwi/Māori that relate to freshwater management.

14.3 Environmental and ecological impacts of actions to reduce land emissions

The actions Aotearoa takes to reduce emissions from land could bring positive or negative environmental and ecological impacts.

This section looks more closely at the environmental and ecological impacts of reducing emissions through on-farm practice change or new technologies, afforestation and land use change to horticulture.

14.3.1 On-farm practice change impact on water quality and soil health

Changing farm practices to reduce emissions can also bring environmental and financial co-benefits, however the extent of these co-benefits would depend on the farm, the farm's specific climate and soil conditions, the current management system and the advice and skills farm businesses can draw on.

Making practice changes on farm can reduce emissions and improve water quality and soil health. This is particularly the case for practice changes that reduce nitrous oxide emissions, as nitrogen in the soil reacts to produce both nitrous oxide and nitrate that runs off into waterways.

Careful balancing of stocking rates, pasture management and supplementary feed can lead to a farm system where production, profit, emissions and other environmental outcomes are optimised. What an optimal system looks like would vary considerably between farms and what any given farm can achieve would depend on how that farm is managed overall. For example, for some farmers applying nitrogen fertiliser more precisely – by using less and/or adjusting the rate and timing of applications – would reduce nitrous oxide emissions and nitrogen leaching and runoff. However, this must be carefully managed because if reductions in fertiliser result in lower pasture growth, but stocking rates are maintained by using high-nitrogen supplementary feed, the reductions of nitrous oxide may be minimal.[14]

Regenerative agriculture is an approach to farming that focusses on regenerating soil, improving water quality, enhancing ecosystem services, improving biodiversity and promoting livestock welfare.[15] Many farmers in Aotearoa already implement practices in line with these principles, such as cover cropping and mixed grass species in pastures that help to fix nitrogen and promote soil microbial diversity.[16] However, there is scope for further actions on our farms, for example by reducing synthetic fertiliser use and planting more trees.

[14] See, for example (de Klein et al., 2016)
[15] (Lal, 2020; Newton et al., 2020; Siegfried, 2020)
[16] (Vukicevich et al., 2016)

Improving the drainage of soils that are not draining well or avoiding soil compaction could improve soil structure and therefore soil health,[17] and reduce nitrous oxide emissions.[18]

14.3.2 Biodiversity and water quality benefits from afforestation

The environmental and ecological impacts of land use change to forests depends on the desired objectives, the type of forest, where it is being planted and how it is managed.

Trees sequester carbon dioxide no matter where they are planted – albeit at a faster rate for exotics compared to natives.[19] However, other environmental impacts are location and management-specific. For example, planting trees on steep slopes and gullies can help reduce erosion and sediment runoff if the trees are selected and managed for that purpose.[20]

If the right type of tree is planted in the right place at the right time, it can have water quality, soil health, erosion and biodiversity co-benefits in addition to sequestering carbon dioxide. Aotearoa research suggests that planting trees on agricultural land can improve water quality and stream health within four to six years, including reducing stream temperatures and reducing nitrogen and phosphorous run-off to water. While exotic forests provide many of the same benefits as native forests over much of the forest-growing cycle, there are negative impacts on waterways when exotic production forests are harvested through clear-fell.[21]

About one third of the original soil protection plantations in Aotearoa are now production forests that are being clear-felled. After clear-felling, the risk of landslides in exotic production forests – particularly those on steep slopes – increases and may cause debris to flow downstream affecting houses, roads and bridges. This can be reduced by changing forest management practices to harvesting over longer rotations, small-coupe clear-felling, continuous cover forests,[22] or retiring the forests from production.[23]

The type of tree that is planted is important in determining the biodiversity co-benefits. Exotic forests provide some habitat for some native species, such as robins, fantails, kiwi and native falcons;[24] they host more native species than pasture. However, the biodiversity benefit of exotic forests is small in comparison to native forests, which host hundreds of threatened species and thousands of species.[25]

Synergies can occur between carbon sequestration efforts and biodiversity protection for native forests. When carbon gain is prioritised for natural regeneration in Aotearoa, biodiversity suffers a larger trade-off than carbon when biodiversity is prioritised. If both carbon and biodiversity are

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[17] (Kibblewhite et al., 2008)
[18] (de Klein & Ledgard, 2005)
[19] Sequestration rates vary depending on tree species and site conditions (e.g. temperature, soil, slope) where trees are planted. Planted pines in Aotearoa sequester carbon dioxide about five times more quickly than native forests (Ministry for Primary Industries, Unpublished)
[20] (Bloomberg et al., 2019; Satchell, 2018)
[21] (Baillie & Neary, 2015)
[22] (Amishev et al., 2014)
[23] (Phillips et al., 2015)
[24] (MacLeod et al., 2008)
[25] (Brockerhoff et al., 2008)

prioritised, then the average gains in carbon and biodiversity could be 10%-20% more than if either carbon or biodiversity is prioritised independently.[26]

Controlling herbivores and predators may enhance carbon stocks and biodiversity in native forests in the long term. Deer, wild pigs, wild cats, goats, possums and livestock can have negative impacts on native forests. These animals change both the composition of plant species and the animal communities that depend on them.[27] In Aotearoa possums are the major cause of the decline of native trees such as pōhutukawa, rewarewa, kāmahi, māhoe, tawa and rātā.[28]

Carrying out more predator control, fencing out grazing and browsing animals and preventing fires in our regenerating and native forests can result in more native birds, more tree growth and prevent forest decline in the long term.[29] However, removing grazers and browsers is no easy task. Studies have shown that it is difficult to sufficiently suppress these species over large enough areas and for long enough to see a response.[30] Active control of browsers was found to be more beneficial in young forests that were still establishing.[31]

Woody and riparian vegetation in production landscapes increases biodiversity values, improves water quality and reduces erosion. Increasing the amount and diversity of vegetation within production landscapes can have a range of environmental and ecological benefits, even without large-scale changes to forests. Woody patches, hedgerows and shelterbelts, riparian planting and wetlands can all increase the range of plants and animals found on farms and improve both the amount of carbon storage and biodiversity.[32]

On-farm native vegetation expands over 1.5 million hectares of sheep and beef land.[33] Much of this vegetation is on lowland ecosystems and is critical for biodiversity conservation as part of a larger network of sites that can improve connectivity in the landscape and serve as stepping stones for birds that disperse tree seeds.[34] Revegetation and fencing of farm gullies have co-benefits for erosion and biodiversity.

Planting trees and shrubs along gullies and stream banks can reduce soil erosion and the amounts of phosphorus getting into waterways by up to 60%.[35] A recent review of over 300 international studies found that the presence of these sorts of 'non-productive' vegetation resulted in positive improvements of ecological processes in most cases.[36]

In Aotearoa, rare and unique native birds are of interest to many people and several studies have looked at native birds in production landscapes. For example, open farmland can provide important

26 (Carswell et al., 2015)
27 (Peltzer et al., 2014; Wardle et al., 2001; Wright et al., 2012)
28 (Nugent et al., 2010)
29 (Carswell et al., 2015)
30 (Nugent et al., 2010)
31 (Carswell et al., 2015)
32 (Burrows et al., 2018)
33 This comprises 8.2% indigenous forest (0.81 million ha), 5.5% mānuka/kānuka (0.56 million ha), 1.7% indigenous scrub and shrubland (0.17 million ha) ((2020)).
34 (Norton et al., 2018; Norton & Pannell, 2018)
35 (Parliamentary Commissioner for the Environment, 2012)
36 (Case et al., 2020)

habitat for species like South Island pied oystercatcher and the world's rarest gull, the black billed gull.[37]

The diversity within an individual farm can also affect the birds that are found there. A study of South Island sheep and beef farms found that the number of species present was strongly influenced by habitat composition, extent and diversity, with the most diverse farms having the greatest number of bird species and native birds.[38]

14.3.3 Water quality impacts from land use change to horticulture

Land use change from dairy to horticulture on flatter and more productive land could reduce biogenic emissions per hectare.[39] However, this could also cause water quality to deteriorate due to the increased use of fertiliser and consequential nitrogen and phosphorus losses. Nutrient losses would vary depending on the crop, the site, weather conditions, the soils' physical and chemical properties and how the land is managed.[40]

Increasing the area of horticulture would increase water demand in Aotearoa. Climate change modelling for kiwifruit indicates that there would be higher water demand by the industry in regions such as Waikato and Hawke's Bay and variable demand in other regions like Southland towards 2090.[41] In light of the physical impacts of climate change, this increased future demand needs to be balanced when considering expansion of horticulture as a way to reduce emissions.

14.3.4 Policy synergies

Other environmental policies would also help to reduce emissions. Many of the actions that are taken on-farm to improve fresh water in Aotearoa would also deliver emissions reductions.

The National Policy Statement for Indigenous Biodiversity could provide synergies with climate change mitigation policies if support for biodiversity outcomes on productive land is recognised on a tangible way. In its current version the draft policy recognises the role of landowners, communities and tangata whenua as stewards, but does not mention how they would be supported to achieve the outcomes.

Policy would need to be designed to make the most of the co-benefits and reduce the negative impacts of land use change and agricultural practice change. It would also need to be designed in the context of how different land uses and practices could integrate in a mosaic landscape, factoring in the impacts of land use change on rural communities and what this means for the whole food and fibre production system.

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[37] (Parliamentary Commissioner for the Environment, 2017)

[38] (Blackwell et al., 2005; MacLeod et al., 2008)

[39] The BERG estimates that that biological emissions from dairy are about 12 tCO_2e per hectare and between 3.5-2.1 tCO_2e for sheep and beef. They estimate that biological emissions from horticulture range from 0.17-1 tCO_2e per hectare. (Reisinger et al., 2017)

[40] (Norris et al., 2017)

[41] (Ausseil et al., 2019)

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