Resource Economics

Resource Management Reform: *Impacts Analysis of Resource Allocation Proposals*

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Report for Ministry for the Environment - Manatū Mō Te Taiao

Authors:

Tim Denne (Resource Economics) and Preston Davies (Sapere Research Group)

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Glossary of Terms

AAAQT	Auckland Ambient Air Quality Targets
AAQG	National Ambient Air Quality Guidelines
AUP	Auckland Unitary Plan
BOPRC	Bay of Plenty Regional Council
BPO	best practicable option
CBA	cost benefit analysis
CMA	coastal marine area
CO	carbon monoxide
CO_2	carbon dioxide
COC	coastal occupation charge
CSAPR	Cross-State Air Pollution Rule (USA)
EDS	Environmental Defence Society
EEZ	exclusive economic zone
ESP	electrostatic precipitator
FIFS	first-in, first served
FMU	freshwater management unit under the NPS-FM
GHG	greenhouse gas
GST	goods and services tax
HRC	Horizons Regional Council
IGC	infrastructure growth charge
ITQ	individual transferable quota
LEZ	low emission zone
LPG	liquid petroleum gas
LRMC	long-run marginal cost
MACA	Marine and Coastal Area (Takutai Moana) Act 2011
MCACSA	Māori Commercial Aquaculture Claims Settlement Act 2004
MfE	Ministry for the Environment
MDC	Marlborough District Council
MPA	marine protected area
NAAQS	national ambient air quality standards (USA)
NBA	Natural and Built Environments Act
NES	national environmental standard
NES-AQ	national environmental standards for air quality

NES-F	national environmental standards for freshwater
NES-MA	national environmental standards for marine aquaculture
NO_2	nitrogen dioxide
NOx	oxides of nitrogen
NPF	National Planning Framework
NPS-FM	National Policy Statement on Freshwater Management 2020
NZCPS	NZ Coastal Policy Statement
NZIER	NZ Institute of Economic Research
O_3	ozone
$PM_{2.5}$	particulate matter less than 2.5 µm in diameter
PM_{10}	particulate matter less than 10 µm in diameter
RM	resource management
RMA	Resource Management Act 1991
SO_2	sulphur dioxide
SRMC	short-run marginal cost
TEV	total economic value
ToKM	Te Ohu Kaimoana
WHO	World Health Organisation
WTA	willingness to accept
WTP	willingness to pay

Contents

Summary

1 Background

This report examines the potential impacts of proposed changes to resource allocation under the resource management (RM) reforms. The problems addressed are particularly those identified by the Resource Management Review Panel ('the Panel')[1] set up to review the Resource Management Act 1991 (RMA). The Panel identified the problem with the current approach to resource allocation as being focussed on the widespread use of first-in, first-served (FIFS) for the allocation of consents to use resources - that it was not resulting in optimal allocation of resources and was providing little opportunity for reallocation during a consent period (often with renewal at the end of the consent).

The reform proposals analysed in this report are taken from the exposure draft of a new Natural and Built Environments Act (NBA) and additional advice from officials, recognising that the proposals were still being discussed and developed as we undertook this work. Proposals that are relevant to this impacts analysis include the following:

- The overall purpose of the NBA is to enable *Te Oranga o te Taiao* to be upheld and allow current and future generations to use the environment to support their wellbeing. *Te Oranga o te Taiao* incorporates the health of the environment, the relationship of people (particularly iwi and hapū) to it and the environment's capacity for sustaining all life.[2]

- The allocation approach will need to give effect to the *Te Tiriti o Waitangi* (*Te Tiriti*) clause.

- The NBA will be broadly enabling for councils, which will have flexibility in how they respond. At the same time, there is likely to be more detailed direction from central government. There would be a greater focus on allocation at a planning rather than consenting stage, via a National Planning Framework (NPF) and regional NBA plans.

- Resource allocation methods will need to have regard to principles of sustainability, equity, and efficiency. When there is resource scarcity, FIFS is unlikely to be regarded as appropriate.

- It will be possible for the NPF to provide direction on consent durations, including the use of common expiry dates.

- Officials are still working on the potential for resource user charges to be applied to a wider range of resources, with the primary objective of enabling communities to gain some value when resources are allocated to private use. They would not be used for freshwater takes and diversions.

[1] Resource Management Review Panel (2020)

[2] This is incorporating Māori concepts of wellbeing, deeply rooted in the interconnection to the environment, alongside the wellbeing of all people.

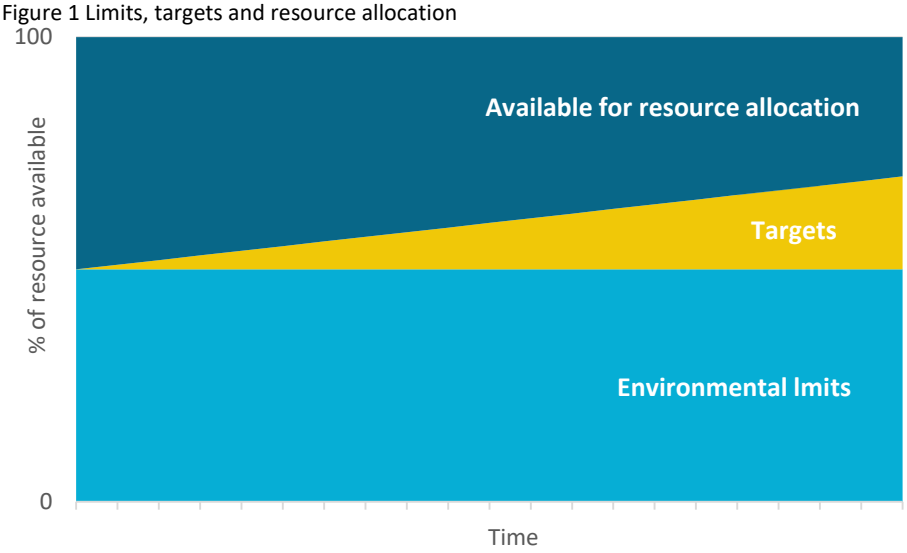
The scope of the resources to which the new resource allocation framework would apply was yet to be determined while this impacts analysis was being developed. It was agreed that specific impacts analysis would be undertaken in this report for the following resources: coastal marine area, discharges to air, freshwater takes, freshwater discharges, and sand.

2 Expected Impacts of Reforms

Allocation in the Context of Limits and Targets

Under the proposed NBA, resource allocation is limited to the quantity of a resource available after any constraints have been defined through limits and targets[3] (Figure 1).

Figure 1 Limits, targets and resource allocation



Limits and targets are mandatory for certain domains (air, indigenous biodiversity, coastal waters, estuaries, freshwater, and soil) and will apply at a scale defined by 'management units', such as catchments or airsheds. Included within the limits and targets portion will be cultural use and any other resource use (or non-use) that ensures "*the relationship of iwi and hapū, and their tikanga and traditions, with their ancestral lands, water, sites, wāhi tapu, and other taonga is restored and protected*" (Section 8(f) of the NBA exposure draft).

Anything that remains is available for resource allocation amongst potentially competing users (via resource consents or other use rights), while still giving effect to *Te Oranga o te Taiao* and *Te Tiriti*. One potential problem with defining an allocation quantum in this way is that (adequate) consideration may not be given to non-commercial uses, eg allocating resources to obtain additional environmental rather than commercial value. This is also a reason why FIFS is never an adequate methodology; even where there is no competition amongst potential consent holders it does not weigh up the value of not allocating resources to commercial uses.

[3] Environmental limits will define the current state of the natural environment or the current or future target state required to ensure human health, and will be used to ensure 'no net loss' from the current state. Targets are used to ensure ecological integrity is restored where it is already degraded and, in all places, to set quantified objectives for further improvement in environmental outcomes.

Allocation Principles

In developing allocation approaches, decision makers must have regard to principles of sustainability, efficiency and equity. These principles will be defined through the NPF and as such, are still to be defined, but are likely to cover the following matters articulated in the Panel's report:

- **Efficiency** – resources are used to maximise community wellbeing at all times;

- **Sustainability** – allocation will be within limits and targets which protect the environment, and take account of the wider environmental effects of use and the wellbeing of future generations;

- **Equity** – ensuring relative equality of outcome (eg the community benefits from local resource use via resource charges) and equality of opportunity (potential access for new users). Fairness across generations is addressed via the sustainability criterion.

Initial Allocation and Reallocation

The Panel identified problems with both initial allocation (to the first user of the resource by consent or other mechanism) and reallocation (to subsequent users, including allocation to higher value uses rather than consents being simply renewed).

Initial allocation approaches consistent with the principles could include:

- Market-based approaches, including tenders, auctions and ballots in which allocation is to the highest bidder.

- Merit-based approaches in which alternative uses or users are analysed to identify which would produce the greatest community wellbeing.

Reallocation approaches include:

- Markets in which use rights could be directly tradable during a consent period.

- Merit-based analysis at the end of any consent period rather than automatic renewals.

Potentially, consent withdrawal and reallocation during a consent could be undertaken - in our view this might require compensation to be paid to address both efficiency (higher investment risk) and equity concerns.

Initial Allocation

Resource allocation is likely to be efficient, equitable and sustainable when resources are used by those who would produce the most community wellbeing, within the constraints of limits and targets and with allocations to Māori consistent with *Te Oranga o te Taiao* and *Te Tiriti*. Because of the very wide range of potential impacts on wellbeing of natural resources and the environment (as summarised in concepts such as Total Economic Value and Ecosystem Services), the optimal approach to initial allocation is not necessarily obvious.

Markets work best when they are (or can be):

- **competitive**, with many competing participants;
- **liquid** in which there are low costs of participation, eg it is easy to find a counter-party to trade with and the transactions costs are very low; and
- **complete**, such that all components of value are included and with no externalities such as additional environmental effects that are not also priced[4] or otherwise regulated (efficiently).

Markets are favoured when these conditions are met (or are close to being met) because they enable the value of resources to different users to be revealed by their bids or other market behaviour.

Merit-based allocation enables a council (or central Government) to analyse which is the optimal use, taking account of the wide range of effects. This can be a useful approach particularly when the market is unlikely to be competitive, liquid or complete. However, merit-based approaches rely on analysts identifying all potential effects and values, whereas natural resource allocation decisions are typically limited by uncertainty and data gaps.

Thus, there is no perfect solution for all circumstances and decision makers will need to weigh carefully which is the best method for any resource and region.

Reallocation

Even if the initial allocation is optimal, ideally it would continue to be optimal even when circumstances change, such as changes in relative prices, new technologies or simply the arrival of a high value user that was not present when a resource was first allocated.

Markets enable reallocation to occur simply, provided the existence of tradable use rights and the market conditions discussed above (competition, liquidity, completeness). They ensure a new user can obtain access (meeting equity objectives) and that use can switch to a higher value user (meeting efficiency objectives).[5] When payment is made for use, both parties agree to the trade and current users are therefore adequately compensated for any loss of use rights.

Merit-based approaches are generally limited by the consent duration. They also require that the investment plans of any potential new user are consistent with the end of an existing consent. Partly reflecting this concern, shorter duration consents have also been considered (see below).

[4] Charges provide a more economically efficient outcome by providing marginal signals to limit discharges

[5] We acknowledge that this might be constrained by endowment effects in which an owner's valuation of a resource (or willingness to accept payment for it) is greater than the willingness to pay of a potential new user, in a way that might appear irrational. However, this might partly reflect an uncompetitive or illiquid market.

Allocation and Māori

Allocation to Māori will better enable them to meet their development aspirations and directly addresses historical inequities or recognise *Te Tiriti* rights and interests. This may also be consistent with the allocation principles of equity and efficiency to the extent that Māori value natural resources more than others, eg within the context of sustainable use to meet multiple objectives.

Māori aspirations for resource management to meet long-term objectives might be constrained by short duration consents which set, unless allocation consistent with *Te Tiriti* effectively gives iwi consent renewal rights that are not available to other resource users. Māori aspirations might be driven by developmental goals but are also governed by a world view that is holistic and interconnected with respect to the environment. The Māori world view acknowledges a natural order to the universe, a balance or equilibrium, and that when part of this system shifts, the entire system is put out of balance. The diversity of life is embellished in this world view through the interrelationship of all living things as dependent on each other, and Māori seek to understand the total system and not just parts of it.[6] This means, allocation approaches for a specific resource are intrinsically linked to other resources and the environment/ecosystem as a whole.

Comparison of Approaches

Table 1 summarises the impacts of the different allocation options.

Table 1 Summary of allocation approaches against principles

Principle/Issue	First-in, first served	Merit-based	Markets
Efficiency			
Immediate (static) efficiency	No consideration of best use and no comparison with no commercial use	Competing resource users can be compared based on contribution to wellbeing using CBA (limited by data availability)	Allocation to optimal use via market transactions where market is competitive, liquid and complete.
Ongoing (dynamic) efficiency	Markets might be used for reallocation, but otherwise this is limited by consent duration	Limited by consent duration unless markets enabled for reallocation	Allows reallocation where use rights are tradable
System costs	Low	Will depend on the level of analysis undertaken and data availability	Can be high, depending on need for monitoring and system architecture
Sustainability	Impacts on future generations may require constraints to allocation in addition to limits and targets. Sustainable management will be influenced by consent duration. Wider impacts will be as for static efficiency		
Equity	Low: allocation based on first application	Initially can be high (allocation based on merit) but can exclude subsequent new entrants.	Can be high, although allocation based on willingness to pay may exclude uses with high community benefits.

[6] Harmsworth and Awatere (2012)

Short Duration Consents

One approach to enabling greater transferability is by using short consent periods, as proposed for a transition period. This has the potential advantage of not committing a resource to a particular use over a longer period, particularly when the initial allocation is sub-optimal. Set against this, the significant disadvantages include:

- Impacts on investment – some resource uses, particularly those with high capital costs for plant & machinery or for land use change, will require a long(ish) consent period over which to obtain a return on investment. Ideally the consent duration is related to the economic life of the capital. Where consents are shorter, this may preclude some investments.

- Impacts on sustainable use – where long term rights are not guaranteed, resource managers may not have incentives to manage a resource well. This can result in over-exploitation (when consent conditions do not adequately cover these impacts).

- Higher total costs because re-consenting costs are brought forward in time.

As noted above, short-term consents are particularly an issue for Māori resource users who tend to take a longer-term view to resource management.

Unless short-duration consents are limited to resource uses for which there is no significant capital cost element, they are a sub-optimal approach to resource allocation with potential for high costs. Other approaches to ensuring resources are not committed to low value uses over the longer run will be better solutions. This is particularly in the form of tradability of resource use rights.

Resource User Charges and the Potential Redistribution of Benefits

Resource user charges are proposed with several potential benefits including:

- Efficient use of infrastructure, ie ensuring that users pay a charge which is equal to the costs of supply so that people only use a resource to the extent that they value it more than the costs of supplying that resource.

- Efficient revenue raising that might be used to replace current charges for local government.

- Re-distribution of revenue, ie obtaining some of the surplus value of resource use for the benefit of the local community in related or unrelated expenditure.

- Charging for externalities such as pollution to ensure efficient decisions are made on discharges and there is an ongoing marginal incentive to limit them.

System Costs

The proposed changes to the resource allocation system, including greater use of plans for allocation, more national direction and greater flexibility for users is expected to have the following broad impacts on costs:[7]

- lower total system costs;
- lower costs for users, eg for obtaining consents; and
- higher costs for government and councils, and for taxpayers and ratepayers.

3 Coastal Marine Area

The Reform Issues

The coastal marine area (CMA) is the area between mean high-water springs (MHWS) and the 12 nautical mile limit of the territorial sea. Uses of the CMA include transport of goods, movements (navigation) of ships and other vessels, occupation by structures (such as wharves), recreation, fishing, customary practices, oil and gas exploration, sand (and potentially other) mining, aquaculture, and buildings (eg cafes and boat sheds) in and beside the water and on wharves. The resource allocation issue is for this marine space to be allocated to produce most wellbeing.

Potential Reforms and Impacts

The impacts we have assessed are those from the following:

- an assumed greater level of planning for the allocation of coastal space or activity in the CMA;
- larger areas zoned for aquaculture and for marine protected areas, with the assumptions that these areas are allocated well, ie where the benefits exceed costs and wellbeing is improved;
- more flexibility in the location of aquaculture within areas zoned for aquaculture; and
- greater use of resource user charges as coastal occupation charges or on some other basis, eg biomass taken or some measure of harvest effort.

As with other resources, many of these changes could occur under the existing legislation. The RM reforms make the changes more likely to occur.

It is noted that a number of Treaty settlements relate to activities in the CMA, and any changes to allocation in the CMA would need to recognise this context.

The expected impacts across the individual dimensions are summarised in Table 2. For this and other resources, we use a very narrow definition of economic impacts here: that relating to impacts on the consumption of market goods, including via changes to income and wealth.

[7] This is MfE's assessment, building on Castalia (2021)

Table 2 Potential impacts of reforms on wellbeing from the CMA

Dimension	Benefits	Costs
Economic	Increased value of aquaculture, based on: • increased area allocated in plans • lower transaction costs • greater potential for relocation and transfer	Potential for: • higher planning costs for central and local government • reduced investment if councils choose to issue consents with significantly shorter duration.
Environmental	Potential for: • increased creation of marine protected areas • improvements in aquaculture location, eg with better planning of suitability or incentives for reduced impact locations	Impacts of increased aquaculture area, including: • nutrient discharges • smothering of benthic communities • habitat exclusion • pests & disease spread
Social	Potential for: • fairer access to aquaculture consents • use of resource user charge revenue to provide community benefits	Potential for: • reduction in local input to, or influence over, allocation decisions • exceedance of 'social carrying capacity' for aquaculture.
Cultural	Increased kaitiakitanga role for Māori, including via increased levels of access to resources.	Shorter term consents reduce ability to manage for sustainability

4 Discharges to Air

Reform Issues

The clean air resource is the quality of air required to meet people's health needs. When contaminants are emitted to air, they reduce the availability of clean air, and when limits are set for pollutant concentrations or emission rates, the allocation challenge is in deciding which sources of air pollution can discharge and by how much. The allocation challenge can be conceived of as allocating the right to emit within a limit and within a defined airshed.

Potential Reforms and Impacts

The impacts that we assess are based on the following assumptions:

- some increased flexibility in the source of emission reductions within airsheds, eg from greater use of offset or equivalent mechanisms allowing reductions to include a changed mix of reductions from, eg vehicles, industry and residential heating;
- more analysis to identify optimal sources of emission reductions; and
- resource user charges applied to air pollution, including possible pollution taxes.

Table 3 summarises the potential impacts of the reforms as they apply to air quality, summarised across the different dimensions of interest.

Table 3 Potential Impacts of Reforms on Wellbeing from Air Quality

Dimension	Benefits	Costs
Economic	• Flexibility in response would be expected to reduce costs of mitigation per unit of pollution reduced or (health) outcome improved. • Expected reduced costs of consenting, especially if more use of economic instruments	Potential for: • increases in costs of plan preparation at national and regional level from increased level of analysis to determine limits and targets. • increase in total costs of mitigation, but this is from tighter limits rather than allocation
Environmental	Main environmental benefits via limits and targets.	Any environmental costs would depend on simplifications made in use of offsets or other economic instruments, eg allowing offsets without fully accounting for exposure.
Social	Social impacts could be improved by analysis that takes account of the impacts of policies on low-income households.	Potential for high relative costs for low-income households and reduced social participation if more focus on low-cost vehicles and/or home heating for emission reductions.
Cultural	Māori stand to gain from better air quality as they currently suffer disproportionate hospital admission rates for respiratory disorders	Shorter term consents reduce ability to manage for sustainability Māori are more likely to own older, less fuel-efficient vehicles

5 Freshwater Takes

Reform Issues

Freshwater takes are included in this analysis although the resource allocation proposals will not apply to it fully. Specifically, resource user charges will not be extended to freshwater, and neither will any allocation system that results in revenue being collected by central or local government. Pricing systems for water allocation are still likely to be enabled where these involve trades amongst rights holders.

The allocation challenges include the over-allocation of water in some regions and the potential for allocation to higher value uses, such as irrigation for horticulture rather than pastoral farming.

Potential Reforms and Impacts

The benefits of reforms to allocation are highly uncertain for water, reflecting:

- uncertainty in current data on supply and demand imbalance;
- the potential for storage as a response to supply limits;
- the various barriers to trading that exist currently and the reasons why trading has diminished over time despite the existence of a market; and
- uncertainty over the extent to which allocation reforms will lead to changes in land use or to changes in the productivity of existing land uses.

We summarise possible impacts in Table 4.

Table 4 Potential impacts of reforms on wellbeing from freshwater takes allocation

Dimension	Benefits	Costs
Economic	• Potential for allocation of freshwater use rights to higher value uses, such as for irrigation of horticulture. • Value of transferability will depend on whether storage is used also to increase supply.	• Cost for any trading framework that would need to be weighed against the benefits of trade. • Costs of storage.
Environmental	Environmental effects (positive or negative) will depend on whether any flexibility in allocation leads to changes in the location of water use in a catchment. Effects will be constrained also by limits under the NPS-FM (or any future instruments).	
Social	Potential shifts in location of employment from land use changes associated with reallocation or trading of water take use rights.	
Cultural	• Flexibility in allocation may provide Māori with better access to water and to land development potential. • Water allocation to Māori enables land management to wider objectives.	Shorter term consents reduce ability to manage for sustainability

6 Freshwater Quality

Reform Issues

Freshwater quality has deteriorated in New Zealand from factors that include run-off or leaching of nutrients and contaminants (nitrogen, phosphorus, sediment and pathogens such as *E coli*, in addition to other anthropogenic chemical contaminants such as heavy metals from industry and endocrine disrupters from wastewater). They can affect water clarity, ecosystem health, the aesthetic value of waterways, the diversity of aquatic life and the potential for recreational and commercial use, including from potential impacts on human health.

The allocation challenge is, within tighter limits for discharges, which point- and non-point sources of discharges will be allowed.

Potential Reforms and Impacts

The potential impacts assessed are focussed on flexibility in the allocation of discharge rights, eg via nutrient allowance trading. In addition, there is the potential for reduced duration of consents. We summarise possible impacts in Table 5.

Table 5 Potential impacts of reforms on wellbeing from allocation of discharge rights to freshwater

Dimension	Benefits	Costs
Economic	Potential cost savings from flexibility in allocation, eg more use of N-trading.	Costs for design and establishment of trading schemes.
Environmental	Environmental impacts expected to be the same but limits achieved at lower cost.	
Social	• Increased fairness of access to discharge allowances. • Social impacts will depend on land use change outcomes of flexibility, eg changes to employment.	Employment impacts are uncertain.
Cultural	• Flexibility in allocation may provide Māori with better access to discharge rights and to land development potential. • Allocation to Māori enables land management to wider objectives.	Shorter term consents reduce ability to manage for sustainability

7 Sand

Reform Issues

Uses of sand and other aggregates include providing hardfill for road bases and as an input to the production of concrete and general industrial uses.

Potential Reforms and Impacts

There would appear to be little potential for trading of sand extraction rights. The main impacts assessed for sand are from reduced consent duration and the introduction of resource user charges. We summarise possible impacts in Table 6.

Table 6 Potential impacts of reforms on wellbeing from allocation of discharge rights to freshwater

Dimension	Benefits	Costs
Economic		Reduced consent duration brings forward the time for new consenting costs and increases investment uncertainty.
Environmental	Potentially reduced extraction impacts if consumption reduces in response to price increases.	
Social	Resource user charges enable community benefits via shifting sources of revenue	Potential increased construction costs
Cultural	No significant impact from reforms	

8 Conclusions

The overall conclusions from the analysis are:

- Some of the proposed new approaches are technically possible under existing legislation but have not been used. The reforms provide tools for more varied approaches to allocation and a focus and stimulus for change, particularly the increased use of national direction and the shift away from FIFS.

- FIFS has little merit as an allocation approach, even in the absence of competition for resource consents. This is because it fails to address the benefits of not allocating to commercial use.

- Allocation against principles or efficiency, sustainability and equity can be achieved via merit-based approaches or markets.

    - Markets can reveal the optimal allocation, provided certain market criteria are met. This will differ regionally and by resource, particularly in the number of potentially competing users and the extent to which all (or most) effects of resource use can be priced.

    - Merit-based approaches (making wider use of CBA) can be an improvement over FIFS, and better enable allocation that maximises wellbeing. The advantage of this approach depends on availability of data on effects and values, and on best practice use of CBA.

- Shorter duration consents can be used to address the potential downsides of long consents where "best use" may change over time. However, there are disadvantages of short consents particularly for investments in land use change or capital equipment. The objectives of short duration consents could be better met through facilitating markets that enable reallocation of resource use, or even reallocation with compensation.

- Resource user charges can be used to achieve wide objectives that include efficient use of infrastructure, efficient revenue raising, redistribution of benefits and efficient (wellbeing maximising) allocation via charging for externalities.

1 Introduction

1.1 Background and Purpose of the Report

This report examines the potential impacts of proposed changes to resource allocation under the resource management (RM) reforms, including new principles for allocation and the wider use of resource user charges. The report is to provide the Ministry for the Environment (MfE) with a better understanding of the expected effects which will, in turn, provide inputs to further policy development and regulatory impact analysis.

In undertaking this analysis, our understanding is that the proposed reforms are broadly those suggested by the Resource Management Review Panel ('the Panel'),[8] but that these have been further developed and modified by officials. The reforms are expected to result in a Natural and Built Environments Act (NBA) which will provide an enabling framework for resource allocation and user charges.

In this section we first set out our understanding of the scope of resource allocation and the current problem(s) that the resource allocation proposals are addressing. We then set out our approach to analysis of the impacts. This is somewhat speculative as the proposals are broadly enabling, with the reform outcomes also relying on future government direction through secondary legislation and the responses of local government and resource users.

1.2 Scope of Resource Allocation

The Resource Management Act 1991 (RMA) does not expressly distinguish between the management of a resource and the allocation of that resource. It defines 'natural and physical resources' to include land, water, air, soil, minerals, and energy, all forms of plants and animals (whether native to New Zealand or introduced), and all structures. Other definitions of resources are even wider in scope.

The resources to which the new resource allocation framework will apply were not yet confirmed at date of publication. We understand they may include:

- freshwater takes, diversions, and discharges;
- discharges to air;
- geothermal water and heat.

We understand there will also be an ability for the National Planning Framework (NPF) to add resources to this list at a later stage. It will be possible for the Minister for the Environment to provide direction on allocation approaches for resources within scope of the new framework.

Where a resource is not included in this list the standard planning and consenting provisions in the NBA will apply.

[8] Resource Management Review Panel (2020

MfE has indicated that resources in scope of this impacts analysis should include:

- freshwater for takes and diversions;
- assimilative capacity of the environment, including air and freshwater;
- coastal marine space;
- geothermal water and heat; and
- river and coastal marine area materials (eg, gravel and sand).

Resources specifically excluded from this analysis are:

- the development capacity of land;
- natural resources covered by dedicated legislation (such as resources allocated under the Crown Minerals Act 1991 and greenhouse gases under the Climate Change Response Act 2002); and
- biodiversity.

1.3 The Resource Allocation Problem and Solutions

1.3.1 First-In, First-Served

The Panel identified the problem with the current approach to resource allocation as being focussed on the widespread use of first-in, first-served (FIFS), with no (or very little)[9] opportunity for reallocation during a consent period and often with renewal at the end of the consent. The Panel noted "*this principle is not explicitly stated in the RMA but rather has been developed through case law in response to a lack of more substantive guidance*" (p322).[10]

The Panel concluded that FIFS was not problematic when there is no resource scarcity (when demand does not exceed supply), because it provides access to resources and resources users with sufficient certainty to make investments. However, when there is scarcity, FIFS "*does not guarantee that it is allocated to current or future uses which offer the greatest environmental, social, cultural or economic value. Historic uses may not make best use of the resource, and their privileged and uncontested access may limit the interest of users in doing better. Further, where there is a looming shortage, or a sense this will occur, a 'gold rush' effect can emerge where parties rush to claim a resource use right without any plans to use it in the immediate future*" (p329).

The Panel suggests the current approach to allocation is unsustainable, inefficient and inequitable and that "*in a world in which we are increasingly challenged to manage resources within environmental limits, allocation of the right to use those resources will need to be more systematically approached to ensure it contributes to the overall wellbeing of people and communities*" (p321).

[9] There are some examples where trading is possible, eg for water take rights and N trading at Lake Taupo

[10] Officials note that this has been reinforced by the introduction to the RMA of sections 124A – 124C, and section 104(2A), which states that, when considering a consent application, a consent authority "must have regard to the value of the investment of the existing consent holder." This latter consideration may be valid in some circumstances (see discussion in Section 2.6.3 below), but it may simply be used to privilege rights holders.

Although the Panel suggests FIFS may not be problematic when there is no scarcity, their definition of scarcity appears somewhat limited. Resources are scare whenever one use reduces that available to another, which includes resources that are providing value as part of the natural environment with no current commercial use. To the extent that FIFS allocation does not consider whether a commercial use of the resource is better than it remaining unused commercially, then it is not wellbeing enhancing. It is too simplistic to suggest that FIFS remains a useful approach when there is no competition amongst potential commercial users. All potential uses should be evaluated, either at the plan or consent stage. Such analysis also has the potential to enable Māori to express their values in resource use (or non-use).

1.3.2 The Wellbeing Objective

The Panel identifies the current approach as being unsustainable, inefficient and inequitable, and this provides the basis for the proposed allocation principles (sustainability, efficiency and equity) that we assess in Section 2. Here we address the overarching problem of the failure of the current allocation approach to contribute as much as it could towards overall wellbeing.

The pursuit of improved or maximum possible wellbeing is long-standing as a policy objective (Box 1-1), although it is not stated as an overall objective of the Government, its pursuit is part of the Standard of Integrity and Conduct of NZ public servants.[11]

Box 1-1 Measuring wellbeing: Pareto improvements and Kaldor-Hicks optimality

Moral philosophers from the 18th and 19th Centuries had addressed the question of "what is a good or a right decision?" One influential line of thinking suggested the "good decision" is that which produces the most pleasure and the least pain for the most people.[12] This idea has been widened over time by policy thinkers such that the understanding of what is to be maximised, termed utility or wellbeing, has expanded from pleasure or happiness to encompass anything which a person needs or enjoys, including adequate nutritious food, warm and dry housing, entertainment, natural beauty, freedom of expression, sense of belonging and so on. Effectively it includes anything that a person or a community would unambiguously want more of and not want less of. Improving wellbeing makes people's lives better.

Historically, measurement of wellbeing or utility improvement started from the notion that a change in resource use is desirable, and is said to provide a Pareto improvement,[13] if at least one person is made better off and no-one is made worse off.[14] However, this is a difficult criterion to satisfy, as most changes usually make some people better off while making others worse off. For example, allowing increased discharges to a river might result in resources shifting from providing public benefits, (water quality for the benefit of all), to providing private benefits, such as enabling increased industrial profits.

Kaldor and Hicks introduced an alternative decision criterion in which there can be a wellbeing improvement even if some lose from a decision, provided the winners could compensate the losers and still be as well off, or the losers were not willing to 'bribe' the winners not to act.[15] The Kaldor-Hicks compensation principle does not state that compensation must be paid, only that it *could* be paid. [16] The test is simply whether society is made better off in aggregate such that there is a *potential* Pareto improvement. The underlying

[11] State Services Commission (2007).
[12] Mostly the developments are attributed to Jeremy Bentham and John Stuart Mill: see Galbraith (1987); Heilbroner (1953)
[13] After the Italian economist Vilfredo Pareto (1848-1923)
[14] Johansson (1991)
[15] Kaldor (1939); Hicks (1939)
[16] Johansson P (1991) *An Introduction to Modern Welfare Economics*. Cambridge University Press, Cambridge

notion is that there may be numerous policies and projects, all of which will make some people better off and others worse off, but in aggregate across all projects/policies, all are expected to be made better off. Explicit re-distribution policies might be required to ensure there are no net losers and/or all are net winners.

The meaning of wellbeing is broad in scope. Improving wellbeing means any action that makes people's lives better, including "*such qualitatively diverse goods as physical and mental health, freedom from pain, a sense of meaning, culture, clean air and water, animal welfare, safe food, pristine areas, and access to public buildings*."[17]

In welfare (or wellbeing) economics, the '*efficiency*' term is used to express the same idea. Efficient resource allocation means that resources are allocated in a way that provides most wellbeing to the community. Welfare economics uses the standard definition of efficiency, that there is no waste; resources could not be allocated differently to produce more wellbeing. Both static and dynamic efficiency concepts are relevant.

- Static efficiency involves the efficient use of resources currently, and in the context of resource allocation decisions, whether initial allocations are to the user likely to produce the most wellbeing.

- Dynamic efficiency involves the ongoing use of the resources in the most efficient way. This requires that resources can be reallocated if better uses arise.

The Panel suggests (p337) "*resources should be used efficiently to improve the overall wellbeing of people and communities.*" In the remainder of this section we explore the ways in which resource allocation might be better focussed on the pursuit of maximum wellbeing. We explore this by discussing in turn:

- The measurement of wellbeing in resource allocation decisions;
- The use of markets to reveal what provides wellbeing; and
- The importance of reallocation because of the dynamic element of efficiency.

1.4 Measuring Wellbeing

If FIFS has no regard to what produces most wellbeing, the obvious starting point is to evaluate competing users for resource allocation against wellbeing criteria.

Measuring changes in wellbeing has been more challenging than its identification in theory. In the absence of direct measurement of experienced wellbeing improvements, social cost benefit analysis (CBA) using preference ranking has been regarded as the best approach.[18] When there are options for a decision maker (including do nothing), the objective of CBA is to inform the decision maker as to which is the most socially desirable.[19] The theory of CBA stems directly from the deliberations on what is a good decision and is the practical application of the Kaldor-Hicks criterion that a good decision is one in which society is made better off in aggregate (Box 1-1), ie it is "applied welfare economics".[20] It aggregates the

[17] Sunstein (2018), p23
[18] Sunstein (2018); Johansson (1991). Adler (2019) argues that his Social Welfare Function is an improved approach, although it is largely a variant of CBA that uses distributional weights in analysis (see Section 1.4.4 and Adler 2012)
[19] Dasgupta and Pearce (1972)
[20] Johansson (1991), p8

sum of total costs (things that reduce wellbeing) and benefits (things that increase wellbeing) across the whole community.[21]

Thus ideally, resource allocations should meet a cost-benefit test: the benefits should exceed the costs. The Panel critique is that FIFS-based allocation does not. In this report we use CBA of the proposed reforms as a framework for analysis, through compiling information on a wide set of effects, and as a technique through quantifying effects where possible.

CBA has lofty objectives but is not always widely regarded as being sufficient to address the full scope of wellbeing improvement. There are complexities in the practical application of CBA that can limit its ability to achieve the high objectives. These include:

- the very wide range of things that contribute to wellbeing;
- the need to measure all wellbeing impacts using a single numeraire so they can be aggregated;
- accounting for effects that occur in different time periods; and
- distributional effects and whether aggregate wellbeing is always useful.

This report is not a review of CBA so we limit our discussion of these factors to a brief summary below, making links to the issues relevant to this report.

1.4.1 The Wide Scope of CBA

To ensure the widest set of things or effects are valued, classification systems have been developed to describe as full a range as possible. In valuing the environment, this includes concepts of ecosystem services (Figure 1-1) and total economic value (TEV) (Figure 1-2),[22] as referred to by the Panel. These classifications are used as a checklist in estimating the value of natural resources[23] or the net benefits in a CBA of their use for one purpose (amongst the set of TEV or ecosystem service options) versus another.[24]

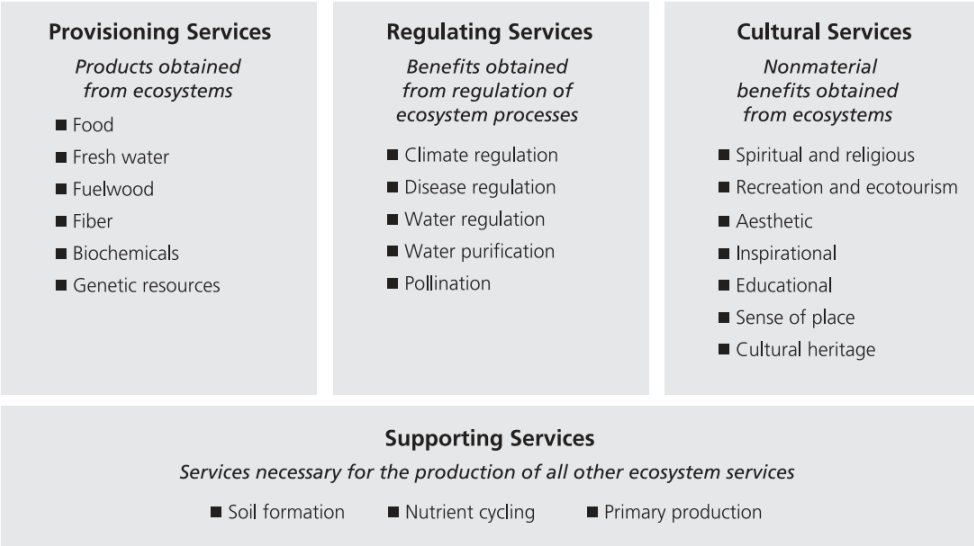
[21] Normally CBA measures aggregate wellbeing as the sum of the changes in wellbeing for all individuals in the community, but Arrow (1963) noted the problem of aggregating wellbeing across individuals, especially when the ranking of preferences may be quite different. Sagoff (1988) and others have suggested that people might state different levels of preference if responding as members of a group rather than as individuals. Suggestions have been made for studies to use values derived through collective discussions, rather than surveys of individuals (Wilson and Howarth 2002; Lo and Spash 2011), although there are methodological difficulties, including that of obtaining representative samples of people (Turner 2006).

[22] See also the Box on p338 of Resource Management Review Panel (2020)

[23] See, eg Patterson and Cole (2013)

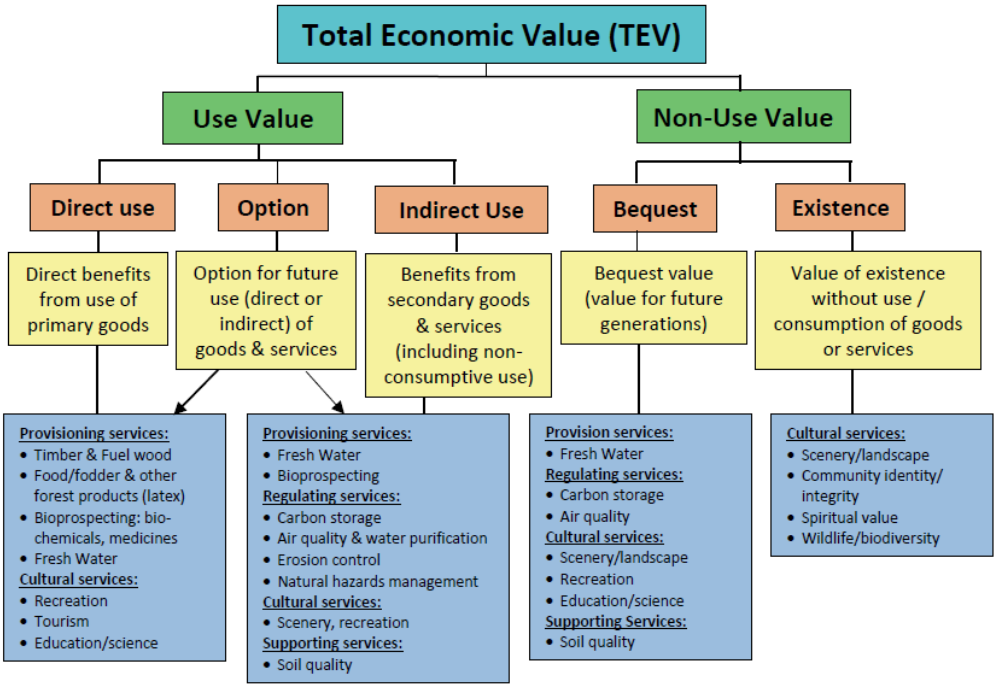
[24] Clough *et al* (2013)

Figure 1-1 Ecosystem Services



Source: Millennium Ecosystem Assessment (2005)

Figure 1-2 The components of total economic value and the relationship to ecosystem services



Source: Roberts *et al* (2015)

1.4.2 Monetary Values

All the effects on wellbeing need to be converted into a single numeraire so they can be aggregated. Using a single numeraire enables comparisons to be made between all the things that people value when decisions require trade-offs,[25] such as:

[25] Turner *et al* (2003)

- where there is resource scarcity, allocation to one person means less is available for another; and

- use of one resource may have spillover impacts in other domains, eg water allocated to irrigation frequently results in increased discharges of nutrients to waterways.

Measurements used in a CBA are based on people's relative preferences amongst options, eg how much they would be willing to give up in terms of water quality to enable more intensive food production and lower prices.[26] Because people sometimes make these relative preferences clear in markets using money, eg via the price elasticity of demand for vegetables, and by assuming that people are consistent in their preference rankings, effectively all preferences can be converted into monetary terms.

Alternative metrics might be used (and economists use the theoretical notion of a *util* as a measure of utility or wellbeing), but money is useful because people already make decisions using money that express (we assume) their value for some things relative to others. The argument is that, without using monetary valuation, some effects tend to be ignored or are included in analysis using simplistic weights rather than more rigorous estimates from empirical studies.

Non-Market Valuation

Techniques for non-market valuation of the environment use a mix of revealed and stated preference techniques to estimate relative values.

- **Revealed preference** techniques observe how people behave and use the results as a measure of relative preferences. For example, they might measure how far people will travel and how much they expend, to visit a site with high aesthetic value, and they might measure how much more they spend to visit a site with higher quality than another.

- **Stated preference** techniques rely on surveys in which people are asked to state their relative preferences, often in terms of willingness to pay (WTP). The more sophisticated approaches use choice experiments in which a clear payment method is shown and trade-offs are demonstrated; having more of one thing means having less of another.

Methodologies for non-market valuation have improved significantly over time, and if values are not available for specific sites or resources, values are obtained from studies in different locations and often with different ecosystems. This approach is known as benefit transfer and is generally accepted as providing rough estimates of values in the right order of magnitude.[27] However the assumption is that, systematically identifying effects and assigning values using results of empirical studies where possible, provides a better basis for estimating total value of a resource than other methods, such as multi-criteria analysis.

[26] Sometimes these effects move in the same direction, eg more efficient use of fertiliser, but this will not be so across the full extent of resource use.
[27] Sharp and Kerr (2005)

1.4.3 Impacts in Different Time Periods

When analysing costs and benefits in a CBA for policy purposes, we are measuring changes in total community wellbeing. Wellbeing is assumed to be the result of 'consumption', using a very broad definition of that term, eg financial expenditures have opportunity costs (less consumption possible) and wellbeing benefits can be expressed as consumption (we 'consume' a view etc).[28] Wellbeing is affected by what people consume, how much they consume and when they consume. Discounting is a means of adjusting the size of costs and benefits that arise in different time periods to account for preferences over the timing of consumption.

Discounting is usually used to reduce the value of future costs and benefits. This is because people generally prefer to consume sooner rather than later and, consistent with assumptions of rational decision making, this is assumed to mean people obtain greater wellbeing benefits from earlier consumption. Although several authors have questioned whether time preference is rational[29] and/or if it should be used for public decision making,[30] mostly there is acceptance of a theoretical basis for using a discount rate greater than zero and for using it in public policy decision making.[31] For example, Nicholas Stern who discussed the use of discount rates in the context of climate change policy affecting future generations, suggested a low but positive rate on the basis of some less than zero probability of human extinction favouring current consumption.[32]

Methodologies

There have been two main methodologies for deriving a discount rate for public policy purposes.

- The **social rate of time preference** (SRTP) measures time preferences directly – how much people prefer to consume now rather than later. Because people usually prefer to consume earlier in time, and for adverse effects to be delayed, there is a cost when consumption is shifted to a later time, and a benefit when it is brought forward. SRTP analyses often also assume that people in the future will be richer and therefore the wellbeing gained from an additional dollar's worth of consumption will be less than it is for current (and assumed poorer) individuals.[33]

- The **social opportunity cost of capital** (SOC) examines returns on investment in which investing money, which might otherwise have been used to pay for consumption goods now, obtains a return enabling greater future consumption.

[28] See Carver and Grimes (2019) for an analysis of the importance of consumption to wellbeing in New Zealand
[29] eg Pigou (1932); (Ramsey 1928). Arthur Pigou (1932) argued that someone's satisfaction obtained from consuming this year rather than next, is balanced by the satisfaction obtained next year from consuming then, rather than this year! He suggests "*it implies that people distribute their resources between the present, the near future and the remote future on the basis of a wholly irrational preference*" (p25).
[30] Samuelson (1937)
[31] Arrow *et al* (1995)
[32] Stern (2006)
[33] Recent analyses in the context of climate change have questioned this assumption.

The NZ Treasury has generally used the SOC as the basis for setting discount rates for use in public policy,[34] currently recommending use of a 5% default rate.[35] However, for sensitivity analysis they have used a 2% rate in their CBAx tool, which contains a database of values to help agencies measure impacts and undertake CBAs.[36]

The assumption in analysis is usually that the same discount rate can be used across all decisions,[37] despite differences in preferences within the population about how consumption over time should be weighted, including the length of the analysis and consideration of future generations.

Māori and discounting over long time periods

Tā Tipene O'Regan has expressed the intergenerational horizon used by Māori as serving "the shareholder who never dies." He goes on to state "The basic task of an Iwi economy is different and distinct from the economy it sits within. It has a multi-generational time horizon and thus a fundamentally different requirement from its capital. It must produce wealth over the long term and not just for the generation in which it finds itself."[38]
This has implications both for the time period of analysis and the discount rates used, especially given the finding that long run discount rates should fall over time (see Box 1-2).

A lower discount rate might be appropriate for any analysis that affects Māori because of the longer run perspective, any discount rate for longer time periods should be low and falling.

Box 1-2 Why discount rates should fall over the long term

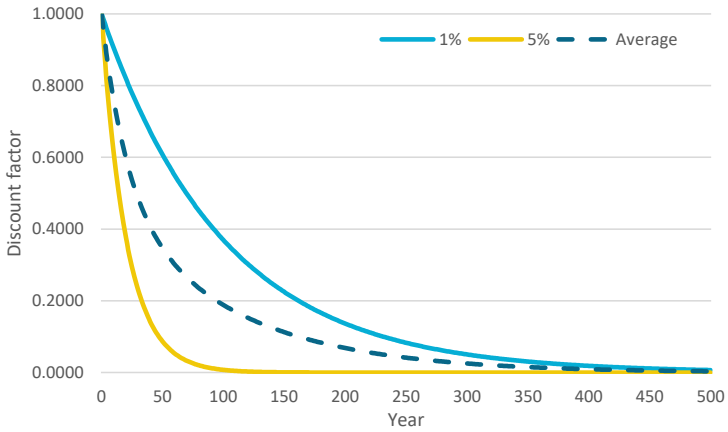
When there is uncertainty over the appropriate discount rate, over the long run the appropriate discount rate falls. This is explained by simple averaging.
Even though discussion focuses on **discount rates**, our interest is really in **discount factors**, which are used in a CBA to adjust impacts in different time periods and derived using the following formula:

$$DF = \frac{1}{(1+r)^t}$$

Where DF is the discount factor, *r* is the discount rate and *t* is the years from the current time (year 0). With a discount rate of 5%, the discount factor in year 10 is 0.614. A project with a benefit of $1,000 in 10 years' time has a present value (PV) of $614. Figure 1-3 shows discount factors for two different discount rates: 1% and 5%, plus the average of the two.

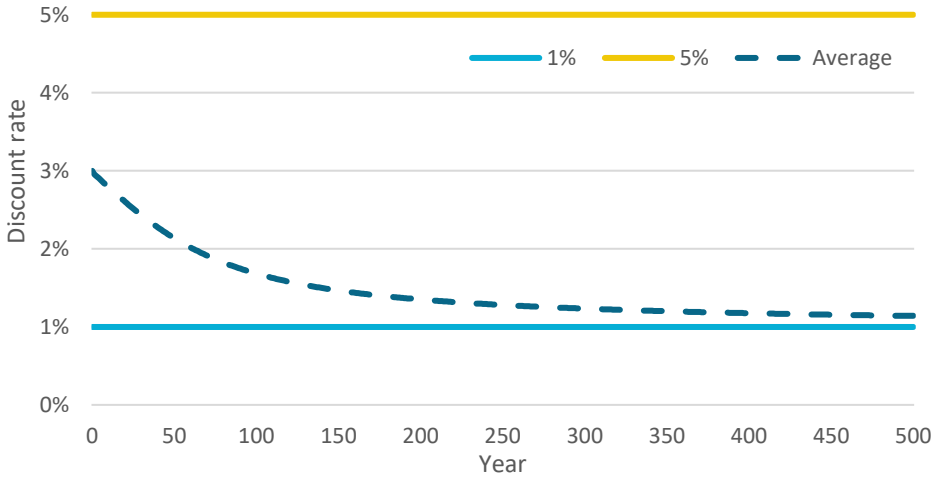
[34] NZ Treasury (2015)
[35] https://treasury.govt.nz/information-and-services/state-sector-leadership/guidance/financial-reporting-policies-and-guidance/discount-rates
[36] NZ Treasury (2021a). Some studies in New Zealand have attempted to measure the SRTP, including a (real) rate of 4.4% estimated in 2006 for the national energy strategy (Ministry of Economic Development 2005), a range of 2.7 to 4.2% developed in the context of decisions on investments in the national electricity transmission grid (Castalia 2006) and 3% in a study relating to transport infrastructure investments (Parker 2009). Auckland Council adopted a rate of 4% for CBAs, building on advice from NZIER for a rate of between 3% and 4% (Chief Economist Unit 2013).
[37] NZ Treasury suggests some sectoral differences in SOC reflecting differences in sectoral investment risks
[38] https://www.beehive.govt.nz/speech/wellbeing

Figure 1-3 Discount factors at different discount rates



If we were uncertain which discount rate to apply for the long run but calculated a rate as that which would produce the average discount factor,[39] the surprising result is shown in Figure 1-4. The discount rate falls towards the lowest estimated rate.

Figure 1-4 Discount rates that would produce discount factors in Figure 1-3



This result was noted by Weitzman (1998) who concludes that the 'lowest possible' rate should be used for discounting the far-distant future.[40] This approach has been adopted for the UK Government's CBA guidance.[41]

1.4.4 Distributional Impacts

There are two issues that arise relating to distributional effects. One is the focus on aggregate wellbeing only; the other is the treatment of the preferences of people in different income categories.

Aggregate Wellbeing

Normally CBA does not take account of distributional issues when assessing individual projects or policies. This reflects the theoretical underpinnings to CBA (Box 1-1) in which aggregate wellbeing is the primary focus of analysis. It is assumed, if there are winners and losers of any one policy or resource allocation, these will balance out over numerous

[39] $r = (\frac{1}{DF})^{\frac{1}{t}} - 1$

[40] See also: Weitzman (2001); OXERA (2002); Lowe (2008)

[41] HM Treasury (2020)

projects or policies, or the Government may decide at some stage to address distributional issues directly. The analogy can be used of a single project being like an ingredient used in making the national wellbeing pie. The emphasis initially is on making a big pie (lots of wellbeing). The Government then has a role in ensuring everyone has a fair slice of the pie, including via the tax or benefit system or by direct investment in things as diverse as road infrastructure and national parks.

This approach has not always been regarded as satisfactory, particularly for significant projects or when the distributional issues tend to be geographically focussed, eg developments with environmental impacts generally located close to low-income households.[42] In addition, redistributive policies have costs (the deadweight costs of taxation), such that addressing distributional issues at the level of the initial project may be preferred.[43] Often CBAs will identify impacts separately for different groups (including Māori), so that these distributional impacts can be considered in decisions, although without clear guidance on how this information should be used.

Income weighting

WTP is likely to differ by income category reflecting ability to pay. This means the values expressed by those with low income may be given less weight than those with high income. This may not matter if preferences are reasonably constant across the population or if the effects are also equally well distributed. However, sometimes it may, such as when pollution impacts are localised.

Because CBA is interested in changes in wellbeing for all people and uses money only as a proxy for wellbeing impacts, distributional weights can be used to adjust values. Outcomes for different income categories are weighted differently by multiplying costs and benefits by a weighting factor.[44] The usual theoretical basis for using weights is the diminishing marginal utility of income (or declining marginal well-being impact).[45] This principle states that the value (or wellbeing gain) of an additional dollar of income is higher for a low-income recipient than for a high-income recipient. The more difficult issues surround whether this applies to any source of wellbeing, eg if an additional unit of wellbeing via a better environment also provides greater marginal utility to different groups in the same ratios as applies to income, or if preferences differ.

The existing Treasury guidance on CBAs is against using distributional weights. Rather, it recommends that, where projects or options have significant favourable or unfavourable distributional consequences, that they be analysed separately in terms of their relationship to wider government distributional policies and drawn to decision-makers' attention.[46] This contrasts with the UK Treasury which recommends both income equivalisation (to adjust income to available income, taking account of household size)[47] and distributional weights,

[42] This is the concern of the environmental justice movement, particularly in the USA. And even when there may be policies to redistribute income, the distributions may always be biased towards compensating low income communities for experiencing poorer environmental outcomes.
[43] See discussion in Drèze and Stern (1987)
[44] Adler (2012, 2016, 2019)
[45] Adler (2019) uses this terminology partly to account for different approaches to measuring wellbeing, including preference-based, hedonic or experientialist and objective (which differentiates things that are good for someone even if they do not prefer them).
[46] NZ Treasury (2015)
[47] See, eg StatsNZ (2019) and Perry (2019) for a discussion of equivalised income in New Zealand

while noting that weighted results should be presented alongside unweighted results to demonstrate the impact of the weighting process.[48]

1.4.5 Use of CBA in Resource Allocation

The discussion above is used to suggest that many of the criticisms of CBA have been addressed by users in the pursuit of a technique for better evaluating the full range of impacts on wellbeing. This occurs to some extent currently under the RMA via Section 32 analyses, although CBA has been treated as one option amongst others for evaluating proposals.[49] Where there is competition for scarce resources, greater use of CBA in merit-based resource allocation decisions would be expected to improve allocation relative to FIFS.

1.4.6 Wellbeing and the Four Wellbeings

The analysis in this report discusses the impacts on wellbeing as a whole. MfE has asked us to include the different components of wellbeing as used in the exposure draft of the NBA, ie "*the social, economic, environmental, and cultural well-being of people and communities, and includes their health and safety.*" Dividing wellbeing into component parts is not always possible because there are large overlaps between them. Economics when applied to public policy decisions includes everything that contributes to wellbeing as suggested by the wide scope of CBA discussed above. Within its definition of the environment, the NBA exposure draft includes (a) the natural environment; (b) people and communities and the built environment that they create; and (c) the social, economic, and cultural conditions that affect the matters in (a) and (b) or that are affected by those matters. There are similarly significant overlaps between social and cultural components of wellbeing and the other components, as discussed by Dalziel *et al* (2019) and others. Treasury in its living standards framework sees culture as encompassing everything, ie "all aspects of our wealth, our institutions and our wellbeing are cultural."[50] In other words, when it comes to wellbeing everything is economic, everything is environmental, everything is social and everything is cultural!

Nevertheless, when we discuss impacts, we have to the extent possible organised the effects using these headings, while noting that the demarcations are not necessarily consistent.

1.5 Markets for Allocation (and Reallocation)

1.5.1 Potential Efficiency Benefits of Markets

Markets can achieve an efficient (wellbeing maximising) allocation of resources because, in contrast to administrative allocations (based on the application of CBA) that might require assessments of value by independent analysts, markets effectively reveal the value of the resource when they enable potential users to bid for their use based on their willingness to pay. This assumes individuals are the people with the most interest in their own wellbeing[51] and therefore they can best reveal this when enabled to. However, markets do not always

[48] HM Treasury (2020)
[49] Ministry for the Environment (2017)
[50] NZ Treasury (2021b), p3
[51] Mill (1859)

produce efficient outcomes, and achieving efficient allocations assumes the following.

- Markets are **competitive**, with many competing participants.

- Markets are **liquid** in which there are low costs of participation, eg it is easy to find a counter-party to trade with and the transactions costs are very low.

- Markets are **complete**, such that all components of value are included and with no externalities such as additional environmental effects that are not also priced or otherwise regulated (efficiently).

We explore these issues in more detail below.

Competitive Markets

A competitive (and liquid and complete) market with many buyers and sellers, with traded goods (or resource allocations) divisible into small parcels, means buyers reveal the maximum they are willing to pay for use (such as via their highest auction bid), sellers reveal the minimum they are willing to sell for (when they compete with other sellers to obtain a sale) and the highest value users can obtain as much as they want within the constraints of limits and targets. This is an optimal outcome as it is achieving two things at least:

1. **The best use**: It ensures that the resource is allocated to the user or users willing to pay the most for it. When a number of other conditions are met (complete markets in particular) this can mean it is allocated to the use with the greatest community wellbeing benefits.

2. **The optimal amount of use**: The competitive market pricing of the resource means that the level or rate of use is optimised also. This is especially relevant if the highest value user has diminishing marginal returns to use, so that beyond a certain level of use marginal additional quantities of a resource are better allocated to another user.

Markets for resource allocation can be used for the initial allocation or for reallocation. Initial allocation markets, eg resource use auctions or resource user charges might achieve efficiency gains where there is potential competition amongst resource users. Greater efficiency is obtained where there is competition on the sell-side also, eg competition between councils for the location of a resource-using company.

Markets for reallocation, eg via the allocation of tradable rights, can enable greater sell-side competition, especially where resources are allocated initially to several resource users.

Uncompetitive Markets: Market Power

One issue of concern raised by the Panel was the potential for market power. If resources are allocated using a tradable allocation regime in which use rights can be bought and sold, they might be purchased by and concentrated in the hands of a limited number of market

participants who use their market power to raise costs, and/or exclude access, reducing the benefits to consumers.[52]

This is not an insurmountable problem and the risk has been identified and managed previously for resource allocation in New Zealand and elsewhere. For example, in New Zealand's Individual Transferable Quota (ITQ) market for fisheries, to prevent monopolisation of any stock, no Quota Owner can hold more than a certain percentage of quota in any particular stock or species. These "aggregation limits" are set in Section 59 of the Fisheries Act 1996; generally the maximum is 35% or 45% of the quota of any species, with a 20% limit for bluenose, a 10% limit for crayfish stock and a 20% limit for Paua stocks. Similar limits could be set for resources under the NBA or in national direction.

Liquid Markets

Efficient markets are those which have a characteristic defined as "liquidity". This refers to the ease with which the market functions. Components include market participants (buyers and sellers) being able to easily find each other, such as via a market platform on which they can readily interact, and low costs of trades, including low administrative costs of interacting with a council. HydroTrader is an example of a platform established to make interactions simple and low cost for participants. The Government might facilitate this or provide guidance.

Complete Markets

Markets are able to achieve efficient allocations when they are competitive and liquid, but they also need to be complete in the sense that nothing of value is missing when bids are evaluated or are made in a market. The Panel noted that resources often have values different from what is observed in a market. This may require a much wider set of markets than simply the individual resources being allocated. For example, a take market for water may be inefficient if there is no market relating to water pollution or any other policy instruments that internalise pollution costs.[53] Uses of water for irrigation that are associated with land uses with increased nutrient leaching may be willing to pay more for water than they would be if they paid the full price of these wider effects on water quality.

Current Use of Markets

The RMA currently enables markets for resource allocation, and examples include the trading of water take permits, particularly in Canterbury,[54] and trading of nitrogen discharge allowances in the Lake Taupō catchment.[55] We outline the various types of market-based instruments in more detail in Annex A.

Treatment of Markets in Analysis

In this analysis we use markets as an example of a more flexible approach to resource allocation that might be used by councils to maximise the wellbeing outcome. And we note the endorsement by the Panel of their greater use, eg they "*consider the case for*

[52] Resource Management Review Panel (2020), p344

[53] Regulatory controls on water quality can internalise costs but they do not provide a marginal price on discharges that a water pollution charge would. A pollution charge ensures effects are taken into account even if water quality is better than limits.

[54] The majority of these are currently facilitated by HydroTrader (http://hydrotrader.co.nz/)

[55] https://www.waikatoregion.govt.nz/community/your-community/for-farmers/taupo/nitrogen-trading-in-the-lake-taupo-catchment/

empowering local authorities to use taxes and charges for environmental management remains strong in principle" (p358). We recognise that there will be limits to the applicability and potential for markets, especially where there are few potential users of a resource. However, the principles for allocation that fall out of a discussion of market-based instruments is valid. Efficient allocation is best achieved when:

- anyone can have access, ie there are no barriers to entry;
- resources can be reallocated; and
- all effects of resource use are addressed in allocation and reallocation decisions.

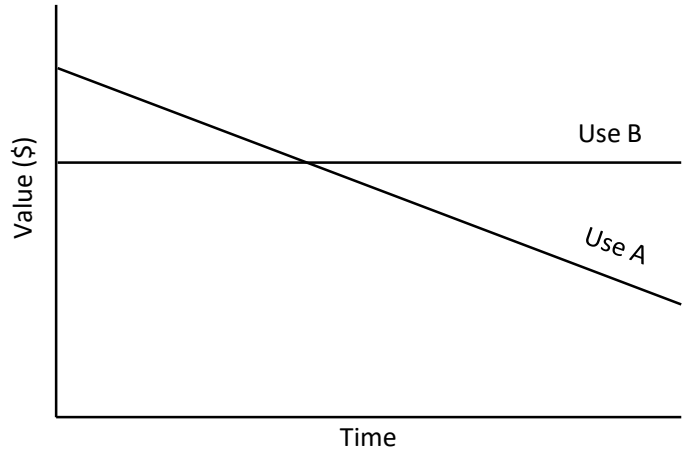
1.6 Reallocation and the Role of Markets in Optimal Allocation

1.6.1 The Time Dimension in Optimal Allocation

If resource allocation is optimal when it provides most wellbeing, then ideally resources are allocated to those who will use them consistent with this objective. Potential uses will always be limited by the set of proposed uses by the applicants, so this is not about some central planner defining or deliberatively achieving best use. Rather it is about ensuring that if there is competition for a scarce resource, the allocation is to the use that would produce the most wellbeing. Ideally this would be dynamic such that, if circumstances change (eg technological development or changes in relative prices), reallocation could occur so that resources are always use for their best use.

Figure 1-5 illustrates two potential uses of a resource (A and B) with different valuations (willingness to pay for the resource). Currently the resource has the highest value in Use A, but at some future date, it is expected to have a higher value in Use B. For example, we could imagine the resource being allowances for pollutant discharges to air, with Use A being solid fuel burners or passenger vehicles and Use B an industrial process. Because of the increasing shift of home heating to electric heat pumps and the vehicle fleet to electric vehicles, discharge allowances will be valued less. The highest net wellbeing allocation in the future will be different from now.

Figure 1-5 Changing values of use



One approach to this is to use short-duration consents, so that resources can be reallocated to better uses if the market shifts. Short duration consents are one of the options being considered in the reforms and we discuss this in more detail in Section 2. Alternative approaches enable easier reallocation.

The Panel criticised FIFS for constraining the potential for reallocation to higher value uses. This problem is greatest when consents are both restrictive and long, with the Panel noting that consents tend to be set with firm conditions and for lengthy periods of up to 35 years. Efficient resource allocation means that resources are always allocated in a way that provides most wellbeing to the community in the short and long runs, with both static and dynamic efficiency concepts being relevant.

Thus, reallocation is important and, depending on how it is achieved, might mean less "protection" of the rights of existing users. Set against this, the Panel suggests that, for equity reasons, the investments of existing users should be recognised in allocation decisions. What is meant by recognised is not clear, but we discuss the relevant issues below,[56] including sunk costs, the equity and efficiency implications of reallocation and the role of markets.

1.6.2 Sunk Costs and the Rights of Existing Consent Holders

The efficiency principle would state that resources are always allocated to the best value use. Sunk costs can affect what is the best value use in the following way. Imagine two potential uses of a resource, one of which is higher value and would thus be the most efficient use. However, no such use of the resource was available when it was first allocated to a lower value use, and that user invested in capital stock (plant and machinery or land conversion to a high value horticultural use) to use the resource. Now, imagine a potential high value user came along. It may no longer be the most efficient use because the existing user has already invested in a plant or land use conversion and its capital costs are unavoidable; these costs are irrelevant to its valuation of the resource which is based solely on whether it can cover its variable or avoidable costs. If there was a market for the resource, the new potential user would not be willing to pay enough to persuade the incumbent to sell access to the use rights. In this case, if there was a market for the resource, the existing user would be expected to continue to use the resource rather than sell use rights to the other potential user.

We illustrate this with worked examples in Box 1-3. We also include another potential user with even lower production costs who might be willing to pay an amount the incumbent rights holder is willing to sell for.

The issue this raises is that, in many cases when there are sunk costs, the existing user may well be the most efficient (wellbeing maximising) user of the resource, even if there is a user who would have been the higher value user if present at first allocation. However, this is not always the case. A simple rule that meant allocation to existing users continued, may not be the most efficient. A market would reveal this but a council-led analysis without detailed market understanding may not come to the same conclusion.

[56] This is separate from the issue of existing use rights under section 10 of the RMA, which the Panel refers to (p161).

Box 1-3 Impact of Sunk Costs on Willingness to Pay for a Resource

	User A	User B	User C
Capital costs ($m)	$100	$80	$60
Annualised capital costs ($m) @5% over 20 years	$8.02	$6.42	$4.81
Annual operating costs ($m)	$10	$8	$5
Production ('000 tonnes)	1,000	1,000	1,001
Average production cost ($/t)	$18.02	$14.42	$9.80
Marginal production cost ($/t)	$10.00	$8.00	$5.00
Sales price ($/t)	$20.00	$20.00	$20.00
Average profit ($/t)	$1.98	$5.58	$10.20
Marginal profit ($/t)	$10.00	$12.00	$15.00
Willingness to sell/buy ($m)	$121	$69	$127

User A has obtained a consent to use a resource; they have invested in a 1 million tonne per annum production plant at a cost of $100 million and have annual operating costs of $10 million. The average production costs, including a 5% return on capital, are $18/t, yielding a profit of approximately $2/t from a sales price of $20/t. A new potential resource user (User B) arrives one year after the plant has been established with a technology with lower capital and operating costs for the same resource. User B would be the better long-run user of the resource.

If the allocation system allowed them to purchase the consents from the incumbent, the amount User B would be willing to pay for the right to use the resource is a sum that, when spread over the lifetime of the plant, would reduce their profit to just above zero. This is approximately $69 million, at which their average profit would reduce to $0.01/tonne while providing them with a 5% return on capital.
However, this would be less than User A would be willing to sell for. Their capital costs are already expended (they are sunk); by selling, User A would avoid their marginal production costs only ($10/t) but they would lose the revenue of $20/t, so they would be worse off. They would need to be paid an amount to compensate for the marginal profit loss of $10/t. Assuming the same 5% return on capital (spread over 19 years, reflecting that the plant is now one year old) they would not be willing to sell the use rights for an amount less than $121 million.

In contrast, User C has lower capital and operating costs and would be willing to pay more for the resource than User A. If there was a market for use rights, User A would sell to User C.

1.6.3 Equity and Efficiency in Reallocation

If reallocation occurs by removing existing rights to use a resource and shifting them to another user, this has efficiency and equity impacts.

- The efficiency impacts arise because it makes all investments to use a resource less certain. This reduces the willingness to invest or the costs of investments when potential investors adopt a higher hurdle rate for investment returns reflecting the higher level of risk.

- The equity impacts arise because it is changing the nature of rights. These impacts could improve or reduce equity

In some cases it might be possible to address negative effects on equity so that the current resource user is as (financially) well off after the reallocation as before. Reallocation using

markets provides compensation also, while making the reallocation choice voluntary for the existing rights holder.

1.6.4 Reallocation via Markets

Allocation systems that include markets can achieve more efficient allocation and protect the equity concerns of existing users. This is consistent with the Panel's explanation of the equity principle that suggests efficiency is paramount ("*the balance struck between recognising the investment of existing users and providing for new opportunities should improve the overall wellbeing of people and communities*", p338). Under a market (eg if a resource user holds a right to use a resource and that use right is transferable to another user), if a higher value user comes along, bargaining between the parties can result in the resource use transferring to the new user, to the benefit of both parties. There may be limits to this in practice, depending on the efficiency of the market (as discussed in Section 1.5.1) and the behaviour of participants.[57]

1.7 Impacts to and from Māori

We look at impacts of allocation approaches *on* Māori, and the impact that Māori being more prominent in resource use (as envisaged by the Panel and officials) may have on allocation approaches.

We do not focus on purely an 'avoided costs' approach that tallies the legal, transaction, and opportunity costs faced by Māori in ensuring that a Māori world view and associated principles are factored into resource allocation and use. We also recognise the development opportunities and aspirations of Māori based on possible differences in value of a resource for Māori.[58]

To the extent that Māori have a willingness to pay (WTP) that is above that of others then it follows that societal welfare is likely to be improved by more Māori in resource allocation decisions and by Māori receiving a greater (initial) allocation. An example is the industrial and residential developments undertaken by Ngāi Tahu around the country.

Ngāi Tahu Property has recently launched its third Ahumahi industrial development, Mānia in the Christchurch suburb of Hornby. Ahumahi, meaning industrial in Te Reo, commits to and embraces Ngāi Tahu iwi values, taking an intergenerational approach to investment. It approaches each development as long-term custodians, considering options to minimise overall environmental impacts using life-cycle analysis and other techniques as part of a sustainable development philosophy.[59]

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[57] Prospect theory (see simple discussion in Kahneman 2011) suggests existing rights holders may be less willing to trade than prospective new entrants, although some of this (endowment) effect may be simply the result of inefficient markets. Owners of resource use rights may be less willing to sell if purchasing again is more difficult because there is not a liquid market for these rights.

[58] This is particularly because of a resources value over a longer time period and for both current and future generations. We note a recent paper that demonstrated negative intergenerational effects are possible and that historical land loss by Māori has led to negative health and well-being effects that persist to this day. See Thom and Grimes (2022)

[59] https://www.oneroof.co.nz/news/ngai-tahu-brings-iwi-values-to-christchurchs-ahumahi-industrial-development-39360

There are likely to be impacts outside of the Māori players themselves as well. For instance, the $50 million-plus redevelopment of Port Whanganui, Te Pūwaha,[60] has involved inductions for over 100 workers on iwi values. Despite initially being a little unsure of what to expect, the workers have rated the experience as a powerful eye-opener. There was a real appreciation of the history of the awa and its people and the value of the river as a result, meaning that the awa needs to be cared for and treated with respect. Workers found it refreshing that they were 'doing the right thing' and were doing something important.

While this example might relate more to the property rights dimensions rather than strictly allocation, the underlying premise is the same: that Māori exercising rights and interests can not only benefit Māori, but others as well.

1.8 Implications for Analysis

In this section we have discussed the nature of the resource allocation problem, building on the analysis provided by the Panel. This has focussed on the following.

- Ideally, resources would be allocated so they provide the most wellbeing for the community.

- Wellbeing is a very broad concept that includes everything of value to people and that makes their lives better.

- FIFS fails to achieve maximum community wellbeing and the resulting sub-optimal allocation can be locked in for long periods because of long consent durations and no options for reallocation. Sub-optimal allocations are then often renewed at the end of the consent period.

- Achievement of greater wellbeing might be achieved via:
    - Better analysis as an input to allocation decisions using a cost benefit framework that takes account of a very wide set of values;

    - Fostering market mechanisms that enable individuals and companies to express what they value, provided that markets are as competitive, liquid and complete as possible.

    - Enabling reallocation via markets, with compensation, or via shorter consent periods (that we analyse below).

[60] Te Pūwaha operates under the legal status of the Whanganui River as Te Awa Tupua.

2 Analysis of Proposals

2.1 Introduction

In this section we summarise and then analyse the reform proposals as they apply to all resources. In later sections we analyse the implications for individual resources.

As discussed in the previous section, our analysis focuses on the wellbeing impacts of policy. However, in suggesting improvements to resource allocation the Panel has recommended this is guided by principles of sustainability, equity and efficiency. We follow this lead. The focus is on efficiency and producing results suitable for inclusion in a CBA, while also taking account of implications for equity and sustainability.

2.2 The Proposals

2.2.1 Purpose

The proposals for resource allocation reform are designed to be consistent with the Panel's understanding of the problem(s) and its recommendations, in addition to being consistent with the overall objectives of the RM reforms (Box 2-1).

Box 2-1 Objectives of the Resource Management system reforms

a. Protecting and where necessary restoring the natural environment (including its capacity to provide for the wellbeing of present and future generations).
b. better enabling development within biophysical limits, including a significant improvement in housing supply, affordability and choice, and timely provision of appropriate infrastructure, including social infrastructure.
c. giving effect to the principles of Te Tiriti o Waitangi and provide greater recognition of te ao Māori, including mātauranga Māori.
d. better preparing for adapting to climate change and risks from natural hazards, and better mitigate emissions contributing to climate change.
e. improving system efficiency and effectiveness, and reduce complexity, while retaining appropriate local democratic input.

The starting assumption for analysis is that the optimal allocation of resources is that in which New Zealand aggregate wellbeing is maximised over the long run as discussed in Section 1 above. The question of whether the limits and targets are also consistent with maximising human wellbeing or if they are a constraint on whether resource allocation can maximise wellbeing is beyond the scope of this paper.

The NBA proposals are consistent with maximising wellbeing, while also introducing the idea of *Te Oranga o te Taiao*. In the exposure draft of the NBA,[61] the purpose of the Act (Section 5(1)) is to enable:

- *Te Oranga o te Taiao* to be upheld, including by protecting and enhancing the natural environment; and

[61] Analysis is undertaken based on the exposure draft but it takes account of further decisions and changes where these are known.

- people and communities to use the environment in a way that supports the wellbeing of present generations without compromising the wellbeing of future generations.

2.2.2 Te Oranga o te Taiao

Te Oranga o te Taiao is still being defined but in the exposure draft it incorporates (Section 5(3)):

(a) the health of the natural environment;
(b) the intrinsic relationship between iwi and hapū and te taiao;
(c) the interconnectedness of all parts of the natural environment; and
(d) the essential relationship between the health of the natural environment and its capacity to sustain all life.

Te Oranga o te Taiao, and concepts such as the wellbeing of the environment itself within a Māori conception of wellbeing,[62] is partly upheld by the limits and targets but must also be upheld via resource allocation itself. Our assumption is that it is (to some extent) consistent with maximising wellbeing, eg the interconnectedness of the environment and people is a concept consistent with the ecosystem services concept in valuation (Section 1.4).[63]

A difference may lie in the interpretation taken of the wellbeing of the environment itself,[64] independent of people (ie its intrinsic value), and whether this can be separated to any meaningful extent from notions of, say, existence value (preferences for preserving something one may never see or visit). To the extent that people (the Government and councils in this case) are making decisions to implement *Te Oranga o te Taiao*, which involve making trade-offs between preservation and use or deciding on allocations between different potential uses, they are expressing a human preference for intrinsic value.[65] This is not to argue that nothing had any value until there were humans but that, in the context of resource allocation decisions, where we are explicitly making trade-offs amongst potential uses, the only basis we have is that of relative value. If we, for example, wanted to see which outcome produced greater intrinsic value or contributed most to *Te Oranga o te Taiao*, we are limited to human views on that question. Regardless of an objective of taking non-human values into account, pragmatically we are limited by our humanity.

Those exercising allocation powers and functions will also need to give effect to the principles of *Te Tiriti o Waitangi* (*Te Tiriti* clause). If allocations for Māori are set aside to enable greater access to scarce resources, then this is more equivalent to an addition to the limits and targets.

2.2.3 Proposal Elements

The proposals give flexibility to councils in their response (it is an enabling framework) but may include more detailed direction from central government. They include the following:

[62] See McMeeking *et al* (2019) for example
[63] Harmsworth and Awatere (2012) note the interpretation of ecosystem services from a Māori perspective.
[64] This idea is explored in the mātauranga Māori wellbeing framework of *He Ara Waiora* (see McMeeking et al 2019)
[65] See discussion in, eg Attfield (1998; 2021); Rea and Munns (2017)

- The purpose, outcomes, and *Te Tiriti o Waitangi* Clause of the NBA which govern all actions under the NBA.

- The resource allocation principles of sustainability, equity, and efficiency will specifically guide allocation.

- A requirement or ability for NBA plans to include allocation approaches for specified resources, giving effect to any direction in the NPF and having regard to the allocation principles where there is no direction. These allocation approaches may or may not be resource-specific and are unlikely to be FIFS when there is resource scarcity. The proposed system would shift towards greater focus on allocation at a planning rather than consenting stage.

- The ability to direct allocation approaches through the NPF including:
  - that a particular allocation approach must or must not be used for a particular resource or in certain circumstances, eg administrative merit, auctions or tenders, trading regimes and FIFS (or simple allocation);
  - objectives, policies, processes, methods, parameters, monitoring and reporting requirements, and other matters, for regional planning committees to adopt or consider.

- Changes to consent duration provisions including:
  - an ability to set shorter durations, and a new consenting pathway to support the implementation of alternative allocation approaches (including the ability to set common expiry dates);
  - Short transitional consents for freshwater takes, diversions, and discharges in the period between enactment and NBA plans being notified.

- Market-based allocation methods (as defined in the NBA) cannot be used for taking, using or diverting freshwater. It will remain possible to transfer water permits, as is the case under the RMA.

The Ministry has requested resource user charges be included in this analysis to gain a better understanding of impacts of any change in this area.

2.2.4 Assumptions for Analysis

For analysis in this section, we focus on the following:

(1) The adoption of principles for allocation and the assumed shift away from FIFS;
(2) The potential for short-duration consents; and
(3) The adoption of resource user charges.

2.3 Improved Allocation using Principles

2.3.1 Allocation in the Context of Limits and Targets

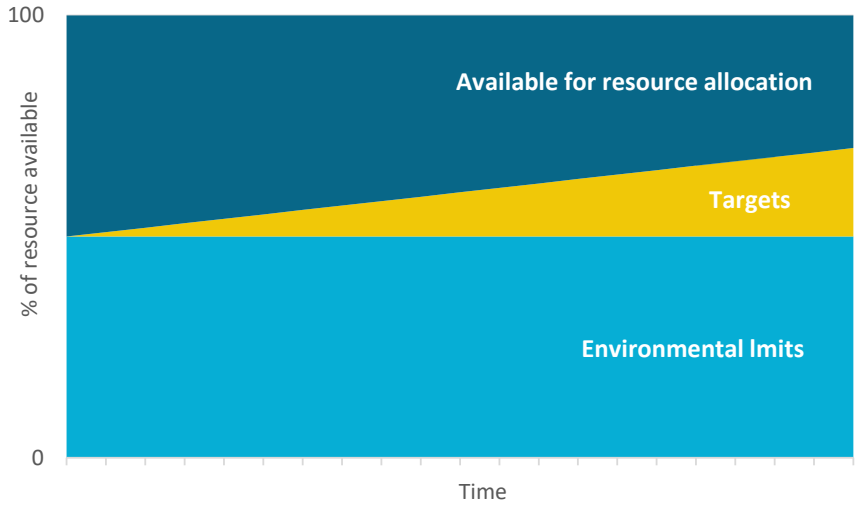
Resource allocation has a limited meaning under the proposed NBA. Rather than encompassing all uses or non-uses of resources, resource allocation is limited to the quantity of a resource available after any constraints have been defined through limits and

targets (Figure 2-1), where:

- environmental limits will define the current state of the natural environment, or the current or future target state required to ensure human health, and will be used to ensure 'no net loss' from the current state; and

- targets are used to ensure ecological integrity is restored where it is already degraded and, in all places, to set quantified objectives for further improvement in environmental outcomes.

Figure 2-1 Limits, targets and resource allocation



Limits and targets are mandatory for certain domains (air, indigenous biodiversity, coastal waters, estuaries, freshwater, and soil) and can be set in the NPF or in NBA plans subject to the NPF prescribing the requirements. Limits and targets will apply at a scale defined by 'management units', which will be a size and location appropriate for measuring no net loss of current ecological integrity, protecting human health, and achieving targets.

The proposals suggest that offsetting can occur within a management unit, (ie some activities could generate a net loss provided that others generate a net gain that makes up for it). This would include:

- airsheds to manage air quality in defined urban or rural areas and/or with unique weather patterns and/or geography; or

- watersheds for freshwater, in a similar way to freshwater management units (FMUs) under the National Policy Statement on Freshwater Management 2020 (NPS-FM).

Offsetting would generally need to be like for like, (eg reduced emissions to air of a contaminant to offset rights to increase the same contaminant in the same airshed). The scale might be defined based on ecological criteria (the appropriate size for managing to maintain ecological integrity) or human criteria (the community might be indifferent to offsetting within that level of aggregation).[66]

[66] There is a separate issue over time delays for the offsetting, eg native bush removed this year and replaced at some time in the future

For the achievement of limits and targets, the draft NBA requires effects to be managed according to a hierarchy of avoid, remedy, or mitigate, followed by offsetting and environmental compensation.

Under Section 8(f) of the NBA exposure draft, the limits and targets component includes cultural use and any other resource use (or non-use) that ensures "*the relationship of iwi and hapū, and their tikanga and traditions, with their ancestral lands, water, sites, wāhi tapu, and other taonga is restored and protected*". Anything that remains is available for resource allocation amongst potentially competing users.

As noted above, within this allocable quantum, effect still needs to be given to *Te Oranga o te Taiao* and *Te Tiriti*, including by better enabling access for Māori, in a similar way to an addition to the limits and targets.

2.3.2 Principles for Allocation

The principles for allocation suggested by the Panel were sustainability, efficiency, and equity.[67] The expectation is that these will be defined in the NPF. Our understanding is that allocation approaches must have regard to these principles, rather than giving effect to them and that, from the Panel's perspective, the principles covered the following issues: (we place efficiency first because of its priority in our analysis and the Panel's considerations):

- **Efficiency** – ensure resources are used to maximise wellbeing at all times;
- **Sustainability** – allocation will need to have regard to limits and targets which protect the environment, and take account of the wider environmental effects of use and the wellbeing of future generations;
- **Equity** – ensuring relative equality of outcome (eg the community benefits from local resource use via resource charges) and equality of opportunity (potential access for new users). Fairness across generations is addressed via the sustainability criterion.

We make some limited comments on these principles below, building on our understanding as gleaned from the Panel's report. We include this here because of the expected importance of the principles to the way in which allocation is to be interpreted by councils and NBA Plan Committees.[68]

Efficiency

As noted above, efficiency is a concern with whether a resource is producing the most wellbeing, which implies that allocation to any use has to meet the test that no other available use would produce more wellbeing.

[67] Resource Management Review Panel (2020)

[68] NBA Plan Committees would operate within each region and include members from mana whenua, council(s) and a Minister of Conservation nominee.

Sustainability

The Panel notes a lack of clarity about what was meant by sustainable management in the RMA and that it needs to be replaced "*with a more specific and positive purpose statement*" in the NBA.[69] They saw sustainability being addressed substantially by the setting of limits and targets, but that as a principle for resource allocation sustainability includes "*providing for the needs of present and future generations and consistency with the purpose and principles of the* [NBA]" (p337). Officials consider the sustainability principle includes, in addition, the stress on the wider environmental effects of resource use, ie the breadth and depth of impacts in addition to the time dimension.

The sustainability principle is an elaboration of some aspects of efficiency and equity. It aims to ensure wellbeing effects are measured widely over space and time. The practical effect of this principle on allocation regimes is not immediately clear and the issues may differ between renewable and non-renewable (depletable) resources.

- Sustainable use of a renewable resource can easily be understood as a level of use at which the size of annual removal is no higher than the level of annual replenishment, so the size of the stock at the end of the year is no smaller than at the beginning and the amount harvested does not reduce the size of future potential harvests. This concept is used in defining maximum sustainable yields (MSY) for fisheries[70] or sustainable management of indigenous forests under the Forests Act 1949 to provide a full range of products and amenities in perpetuity while retaining the forest's natural values,[71] for example.

- For a non-renewable resource, any level of resource extraction reduces that available in future years, and if continued over a long time may eventually deplete the stock. Resource management theory has addressed these issues by, for example, identifying the optimal rate of resource extraction that would maximise the total present value obtained from the use of the resource over its lifetime.[72] Modifications to this approach include assessments of whether a resource really matters,[73] which suggests some limits to rates of depletion for particularly important (strategic and not readily substitutable)[74] resources, while suggesting others might be depleted, at least at the local or regional level.

Providing for the needs of future generations may require constraints to resource use. This would need to be beyond limits and targets which, we assume, would be a permanent limit to resource use even for future generations.

To the extent that limits to resource use are introduced to meet a sustainability principle, this is most likely to function in the same way as introducing a more stringent target (Figure

[69] Resource Management Review Panel (2020), p64
[70] See description in Peart (2018)
[71] Section 2 (interpretation) of the Forests Act 1949. See also: Te Uru Rākau – New Zealand Forest Service (2021)
[72] The theoretical work on optimal depletion builds on the work of Hotelling (1931). Hotelling's theory suggests the maximum value can be extracted from a resource if the rate of depletion results in an annual increase in (real) price that is equal to the discount rate.
[73] Solow (1974)
[74] What is strategic may change over time, depending on technological development. For example, resources required for electric vehicle batteries have recently become of more strategic value.

2-1) further limiting quantities available for allocation. But it does not mean that allocatable resources, beyond a sustainability limit, could not be allocated using market or other mechanisms.

Efficiency and equity are still important, but the intergenerational perspective of the sustainability principle has some primacy for Iwi/Māori, in particular "*taonga tuku iho* – the treasures handed down to us by our ancestors." In addition, wealth created by iwi Māori tends to be reinvested back into its people and the environment. Efficiency and equity may be key to determining the scale and scope of wealth (and hence wellbeing), it is sustainability that matters for the preservation and use of that wealth.[75]

The extent to which the sustainability/intergenerational horizon of iwi/Māori is captured and reflected in limits and targets is an open question. However, such a perspective is highly likely to be significant for iwi/Māori decision-making and actions around the actual use of resources as well as their preservation and protection.

Equity

Equity issues are not understood in the same way by all people, but are usually taken to include:[76]

- Relative equality of outcomes – no sector of society is consistently a winner from allocations while other are consistently losers.

- Equality of opportunity – anyone can gain access to a resource, eg there is the potential for new entrants.

- Intergenerational equity – net costs are not passed on to the future and future generations are provided with opportunities for use.

The Panel's comments are consistent with these. They made the following comment in explanation of the equity principle (p338): "*the balance struck between recognising the investment of existing users and providing for new opportunities should improve the overall wellbeing of people and communities. Allocation systems should meet obligations under Te Tiriti. Users should pay a fair return for their use of scarce public resources.*"

Other comments that they make relating to the equity principle include:

- fairness and equity including across generations (p189) – these are addressed under the sustainability principles discussion above;

- equity concerns [around free allocation of permits] that some users do not have to pay to use or pollute the resource, while others do (p345). This is a concern specific to the design of market-based systems.

[75] The importance of an intergenerational view of prosperity for Māori is discussed in NZ Treasury (2020); Cook *et al* (2020) and McMeeking *et al* (2019).
[76] Carney (2021)

Thus, the equity principle is partly an expansion on the efficiency principle, eg ensuring access for new potential users. It also includes a suggestion of protection for existing users, in addition to meeting *Te Tiriti* obligations and obtaining a fair return.

2.3.3 Allocation using Principles

Regardless of whether there is the potential for reallocation, such as via a market mechanism, there is a need for an initial allocation that is consistent with the criteria. The current FIFS framework is used for initial allocation but fails to allocate to the highest value uses. In practice, even at renewals, status quo uses are favoured over potentially higher value new uses. The intent of the system is that this will need to be an improvement over FIFS. If resource use rights are transferable, the standard argument is that the initial allocation does not matter and the final allocation of resources after trading will be with the user who values the resource most highly.[77] However, when there are barriers to trading or markets do not exist, initial allocation matters to wellbeing and is of equity concern because initial allocation (if it is distributed gratis) is the allocation of wealth, particularly if subsequent trading of rights is allowed.

Administrative or Merit-Based Systems

If initial allocation matters, then it is most efficient if it can ensure that:

- the allocated user produces positive net benefits. This would include assessment of the full set of values (and costs) such as the full set summarised in ecosystem service and TEV categories (Figure 1-1 and Figure 1-2 above);

- if there are competing users, the resource is allocated to the user with the highest expected net wellbeing impacts. This might include assessment of option values.[78]

The Panel suggests that, if there is no resource scarcity, then a FIFS allocative system can work well. This relies on the process including analysis consistent with these points, rather than simply allocating to any potential user that turns up, regardless of the merit of the use, ie the use still has to pass a cost benefit test. There are advantages and disadvantages of administrative approaches.

A disadvantage is that they make reallocations more difficult (see below) as they require either:

1. A fixed consent period. A shorter period gives more opportunity for reallocation to a future higher value use, but may limit consent applications to those with low capital costs (because of the shorter time over which a return to capital can be earned) and may also limit the potential size of resource user charge;[79] or

2. A long initial consent period that can be shortened later, but with a requirement to compensate the current consent holder.

[77] Coase (1960)
[78] Option value is the value of retaining an option for some other use typically by not making irreversible choices in the existence of uncertainty.
[79] This is because of a higher cost of capital squeezing available surplus which a resource user charge could extract.

Effectively a market mechanism achieves option 2. The consent period is shortened when the new user agrees a price to pay the existing consent holder, and this price compensates them adequately.

The advantages of administrative approaches are that they can allocate to uses for which the community benefits may not be valued in a market, eg where there are greater environmental or social benefits, which go beyond the internalisation of external costs. One example might be consideration of the maintenance of domestic food security which may not be adequately priced and where the benefits may extend beyond the regions making allocation decisions.

The Panel suggested administrative approaches would allow communities to maintain an active role in decision-making on how their local resources are used and may be lower cost than establishing market-based approaches. They also provide a mechanism to help prioritise access to resources for Māori to address Tiriti interests. Set against this, the Panel suggested costs to councils and land users are likely to increase for preparing and assessing applications and supporting evidence.

The requirement for allocation approaches to be developed having regard to the principles and to give effect to the principles of *Te Tiriti* may limit the potential use of markets. Further national direction may be required if this is not the intent.

Allocation to Non-commercial uses

The scope of resource allocation is constrained by limits and targets which are set to ensure there is no net loss of environmental quality and, over time, an improvement from the status quo. Effectively this means, within the spectrum of values that contribute to community wellbeing, across all environmental domains and locations, the shift will be towards more environmental value and less from other domains. For example, this might mean more regulating, cultural and provisioning services within the ecosystem services classification and less provisioning services (Figure 1-1), or more indirect use, option or non-use value in the TEV classification (Figure 1-2).

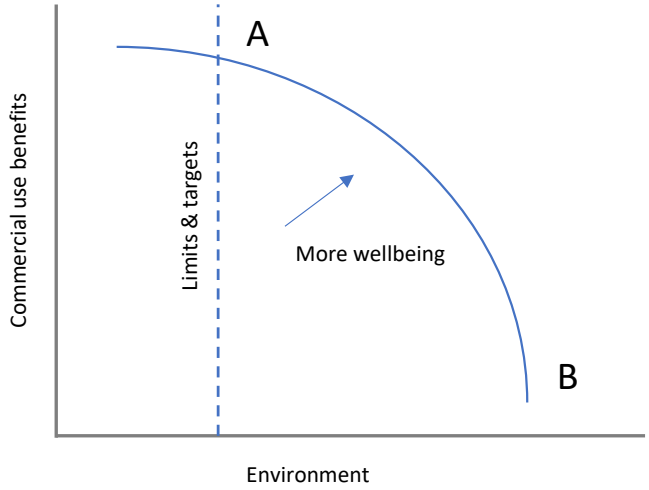
We do not address whether the setting of limits, or more importantly targets, will be consistent with wellbeing optimisation, but we assess the implications of this overall approach for optimisation within the remainder (Figure 2-1).

In the proposed reforms, resource allocation is limited to a sub-set of potential resource uses, eg with the exception of some commercial recreational uses, resource allocation will be largely within the provisioning services classification of Ecosystem Services and the direct use values of TEV. This means resource allocation may not be optimal because certain uses are effectively excluded.

We illustrate this issue in Figure 2-2 where we imagine a resource that can provide wellbeing benefits to the community from how much natural environment there is or how much commercial use is enabled. The curved line on the chart represents the maximum wellbeing that can be produced. It is shown as an indifference curve in which total wellbeing is the same at the community level at any point on the curve but it can comprise largely commercial use of the resource with benefits being concentrated amongst the users

or largely maintenance of the natural environment with benefits more widely spread in the community. Limits and targets set a minimum amount of environment that must be protected. However, because resource allocation is limited to bids for use, it will tend to produce outcomes closer to A (maximum wellbeing from commercial use within limits) than to B (maximum wellbeing from environmental preservation). Total wellbeing may be the same from either outcome, but the distributional effects will be quite different.

Figure 2-2 Wellbeing from environment or commercial use



This is likely to be the outcome of any system that is responsive to bids for use of a resource from those wanting to have some form of exclusive use of a resource. It does not provide easily for, say, community bids for more of a resource to be allocated to the environment. That said, this might be achieved if the default position for any allocation of resources is to maintain the current environment or to return it to a previous more natural state;[80] any allocation to an alternative use would need to be evaluated as to whether it would provide a net wellbeing improvement over the default state. This is effectively the position where alternative uses of a resource are defined as controlled, restricted discretionary, discretionary and/or non-complying activities in the RMA (Sections 77A and 87A).

2.3.4 Markets

Markets and market-mechanisms are not specifically promoted under the proposed NBA, but may be more likely to result if there is a shift away from FIFS and councils are therefore required to identify alternatives. Markets are consistent with efficient (wellbeing maximising) resource allocation provided the markets operate under the conditions described in Section 1.5, ie if they are as competitive, liquid and complete as possible.

There are examples currently of the use of market mechanisms for resource allocation, including water take rights in Canterbury and tradable nitrogen discharge allowances in Taupō and Rotorua. Additional use of market mechanisms is likely to result, especially if further guidance or promotion is provided in national direction.

[80] For example, retuning Waikato River water quality to an 1863 level of quality (when the New Zealand Settlements Act 1863 was passed and substantial tracts of land were confiscated from local iwi) (Doole *et al*, 2018)

2.3.5 Allocation and Māori

If Māori development aspirations are assisted by the proposed allocation approaches the impact question remains of whether there is likely to be a net wellbeing benefit. To answer this question we need to assess whether or how Māori motivations and consequent behaviour might differ from non-Māori. Are Māori more or less willing to make trade-offs around resource use, given underlying preferences?

There are a number of theoretical reasons why people may behave in a way that is "commercially harmful" when they have an allocation of freshwater, and previous analysis suggests Māori could also be susceptible[81]. This finding is based on consideration of the key sources of bias that influence decision-making:

- *Loss aversion* - basically losses "hurt" people more than commensurate gains would "help" them. When someone sells a good, they view that as a loss and when thinking about purchasing the same good, they view this as a gain. To compensate for the fact that the "pain" from losses outweighs the "pleasure" from gains that are of equal size, people will demand more to part with the good than they would to acquire it.

- *Bound-up goods* - such goods essentially become part of an individual's personality. They see the good as part of themselves and their being. Until the good is acquired it is just a generic commodity, but once in one's possession parting with the good is akin to parting with part of oneself. Hence people expect to be paid more to part with the good than they would be prepared to pay to acquire the same good.

- *Closing transactions* - this explanation relates to the psychological preference of people to effectively "close" transactions through completing actions that are part of the exchange. Once transactions are closed (ie through the acquisition of a good in exchange for something), then the person would need to be compensated for the mental anguish associated with re-opening the transaction.

The presence of these factors leads to endowment bias and a divergence between willingness-to-pay (WTP) and willingness to-accept (WTA). This contravenes the 'basic independence' assumption of markets that an individual's valuation of a good is independent of their entitlement to the good, and therefore the WTP and WTA are the same.[82] If, as a result, people value commodities more when they "own" them (or when the commodity is seen as part of an entitlement), then the presumed economic choices and behaviour predicted to result from the asserted symmetrical valuations of gains and losses is questionable.[83]

Closer examination of the arguments that Māori might be susceptible to endowment bias (and hence not make trades that have commercial merit), expert input and practical observation casts doubt on the bias proposition. In particular, say for freshwater:

[81] Davies et al (2015)
[82] The reference to individuals is one of convention. Results would generalise to groups where preferences are able to be adequately expressed.
[83] Kahneman et al (2008)

- The iwi allocation applies only to a clearly defined portion of the water bodies in question; utilisation being exchanged (eg leasing) not residual rights, meaning arguments based on aversion to loss are not relevant.

- Other important values and limits are established prior to an allocable quantum being determined, reducing the potential for significant conflicts and hence reluctance to trade.

The prediction that most Māori would act in a commercially driven or economically efficient manner is also supported by observations in practice, specifically:

- the use of organisational structures that separate commercial activities from wider iwi undertakings, with provision for distinct commercial targets and use of specialist skills and expertise;

- current agreements in place between iwi/Māori and others in respect of resource use with a commercial focus such as fisheries, carbon trading/forestry, some water-related uses, and geothermal energy; and

- the views of experts with experience and deep knowledge of iwi behaviour.

To reiterate, the previous analysis of Māori responses to recognition of rights to an allocable quantum of freshwater, supports the view that Māori would act in a similar manner to non-Māori at least in relation to commercial opportunities. This finding should hold for all allocation approaches that see Māori gain access to particular resources. We suggest that such conclusions can be applied more broadly to other resources, notwithstanding the important place that water holds in *Te Ao Māori*. Thus, at a minimum, a greater resource use allocation to Māori would not appear to result in societal outcomes that are worse than the existing situation. Indeed, it may be the case that gains can be made by virtue of the possibility of surpluses resulting from enhanced Māori resource use.

Merit-Based Approaches

Administrative merit approaches may enable the wide and long-term values of Māori to be considered. However, they may suffer from inconsistency in the absence of greater national direction and prescription, which is at odds with the enabling purpose of the reform proposals. In addition, the relationship between Māori and local government has historically been somewhat fraught, as local government had historically taken some time to recognise the need to build relationships with Māori and the need to fulfil *Te Tiriti* obligations.[84] While improvements appear to have been made over time, there is potential for lingering issues to affect the degree to which an administrative merit approach could achieve its allocation objectives for Māori.

Markets

It is uncertain whether markets could sufficiently account for different notions of value between Māori and non-Māori and strike the right balance sought. In saying this, auctions can reveal actual values well and the bidding behaviour of participants may be such that the full array of values is contained in the bid strategy, so that the highest bid is a

[84] https://www.lgnz.co.nz/assets/Uploads/Our-work/5ac0700057/CME-pub1065048016.pdf

reasonable approximation of the greatest WTP and value, regardless of the composition of the WTP/value.

The development of hybrid or dual approaches that use elements of market mechanisms/economic instruments and administrative merit might be a possibility. In effect, this is what occurred in the Māori Commercial Aquaculture Claims Settlement Act 2004 (MCACSA). Broadly, under the MCACSA the Crown agreed to transfer 20 per cent of the value of aquaculture space to Māori, with a national organisation (*Te Ohu Kaimoana* - ToKM) having discretion in the transfer process. Calculating the value of aquaculture space uses economic instruments, but there is an effective 'administrative merit' element also involved.[85] While such an approach could be considered more as a 'rights and interests' issue, to the extent that rights and interests as applied to allocation are to be resolved, significant conversations between Māori and the Crown are needed.

2.3.6 Comparison of Approaches

Table 2-1 summarises the impacts of the different allocation options (FIFS, merit-based and market-based) against the proposed allocation principles.

Table 2-1 Summary of allocation approaches against principles

Principle/Issue	First-in, first served	Merit-based	Markets
Efficiency			
Immediate (static) efficiency	No consideration of best use and no comparison with no commercial use	Competing resource users can be compared based on contribution to wellbeing using CBA (limited by data availability)	Allocation to optimal use via market transactions where market is competitive, liquid and complete.
Ongoing (dynamic) efficiency	Markets might be used for reallocation, but otherwise this is limited by consent duration	Limited by consent duration unless markets enabled for reallocation	Allows reallocation where use rights are tradable
System costs	Low	Will depend on the level of analysis undertaken and data availability	Can be high, depending on need for monitoring and system architecture
Sustainability	Impacts on future generations may require constraints to allocation in addition to limits and targets. Sustainable management will be influenced by consent duration. Wider impacts will be as for static efficiency		
Equity	Low: allocation based on first application	Initially can be high (allocation based on merit) but can exclude subsequent new entrants.	Can be high, although allocation based on willingness to pay may exclude uses with high community benefits.

FIFS has low costs but is unlikely to be regarded either as efficient or equitable. Merit-based allocation has higher costs for analysis but is more efficient in its initial allocation; it may not provide a basis for reallocation to achieve dynamic efficiency benefits. Markets can allocate efficiently when all (or most) effects are priced and are ideal for reallocation,

[85] An amendment to the MCACSA provides for more discretionary power to ToKM to expedite the allocation and transfer process.

enabling dynamic efficiency benefits and compensation for incumbents. The sustainability impacts of the approaches may depend on additional limits to how much is allocated or the duration of consents (see below).

2.4 Short Duration Consents

One approach to enabling greater transferability is for consent periods to be shorter. The panel noted that shorter periods "*allow councils to make more frequent reallocations, if required, to preserve environmental limits, accommodate new uses and reflect the changing preferences of society*" (p348). While noting the negative implications for investment certainty and the costs of frequent applications, the Panel suggested "*the current maximum permit term of 35 years is now only appropriate in very limited circumstances*" (p340).

Below we address issues relating to investment and to sustainable resource use.

2.4.1 Impacts on Investment

Resource uses may require capital investment in the form of plant or machinery or in land use change to higher value uses (eg from pasture-based farming to kiwifruit production). If the duration of the consent is shorter than the economic life of the capital employed, the return on capital will need to be achieved over a shorter period. This adds to the costs of production (or to the required sales price of any output) potentially making the activity less profitable than competitors in some other location in New Zealand or elsewhere or passing on higher costs to customers.

The risk of investment will vary with the resource and the markets into which the users sell. For some there will be other sources of uncertainty that mean a return on capital will need to be obtained on a short period also. This might be for sectors where there is significant technological improvement and new entrants will be able to outcompete existing suppliers.

Consent duration is a critical issue for investments in infrastructure where households or processing industries face the costs via charges for network goods including water, wastewater services and electricity. For example, Watercare has obtained several 35-year consents for discharges to freshwater and coastal environments from wastewater treatment plants (WWTPs) in Auckland and Waikato regions. Watercare argues the importance of long consents to "*keeping the overall costs of water supply and wastewater services to its customers (collectively) at the minimum levels consistent with the effective conduct of its undertakings and the maintenance of the long-term integrity of its assets*."[86]

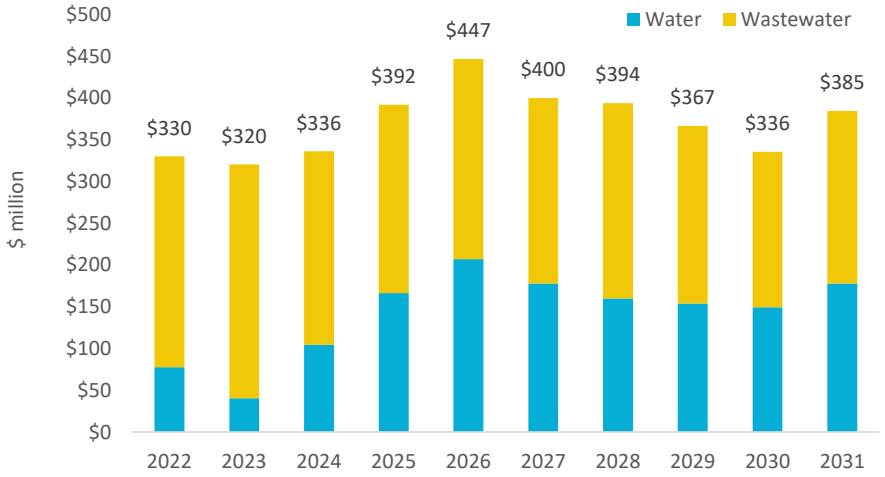
To illustrate the effect, we examine the forecast investments by Watercare over the next 10 years to meet anticipated growth. This is an estimated $3.7 billion of capital expenditure (capex) to meet the demand of an additional 476,000 people (Figure 2-3).

To simplify the analysis, we assume the capex is all in the first year (2022), that the costs are recovered using infrastructure growth charges (IGCs) on new households (assuming 2.7 people per household) and that the period over which the IGCs recover the costs is the duration of the consent. The results are shown in Figure 2-4; because the amount is

[86] Bourne and McNamara (undated)

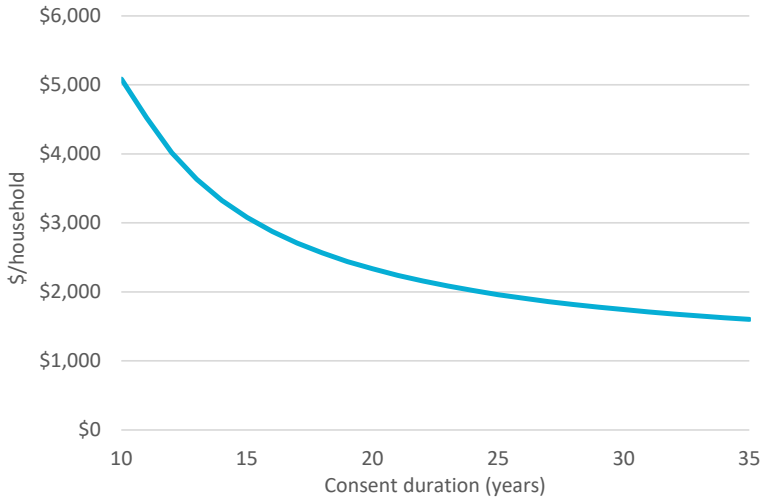
recovered over a shorter time period, the annual costs to households falls from over $5,000/household with a 10-year consent to $1,600/hh with a 35-year consent.

Figure 2-3 Watercare's forecast growth investments in water and wastewater



Source: Watercare (2021)

Figure 2-4 Impact of consent duration on per annum household costs



Land use conversions are also expensive. For example, converting land to kiwifruit production costs $150-$400,000/ha.[87] We estimate the payback period for this using the using assumptions set out below.

Plant variety rights (PVRs) gives the exclusive right to produce for sale and to sell propagating material of a specified plant variety. PVRs are valid for 23 years from the date of initial grant of the right.[88] For gold kiwifruit this is from 2016,[89] so in 2022 there are 17 years remaining. A PVR is no longer required for Haywards green kiwifruit. Zespri holds the PVR for G3 Sungold kiwifruit and issues licenses (with conditions) under the PVR it holds. A purchaser of the licence owns this right for the remainder of its life but can sell it if they change land use (and remove the plants and root stocks). Zespri G3 licence prices have

[87] Tupu (2022)
[88] Section 14(2)(a) of the Plant Variety Rights Act 1987
[89] Zespri (2017)

increased significantly over time, particularly recently when the number of licensed hectares has been reduced. The median price in 2022 has been $800,000/ha, up from $550,000/ha in 2021.[90]

Because the licences are tradable independently of the land, the cost for a license holder is the opportunity cost of holding it over the time they own and use the license. The annual cost of holding the licence based on the current value of $800,000 spread over 17 years at 5% is $70,959. It is assumed this cost applies from the time of planting, ie year zero for the project. In analysis we assume these costs apply for 14 years (at which stage the licence has no value so there is no opportunity cost), equivalent to the investment occurring in 2025.

Operating costs are estimated for 2018 at $38,900/ha from a 2019 ANZ forecast.[91] This is inflated to 2022-dollar values using ANZ's estimated average annual costs increases (2013 to 2018) and a 2.5% inflation rate; it suggests a real increase in costs of 8.1% per annum to an estimated $53,104/ha in 2022, which is assumed to be the same for green and gold varieties. This cost is consistent with the Tupu (2022) estimate of $40-$50,000/ha and with AgFirst Waikato (2019) which estimated annual operating costs of $43,000/ha.

Average orchard gate returns (OGRs)[92] for 2021/22 were $75,494/ha for green and $176,026/ha for gold.[93] Returns are not available immediately; we assume they are obtained after two or three years for G3 and Haywards green respectively.

These are combined to estimate annual operating pre-tax profits (before payment of capital costs) of approximately $22,000/ha for green and $52,000/ha for gold kiwifruit (Table 2-2).

Table 2-2 Net annual profit from kiwifruit production (2022 estimates)

		2018 costs ($/ha)	Green ($/ha)	Gold ($/ha)
Annual Costs	Annual licence cost			70,959
	Wages & contracting	20,600	28,122	28,122
	Fertiliser	2,300	3,140	3,140
	Weed & pest	2,200	3,003	3,003
	Pollination	2,200	3,003	3,003
	Other	11,600	15,836	15,836
	Total	38,900	53,104	124,064
Orchard Gate Return (OGR)			75,492	176,026
Annual operating profit			22,388	51,962

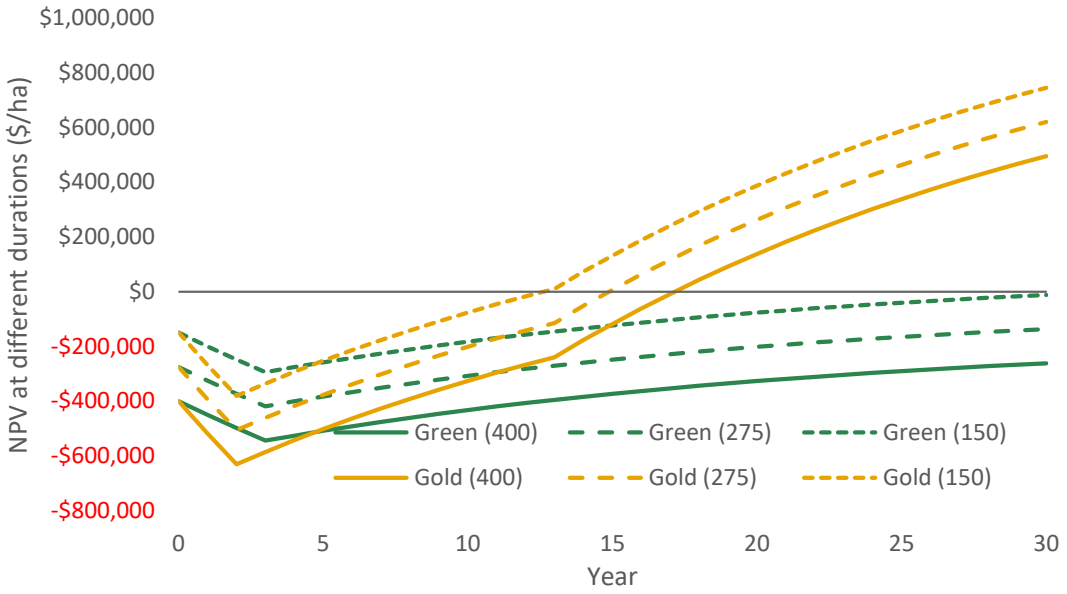
Source: See text

In Figure 2-5 we show the cumulative discounted value of investment for green and gold estimated using these figures and a 5% real discount rate, ie the NPV of the project to the time period on the x-axis. The lines start at a negative value reflecting the initial costs of

[90] https://www.nzherald.co.nz/the-country/news/sought-after-kiwifruit-licences-selling-for-top-prices/BDHBVR2OJMFYJTFZCUMQPG4VKU/
[91] ANZ (2019)
[92] OGR is the revenue received by an orchardist after post-harvest costs (eg coolstore, packing costs, marketing, logistics, etc) are deducted (ANZ 2019)
[93] Zespri (2022)

conversion and management before any revenue is obtained. For G3 gold, the slope changes after 14 years when the opportunity cost of holding the licence ends.

Figure 2-5 Net present value of kiwifruit investments for different land conversion costs



Note: (400), (275), (150) = land conversion costs of $400,000, $275,000 and $150,000

The period beyond which the NPV is positive (equivalent to a payback period) is estimated at 17.8 for G3 with the mid-estimate of conversion costs of $275,000/ha (Table 2-3). For Haywards green a positive NPV is only achievable with a $150,000/ha conversion cost (after 32.4 years), so realistically, Haywards green would only be planted on land with low conversion costs.

Table 2-3 NPVs ($/ha) at different consent durations and payback period for kiwifruit investments

Variety	Land conversion Cost ($/ha)	10 years ($/ha)	15 years ($/ha)	20 years ($/ha)	25 years ($/ha)	30 years ($/ha)	Payback (years)
Haywards Green	$400,000	-432,711	-373,206	-326,582	-290,051	-261,428	NA
	$275,000	-307,711	-248,206	-201,582	-165,051	-136,428	NA
	$150,000	-182,711	-123,206	-76,582	-40,051	-11,428	32.4
G3 Gold	$400,000	-326,064	-117,980	138,011	338,587	495,743	17.9
	$275,000	-201,064	7,020	263,011	463,587	620,743	15.5
	$150,000	-76,064	62,048	197,006	397,582	554,738	12.6

Shorter duration consents have the potential to reduce investment in kiwifruit and other land uses where there are significant land conversion costs.

2.4.2 Sustainable Resource Use

The Panel suggested that shorter permit durations could be used to better preserve environmental limits, accommodate new uses and reflect the changing preferences of society, while noting the risks for investment and the cost of applications.[94] The Panel

[94] Resource Management Review Panel (2020), p348

suggested 20 to 35-year durations might be appropriate in some cases, but shorter terms should be considered for scarce coastal space.

One issue of concern with shorter durations, in addition to the impacts on investment, is that of sustainable resource management. One historical example is the harvesting of sphagnum moss on the West Coast of the South Island.[95] This activity was originally permitted via short term licences; the Department of Lands and Survey (which was draining and developing land for farming) issued 12-month permits to remove sphagnum (for a fee and a royalty payment) and the NZ Forest Service auctioned 90-day permits for removal on areas planned for afforestation. Economic analysis suggested that sustainable management of the sphagnum crop had the potential for high returns per hectare, but the short-term permits incentivised a mining operation rather than sustainable management which involved leaving some moss behind to regenerate, with return periods of several years.

This is an extreme example with very short duration permits under very different institutional arrangements. But the lessons are clear; permit durations need to ensure they are in sync with the biology of the resources being managed.

2.4.3 Māori and Long-Term Perspectives

The intergenerational horizon of Māori also applies to investments and development opportunities. A long-term (and patient) planning and investment focus (see the Kono example in Box 2-2) suggests sufficient value may not be accrued from a short consent duration,[96] relative to other potential consent holders who have a more short-term focus, because of the approach taken to management and how value is obtained.

Box 2-2 Kono - an example of long-term business objectives

Kono is a vertically integrated family-owned food and beverage producer that is part of the Wakatū Incorporation. It has a 500-year plan that places sustainability at the heart of its operations. Kono defines its duty as being: *"…collectively responsible for protecting and enhancing our precious natural resources that are our life force. They have been entrusted to us by our ancestors and will be passed on to future generations."*[97]

Kono also describes its purpose as: *"…to grow an economic base that enables Wakatū whānau whānui to achieve sustained spiritual, environmental, social and cultural well-being and economic aspirations. Integral to achieving our aspirations is managing our commercial operations in a way that meets our kaitiakitanga obligations. This is our duty and it will be our legacy*."

Kono draws on the following whakataukī as part of its 500-year plan: *Whatungarongaro te tangata toitū te whenua* (as people disappear from sight, the land remains.)

2.5 Resource User Charges and the Potential Redistribution of Benefits

In addition to concerns raised about the way in which allocation under the RMA does not maximise environmental, social, cultural or economic value, another component of resource allocation discussed by the Panel was the potential benefits from the wider use of some form of resource user charge (including royalties and rentals). The Panel noted "*For efficiency, a royalty payment is an incentive not to waste resources and to encourage their*

[95] Denne (1983); Denne and Sharp (1983)
[96] Sometimes it may be a bank that sets the timescale for a project via its lending terms
[97] https://kono-nz.squarespace.com/our-story/#identity-and-values1

best use. Similarly, an incentive is created to surrender resources that are not put to good use. For equity, private users who use a free public resource for profit, should share some of those benefits with their community. In addition, the scarcity value accruing to resource entitlements over time is also (partially) captured through a resource rental" (p360).

In addition to encouraging efficient use of infrastructure, funding infrastructure and distributing the benefits of resource use to the wider community, resource user charges can also be used to internalise external costs, eg a pollution tax based on marginal damage costs, or to address sustainability concerns around rates of depletion.

The design of these different charges can be quite different.

2.5.1 Efficient Use of Infrastructure

Alignment of costs and revenues through cost-reflective pricing is a key principle for achieving efficient allocation of resources. Efficient allocation occurs when people only use a resource to the extent that they value it more than the costs of supplying that resource. For infrastructure users (eg wastewater), this means users will only discharge to the extent that they value discharging more than the costs of managing their discharge. We do not need to know how much customers value the ability to discharge but can ensure efficient use of the wastewater service by making the price of discharging equal to costs.

Costs differ over the term considered:

- In the short run, ie a period over which there is no increase in capacity to manage wastewater, efficient discharge prices reflect the short run additional cost of managing another unit of wastewater, eg the costs of chemicals and energy for treatment. This is the **short run marginal cost**;

- In the long run, efficient investments in water using premises, plants or machinery, are made if prices reflect the **long run marginal costs** of treating another unit of wastewater. This will include the short run costs *plus* the costs of additional pipes and/or expansion of treatment plants required to manage increases in volumes.

In other jurisdictions, and consistent with economic theory, long run marginal cost (LRMC)-based pricing of water and wastewater volumes is regarded as the efficient approach to setting prices. This is a *forward-looking* measure of costs; it anticipates how much total costs will increase to meet an incremental increase in demand for services from the current level. If there is a shortfall between the revenue requirement and the amount that is raised using LRMC-based pricing of volumes, fixed prices (eg $/household per annum) can be used, in addition, to raise revenue to fill the gap. Fixed prices can be structured to meet other objectives while not affecting consumption decisions because the fixed price is independent of the volume of water consumed.[98]

Defining LRMC for wastewater or other resource-using infrastructure is not necessarily straightforward. Costs will differ between existing and new customers and/or locations. Within the current supply network, significant increases in demand may be accommodated

[98] Fixed cost pricing can be used to influence longer run decisions to connect to wastewater services.

within existing infrastructure, however, in new locations there will be a need to expand the network.

2.5.2 Efficient revenue raising

Tax theory would suggest that an efficient revenue raising charge is one that is least distortionary, ie it does not lead to a change in allocation from the highest value user or incentivise that user to shift location to another region. Normally this is achieved by:

- taxing as low and widely as possible, and with everything charged the same rate (the theory behind GST): or

- by charging in-elastic goods, like cigarettes or petrol, where changes in price have only a small impact on consumption.

Where there is no regional competition, and some degree of a local monopoly in supply, then the incentive is to raise the charge level to that at which only the highest value user is willing to invest (or use a resource), but importantly they are still willing to invest.

In the absence of detailed market analysis, the simplest approach to development of revenue raising resource user charges may be via low level charges to avoid distortion.

2.5.3 Re-distribution

A charge that aims to redistribute the benefits of resource use is effectively a revenue raising charge that is extracting some of the economic surplus (or rent) [99] that otherwise would accrue to the resource user. In theory, redistribution might include using the revenue to displace other sources of revenue such as rates, but in practice might be hypothecated to fund related expenditure.

This is equitable from the perspective of a community that perceives it has some ownership of the resource as it provides the community with a benefit from its use. Otherwise, resource use may be efficient in that it is the highest value use of the resource, but the benefits might pass through to the local community only via direct employment and indirectly via the expenditure of local owners and workers. A resource user charge can ensure the local community benefits even when owners are located elsewhere.

Hypothecation can be problematic. If the revenue is used to fund actions, activities or investments that otherwise would not occur or that do not pass a cost-benefit test, then the generation of revenue may lead to a reduction in national or regional wellbeing. Wellbeing may have been higher if the revenue had been left with the resource user. This simply suggests that increasing wellbeing is best achieved by assessing whether any use of revenue will achieve that aim.

2.5.4 Charging for Externalities

Charges set at a level equal to the marginal external costs of resource use have the potential to raise revenue and lead to more efficient use of the resource. As noted above,

[99] A resource rent is the excess surplus, ie the amount that is above a level of normal profit. A normal profit is one that provides an industry-expected return to capital, after all labour and other costs have been paid. Thus the existence of a rent assumes a less than fully competitive market.

efficient use means that the maximum wellbeing is gained from the use of the resource from the perspective of the whole community. If resource use is charged based on the external costs and this reduces potential profits to zero or below, the community is better off without the resource being used (or it being used in a non-extractive way). Externalities as a basis for a charge will always lead to a more efficient outcome. Charging higher than external costs may still be efficient if the charge levels are not distortionary (as discussed above).

2.6 System Costs

Building on work by Castalia,[100] MfE has estimated the changes to process costs of the proposed reforms; the results are summarised in Table 2-4. These costs include other components of the system in addition to the resource allocation components, but the overall pattern is clear. There is estimated to be an overall 7% reduction in process costs, with increased costs for central and local government and reduced costs for users, eg consent applicants. The increased costs for central and local government will be passed on, in turn, as increased taxes or rates, or a reduction in other services.

Table 2-4 Current System vs Proposed System Process Costs (estimate), Average Annual Costs ($million)

Party	Current system process costs	Proposed system additional process costs	Proposed system: cost savings	Proposed system: net cost change
Central government	17	21[a]	-2	19
Local government	401	102	-59	43
Users	799	61	-210	-149
Total	1,218	185	-270	-85

[a] Costs to central government may increase further if full system monitoring and oversight functions are approved. This would add around $30 million per year to central government's ongoing costs. This will be confirmed for the final RIS.
Source: MfE

2.7 Conclusions

In this section we have reviewed the current proposals and provided some commentary on key aspects. This includes:

- Allocation against principles or sustainability, equity and efficiency can be achieved via merit-based approaches or markets.
    - Merit-based approaches using wider use of CBA can be an improvement over FIFS, and that best practice use of CBA can be encouraged.
    - Markets can be used to reveal what is the optimal allocation, provided certain market criteria are met. This will differ regionally and by resource, particularly in the number of potentially competing users and the extent to which all (or most) effects of resource use can be priced.

[100] Castalia (2021)

- Shorter duration consents can be used to address the potential downsides of long consents where what is best use may change over time. However, there are disadvantages of short consents particularly for investments in land use change or capital equipment. The objectives of short duration consents are better met through facilitating markets that enable reallocation of resource use, or even reallocation with compensation.

- Resource user charges can be used to achieve wide objectives that include efficient use of infrastructure, efficient revenue raising, redistribution of benefits and efficient (wellbeing maximising) allocation via charging for externalities.

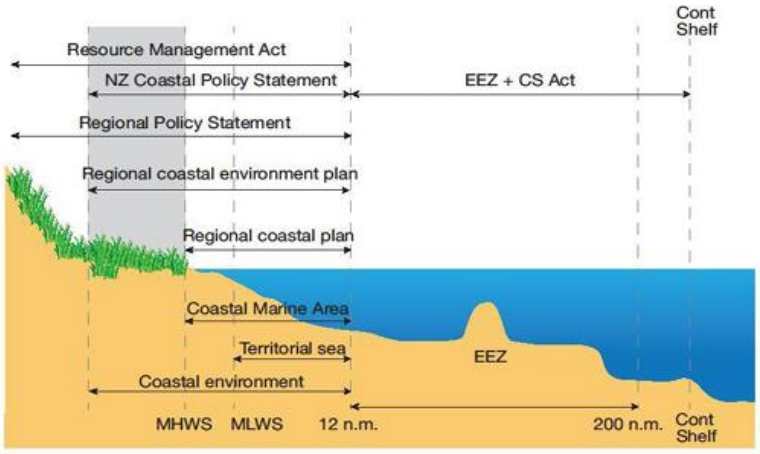
3 Coastal Marine Area

3.1 Resource Allocation Issue

3.1.1 Uses and Conflicts

The coastal marine area (CMA) is the area between mean high-water springs (MHWS) and the 12 nautical mile limit of the territorial sea (Figure 3-1).

Figure 3-1 RMA Coastal Management Jurisdiction



MHWS = Mean High Water Springs
MLWS = Mean Low Water Springs
EEZ = Exclusive Economic Zone
Cont Shelf = Continental Shelf
EEZ + CS Act = Eclusive Economic Zone + Continental Shelf (Economic Effects) Act 2012
n.m. = nautical miles

Source: Quality Planning (2013)

Uses of the CMA include transport of goods, movements (navigation) of ships and other vessels, occupation by structures (such as wharves), recreation, fishing, customary practices, oil and gas exploration, sand (and potentially other) mining, aquaculture, buildings (eg cafes and boat sheds) in and beside the water and on wharves. The resource allocation issue is for this marine space to be allocated to produce most wellbeing.

Aquaculture

One of the areas of focus for resource allocation has been aquaculture (marine farming of mussels, oysters and salmon and potentially other species including other finfish), with the Government targeting a significant increase in area and value[101] while the Panel suggested the aquaculture management regime is not fit for purpose and that improvements might include:[102]

- more or improved marine spatial planning to identify areas appropriate for aquaculture development within environmental limits;

[101] NZ Government (2019; 2021)
[102] This builds of recommendations by Peart (2019), one of the Panel members.

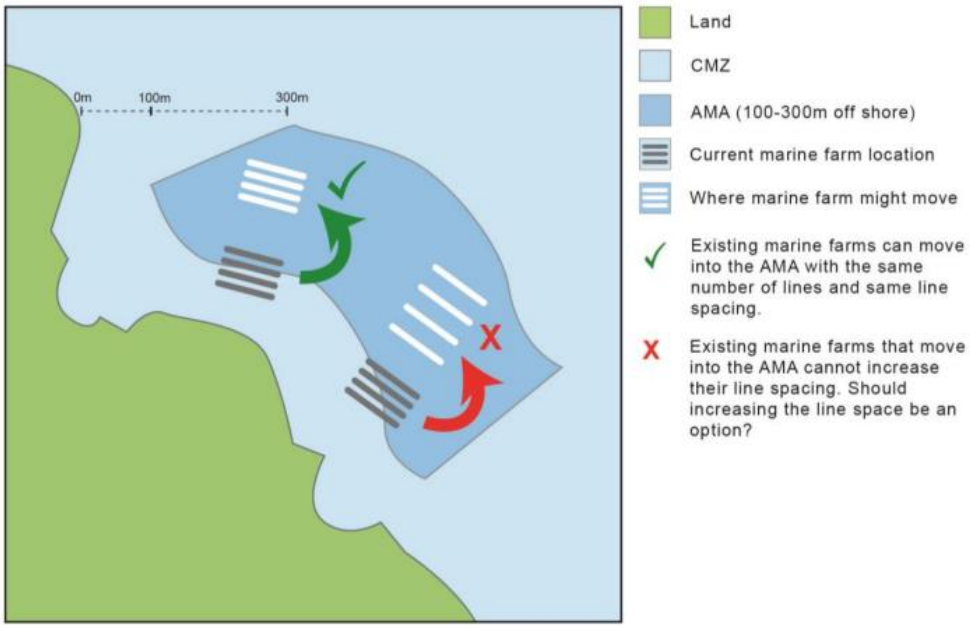
- flexible licensing in which permits are attached to biomass, rather than specific locations. This means aquaculture activities might be moved between different aquaculture areas depending on environmental conditions and market requirements; and

- a more developed allocation framework including principles for determining competing applications and charges for the use of public space in the coastal marine area.

Competition for space is illustrated by recent changes implemented by the Marlborough District Council (MDC) which has led to shifts in location of aquaculture because of the adverse impacts associated with near-shore location. MDC recently reviewed its aquaculture provisions, suggesting no increase in the current area because: (1) the Council did not have enough robust evidence either that the marine environment has the capacity to absorb more aquaculture, or that the adverse effects require the level of farming to be reduced; (2) some communities are strongly opposed to an increase in aquaculture, suggesting that "*the 'social' carrying capacity has been met*;" and (3) maintaining the current area retains the existing economic benefits generated by the industry.[103] However, the proposal is to shift the location of marine farms as this would restore ecosystem health,[104] reduce effects on other coastal values, maintain the same level of aquaculture in the inner Sounds and provide future capacity.

Existing farms would be given priority, with replacement consents assessed as controlled activities, provided they have the same number of lines and same line spacing (Figure 3-2). This is expected to have reduced environmental impact while, potentially leading to increased production.

Figure 3-2 Example mussel farm movement into an Aquaculture Management Area (AMA)



Source: Marlborough District Council (2020)

[103] Perception Planning (2020)
[104] This includes restoring foreshore euphotic zone health (the upper layer of a waterbody that receives enough sunlight to enable photosynthesis)

An economic analysis estimated one-off costs to relocate lines seaward at $1,500 - $3,000 per farm with a total estimated cost for the Marlborough region of $0.9 - $1.8 million.[105] It was suggested this was outweighed by a reduction in re-consenting costs (from changing status from discretionary to controlled and thus reducing assessment costs) of close to $18 million, with other costs and benefits unquantifiable but the implication being that environmental and social costs would be lower.

Habitat Protection

The human impacts on the coastal environment include those from land-based activities that produce sediment, nutrient and chemical (including pharmaceutical and cleaning product) discharges, in addition to plastic and other materials entering and polluting the marine environment.[106] These contaminants come from land uses that include agriculture, forestry and human settlements. There are also marine-based activities that affect the marine environment directly.

- Coastal hardening, which involves replacement of natural coastal environments with hard surfaces. This includes coastal protection works, building ports, wharfs and jetties, residential development, and reclaiming land from the sea.

- Dredging to increase channel depth, which disturbs the seabed affecting seabed habitats and resuspending sediment.

- Fishing activities, including:[107]
    - Unsustainable levels of harvest of some fisheries. Although those assessed under the Quota Management System (QMS) are managed back to sustainable levels under the Harvest Strategy Standard,[108] this is not a precise science and does not use a precautionary approach. In addition, many stocks are not assessed including those fished largely for recreational purposes or caught mainly as bycatch;

    - Bycatch of non-target species during fishing activities, including marine mammals and birds;

    - Direct impact of some fishing methods, including bottom disturbance by trawling.

- Aquaculture, which can concentrate nutrient deposition and foster the development of diseases which can spread to wild populations.

- Mining of minerals and extraction of oil and gas, which can disturb the seabed and surrounding habitats, and cause direct pollution, eg leakage from oil platforms. Other activities that can have impacts include laying of cables.

- Shipping, which can result in:

[105] Appendix 10 in Perception Planning (2020)
[106] Building on Ministry for the Environment & Stats NZ (2019)
[107] Fisheries New Zealand (2020a)
[108] Ministry of Fisheries (2008)

- spread of non-native species;
- leaks of fuel oil;
- waste discharges, including plastic pollution; and
- associated need for wharves and port facilities (coastal hardening).

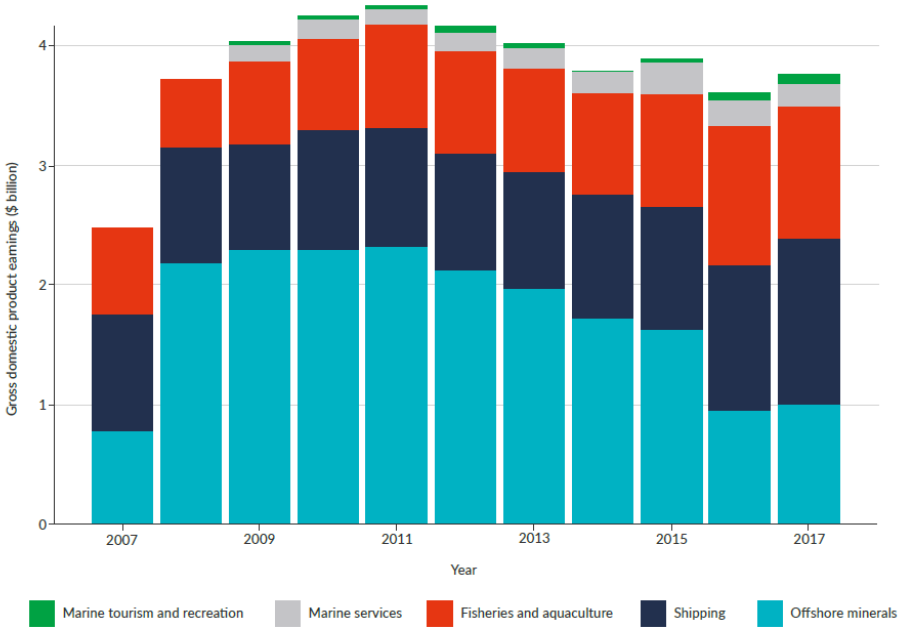
The interaction of the marine environment with human activity is also affected by climate change, and sea level rise in particular.

Actions to reduce impacts have included proposals for more marine protected areas (MPAs).

Economic Importance of the Marine Environment

The impacts of human activities in the marine environment are offset by the contribution of that activity to the economy and to community wellbeing. As part of its development of satellite accounts, Statistics NZ compiled data on the contribution of the "marine economy" to GDP for 2007-2017. This included fishing, aquaculture, shipping, and coastal development (Figure 3-3).

Figure 3-3 Contribution of activity category to the marine economy, 2007—2017



Source: Ministry for the Environment & Stats NZ (2019)

In 2017, the marine economy contributed $7 billion (approximately 2%) to GDP and employed more than 30,000 people (approximately 1% of the labour force). Of the GDP contribution, 37% was from shipping, 29% from aquaculture and fishing, and 27% from offshore minerals. Additional contributions are from the industries that depend on shipping for exports or imports, eg $48 billion in exports and $43 billion of imports.[109]

[109] Fob and cif bases respectively

3.1.2 Current Regulation

RMA and New Zealand Coastal Policy Statement

The marine environment is governed by several pieces of legislation, including the Fisheries Act, legislation setting up marine protected areas (MPAs) and that managing the Exclusive Economic Zone (EEZ). The RM reforms will not affect these existing pieces of legislation, though there is an obvious interaction of effects.

The RMA controls factors that cannot be managed through area-based restrictions, including:[110]

- management of the land-sea interface to address issues such as sedimentation and eutrophication, through measures including the establishment of riparian strips to filter run-off and implementation of catchment management strategies; and

- the requirement for regional councils to prepare Regional Coastal Plans to address their functions in the coastal marine area, including aquaculture management areas.

The area under the control of the RMA is partly defined by the definition of the areas governed by regional councils. This includes the CMA. Currently a New Zealand Coastal Policy Statement (NZCPS) and regional coastal plans are compulsory.[111] The latest NZCPS was produced in 2010.[112] Its purpose is to set out policies to achieve the purpose of the Act in relation to the coastal environment. It states policies on issues including preservation of natural character; coastal subdivision, use and development; and coastal hazard risks. The Review Panel noted that the NZCPS covers the 'coastal environment', but that it does not include all areas that generate impacts on the CMA (eg land uses generating sediment) or that depend on coastal infrastructure, eg export ports.

RMA Part 7A

Part 7A of the RMA provides tools to manage demand for coastal space in the common marine and coastal area (CMCA).[113] Allocation is limited to occupation of coastal space rather than allocation of some other rights, eg biomass harvest levels or numbers of lines.

Regional councils are responsible for allocating the right to occupy space in the CMA through their plan provisions (section 30(1)(fb)), and for issuing coastal permits for occupation (section 12(2) of the RMA).[114] Generally FIFS is applied to applications for aquaculture resource consents, but under Section 165F, councils can also include provisions in their regional coastal plans to manage competition for space. These provisions can include rules that no application can be made for a coastal permit to occupy space before a particular date, and that applications to occupy space (and any related applications) must be processed and heard together.

Councils can also define allocation methods:

[110] Froude and Smith (2004)
[111] Sections 57 and 64 of the RMA
[112] Department of Conservation (2010)
[113] As defined under the Marine and Coastal Area (Takutai Moana) Act 2011. It represents a part of the CMA.
[114] Ministry for Primary Industries (2012a)

- in a regional coastal plan; or

- by requesting the use of ministerial powers to manage demand when a plan change would take too long. They may:
    - request the Minister of Conservation to introduce an alternative allocation method via *Gazette* notice; or
    - they may ask the Minister responsible for Aquaculture to suspend applications for consents to occupy space for specified aquaculture activities while an allocation method is established.

Allocation methods as alternatives to FIFS include:[115]

- tendering, whether public (the default alternative to FIFS) or otherwise and using financial or non-financial (weighted attribute) criteria;

- auction; and

- ballot.

NES: Marine Aquaculture

An NES for Marine Aquaculture (NES-MA) was introduced in July 2020.[116] The NES provides a process to consider applications for replacement coastal permits for existing marine farms, including the ability for an existing marine farm to realign or make changes to consented species.[117] The NES-MA:[118]

- enables most replacement consents (which may include some species changes) to be non-notified, restricted discretionary activities with a confined list of matters of discretion while still allowing management of existing marine farming within environmental limits;

- provides for small scale realignments of existing marine farms, particularly where realignments can reduce adverse effects; and

- requires all marine farms (existing and new) to prepare, implement and keep up to date biosecurity management plans.

A 2018 estimate was of approximately 1,150 marine farms in New Zealand and 1,800 aquaculture resource consents.[119] Of the total, nearly two-thirds are in the Marlborough region, with the rest largely in Northland, Auckland and Waikato regions.[120] Approximately 60% of the existing consents are due to expire by 2025, primarily as a result of licences approved under the Marine Farming Act 1971 or Fisheries Act 1983 being deemed resource consents under the RMA through the 2004 amendments; they will need to be reconsented

[115] Ministry for Primary Industries (2012a; 2012b);
[116] Resource Management (National Environmental Standards for Marine Aquaculture) Regulations 2020
[117] Fisheries New Zealand (2021)
[118] Ministry for Primary Industries (2017)
[119] Stantec (2018)
[120] Nixon (2017)

during 2024/25.[121] NZIER's CBA of the NES-MA estimated benefits from improved industry certainty[122] and consistency and from biosecurity improvements.[123] These were set against changes in administrative costs for councils and central government, while noting that environmental impacts were both uncertain and unquantified.[124]

Government Aquaculture strategy

The Government is targeting significant growth in the aquaculture industry, with the NZ Government Aquaculture Strategy aiming for a growth in annual sales increasing from approximately $600 million currently (c2019) to $3 billion by 2035.[125] This growth is expected to come from:

1. maximising the value of existing farms through innovation, eg deriving greater value from production of products such as mussel oils, powders and extracts, high value nutrition and premium salmon;

2. extending into high value land-based aquaculture, eg hatcheries; and

3. extending aquaculture into the open ocean.

More recently, seaweed farming has been identified as a potential area for growth.[126]

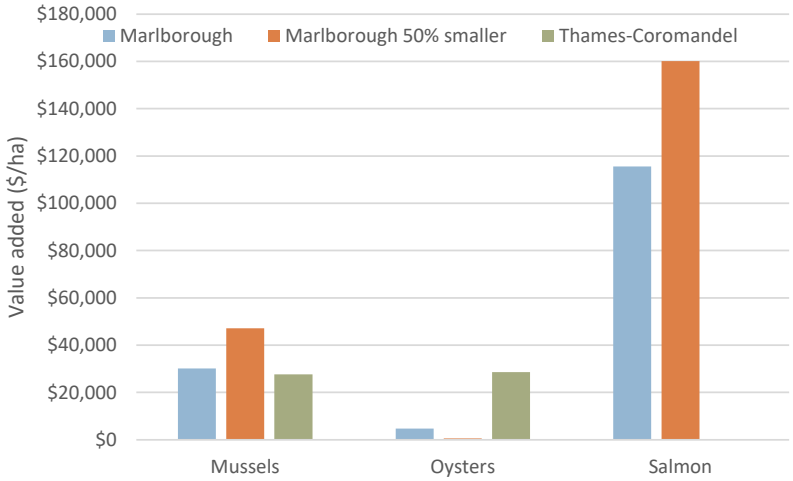
Several studies have estimated the value of aquaculture activity in New Zealand, including national and local/regional analyses. Figure 3-4 shows estimates of the value of aquaculture per hectare of coastal area consented in two regions: Marlborough in 2015, plus an estimate of the average value if there was a 50% reduction in farms; and Thames-Coromandel in 2017. The results are from a modelled analysis using a regional computable general equilibrium (CGE) model, so there are numerous assumptions involved. The value added (GDP contribution) is an estimate of the value of firm profit and payment to staff and owners. The analysis illustrates that:

- There are significant differences in value per hectare between– mussel, oyster, and salmon farms.[127]

- There are differences across space – this includes regional differences and from a small area in the same region (although this latter effect may be a function of the modelling more than reality).

[121] Nixon (2018), p8
[122] The investment certainty benefits (greater certainty of re-consenting) were estimated at $10.5 to $22 million per annum using a simple estimate of 0.5% to 1% of estimated sector turnover.
[123] Fisheries New Zealand (2020b)
[124] Nixon (2018)
[125] NZ Government (2019)
[126] NZ Government (2021)
[127] The Government has also published estimates of the large differences in value between mussel, oyster and salmon farms (NZ Government 2019)

Figure 3-4 Value of aquaculture ($/consented hectare) in different regions



Source: Data from Clough and Corong (2015b); Pambudi and Clough (2017)

Government Response to the Sea Change Proposals

The Sea Change Tai Timu Tai Pari Hauraki Gulf Marine Spatial Plan[128] was produced through a collaborative, stakeholder-led, co-governance process and included proposals to improve the health, mauri (life force and vitality) and abundance of marine life in the Hauraki Gulf through controls on activity in the marine area and reducing the impacts of sedimentation and other land-based activities on water quality. The Government has responded to the Sea Change proposal with a strategy published in June 2021.[129] It includes a set of new initiatives as outlined in Table 3-1.

Much of the focus is on increased protection (including restrictions on commercial fishing and increased use of marine protected areas) and habitat restoration but it also includes reducing restrictions to aquaculture expansion.

The responses to the Sea Change proposal are being developed under existing legislation, suggesting that collaborative, stakeholder-led, co-governance processes that aim to deliver both development and protection are possible under the RMA. However, the Government's Hauraki Gulf strategy suggests the RMA reforms are part of the background to the achievement of the strategy, as illustrated by the aquaculture initiative of "*identifying government actions to remove impediments to aquaculture initiatives."*[130] The reforms are listed alongside other initiatives underway including:

- the Government's essential freshwater (EFW) programme (including NPS-FM and NES-F) and the Productive and Sustainable Land Use (PSLU) packages that will reduce land-based sources of sediment and other contaminants;

- Auckland Council and Waikato Regional Council projects;[131] and

[128] Sea Change (2017)
[129] Department of Conservation *et al* (2021)
[130] Department of Conservation et al (2021), p4
[131] These are actions in response to various land and freshwater proposals in the Sea Change Plan, including habitat restoration, managing sedimentation, improving water quality and managing marine debris.

- projects led by mana whenua and community groups.[132]

Table 3-1 Initiatives under the Tai Timu Tai Pari Hauraki Gulf Strategy

	Initiative	Detail
1	Fisheries management	An area- and ecosystem-based fisheries plan for customary, commercial and recreational fisheries by June 2022. It will include: • removal of trawl fishing for a significant portion of the Gulf; • limits on scallop dredging; • management strategies to address localised fisheries depletion; • more intertidal harvesting controls, such as blanket seasonal closures; • greater mana whenua and regional participation in management; • a fisheries indicator and monitoring framework.
2	Active habitat restoration	Establishing a habitat restoration framework to guide new investment and restoration initiatives, to be completed in 2021.
3	Aquaculture	Identifying government actions to remove impediments to aquaculture initiatives by 2023.
4	Marine biosecurity	Continuing agency support for the Top of the North Marine Biosecurity Partnership.
5	Marine protection	Increase the area under marine protection in the Gulf from 7% to 18% via new legislation to be passed in 2024. To include: • 11 new High Protection Areas to protect and restore marine ecosystems, and recognise the role of mana whenua as rangatira and kaitiaki through provision for customary practices, consistent with biodiversity objectives. • 5 Seafloor Protection Areas and 2 areas of marine protection adjacent to existing marine reserves.
6	Protected species	Expanding the existing work by DOC and MPI/FNZ for protected marine species in the Gulf over the next three years, including threats to burrow-nesting seabirds on island refuges, improving by-catch measures, and prioritising research and monitoring of protected species.
7	Ahu Moana (local marine management by mana whenua and local communities)	Initiating pilot projects with mana whenua and local communities in 2021 to explore how to improve fisheries and conservation in local areas. Existing fisheries regulatory tools will support the pilots. Lessons from the pilots will inform the development of an Ahu Moana framework by 2023.
8	Governance	Establishing a cross-agency implementation group comprising DOC and MPI/FNZ (the agencies) to oversee the implementation of the Strategy, noting that future Treaty negotiations relating to the Gulf will focus on governance arrangements (including the Hauraki Gulf Forum).

Source: Department of Conservation *et al* (2021)

While these strategies and the resulting improvements in environmental quality could happen under existing institutional arrangements, it is assumed for the purpose of this analysis that the RM reforms make it more likely that this type of approach will be used more widely across the country and will speed up the implementation of the Hauraki Gulf strategy.

[132] These include the Ngāti Whātua Ōrākei restoration project in Okahu Bay and the Taramaire Stream restoration project

MCACSA

Under Māori Commercial Aquaculture Claims Settlement Act 2004 (MCACSA), iwi Māori must be provided with assets that are representative of 20% of all marine aquaculture space, including five-year future forecasts. Iwi can choose to take a financial settlement rather than a space-based settlement (authorisations that provide iwi exclusive rights to apply for aquaculture space under the RMA), but the intent and expectation is that space-based settlements will be used.[133]

MACA

The Marine and Coastal Area (Takutai Moana) Act 2011 (MACA) provides for the special status of the CMA as an area that is incapable of ownership.[134] It recognises the *mana tuku iho* (inherited right or authority) exercised in the marine and coastal area by iwi, hapū, and whānau as tangata whenua, and it provides for the exercise of customary interests in the CMA, while also protecting wider public rights of access, navigation, and fishing, and recognising the importance of the common marine and coastal area both for its intrinsic worth and for the benefit, use, and enjoyment of the public.

Fisheries Act

Before a marine farm can exercise a resource consent, it must meet an undue adverse effects (UAE) test under the Fisheries Act 1996. If the test assesses there will be an impact on commercial, customary or recreational fishing, the marine farmer may need to compensate commercial fishers or modify their plans.

Coastal Occupation Charges

Legislation enabling councils to levy a resource user charge already exists for the CMA in the form of coastal occupation charges (COCs) under Section 64A of the RMA. COCs can be used where occupation of the CMA leads to a shift from public to private benefit, although they cannot be imposed on some customary groups under the Marine and Coastal Area (Takutai Moana) Act 2011.[135] COCs enable some of the public benefit to be retained by the community, although the revenue earned can only be spent by councils on promoting the sustainable management of the CMA.

3.2 RM Reform Expectations

For the purpose of this analysis, it is assumed that the effects of the RM reforms on coastal management would include greater integration of land management with the coastal marine area (and thus greater flexibility in how coastal issues are addressed), greater direction (and regulation) by central government, raising of allocation decisions to a plan level and greater flexibility in permits for marine farming, noting that these changes are also being pursued under the current system including the Government response to the Sea Change proposal for the Hauraki Gulf, and the NES-MA for reconsenting.

3.2.1 Focus on Aquaculture

The Panel focussed on aquaculture, noting that, although space in the CMA is used for many purposes, aquaculture has received the most attention and criticism under the RMA,

[133] Independent Evaluators (2020)
[134] https://www.doc.govt.nz/about-us/our-role/legislation/marine-and-coastal-area-act/
[135] Section 64A(4A)

including the free-for-all (or gold rush) the Panel attributed to FIFS.[136] The current system for aquaculture management allows applications to be made for any part of the CMA subject to the provisions of the regional coastal plan which, under Policy 8 of the NZCPS, must recognise "the significant existing and potential contribution of aquaculture to the social, economic and cultural well-being of people and communities"[137] by planning for aquaculture activities in appropriate places.[138]

Aquaculture is targeted by the Government for significant increase in value, including providing for new areas for aquaculture, and this will result in the need for additional allocation of space. The reforms are expected to both enable this and ensure that there will be management of the conflicts that will arise.

The environmental effects of aquaculture are estimated to be greater for fed species than for shellfish. They include nitrogen loads from fish farms to compound the effects of land-based nutrient run-off, the overlap of fish farms with other marine animals (including whales) and seabed effects.[139] In contrast, mussel farms have provided sediment filtering benefits and have provided mussels which have been used to repopulate former benthic mussel beds.

3.2.2 Increased Role of Up-front Planning and of Central Government

Allocation decisions for aquaculture and other uses of coastal space, alongside the management of interactions between land use and the marine environment, are expected to be made more up-front in plans rather than reactive at the consent stage. This will include NBA plans and regional spatial strategies (RSSs) under the Spatial Planning Act (SPA).

In addition, the Government is expected to take a greater lead, partly because it can make directions more quickly than councils can under the plan change process. This might include direct regulatory intervention to amend regional coastal and NBA plans to achieve Government objectives for aquaculture. It might also include the involvement of the Minister responsible for aquaculture directly in allocation decisions, including initiating allocation processes, considering offers and directing councils to issue authorisations. This would be particularly relevant to resource allocations for the open ocean where more than one council might be involved. This will, of course, depend on the final form of proposals that are included in the NBA and the extent to which these powers are provided.

Because of the objective to increase the total economic value of aquaculture, greater government involvement would be likely to result in an increased total area allocated to marine farming, including to Māori. The conflicts with other objectives for marine areas, including the greater protection of marine environments such as the Hauraki Gulf, will need to be carefully managed.

[136] Resource Management Review Panel (2020), p328
[137] Department of Conservation (2010), p15
[138] Provisions of regional coastal plans relating to aquaculture can also be amended directly by regulation on recommendation of the Minister of Aquaculture.
[139] Hauraki Gulf Forum (2020)

The RM reforms propose that the UAE test could apply at the planning stage rather than just at the consent stage. While this makes sense, if planning for aquaculture is to have a greater impact on the extent and location of aquaculture areas, assessment should include the full scope of effects including those on the natural environment, other users of the marine environment and any other effects on community wellbeing rather than privileging effects on fishing.

3.2.3 Increases in Aquacultural Area

The Government has targeted a significant increase in the total value of aquacultural production, particularly via an increase in the value per square metre occupied, and (probably) an increase in the total area. The Government or the actions of councils do not necessarily have any impact on underlying demand for aquaculture, but they can reduce the costs and other barriers to establishment. This will be affected (positively for aquaculture) by increases to areas in which aquaculture is a controlled rather than discretionary activity (or by other means that reduce transaction costs), but there may be an impact in the other direction (less aquaculture) from any changes to consent duration (see below).

Environmental Impacts

Environmental effects of aquaculture have been reviewed and summarised by MPI for shellfish (Table 3-2) and finfish (Table 3-3). They also note that there is currently limited understanding of the ecological effects of farming seaweeds and sea cucumbers.

Cumulative effects are an additional concern, with a key concern being that nutrient release from aquaculture will exceed the environment's capability to process these nutrients without adverse effects (the carrying capacity).

Perception Planning (2020) has addressed the issue of the change in environmental effects from a change in the location, ie from a shift seaward as planned in the Marlborough Sounds. Ecological effects of moving mussel farms away from the shore are expected to be minor and mainly positive, including:

- enrichment and smothering effects being less localised, or occurring in more resilient habitats (ie on deeper, soft sediments);
- positive effects on environmental heterogeneity occurring on deeper, soft sediments; and
- shallow areas suitable for seaweeds experiencing less shading.

Table 3-2 Environmental effects of farming shellfish

Domain	Effects
Water column	• Phytoplankton depletion and changes in planktonic community composition • Dissolved nutrient and particulate release into the water column • Effects from biofouling communities
Benthic	• Localised organic enrichment of the seabed beneath the farm • Smothering of benthic organisms by biodeposits • Biofouling drop-off and debris altering the composition of the seabed • Seabed shading by structures which could affect localised algal productivity under the farm
Marine mammals	• Habitat exclusion or modification leading to less use or less productive use • Potential for entanglement • Underwater noise disturbance
Wild fish	• Attraction of wild fish to aquaculture structures (creation of artificial habitats) • Alteration of existing fish habitats
Sea birds	• Entanglement (resulting in birds drowning) • Habitat exclusion • Providing roost sites closer to foraging areas • Aggregation of prey fish
Biosecurity	• Potential to facilitate establishment and spread of pests and diseases
Escapee & Genetics	• Changes to the genetic distinctiveness, fitness, adaptability and diversity of local wild populations
Additives	• Current shellfish aquaculture does not require the ongoing use of chemicals and antibiotics • Intertidal oyster farming racks constructed from treated timber have potential to leach trace contaminants
Hydrodynamic alteration of flows	• Farm structure altering and reducing current speeds, potentially affecting • biological processes, such as phytoplankton production and depletion • Effects on stratification through vertical mixing and partial blocking of some water layers • Wave dampening may affect shoreline habitat and sediment transport

Source MPI (2013)

However, they noted these positive changes were unlikely to occur at all farms and, in many cases, effects are likely be subtle and difficult to detect. Positive changes would be more likely for older farms which may not have been required to submit ecological assessments when they were established. Set against this, there could be seabed disturbance associated with removal and movement of lines. Perception Planning also noted that visual amenity benefits would be highly site-specific.

Thus, the environmental impacts of greater flexibility in location are highly uncertain as:

- the effects may be of some sites being located closer to the shore and others further away; and
- the effects of changes in location being highly uncertain.

If the impact is of greater movement in location rather than aquaculture being fixed in locations, this might produce greater disturbance of the seabed, although how this balances out within the overall impacts is highly uncertain.

Table 3-3 Environmental effects of farming finfish

Domain	Effects
Water column	• Nutrient enrichment effects • Depletion of dissolved oxygen
Benthic	• Localised organic enrichment of the seabed beneath the farm • Biofouling drop-off and debris • Seabed shading by structures • Widespread bio-deposition
Marine mammals	• Habitat exclusion or modification • Potential for entanglement • Underwater noise disturbance • Attraction to artificial lighting
Wild fish	• Effects on existing fish habitats • Attraction of wild fish to farm structures • Consumption of waste feed
Sea birds	• Entanglement (resulting in birds drowning) • Habitat exclusion • Providing roost sites closer to foraging areas • Aggregation of prey fish
Biosecurity	• Potential to facilitate establishment and spread of pests and diseases
Escapee & Genetics	• Competition for resources with wild fish • Alteration of the genetic structure of wild fish populations • Transmission of pathogens from farmed stocks to wild fish populations
Additives	• Use of therapeutants to treat stock
Hydrodynamic alteration of flows	• Finfish cages altering and reducing current speeds • Effects on stratification through vertical mixing and partial blocking of some water layers • Wave dampening may affect shoreline habitat and sediment transport

Source MPI (2013)

3.2.4 Flexibility in Location

Building on Peart (2019), the Panel cites the Norwegian model as an example of greater flexibility in aquaculture licenses. Licences for trout and salmon farms are limited in number but the location of use is movable within defined regions or areas.[140] Norwegian legislation allows for a licence to be sold from one holder to another without any review or approval by public authorities. It also provides grounds for a permit to be withdrawn if the location is no longer deemed to be environmentally appropriate, eg if a survey of biological diversity shows vital natural values have been adversely affected.[141] A new Norwegian 2021 strategy is establishing a committee to review the current licensing regulations.[142]

The Norwegian experience suggests that enabling flexibility in licensing, especially over space occupation, has the potential for financial advantages but these may be offset by:

[140] Standing Senate Committee on Fisheries and Oceans (2016)
[141] Norwegian Ministry of Fisheries and Coastal Affairs (2009)
[142] https://www.hatcheryinternational.com/norways-new-strategy-to-grow-its-aquaculture-industry/

- adverse effects on natural systems, depending on the sensitivity of the site. These may be controlled for if shifts in location can only occur if there is no net loss in environmental effect. Peart notes on the Norwegian approach that "*operators must document the environmental condition of the site at the time of establishment, operation and decommissioning facilities. If unacceptable conditions are identified the Department can order the site to be fallowed until conditions improve. Farms are required to be fallowed for at least two months between growing cycles.*"[143]

- conflicts with other uses, which may have spatial preferences; and

- administrative costs.

These trade-offs would need to be managed but, if these can be controlled for, there are potential gains from flexibility.

3.2.5 Short Duration Consents

Aquaculture consents currently have a minimum duration of 20 years, and this will be retained during the transition period. Thereafter, the NPF or NBA plans could set consent duration. A recent analysis of the costs and benefits of aquaculture options in the Bay of Plenty analysed the period over which a positive return would be achieved.[144] Using their numbers for offshore finfish and recirculating aquaculture system (RAS) based finfish system,[145] and a 5% discount rate, suggests the investments would produce positive NPVs 22 and 23 years respectively after a consent is obtained. This will be an under-estimate of the time required as their analysis did not include some (processing) costs while it included labour benefits that would not accrue to the investor (or to the community).[146]

3.2.6 Resource User Charges

Resource user charges can already be imposed currently in the form of COCs. The RMA does not specify the way in which these are imposed and, conceivably, they might be used to provide more incentives, eg if there was a trade-off between the private benefit of aquaculture (eg it was higher closer to the shore) and the public cost (which might also be higher closer to the shore), charge might be used to make locations closer to the shore higher cost for marine farms.

Not all councils have introduced or intend to introduce COCs. They have been proposed for use by the Marlborough District Council and also are in use by Southland District Council.

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[143] Peart (2019), p42

[144] McIlrath and McLean (2021)

[145] We derive annual net values as the difference between the individual columns in their Figures 2-1 and 3-1

[146] In A CBA, labour is firstly a transfer payment (a cost to employers and a benefit to employees), but opportunity costs arise at the societal level because labour used in one activity is reducing that available in another. Usually the wage rate is assumed to represent the opportunity cost of labour (which assumes firms pay workers based on the marginal contribution to profit), although the social opportunity cost may be less than the wage rate when there is high unemployment. A benefit of employment only arises when there is a net wellbeing gain from labour, eg from reduced boredom or increased self-status (Ministry for Primary Industries 2014) for an otherwise unemployed worker, although because normally people need to be paid something to persuade them to work (maybe less so in the absence of a benefit system), a cost is usually assumed even when there is significant unemployment.

A shift towards the wider use of resource user charges might be used to encourage greater use of COCs so that the adverse environmental and social impacts of aquaculture can be better managed, both via the incentive effect of a differently structured COS and the use of the revenue.

3.3 Potential Impacts of Reforms

3.3.1 Impacts Assessed

The impacts we have assessed are those from the following:

- an assumed greater level of planning for the allocation of coastal space or activity in the CMA;
- greater level of central government influence on allocation in the CMA, particularly for aquaculture;
- larger areas zoned for aquaculture and for marine protected areas, with the assumptions that these areas are allocated well, ie where the benefits exceed costs and wellbeing is improved;
- more flexibility in the location of aquaculture within areas zoned for aquaculture;
- greater use of resource user charges.

Many of these changes could theoretically occur under the existing legislation. The RM reforms make the changes more likely.

3.3.2 Wellbeing Impacts

The expected impacts across the individual dimensions are summarised in Table 3-4.

Financial/Economic Impacts

The potential financial impacts of the reforms are assumed to arise from:

- the shift to greater allocation within plans rather than simply consents;
- reduced transaction costs for obtaining consents;
- greater access to consents, including via transfers; and
- potential for shifting the location of consented aquaculture activities.

Set against this, there are expected to be higher costs for central and local government in developing plans. In addition, after the transition period, any shifts to shorter consent duration may reduce some of the identified potential benefits.

The greater use of plans for defining areas suitable for consents is expected to have greater costs of planning, set against reduced costs for those seeking consents as the weighing up of costs and benefits will be done largely at the planning stage. For those seeking to use aquacultural areas, this is expected to be easier with lower consenting requirements, although reductions in consenting costs may be offset by greater use of resource user charges with the revenue used to provide community benefits.

Table 3-4 Potential impacts of reforms on wellbeing from the CMA

Dimension	Benefits	Costs
Economic[a]	Increased value of aquaculture, based on: • Increased area allocated in plans • Lower transaction costs • Greater potential for access to consents, and for relocation and transfer	Potential for: • higher planning costs for central and local government • reduced consent duration reducing investments
Environmental	Potential for: • Increased use of marine protected areas • improvements in aquaculture location, eg with better planning of suitability or incentives for reduced impact locations	Impacts of increased aquaculture area, including: • Nutrient discharges • Smothering of benthic communities • Habitat exclusion • Pests & disease spread
Social	Potential for: • fairer access to aquaculture consents • use of resource user charge revenue to provide community benefits	Potential for • reduction in local input to or influence over allocation decisions • exceedance of 'social carrying capacity' for aquaculture.
Cultural	Increased kaitiakitanga role for Māori, including via increased levels of access to resources.	Shorter term consents reduce ability to manage for sustainability

[a] As with other resources, we use a very narrow definition of economic impacts here: that relating to impacts on the consumption of market goods, including via changes to income and wealth

Greater flexibility in the location of aquaculture is expected via setting aside areas suitable for aquaculture within plans, while providing greater flexibility in how the area is used in the defined areas.

Environmental Impacts

The environmental impacts of the reforms are uncertain. In theory any changes will require assessments to be made of the environmental effects and include improvements in aquaculture location (eg with a shift from FIFS to merit-based allocation) and the setting of limits and targets that will provide bottom lines for effects within regional management units. However, the Government has also stated its objective to see an increase in aquacultural value and production.

Thus we expect the environmental effects to include those from an increase in aquaculture areas (summarised in Table 3-2 and Table 3-3 above), balanced by changes in location, reductions in some types of fishing activity (eg trawling) and the establishment of a larger aggregate area in MPAs.

Social Impacts

As noted above, in Marlborough there is a perception that the 'social' carrying capacity for aquaculture has been met, and that the local community would view further expansion of aquaculture to have excessive costs. This is being managed by shifting consented aquaculture areas further outwards, but these conflicts will arise elsewhere, especially with the objective of a significant increase in total aquaculture area.

Using a pricing mechanism that reflects the social costs would be one way of addressing this, or via an allocation of space that took account of this public acceptability of aquaculture.

Research into the wider social impacts of aquaculture is limited. For example, a recent study assessing the social dimension of aquaculture in different countries concentrated on the effects on population, health, education, housing and work.[147] However, it did not address the dimensions that are affecting the carrying capacity impacts in Marlborough, which related to impacts on public access and amenity of the near shore marine environment.[148]

The benefits from reforms will occur where the revised system functions to ensure that aquaculture is more optimally located, taking account of the full impacts on the local community. We are unable to quantify these effects as we are unsure of what the impacts might be in practice, including whether it would result in more aquaculture closer to or further from the shore.

Cultural Impacts

The introduction of the principle of *Te Oranga o te Taiao* is expected to provide benefits for Māori in particular. Māori have a strong sense of kaitiakitanga (guardianship) in the management of the coast and of protecting the mauri (life force) of the environment for future generations.[149] This responsibility includes the coastal waters, foreshore, estuaries and river mouths, and all the species that live within these ecosystems. Coastal waters are also strongly associated with traditional/cultural harvesting of marine species for food, such that restrictions on use can reduce the ability of iwi to obtain cultural harvests and reduce the kaitiakitanga.

To the extent that the reforms are to further uphold *Te Oranga o te Taiao* and also protect rights recognised under MACA, then the kaitiakitanga role is likely to increase. The RM reforms are expected to ensure the Government delivers on its obligations under MCACSA. The kaitiakitanga role includes customary marine title holders retaining a right to veto new commercial aquaculture.

3.3.3 Treaty Implications

The introduction of a resource user charge to re-distribute wealth, suggests that the local community has rights to the value of the resource. This might be regarded as a form of ownership, ie if the community has a right to its value, in some ways is behaving like a resource owner. This raises the important issue of who is or should be the rightful owner?

While we understand that the overall question of Te Tiriti implications is being dealt with in a separate and broader workstream, the question around what value means in the context of user charges and community rights is important (ie Māori objectives for the use of a resource may not be expressed in the same way as non-Māori values and fulfilling Treaty obligations may give rise to potential inconsistencies elsewhere). This is over and above

[147] Krause et al (2020)
[148] Perception Planning (2020)
[149] Perception Planning (2020)

geographical questions around the basis of charges where rohe overlap regional boundaries/jurisdiction.

The basis on which resource user charges would be determined would likely give rise to the same concerns around compatibility with the very long-term investment and planning horizon that Māori have. Furthermore, where benefits from allocation to Māori accrue to the community at large then the charge would need to either be based solely on the economic/financial element, to the extent that is calculable, or to include wider societal benefits. This again, may not be straightforward in the context of choosing an allocation method.

The at-times fractious relationship between local government and iwi/Māori may also be a factor in the potential for resource user charges to achieve their allocation objectives.

4 Discharges to Air

4.1 Resource Allocation Issue

4.1.1 Pollutants and Sources

The clean air resource is the quality of air that is required to meet people's health needs. When pollutants (contaminants to use the RMA term) are added to the air, they reduce the availability of clean air, and when limits are set for pollutant concentrations or emission rates, the allocation challenge is in deciding which sources of air pollution can discharge and by how much. The allocation challenge can be conceived of as allocating the right to emit within a limit and within a defined airshed.

Table 4-1 lists the main air pollutants in New Zealand, along with the main sources and impacts. Sources of air pollution and the associated impacts include combustion of fuels, particularly in transport and domestic fires because of the dispersal close to people and from industrial combustion; some industrial processes and natural sources.

Table 4-1 Main pollutants, sources and effects

Contaminant	Main sources	Impacts
Small particulates (PM_{10} and $PM_{2.5}$)	Primary: combustion of fossil fuels, including transport, industry, domestic fires Secondary: chemical reactions, eg oxidation (SO_2 is a particulate) Natural sources: sea salt, soil erosion, volcanic eruptions, pollen	Health impacts: respiratory disease and premature deaths
Carbon monoxide (CO)	Incomplete combustion of fossil fuels, especially in the transport sector	Health effects including respiratory problems and asthma attacks
Oxides of nitrogen (NO_x)	NO_2: combustion of fossil fuels, especially motor vehicles. Also nitric acid manufacture, welding, explosives, refining of petrol and metals, commercial and food manufacturing. Natural sources of NOx: volcanoes and bacteria	Respiratory problems and can cause asthma attacks, cardiovascular problems and premature death. Long-term exposure may cause asthma to develop and decreased lung development in children. May increase risk of certain forms of cancer. NO_2 contributes to brown haze.
Sulphur dioxide (SO_2)	Combustion of fossil fuels that contain sulphur, eg coal and oil, plus industrial processes including fertiliser manufacturing, aluminium smelting and steel making. Natural sources: volcanic (eg White Is)	Eye, nose and throat irritant. Research has linked it with serious health effects, eg pre-term birth, sudden infant death syndrome and cardiovascular mortality
Ozone (O_3)	Forms when NOx and volatile organic compounds (generated by sources such as motor vehicles and industrial processes) combine in the presence of sunlight.	Respiratory and cardiovascular health problems and increased mortality. May also be associated with effects on the nervous and reproductive systems, and other developmental effects.

Source: Metcalfe and Sridhar (2018); Ministry for the Environment & Stats NZ (2021b); Kuschel *et al* (2022)

The complexity of dealing with air pollution is that emissions are determined by factors that include the technology and temperature of combustion. For example, emissions from

internal combustion engine vehicles differ with the age of the vehicle because of the development of emission standards that vehicle manufacturers in producing countries have had to comply with. In addition, during use, emissions will be higher when a vehicle first starts and the combustion temperature is lower. This means the effective use of market-based approaches to regulation are not as straightforward as for greenhouse gases (GHGs) for which: (1) there is a direct link between the quantity of fuel combusted (in whatever location and whatever temperature) and emissions of CO_2 and (2) because location does not matter because of the wide dispersal during its long atmospheric lifetime.

4.1.2 Current Regulation

Discharges of contaminants to air are controlled under section 15 of the RMA.[150]

- Section 15(1) means that discharges from industrial or trade premises are only allowed if they are authorised by a rule in a regional plan, a resource consent, a national environmental standard (NES), or other regulations.

- Under sections 15(2) and 15(2A), the opposite presumption applies to discharges from sources other than industrial or trade premises. Unless these sources are controlled by a NES or a rule in a plan, discharges are allowed as of right and consent is not required.

NES for air quality (NES-AQ) were first introduced in 2004 with several amendments since. The standards include ambient environmental standards for outdoor air quality (see Table 4-2); these are legally binding levels of air pollution that must not be exceeded. In addition, the NES-AQ includes:

- bans on activities that discharge significant quantities of toxins;
- product design standards for new wood burners in urban areas; and
- requirements for large landfills to collect greenhouse gas emissions.

Table 4-2 NES-AQ Ambient air quality standards for contaminants

Contaminant	Threshold concentration	Number of exceedances allowed
Carbon monoxide (CO)	10 mg/m^3 as a running 8-hour mean	1 in a 12-month period
Nitrogen dioxide (NO_2)	200 µg/m^3 as a 1-hour mean	9 in a 12-month period
Ozone (O_3)	150 µg/m^3 as a 1-hour mean	None
Small particulates (PM_{10})	50 µg/m^3 as a 24-hour mean	1 in a 12-month period
Sulphur dioxide (SO_2)	350 µg/m^3 as a 1-hour mean 570 µg/m^3 as a 1-hour mean	9 in a 12-month period None

Source: NES-AQ Schedule 1

MfE released a discussion document in 2020 with proposals for reforms to the NES-AQ.[151] This included introductions of standards for fine particulates $PM_{2.5}$ in addition to PM_{10},[152] plus changes to regulations of solid-fuel burners and controls on mercury. Updating the standards will also take account of new World Health Organisation (WHO) guidelines;[153]

[150] This summary is taken from Ministry for the Environment (2016)
[151] Ministry for the Environment (2020b)
[152] Particulate matter with a diameter less than 2.5µm ($PM_{2.5}$) or less than 10µm (PM_{10})
[153] https://environment.govt.nz/acts-and-regulations/regulations/national-environmental-standards-for-air-quality/

these were released in 2021 and include tighter standards than in both the current NES and proposed amendments.[154]

When assessing ambient air quality, criteria are used to evaluate the measurement results and the results of dispersion modelling (where appropriate). The MfE Good Practice Guidance[155] for assessing air quality, mainly for the purpose of resource consent applications, uses the following hierarchy:[156]

- ambient air quality standards set in the NES-AQ;
- the National Ambient Air Quality Guidelines (AAQG);
- regional targets such as Auckland Ambient Air Quality Targets (AAAQT) are set within the Auckland Unitary Plan (AUP) (unless more stringent than above criteria);
- WHO air quality guidelines; and
- where no guidelines are set by those bodies, reference exposure levels developed by the US Environmental Protection Agency or Texas Commission on Environment Quality have been used.

The new WHO guideline values are particularly significant and an assessment of monitored sites against them between 2017 and 2020 notes exceedances for $PM_{2.5}$, PM_{10} and NO_2.[157] The sites with the highest $PM_{2.5}$ concentrations were above the guideline values for around a quarter of the year (generally during the colder months). For NO_2, two of seven monitoring sites (both in high-traffic areas) were higher than the guidelines an average of 300 days and 235 days respectively per year.

MfE is working on a national policy statement (NPS) and amendments to the NES-AQ that will have new rules to prohibit the installation of new coal-fired boilers for low and medium temperature process heat and to a gradual phase out of existing coal and other industrial fossil fuels. This is largely aimed at councils regulating GHG emissions from these sources (currently they are required not to take them into account) but will have impacts on local pollutants also, noting this might be an adverse impact, eg switching from gas to wood waste may increase particulate emissions.[158] However, the revised WHO guidelines are expected to require a significant improvement in air quality in several locations, limiting the extent to which there will be much scope for allocation of discharges to air beyond limits and targets.

4.2 Reform Expectations

Despite these limitations, the assumption is that the RM reforms will encourage councils to use an approach to allocation that allows more flexibility in where emissions are allowed to

[154] World Health Organisation (2021)
[155] Ministry for the Environment (2016)
[156] As summarised by Tonkin + Taylor (2021)
[157] Ministry for the Environment & Stats NZ (2021b)
[158] Ministry for the Environment (2021)

come from. In this section, we explore the potential for moving to such an approach, including the flexibility that councils use already.

4.2.1 Current Approaches in New Zealand

Most councils manage air quality issues consistent with the NES-AQ. This includes:

- introducing the requirements for home heating appliances – those installed after 1 September 2005 must meet NES-AQ requirements; and
- including conditions in consents for large industrials.

Some councils have introduced additional requirements using the same types of approaches, eg Auckland Council has an additional Air Quality Bylaw for Indoor Domestic Fires that regulates both the effects and the fuels.[159]

Consent conditions have been informed by assessments of best practicable options (BPO).[160] For example, the Glenbrook steel mill in Auckland has consent conditions that limit the discharge rate of contaminants in mg/m^3 of air which it has met through installation of pollutant control devices: a wet scrubbing system and a dry bag house.[161] Similarly, Huntly power station in the Waikato has installed electrostatic precipitators (ESPs).[162]

The NES-AQ includes the potential for emissions of PM_{10} to be offset by reductions in PM_{10} emissions in the same airshed (the recent discussion paper on reforms to the NES-AQ is proposing to transfer this regime to $PM_{2.5}$ emissions). Some councils have introduced formalised offset regimes consistent with this. This includes the Bay of Plenty Regional Council (BOPRC) which has a policy allowing offsets to be used in the Rotorua airshed, which it regards as having the worst winter air pollution in the North Island.[163] Under this policy a PM_{10} emission reduction (in kg/year) in one part of the Rotorua airshed can be used to compensate for a PM_{10} emission increase elsewhere in the Rotorua airshed. Offsets are used for new industrial facilities and for home heating.[164]

For new industrial facilities potential sources of offsets include school boilers and domestic solid fuel burners, but they do not include mobile sources, natural sources, outside burning, fugitive sources (eg dust), oil and gas-fired burners, or geothermal burners or boilers. There is no potential banking or borrowing of offsets. The emission reductions used to generate the offset must be (a) real, ie based on a reduction in actual emissions; (b) enforceable; (c) permanent; (d) located within the Rotorua airshed (or will affect emissions in it); and (e)

[159] Auckland Council (2017)
[160] BPO is specified in Section 108 of the RMA (Conditions of resource consents) as applying to air discharges. Tonkin + Taylor (20210 suggest it is different from international approaches such as "Best Available Technique" (BAT), which focusses on identifying the best technically and financially viable technologies as the basis for setting emission limits (regardless of scale of effects). Rather "BPO is determined on a site-specific basis, taking into account the nature and scale of emissions and the environmental context", p104
[161] Tonkin + Taylor (2021); NZ Steel (undated)
[162] Straterra (2015)
[163] Bay of Plenty Regional Council (2014)
[164] Bay of Plenty Regional Council (2020), noting this is now operational (see: https://www.boprc.govt.nz/your-council/plans-and-policies/plans/regional-plans/regional-air-plan)

surplus, ie additional to any emissions decrease that would otherwise occur or would otherwise be required by the Regional Council. Scaling factors (eg 1.2 kg required to offset a 1kg increase) are used to compensate for fugitive emissions that cannot be readily quantified and emissions of precursors.

For home heating, BOPRC has capped the total emissions (smoke from fires) within Rotorua suburbs.[165] To install a wood burner in a house that does not currently have one, a woodburner must be removed from another house. Offsetting in this manner is a compulsory condition of a solid fuel burner resource consent. These offsets are made via bilateral arrangements between households rather than via a credit mar
ket in which offsets can be bought and sold; in theory such a market might develop.

Other councils allow offsets without having such developed arrangements.[166]

4.2.2 International Approaches – Use of Economic Instruments

Some other countries have introduced more formalised economic instruments to address air pollutants.

Emission charges

Charges for air quality have been introduced elsewhere in the form of a simple charge on measured emissions at industrial plants (eg the NOx charge in Sweden)[167] and charges for entering low emission zones (LEZs) as used in several European countries,[168] (eg Milan allows electric vehicles and alternative fuel vehicles to enter the central city without charge, but cars must pay a daily fee of €5, with lower rates for residents.)[169]

These charges apply to individual sources so are not providing market incentives to discover the least cost way to reduce emissions across all potential options. They do provide incentives for least cost responses within these sources, eg only drivers of vehicles who value their trips highly (or have low price elasticity of demand, potentially related to income) will enter a LEZ.

Tradable Permits

Tradable permits for air quality have been used for SO_2, NOx and ozone emissions.

A cap-and-trade scheme was introduced to limit SO_2 emissions from coal-fired electricity generators in the US starting in 1995. Analyses of the costs and benefits have suggested large savings in costs compared to uniform emissions standards[170] and very significant emission reductions, which combined has led to the approach being extended to other pollutants, particularly NOx (see Figure 4-1). The net benefits of the SO_2 scheme resulted from:

[165] https://www.boprc.govt.nz/media/741560/retailers-information-pc13-offsets-important-information-for-purchasers.docx

[166] For example, the Auckland Unitary Plan (E14.3(11)) includes the objective of enabling the use of air quality offsets.

[167] https://www.iea.org/policies/1198-nitrogen-oxides-nox-charge

[168] https://urbanaccessregulations.eu/

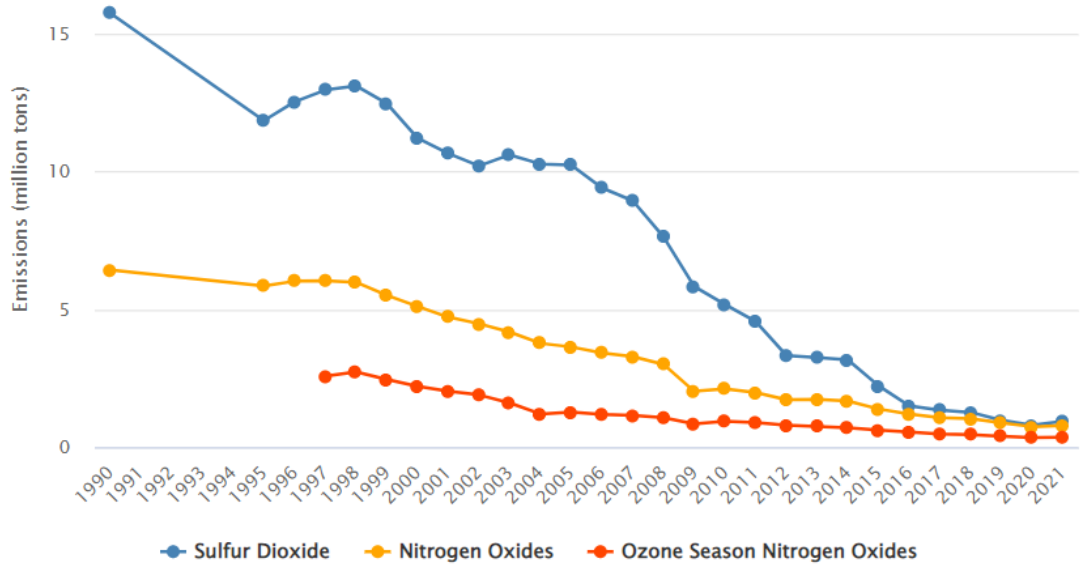
[169] https://urbanaccessregulations.eu/countries-mainmenu-147/italy-mainmenu-81/lombardia/milan-area-c-charging-scheme

[170] Carlson *et al* (2000); Schmalensee and Stavins (2013)

- much lower costs of compliance from using low sulphur coal (the introduction of cap and trade coincided with deregulation of the rail industry that allowed transport of coal) rather than just the use of scrubbers, as anticipated; and

- the benefits being significantly affected by substantial decreases in downwind concentrations of small particulates with consequent public health benefits.[171]

Figure 4-1 Emission reductions under clean air markets programs



Source: https://www.epa.gov/airmarkets/progress

Trading programmes were also introduced for NOx,[172] but these and the SO_2 programme have more recently been combined into the Cross-State Air Pollution Rule (CSAPR), which requires 28 states in the eastern United States to reduce SO_2, annual NOx, and ozone season NOx emissions from fossil fuel-fired power plants that affect the ability of downwind states to attain and maintain compliance with national ambient air quality standards (NAAQS) for $PM_{2.5}$ and ozone.

These programmes have been highly successful at reducing emissions and the costs of emission reduction in a country that has had significant numbers of power and industrial plants burning coal. The schemes have not been extended to the kinds of sources that are far more important to New Zealand's air quality problems: transport and domestic fires.

4.2.3 Flexibility in Allocation

As with all other environmental domains, we would expect the shift away from FIFS to encourage councils to examine other allocation approaches that involve greater flexibility, including via the greater use of economic instruments.

The recent updates to the WHO guidelines suggest tighter standards may be required, which would limit the scope for allocation and for flexibility within allocation. Some flexibility is enabled currently, as seen in the provisions for offsets under the NES-AQ. In

[171] Schmalensee and Stavins (2013)
[172] https://www.epa.gov/airmarkets/nox-budget-trading-program

addition, there is the potential to use schemes such as LEZs or congestion pricing to limit numbers and types of vehicles entering urban areas where potential exposure is highest.

There are significant differences between sources of air pollution that limit the extent to which different emission sources can be included within a single market mechanism to encourage a flexible response. We have not identified any formalised market instruments used elsewhere that include these; they have been limited to industrial sectors (large combustion plants) or to road transport, but have not combined the two or included residential sources. The offset examples in New Zealand are exceptions, although there are clear differences in the quality of monitoring data such that it is not clear how cost-effective they are. They may enable cost savings but the environmental effects of changes in emission source may be quite different.

The differences in effect are further complicated by factors relating to exposure, ie domestic heaters and vehicles can have more significant effects because the emissions occur close to people (and for home heating this may include emissions within houses). In contrast industrial emissions may be both located away from people and at higher elevations (because of tall smokestacks) allowing greater dispersion.

Congestion pricing is expected to achieve emission reductions particularly from reductions in vehicle kilometres travelled in urban areas where charges are levied.[173] LEZs and congestion pricing are limited to a single sector (transport) but they provide flexibility over space; they encourage vehicles (or the most polluting ones) to be used away from centres of population.

The offset schemes enable emission restrictions for one source to be achieved via offsets produced from reductions at another source. This enables efficiency gains to be achieved in the form of lower cost emission reductions. However, there are limits to the potential effectiveness (or certainty) of this approach. Levels of emission measurement are significantly different between sectors. Industrial emissions can be directly monitored, eg in smokestacks, whereas other sources tend to be proxied. Thus, allowing removal of solid fuel burners to offset industrial emissions (or even other solid fuel burners) must make assumptions about levels of use of the burner.

There may be scope for the Government to encourage greater use of offsetting, including providing guidance on how offset markets might develop, eg ways in which offsetting reductions in emissions might be made prior to the demand for the offset they produce (assuming the requirements for additionality and for the timing of emission reductions to be in the same period as the emissions increases). However, whether it would result in environmental improvements is uncertain.

4.2.4 Merit-Based Allocation

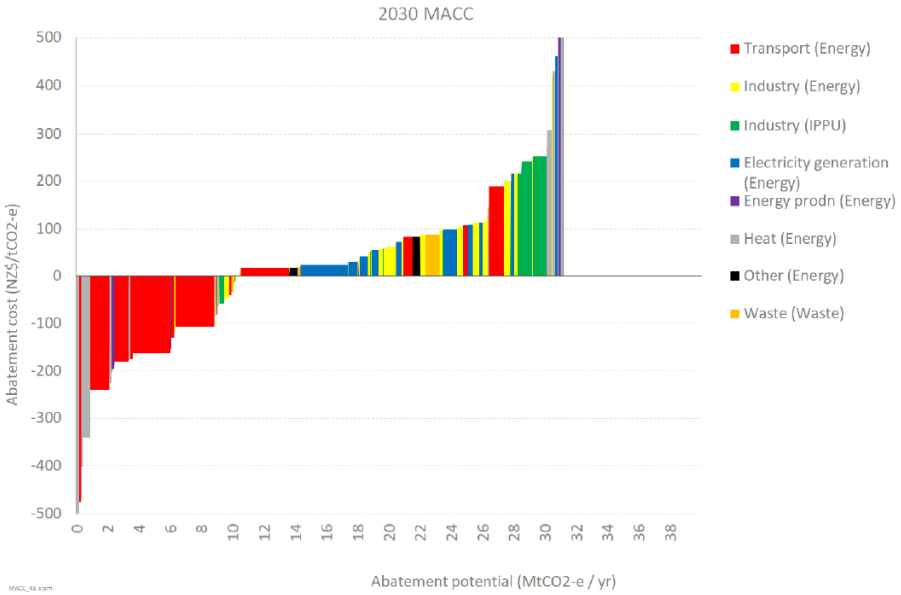
Merit-based allocation approaches might weigh up the effects of the different sources of pollution to set priorities for allocation. This affects both costs and benefits. For example, we are aware that recent research suggests the increased adverse impacts of NO_x relative to particulate matter and thus the increasing importance of vehicles to air pollution health

[173] Auckland Transport *et al* (2020)

impacts.[174] Analysis using this new information might lead to a shift in the balance between controls on home heating and policy instruments targeting road transport.

This type of evaluation occurs currently but to a limited extent, ie CBAs used nationally and regionally (eg in Auckland) have focussed on particular sources rather than through developing regional abatement cost curves, or net benefit curves taking account of the greater benefits of reducing emissions closer to people. Such approaches could happen now although national direction might be used assist, including through the identification of abatement costs. Such analysis might also take account of the co-benefits from reductions in other pollutants, eg reductions in fine particulate emissions are often associated with combustion activities that will also emit CO_2. An example developed for the costs of greenhouse gas (GHG) emission reductions is shown in Figure 4-2.

Figure 4-2 Marginal abatement cost curve for greenhouse gas emission reduction



Source: Ministry for the Environment (2020a)

There have been several analyses of the costs and benefits of air quality improvements in New Zealand, but all are limited to assessments for individual sources, rather than providing a basis for assessing the potential benefits of reallocation amongst sources. Nevertheless, we explore these below.

Existing Studies

The adverse effects of air pollution include human health effects, reduced visibility and discolouration of air, and nuisance and amenity effects, including dust, smoke, materials damage and odour. Studies that have monetised the effects, including New Zealand studies,[175] have concluded that the most significant impacts are those on human health.[176] Most studies to date have attributed health impacts and costs largely to small particulates, although recent analyses suggest NO_2 may be as, if not more, important.[177]

[174] Kuschel *et al* (2022)
[175] Ministry of Transport (1996); Jakob *et al* (2006); Kuschel *et al* (2022)
[176] Hohmeyer (1998); Rabl & Spadaro *et al* (2005); Ricardo-AEA (2014) and Amann *et al* (2017), although Holland *et al* (2013) note the possible importance of unquantified impacts.
[177] Kuschel *et al* (2022)

CBA of NES-AQ

Three CBAs have been undertaken of the first proposed NES-AQ and updates (see summary in Table 4-3). These have compared the costs and benefits of achieving the standards by different dates, using different analysis periods, assumptions about the standards and some differences in methodology and in discount rates. The emission reductions assumed included changes to home heating, eg replacing solid fuel burners with low emission alternatives or heat pumps, plus alternatives to road-seal burning.[178]

Table 4-3 Summary of NES-AQ CBA results

Study	Standards met by	Analysis period	Discount Rate (%)	Costs ($m)	Benefits ($m)	NPV ($m)
MfE (2004)	2013	2004-20	10	$111	$429	$318
Clough and Guria (2009)	2013	2008-20	8	$333	$1,289	$955
	2020		8	$74	$232	$159
Akehurst *et al* (2019)	?	2017-28	8	$98	$820	$723
			6	$110	$931	$822
			4	$123	$1,063	$939

The 2004 study included benefits from reductions in premature deaths (98% of total benefits) measured using a value of a statistical life (VoSL),[179] hospitalisations and restricted activity days (RADs), but adjusted the value of reductions in deaths to take account of the older age of those affected; this adjustment was not used by Clough and Guria in the 2009 update. Akehurst et al updated the values in 2019, although the assumed year in which the standards were met is not clear from their analysis. All the studies have suggested significant positive net benefits.[180]

Other Studies

Other studies include:

- A CBA for Auckland Council on reducing emissions from domestic fires.[181] Several packages of regulations were examined, all of which produced positive net benefits.

- A 2015 study for the Ministry of Transport (MoT) which analysed the costs and benefits of introducing Low Emission Zones (LEZs), regional emissions testing and road pricing in Auckland.[182] It suggested that most options would have net costs, unless limited to restricting only the most polluting vehicles. And effectively the LEZs were banning vehicles rather than operating as economic instruments that

[178] Road-seal burning involves burning excess bitumen off road surfaces. Alternatives include high-pressure water blasting.
[179] VoSL might be better referred to as the value of preventing a fatality (VPF) (Glover and Henderson 2010; Clough *et al* 2018)
[180] Akehurst *et al* (2019) also conducted an analysis using value of life year lost rather than VoSL but over-estimated the benefits. They distributed the total estimated change in air pollution related deaths to different age groups in relation to the population in those age groups rather than using the impact-response relationships to estimate a change in the current death rate in the age groups. This resulted in over-estimating deaths in young age groups and under-estimating deaths in older age groups; it thus significantly over-estimated the reductions in life years lost.
[181] McIlrath (2013)
[182] Denne and Atkins (2015)

provided flexibility in response.

- A CBA of the Warm-Up New Zealand: Heat Smart Programme, a subsidy programme that provided lower cost access to home insulation and "clean" domestic heaters such as heat pumps.[183] It focussed on changes in air quality inside the house and estimated benefits more directly using a relationship between the changes in insulation and heating and house-specific medical bills.

Expected Benefits

The current NES-AQ has been estimated to yield an NPV of hundreds of millions of dollars. This is largely from the high estimated health benefits of reducing emissions. Tighter limits and targets as might be expected in the future would be expected to similarly produce high net benefits. However, our analysis here is focussed on ways in which the costs of achieving these might be reduced.

The NZ studies provide little information to assist with this because they have focussed on a single source rather than examining the costs of reductions from different sources. International studies, such as the US EPA Air Pollution Control Cost Manual[184] have costs for different types of control equipment, but these are focussed on industrial combustion plants. We are thus unable to provide quantitative estimates of expected cost savings.

4.2.5 Resource User Charges

Resource user charges might be applied in the form of emission charges. As noted above, these have been applied in other countries for single sources, particularly industrial plants but these are not as significant sources of charges as are vehicles and domestic heating in New Zealand. User charges would be less simple to apply to these sources. For example, this might need to be in the form of a charge on fuel, in a similar way to the Auckland regional fuel tax, regulated under the Land Transport Management Act 2003,[185] and used to raise revenue to fund transport projects.

4.3 Potential Impacts of Reforms

4.3.1 Impacts Assessed

The impacts that we assess are based on the following assumptions:

- some increased flexibility in the source of emission reductions within airsheds, eg from greater use of offset or equivalent mechanisms;

- a wider use of CBA at the national or regional level to identify optimal emission reductions; and

- resource user charges applied to air pollution, including possible pollution taxes.

[183] Grimes et al (2021)

[184] https://www.epa.gov/economic-and-cost-analysis-air-pollution-regulations/cost-reports-and-guidance-air-pollution#cost%20manual

[185] It is levied under the Land Transport Management (Regional Fuel Tax) Amendment Regulations (No 2) 2018

4.3.2 Wellbeing Impacts

Table 4-4 summarises the potential impacts of the reforms as they apply to air quality, summarised across the different dimensions of interest.

Table 4-4 Potential Impacts of Reforms on Wellbeing from Air Quality

Dimension	Benefits	Costs
Economic[a]	• Flexibility in response would be expected to reduce costs of mitigation per unit of pollution reduced or (health) outcome improved. • Expected reduced costs of consenting, especially if more use of economic instruments	Potential for: • increases in costs of plan preparation at national and regional level from increased level of analysis (costs and benefits) • increase in total costs of mitigation, but this is from tighter limits rather than allocation
Environmental	Main environmental benefits via limits and targets.	Any environmental costs would depend on simplifications made in use of offsets or other economic instruments, eg allowing offsets without fully accounting for exposure.
Social	Social impacts could be improved by analysis that takes account of the impacts of policies on low-income households.	Potential for high relative costs for low-income households and reduced social participation if more focus on low-cost vehicles and/or home heating for emission reductions.
Cultural	Māori stand to gain from better air quality as they currently suffer disproportionate hospital admission rates for respiratory disorders	Shorter term consents reduce ability to manage for sustainability Māori are more likely to own older, less fuel-efficient vehicles

[a] As with other resources, we use a very narrow definition of economic impacts here: that relating to impacts on the consumption of market goods, including via changes to income and wealth

Financial/Economic Impacts

The main impacts on financial costs are from the shift from consenting to up-front plan-driven responses to air quality issues and from greater flexibility in response. The greater role of planning would be expected to increase costs for central and local government, while reducing consenting costs. This would be a shift in costs from those causing pollution to tax and rate payers, while reducing total costs.

Flexibility in response would be expected to reduce costs of mitigation per unit of pollution reduced or (health) outcome improved.

Environmental Impacts

The environmental impacts of alternative allocation approaches depend on the extent to which the approaches take account of exposure in addition to emissions (and on whether environmental impacts are assumed to include human health impacts also). Assuming health effects are included in this definition (and health effects dominate the assessment of benefits), if the focus is on achieving a targeted level of emission reductions then the options will differ depending on which source is reduced, because of the differences in human exposure. In the absence of this information (which sources are most likely to reduce emissions under the reforms) we are unable to identify even the expected direction of change (better or worse) from changes to allocation.

Social Impacts

Some of the proposed measures have potential positive or adverse social impacts.

Several studies have examined the potential effects of regulations that target vehicles for emission reductions, eg those that restrict the use of older more polluting vehicles. Research in New Zealand prior to the introduction of emissions regulations identified possible effects, with potentially vulnerable population groups identified as older people, families with children, low-income households, Māori and Pacific households, people with disabilities and young people.[186] Older vehicles that are most polluting (because of the technology, eg lower Euro class) are cheaper and thus more available to low-income households. Policies that make these vehicles more expensive to use, ban their use or restrict them from certain areas have greater impacts on low-income households, increasing levels of social exclusion.

Similarly, studies that have examined the distributional impacts of congestion charging have found higher total costs for high income households, because they use more transport and are more likely to continue to take trips and to pay the charge, but higher costs as a percentage of annual income for low-income households.[187] This result is consistent with the international literature.[188]

Policies to address home heating may be similarly regressive, depending on the approach taken. So, for example, policies that introduce greater requirements or restrictions on household heating options will increase relative costs for low-income households. In contrast, policies that have subsidised the use of insulation or clean heating are likely to have greater benefits for low-income households.[189]

These effects would be usefully taken into account in any revised allocations, eg via weighting adverse impacts on low-income households.

Cultural Impacts

Recent analysis has suggested air emissions from combustion have existed throughout human occupation of New Zealand, particularly associated with land clearing events.[190] Little is known about the scale and local impact of this, compared with current ongoing levels of emissions. Currently, clean air is regarded as a *taonga*.[191]

Māori and Pacific peoples are more susceptible to the effects of air pollution because of the vulnerability from higher levels of existing health conditions such as asthma.[192] Different approaches to allocation will benefit Māori and Pacific populations to the extent that reductions focus on sources for which they are more exposed.

[186] Denne *et al* (2005); Colegrave and Denne (2006); Rose *et al* (2009)
[187] Auckland Transport *et al* (2020); Denne and Raichev (2019); Nunns *et al* (2019)
[188] Santos and Caranzo (2022)
[189] This depends somewhat on the way in which subsidies are implemented, with the risk that subsidies are not fully passed on in lower prices but significantly retained by producers.
[190] McConnell *et al* (2021)
[191] Kuschel *et al* (2022)
[192] Telfar-Barnard and Zhang (2021); Kuschel *et al* (2022)

5 Freshwater Takes

5.1 Resource Allocation Issue

Freshwater takes are included in this analysis although the resource allocation proposals will not apply to it fully. Specifically, it is understood that resource user charges will not be extended to freshwater takes and it will not be possible for local or central government to generate revenue through allocation approaches for freshwater takes. Pricing systems for allocation could be enabled where these involve trades amongst rights holders.

In this section we set out the nature of the current problem that new allocation rules might address and the expected benefits that might be obtained.

5.1.1 Water Supply and Demand

Defining current water scarcity is made more difficult for freshwater because of measurement uncertainties, seasonal variations in water supply and the potential to enhance supplies via storage (and by demand management). In this section we bring data together on supply limits and discuss the potential role of storage. Dimensions of water supply extend beyond simple quantities to include the quality of supply and its reliability.

Current Supply/Demand Imbalance and the Impacts of Regulation

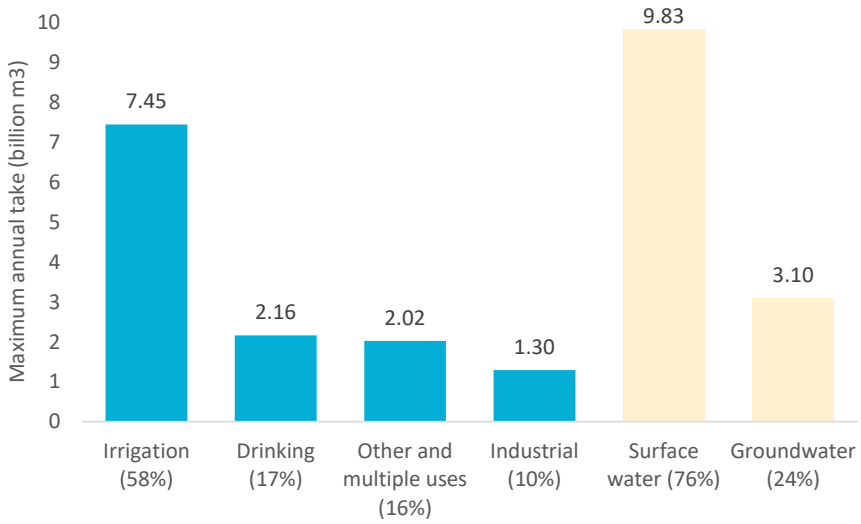
The balance between supply and demand for water, and whether current consents over-allocate water, is not straightforward to define,[193] but a recent analysis for MPI and MfE by Aqualinc estimates the reliability of supply, as the percentage of (consented) demand that can be met within water allocation limits.[194] They noted that, in most catchments with surface water allocation limits, the water potentially available for consumptive use is currently either fully (100% ±10%) or overallocated (>110%) and they suggest allocation is likely to be further constrained by new limits set to implement the National Policy Statement for Freshwater Management 2020 (NPS-FM)[195] and by climate change.[196] The new proposals for limits and targets are expected to be at least as stringent as the NPS-FM and may lead to a faster rate of implementation. As a result, water availability for commercial uses is becoming more variable, and water security less reliable, while demand for production and processing continues to increase; for example, the area of land irrigated in New Zealand has tripled in the last two decades to over 900,000 ha (including surface and groundwater sources).[197]

[193] NIWA notes complexities that include temporal variability, demand from permitted activities (not requiring consent) are often unknown, variability in how consent conditions are expressed, and the effect of restrictions, eg consent conditions that dictate when abstraction must reduce or cease (Booker 2016).
[194] Bright *et al* (2022)
[195] The NPS-FM introduces a new hierarchy of obligations in Te Mana o te Wai (a concept that recognises that protecting the health of freshwater protects the health and wellbeing of the wider environment and the community) that prioritises: (1) the health and well-being of water bodies and freshwater ecosystems; (2) the health needs of people (such as drinking water); and (3) the ability of people and communities to provide for their social, economic, and cultural well-being, now and in the future (NZ Government 2020)
[196] MPI (2021b) note an observable trend of New Zealand becoming drier, with more frequent droughts, which are projected to increase in frequency and intensity (MfE 2022a).
[197] MPI (2021b)

Under the NPS-FM, and/or the new limits and standards under the NBA, less water is expected to be available for commercial uses, and particularly extractive uses, because in-stream values will be given greater priority (and there is growing concern about the effects of some more intensive land uses on the freshwater environment). Aqualinc suggest the supply reductions will be largely for irrigation water because it has lower priority than other uses, including (they assume) hydropower, which redirects water rather than consumes it. They suggest current irrigated area retrenching by about 2% as a result.

Irrigation dominates total consented water in New Zealand (Figure 5-1) and 76% of takes are of surface water.

Figure 5-1 Maximum consented take 2017-2018 (billion m^3)



Source: StatsNZ (https://www.stats.govt.nz/indicators/consented-freshwater-takes)

An estimated 632,269 hectares is irrigated from surface-water sources with the balance irrigated from groundwater. Aqualinc has estimated likely[198] changes to council cease-take-flows and allocation limits in response to the NPS-FM. They find this is likely to reduce the current irrigated area by close to 2% due to reduced supply within limits being available. Half of which is in areas with the greatest potential for increasing the area of high-value land-uses such as horticulture (principally Northland, Bay of Plenty, Hawkes Bay and Otago).[199] Knowledge of groundwater resources is insufficient to enable estimates of groundwater reliability and how it would respond to variations in allocation rules and climate.

In estimating changes to reliability of supply, Aqualinc defines a number of levels (Table 5-1), eg at the highest level of reliability (over 98% of allocated water actually available for use), the supply is suitable for the highest value land use: high-value horticulture.

[198] Modelled from the proposal for a National Environmental Standard on Ecological flows and Water Levels 2008 (Ministry for the Environment 2008)
[199] Dark et al (2022)

Table 5-1 Reliability levels and land use suitability

Level	Reliability	Land use suitability
1	>98%	high-value horticulture
2	>95%	other irrigated land uses
3	85-95%	May be suitable for other irrigated land uses
4	<85%	Least likely to be suitable for irrigated land uses without storage

Source: Bright *et al* (2022)

Using these classifications, Aqualinc estimates the number of regions that have one or more catchments that would be able to meet these reliability levels and thus have sufficient water for the identified land uses (Table 5-2). The environmental limits (including minimum river low flow limits when water takes must cease) are based on draft National Environment Standards (NES) values or 100% of Mean Annual Low Flow (MALF); changing allocation limits to the draft NES or to 20% of MALF has a similar effect. Envisaged environmental limits are expected to halve the regions that have one or more catchments with supply security for high-value horticulture and reduce the number of regions with one or more catchments providing security suitable for other irrigated land uses.

Table 5-2 Estimated impacts of environmental limits on irrigation suitability for different land uses

Supply security	No. of regions (current) with some catchments that will meet supply security requirements	No. of regions (increased environmental standards) with some catchments that will meet supply security requirements
>98% reliable: Suitable for high-value horticulture	12 out of 16 (Exceptions: Northland, Auckland, Wellington, and Tasman)	6 out of 16 (Exceptions: Northland, Auckland, Bay of Plenty, Waikato, Hawke's Bay, Wellington, Marlborough, Tasman, Nelson, Otago, and Southland.)
>95% reliable: Suitable for irrigated agriculture	15 out of 16 (All except Auckland)	11 out of 16 (All except Auckland, Tasman, Nelson, Otago, and Southland)

Source: Bright *et al* (2022)

MPI (2021b) similarly suggest the introduction of limits under the NPS-FM[200] is likely to result in a significant drop in both the security and availability of fresh water currently allocated to and used by food and fibre enterprises for both food production (via irrigation)[201] and processing. They also suggest this will be significant to the future development of underutilised / unproductive Māori land and the associated supply chain requirements. This could also be a barrier to recognising the potential of horticultural

[200] MPI (2021b) notes other Government programmes likely to have an impact on water availability and security include the Department of Internal Affair's (DIA) Three Waters Reform programme reforming water services delivery, Ministry for the Environment's (MFE) proposed update to the National Environmental Standard for Sources of Human Drinking Water, its proposed National Policy Statements for Highly Productive Land and for Indigenous Biodiversity, and the new safety regulations currently in development by the Ministry of Business, Innovation and Employment (MBIE) to protect people, property, and the environment from potential dam failures.

[201] Approximately 8.5% of farmland currently used for food production is irrigated (MPI 2021b)

development of Māori and other land. These impacts are not the subject of this report as they are the result of the limits themselves.

Table 5-3 Irrigable land by region: constraints and potential

Region	2020 irrigated area (ha)	Total potential area (ha)	Irrigable area based on allocatable water	Area of greatest potential	Future land-uses in viable areas	Likely water quality constraints
Auckland	9,938	205,719	1,572	0	Vegetables	High
Bay of Plenty	13,072	292,952	133,970	104,231	Kiwifruit, Dairy, Avocado	Low
Canterbury	546,205	1,547,912	316,365	0	Sheep and Beef, Dairy, Vegetables	High
Gisborne	9,667	130,379	81,150	0	Dairy, Kiwifruit, Citrus, Vegetables	Medium
Greater Wellington	21,487	175,969	36,961	2,035	Dairy, Sheep and Beef, Vegetables	Medium
Hawkes Bay	43,473	289,242	36,697	2,286	Fruit, Vegetables, Vineyard	High
Manawatū-Whanganui	27,480	497,465	221,455	3,421	Dairy, Vegetables, Kiwifruit	Medium
Marlborough	35,351	94,481	41,299	0	-	-
Nelson	0	1,085	569	0	-	-
Northland	12,337	559,648	74,267	22,004	Dairy, Avocado, Kiwifruit	Low
Otago	111,082	998,079	342,721	239,715	Sheep and Beef, Vineyard, Fruit	Low
Southland	22,254	809,384	81,015	0	-	-
Taranaki	4,567	258,030	17,425	0	Dairy	Medium
Tasman	15,808	102,385	36,045	8,291	Fruit trees, Vegetables, Vineyard, Kiwifruit	Medium
Waikato	26,307	973,485	358,284	10,895	Dairy, Kiwifruit, Sheep and Beef	High
West Coast	4,437	227,953	156,357	1,249	Dairy, Sheep & Beef	Medium
Total:	903,465	7,164,169	1,936,152	394,127		

Note: (1) The majority of the remaining surface water allocation will require storage in order to develop a secure water supply. It is not feasible to access the entire allocated volume, even with storage. (2) Groundwater allocations do not imply that groundwater can be economically abstracted in the quantities needed. Typically, if groundwater is easily available, individuals will have developed supplies already.
Source: Data from MPI (2021b)

Water Storage

Under current levels of water availability, the demand-supply imbalance is expected to increase, but one way to address declining water availability is to increase storage capacity.[202] This complicates the assessment of benefits of the reforms to allocation, while raising the question of how the reforms will affect the ability for new water storage proposals to be consented.

[202] MPI (2021b); Dark *et al* (2021); Bright *et al* (2022)

Aqualinc suggests new water storage would enable a significant (over 200%) increase in irrigated area, most likely for high-value land-uses (mainly horticulture), with changes to water allocation rules (or the introduction of limits and targets) likely to reduce this potential by only about 3%.[203] They suggest water storage will be an important development to counter the restrictions from environmental limits and the declining natural availability of water due to climate change.

Thus, assuming storage can be developed where required, Aqualinc suggests the potential for new irrigated area is more sensitive to assumptions about storage refill capacity than to future climate. It is least sensitive to changes in water allocation rules, of the magnitude described above.

However, presuming storage is only developed where there is excess water demand and that it does not lead to additional scarcity, allocation reforms will still be beneficial. Further, as the Panel noted from its use of the Opua Dam example (see further below), markets may be most readily established when associated with water storage facilities.

Water storage infrastructure can have high capital costs and depends on water consents to take water during times of high supply to divert to storage. The introduction of short-term consents would mean capital costs would need to be recovered over shorter time frames, which might make investing in water storage financially unviable.

Costs of Storage

Water storage infrastructure projects have high capital costs and depends on water consents to harvest high flows during time of high supply to be diverted to storage. Aqualinc[204] has estimated as a 'rule of thumb' the volumetric charge to serve the capital cost of storing water in larger 'community scale' storage (active storage volumes larger than 1 million m^3) at \$5/m^3 water stored and for 'enterprise/farm scale' storage at \$15/m^3. It also estimated average capital cost of water distribution infrastructure (water races, pipes etc) at \$5000 per ha irrigated. The difference in cost from smaller versus larger storage is largely due to the economies of scale from larger storage dams. Aqualinc based these costings on experience with water storage projects over the last 20 years and assumed 25-year loans (and consents) and 8% interest rates. The introduction of short-term consents would mean capital costs would need to be recovered over shorter time frames leading to higher water charges to cover storage and distribution capital costs. This may make some capital-intensive water storage commercially unviable for most irrigation uses, or at the very least more expensive.

Demand Management

The other way more stringent limits might be countered is via reduced demand through more efficient use. Efficiency improvements include irrigation scheduling tools (using real-time soil moisture monitoring and local weather insights), variable-rate irrigation (VRI) technology[205] and reduced use of just-in-case irrigation.[206] However, these are partly under-

[203] Bright *et al* (2022)
[204] Dark *et al* (2021)
[205] MPI (2021b)
[206] Srinivasan and Elley (2017)

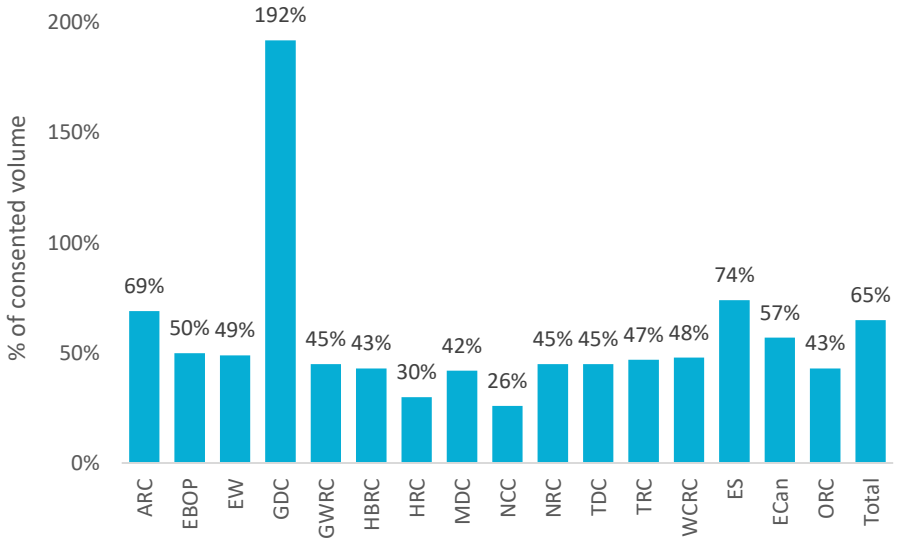
used now because water is under-priced or unpriced. Introducing markets for water would almost certainly result in increased use of efficiency measures.

Demand management will help reduce pressure on water resources making available water go further. However, when certain limits (minimum environmental flow limits etc) are reached (eg during dry conditions) demand management alone cannot address the absence of water for use.

5.1.2 Institutional Arrangements

In addition to any physical factors and planned regulatory interventions, some of the problems of water supply security are the result of regulatory failures or other human components of management, eg the extent of water take consents held by people who do not use it. In a 2010 analysis, Aqualinc noted the percentage of water use compared to the consented allocation varies between regions from below 30% to nearly 200%, with water use in most regions around 50% (Figure 5-2) and a national average of 65%.[207] Irrigation is often used as a risk management mechanism to offset dryer conditions including drought. The need for irrigation water to supplement rainfed production will vary between years and seasons due to changing climate conditions.

Figure 5-2 Actual use of freshwater as a percentage of consented volume



Source: Aqualinc (2010)

Similarly a recent Motu report suggests that barriers to efficient water use and allocation are, in large part, socially constructed, including weak property rights, insufficient data, poor monitoring and enforcement, and variability in temporal and spatial allocations that are not always reflected in the design of institutional arrangements.[208] In addition they note the absence of price signals to signal scarcity for a resource that is increasing in demand and with growing variability in supply.

[207] Aqualinc (2010)
[208] Talbot-Jones *et al* (2020)

Motu also note that governance arrangements often ignore externalities of irrigation and the public good element of water, providing an example of drier regions, such as the east coast of the South Island, where they suggest the marginal value of water left instream to support public goods may exceed its value for irrigation and other uses. They conclude that a failure to implement policy instruments that reflect water's true value contributes to the patterns of overuse or declining water quality that are being increasingly observed across New Zealand.

Even where water is priced currently, such as for domestic and commercial supplies in Auckland and some other regions,[209] costs are limited to supply costs, rather than incorporating any other external costs. This is largely because of regulatory restrictions on council-controlled organisations making profits. The price of water almost never equals its value and rarely covers its costs.[210]

5.2 Reform Expectations

To derive values for the proposed reforms to water resource allocation we need to make assumptions about the expected way in which the reforms will be implemented. Many commentators that have examined the problems with existing institutional arrangements have suggested a greater role for markets and we summarise some of these below.

5.2.1 Land and Water Forum

In its fourth report, the Land and Water Forum[211] (LWF) suggests that allocation rules be changed to give maximum flexibility to water users within the constraints of limits on water use and discharges.[212] The Forum recommended "*once limits have been set, holders of authorisations to take water should be able to easily transfer those authorisations (or a portion of those authorisations) to other users with minimal regulator involvement so long as the act of doing so does not breach a limit, frustrate efforts to reach targets (interim limits) or derogate the rights of others*".[213] This would "*allow resources to move more easily to their highest valued use over time*" because this allows land use to "*change over time in response to changes in all of the inputs that land and water users have to consider – markets, economic trends, climate, soil quality, as well as water availability and environmental limits.*"[214]

Reforms to allocation rules are not the only solution, with the LWF also noting:

- the increased role of storage and other hard infrastructure in increasing available supply or its reliability in addition to the role of soft infrastructure (eg wetlands, swales, and riparian buffers) in increasing assimilative capacity. They also note that infrastructure and catchment-scale mitigations are public good investments that

[209] There is relatively little use of water pricing in New Zealand (Garnett and Sirikhanchai 2018)
[210] Grafton *et al* (2020)
[211] The Land and Water Forum (LWF) was established in 2009 as a collaboration between industry groups, electricity generators, environmental and recreational NGOs, iwi, scientists, and other organisations with a stake in freshwater and land management. With central and local government participants, the LWF has provided advice to the Government on freshwater management.
[212] LWF (2015)
[213] Recommendation 45 (LWF 2015), p64
[214] LWF (2015), p5

tend to be under-provided by private investors and are likely to require public provision.

- demand-side responses, including improved productivity through deintensification, or a move to precision agriculture.

However, infrastructure and catchment-scale mitigations will not always be possible, or the best option, compared to managing within limits. When managing with limits, the LWF notes the importance of providing certainty to resource users, eg the limits should define the reliability of water available for allocation, and the circumstances in which the rate, volume and/or duration of abstraction will vary, such as during times of low flows and/or water shortage, or in response to changes to a limit made through a planning process. And consents should be designed so they are responsive to hydrological change (eg seasonal and climatic variation) and will specify reliability bands and low-flow, dry-year and drought provisions.

LWF (2015) further recommends authorisations should have timeframes of 20 to 35 years, but that longer periods may sometimes be appropriate and provide greater certainty for investment, particularly for long-lived infrastructure for which investments can have high capital costs and high transaction costs for reconsenting. Longer durations may also provide the certainty needed to encourage investment in technologies and efficiency measures that increase the economic value able to be extracted from the water within a limit.

5.2.2 The Panel

The Panel identified several ways in which allocation, and FIFS specifically, could be improved or replaced (p339):

- more flexible regulatory permissions;

- developing an administrative allocation system based on assessing the merit of uses; and

- moving to a market-based approach by better enabling trading of permits within the current system or using auctions and tenders.

The Panel considered the role of administrative merit approaches, while noting that there are limits to the extent to which it can promote efficient use of resources because "*public decision-makers are not necessarily best placed to evaluate the highest value use of a resource.*"[215] However, the Panel was not entirely enamoured with trading of use or discharge permits either, noting that simply moving to a trading system without addressing whether or not to reallocate existing entitlements would be inequitable. Nevertheless, the Panel saw the potential advantages of "small trading or transfer markets", using a South Canterbury (Opua Dam) example to illustrate this. This scheme involved a dam that was used for hydroelectricity, and provided stored water for local irrigation, with trading of shares in the dam. The Panel also considered favourably the example of the Lake Taupō nutrient trading market.

[215] Resource Management Review Panel (2020), p341

Overall, the Panel's recommendations were to encourage greater use of economic instruments, including tradable rights and permits, and central government providing institutional support through a combination of national direction, guidance, and support for capability.

5.2.3 Current Transfers and Trading

To address the over-allocation problem and to unlock the potential gains from transfers to other users, some limited trading of water use rights has been facilitated already.

A person or other entity (eg an irrigation company) can hold a consent independent of whether or not they own the land. However, the usual way in which transfers occur is at the same time as changes in land ownership. The permit is transferred to the new owner of the land and the value of the water right is capitalised in the value of the land.[216] This means there is a high cost of accessing water and it can 'lock in' land uses and existing patterns of water allocation and limit new investment.[217]

Take or use[218] permits can only be transferred to another site (including short term transfers)[219] if both sites are within the same catchment, aquifer, or geothermal field and it:

(i) is expressly allowed by a regional plan; or

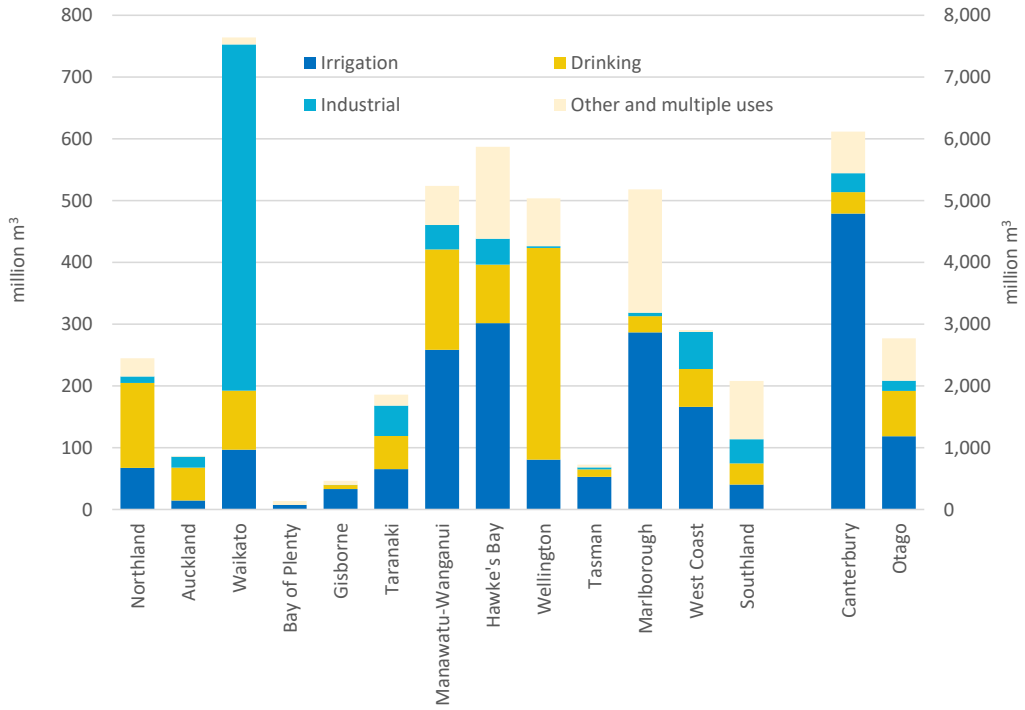
(ii) has been approved by the consent authority that granted the permit, taking account of matters set out in Section 104 including the effects on the environment.[220]

Permits can also be transferred to another person at the end of the (up to 35-year) consent period. There is no right of renewal for a consent, so on expiry a new resource consent must be applied for unless a condition in the plan or resource consent states otherwise. There is no guarantee of renewal but Section 104(2A) notes that, for applications for permit renewal, the council as consent authority must have regard to the value of the investment of the existing consent holder. In making such an assessment, the council must consider, *inter alia*, the efficiency of the person's use of the resource (Section 124B) unless a regional plan states that these provisions do not apply, or if there is an allocation plan for the resource (Section 124A). This implies that there is a requirement to consider whether the existing user requires all of the water allocated. Permits can be cancelled by a regional council if not exercised for a continuous period of five or more years (RMA Section 126).

[216] Grimes and Aitken (2008)
[217] LWF (2015)
[218] Take = abstraction or removing of water from a water body; Use = the final action taken with the water following its removal, eg irrigation or use as stock water.
[219] Amendments to the RMA in 2005 introduced a clause that allows for transfers to be for a limited period only
[220] The impacts on the environment include localised effects relating to ground water takes which might affect any shift in location, and impacts on surface water, particularly associated with shifting the take location upstream. The impacts of water use are separated in space and time from the impacts of take, and this has led to discussion over the separation of the two components.

There are relatively few catchments and regional plans, mainly in Canterbury and Otago, that have capped the overall take of water and created the conditions for trading.[221] These are the regions in which the greatest volume of water is currently allocated via permits. Figure 5-3 shows maximum consented volumes in 2017-18 by region; volumes for Canterbury and Otago are measured against the right-hand axis, which is an order of magnitude higher than that the left-hand axis, used for the other regions.

Figure 5-3 Maximum consented take by region 2017-2018 (billion m^3)



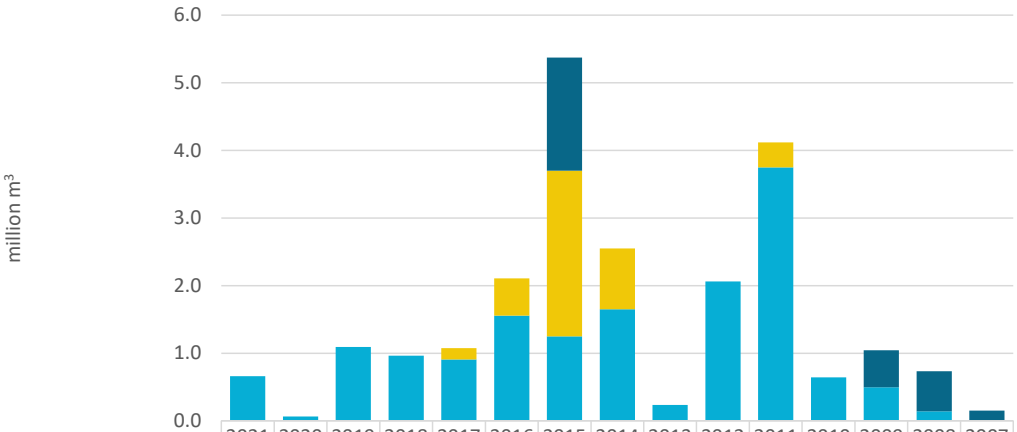
Note: data for Canterbury and Otago on right hand axis; all other data on left hand axis
Source: Data from StatsNZ (https://www.stats.govt.nz/indicators/consented-freshwater-takes)

Trading of water rights has been very limited to date. Figure 5-4 shows quantities traded or leased per annum on the HydroTrader platform.[222] The highest trading year was in 2015 with 3.7 million m^3 of sales and 1.7 million m^3 of leases; this totals less than 1% of consented volumes for Canterbury of over 6,000 million m^3 per annum.

Sales are for durations of between two and 31 years, with an average of 17.3 years. Leases range in length from three years to less than one.

[221] Sharpe (2017)
[222] It estimates it has as much as 95% market share.

Figure 5-4 Water trading in Canterbury (million m^3 per annum)



	2021	2020	2019	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007
Total	0.7	0.1	1.1	1.0	1.1	2.1	5.4	2.6	0.2	2.1	4.1	0.6	1.0	0.7	0.2
Lease(groundwater)							1.7						0.5	0.6	0.2
Sales (surface water)					0.2	0.5	2.4	0.9			0.4				
Sales (groundwater)	0.7	0.1	1.1	1.0	0.9	1.6	1.3	1.7	0.2	2.1	3.7	0.6	0.5	0.1	

Source: http://hydrotrader.co.nz/trade-history

There are several identified barriers to trading and sales and reasons why leases have fallen over time.

- **Significant transaction costs.** Since the Canterbury Land and Water Regional Plan (LWRP)[223] was activated, all sales and leases have required an assessment of effects. This has significant costs for trading parties, particularly in Canterbury because of the importance of groundwater (77% of trades to date - Figure 7). Groundwater systems are highly complex, such that assessments of effects are likely to always be required. Trading will have more potential in catchments dominated by surface water, eg the Clutha or Waikato rivers.

- **Market liquidity is limited by surrender requirements.** The Canterbury LWRP also includes a rule that transferral of permits in over-allocated catchments[224] include a surrender of a proportion (usually 50%) of the allocated water.[225] This is especially problematic for leasing, as 50% is lost each time there is a temporary transfer.

- **Opportunities for efficiency gains are diminishing.** These two issues have impacts on sales also as they are a significant transaction cost for each trade. In addition, sales are falling because those to date have had a significant impact on surplus allocations within the region. Many of the efficiency gains have been obtained already.

- **Temporary transfers may reduce probability of renewals.** There is a perception that the act of transferring water will count against a user when they apply for an

[223] Environment Canterbury (2018)
[224] Where water is over-allocated with respect to environmental limits, councils must reduce allocated amounts. Rationing can be used during periods in which water flows fall close to environmental limits (Ministry for the Environment and Ministry of Agriculture and Forestry, 2004)
[225] Environment Canterbury (2018), Section 4.71.

consent on expiry, which is a significant concern to landowners where the value of water has largely been capitalised into the value of land at purchase or through subsequent investment. [226]

- **Information gaps.** Lack of access to high-quality information on current water use, reduces the ability of rights owners to benefit from opportunities for temporary transfer. [227]

- **Investment requirements.** For a trade to be useful, users will need to drill a bore, establish a means to abstract water, or build distribution and storage infrastructure to make transfer viable.[228] And without water supply certainty, such investments are unlikely.

To better enable trading, the LWF suggested:[229]

- council-level water registries that record transfers. MPI (2021b) similarly suggest that online digital platforms, preferably in real time, will be increasingly necessary;

- Government facilitation of markets, including pro forma legal agreements;

- Set expectations for efficient (low cost) administration of transfers.

5.2.4 Net Benefits of Increasing Transferability

Introducing the potential transferability of water establishes a means for transfers to higher value uses and also establishes a price of water for all users. If water is transferable there is an opportunity cost of holding it: the lost value of a sale. Given this, expected responses to increased use of markets include improving farm practices in response to a price and transitions from low to high value land uses, either in response to water price or water shifting to the highest value users.[230]

The key input to valuation of transferability is the potential change in value of water in one use versus another. This might include:

- water use where otherwise it is not being used, eg those not using consented volumes transfer volumes to those who would use it; and

- transfers from low value to high value use.

Value of Water in Use

The first component of analysis is the value of water to those currently without and for whom increased use of markets may increase total supply. For this we examine the output of studies that have looked at the value of water in irrigation.

[226] Talbot-Jones *et al* (2020)
[227] Talbot-Jones *et al* (2020)
[228] LWF (2015)
[229] LWF (2015)
[230] MPI (2021b)

Macroeconomic Studies

NZIER used a computable general equilibrium (CGE) model to analyse the value of irrigation to the New Zealand economy, ie the estimated size of GDP with and without irrigation.[231] They estimated that irrigation of 721,400ha meant GDP was $2.17 billion higher in 2011/2012 than it would be without, ie a value of approximately $3,000/ha. Another NZIER study estimates the value of increased storage via the Waimea Dam in Nelson following limits to water use that reduce water allocation by 25% or 35%.[232] The dam is estimated to enable an approximate 1,100 ha increase in the irrigated area for land uses that include pasture, fruit, vegetables and flowers and an increase in regional benefit based on increases in gross margins.[233] Attributing a proportion of the costs to the new areas on the same basis as the distribution of benefits, suggests a 2017 value of irrigation of approximately $14,000/ha.

A study in Canterbury estimated increasing irrigation above the 2012 level would produce benefits of $5,308/ha in value added and 33.6 jobs (FTEs) per 1,000 ha.[234]

These are very high values, and we note the average operating profit for dairy farms was estimated at $2,624/ha in 2011/12 (the time of the national study).[235] Although there are higher values for other land uses (see below) this requires some explanation. The NZIER studies used a CGE which measure effects upstream and downstream of the initial impact (which would be limited to the change in profit for the farms themselves, expected to be some fraction of the average profit). In competitive markets, with resources used in farming priced at the opportunity costs of supply, the increase in profit would be expected to capture all the benefits, ie there would be no multipliers. This is the standard CBA assumption and the recommended approach by NZ Treasury.[236] The only explanation for greater benefits than those accruing to the farmer are from uncompetitive markets or from transitional impacts before a new equilibrium is reached.

Farm-level Studies

We have more confidence in the outputs of farm-level studies. They have produced much lower estimates of the value of irrigation, eg a 2014 Massey University study of several example farms found irrigation led to increased revenue of $5 - $513/ha.[237] A 2003 analysis of returns to irrigation using k-lines in Taranaki found that irrigation enabled an increase in grass (dry matter) production and a reduction in supplementary feed, and farms could then support increased stocking rates of 0.4 to 0.6 cows per hectare.[238] As a result, in areas classified as having medium to high development potential, values of irrigation varied from $227 to $524/ha (@ $5.50/kg MS); returns to water (at a lower $4/kg MS) were estimated at $0.01 to $0.05/$m^3$.

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[231] Corong *et al* (2014)
[232] Clough and Pampudi (2017)
[233] The methodology and data used are set out in Clough and Corong (2015a)
[234] Saunders and Saunders (2012)
[235] Dairy NZ (2020). Current estimate of average profit per ha for dairy farms is $2,856 in 2020/21 (Dairy Base Benchmarks: https://www.dairynz.co.nz/business/dairybase/benchmarking/latest-dairybase-benchmarks/, accessed April 2022)
[236] NZ Treasury (2015)
[237] Howes *et al* (2014).
[238] Rout (2003)

Chiewchan et al (2020) examined the potential benefits of establishing a trading system within a community irrigation scheme. They hypothesised a situation in which there was overall water scarcity, some farms facing shortages but others with excess water. They simulated redistribution of water using direct negotiation and auction systems, with increased profit for the sellers. This suggested small marginal increases in profit from increases in water availability.

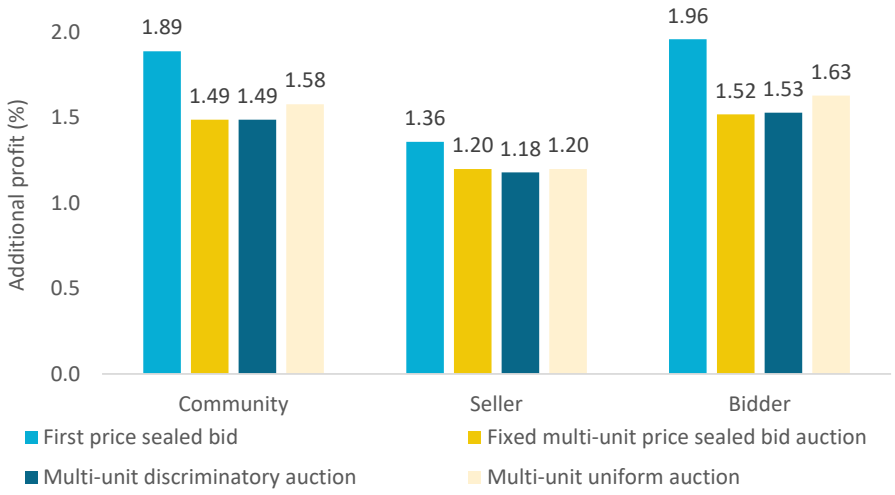
Table 5-4 Value of transfers to sellers (% increase in profit) at different reductions in supply

Reduction in supply	Direct negotiation	First-price, sealed-bid auction
5%	1.97	2.28
10%	2.21	2.85
15%	3.57	3.89

Source: Chiewchan et al (2020)

Chiewchan (2021) also analysed the different impacts on the community as a whole, plus buyers and sellers, of different types of auction (Figure 5-5). The types of market mechanism used can be as significant as the market itself.

Figure 5-5 Effect of auction type on profit



Source: Chiewchan (2021)

Value of Water in Alternative Uses

In addition to providing potential access to water for properties that currently have none, improvements to allocation are also expected to lead to allocation from low to high value uses.

A 2012 analysis of the potential for water allocation reform for MfE assessed the value of water for irrigation, compared with its use as stock water, for hydro electricity generation and in industrial uses (Table 5-5). It suggested a very wide range of values and the potential for gains from trade.

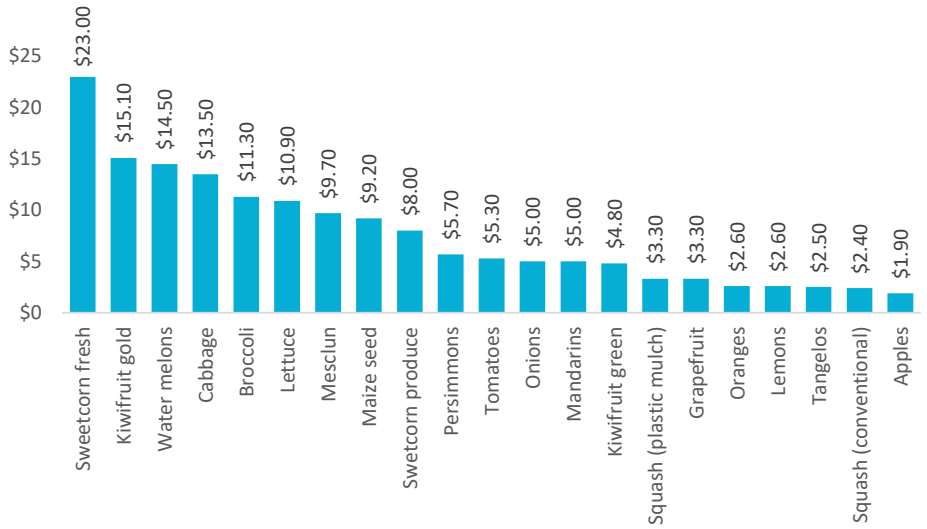
Table 5-5 Summary of estimated values of water in different uses

Use	Value ($/m³)
Irrigation	0.1 - 1
Stock water	10 – 25
Hydro electricity	0.002 – 0.05
Industry	1 - 100

Source: Denne and Hoskins (2012)

It suggested that the areas in which there is competing demand for water are largely in areas with high irrigation use and that potential gains would be within the range of $0.10-1/m^3 reflecting differences in location and type of agriculture. The AgriBusiness Group also estimated a value of irrigation water for pastoral agriculture at less than $1/m^3 but assessed higher values for crop production, ranging from $2 to $23/m^3 (Figure 5-6).

Figure 5-6 Value of water in crop production irrigated crops in the Poverty Bay flats ($/m^3)



Source: AgriBusiness Group (2012)

Jenkins (2015) estimated the value of water to for residential use, irrigation and hydropower generators. The cost of (treated) water supplied to residential and commercial consumers – as estimated by relevant local authorities – ranged between $0.47/m3 in Christchurch to $1.91/m3 in Tasman; the cost of irrigation water from irrigation schemes – as measured by cost of buy-in access amount allocated – was between $0.0475/m3 to $0.32/m3; and the value of each cubic metre of water to hydro-electricity generators was between $0.0057 (for one station at Opuha) to $0.036 (for eight stations at Waitaki).

Table 5-6 Berl estimates of water value in different uses

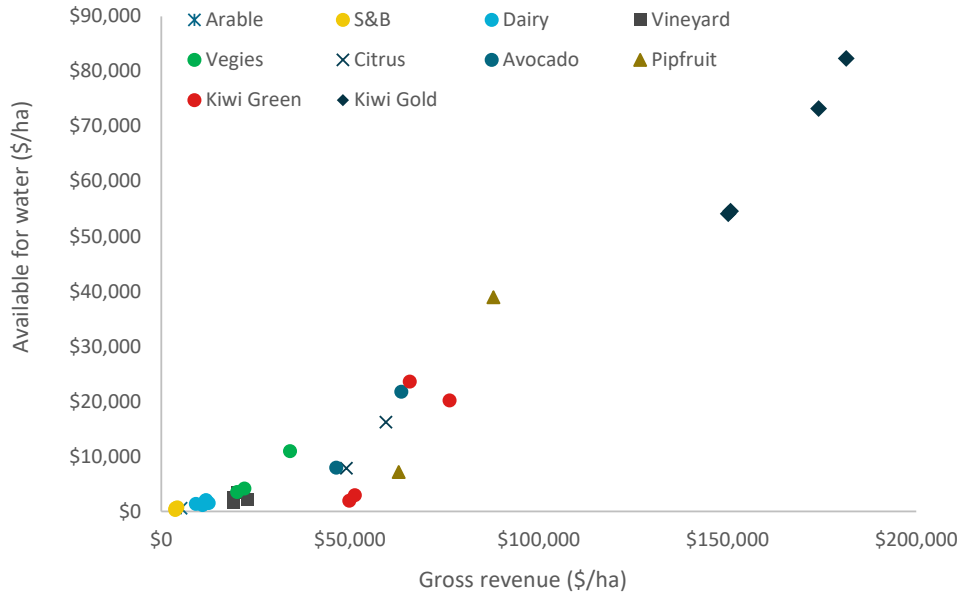
Use	Value ($/m³)	Basis
Potable	$1 - $3	Supply cost only
Urban irrigation (golf courses, amenity)	c.$40	Tourist contribution to GDP
Horticulture irrigation (kiwifruit, avocadoes)	$2 - $16	Gross margins
Pastoral irrigation	c.$1	Dairy farm gross margins
Water bottled for export	c.$1,000	Landed value estimate

Source: Sanderson (2020)

Kravchenko estimated a shadow price of water is $0.02/m^3 in New Zealand overall, and that it varies between 30 cents to 1 cent between regions, with Canterbury and Otago commanding the lowest shadow prices, and Waikato and Auckland Regions the highest.

Dark et al estimated the value of water in different farming and horticultural land uses. Figure 5-7 shows the gross revenue and the estimated willingness to pay for water storage (as net Cash Position minus the interest cost of development).[239] It suggests a high value of water in horticultural uses, particularly in kiwifruit production.

Figure 5-7 Gross revenue and $ available for water by land use



Source: Data from Appendix M in Dark et al (2021)

5.3 Potential Impacts of Reforms

5.3.1 Impacts Assessed

The benefits of reforms to allocation are highly uncertain for water reflecting:

- uncertainty in current data on supply and demand imbalance;
- the potential for storage as a response to further limits on supply;
- the various barriers to trading that exist currently and the reasons why trading has diminished over time despite the existence of a market; and
- uncertainty over the extent to which allocation reforms will lead to changes in land use or to changes in the productivity of existing land uses.

These and other uncertainties mean that quantification is very limited.

[239] Dark *et al* (2021)

5.3.2 Wellbeing Impacts

We summarise possible impacts in Table 5-7 and outline this further below.

Financial/Economic Impacts

The studies above suggest the potential for small incremental improvements in value, including to the greater use of irrigation or its allocation to higher value uses. Studies such as the recent Chiewchan analysis suggest local trading of water can lead to improvements in average profit of 1-2% for all the farmers in the scheme, with benefits to trading parties and the wider community. Set against this, the recent Aqualinc study has suggested that additional water storage has the potential to increase the irrigated area by as much as 200%. The effects of this scale of development would overwhelm any estimates of benefit from allocation reform.

Table 5-7 Potential impacts of reforms on wellbeing from freshwater takes allocation

Dimension	Benefits	Costs
Economic[a]	• Potential for allocation of freshwater use rights to higher value uses, particularly for irrigation of horticulture. • Value of transferability will depend on whether storage is used also to increase supply.	• Cost for any trading framework that would need to be weighed against the benefits of trade. • Costs of storage.
Environmental	Environmental effects (positive or negative) will depend on whether any flexibility in allocation leads to changes in the location of water use in a catchment. Effects will be constrained also by limits under the NPS-FM (or any future instruments).	
Social	Potential shifts in location of employment from land use changes associated with reallocation or trading of water take use rights.	
Cultural	• Flexibility in allocation may provide Māori with better access to water and to land development potential. • Water allocation to Māori enables land management to wider objectives.	Shorter term consents reduce ability to manage for sustainability

[a] As with other resources, we use a very narrow definition of economic impacts here: that relating to impacts on the consumption of market goods, including via changes to income and wealth

The greatest use of irrigation currently is in Canterbury and assessment of the existing trading market suggests that it has been both limited and also may have identified and achieved the majority of available benefits. This cannot be known with certainty without further fostering the development of market-based approaches. However, it is likely that further use of markets will yield small net benefits, even more so if water is more limited in availability and limits are not compensated for by expansion in water storage.

Environmental Impacts

The environmental impacts of any flexibility in take allocations will be constrained by the freshwater limits under the NPS-FM (or any changes under the reforms). Within the allocatable quantum, there may be some shift in effect, eg upstream or downstream in a catchment or to soils (and slopes) with different lag times between nutrients leaving root zones and entering waterways. However, the constraint on total effects is likely to be more important here.

Social Impacts

Within the overall wellbeing impacts, social impacts would be via any changes in land use from flexibility in water use leading to changes in the location of employment. Table 5-8 shows employment counts[240] (EC) per thousand hectares for different land uses, and the much greater employment intensity for horticulture, particularly for production.

Table 5-8 Employment count (EC) intensity of primary production (2019)

Sector	Production EC	Total[a] EC	Ha	Production EC/ 1,000 ha	Total EC/ 1,000 ha
Red meat and wool	29,040	64,055	7,168,146	4.1	8.9
Dairy	33,100	49,080	2,221,459	14.9	22.1
Horticulture	24,930	38,730	132,717	187.8	291.8
Arable[b]	2,530	23,395	487,763	5.2	48.0
Forestry	8,500	40,835	1,597,957	5.3	25.6

[a] Total includes processing & commercialisation also; [b] Areas for arable uses ha classified by Stats NZ as "grain"
Source: Ministry for Primary Industries (2021a); Stats NZ (2021a)

Increased employment is not presented as a cost or a benefit, but rather as a potential social impact. Currently, there is low total unemployment and horticulture industries are facing labour shortages in production.[241]

Cultural Impacts

If the freshwater proposals allow easier access to freshwater takes, Māori would be expected to use more land for income-generating and development purposes. Estimates of the theoretical potential annual income from Māori land is $540 million-$570 million.[242] This is based on under-utilised land, currently around 10 per cent of Māori land, all being allocated to its most profitable use (dairying), ignoring any other constraints on such conversion.

The extent to which greater allocation to Māori to leads to such land use change is highly uncertain. The costs of conversion would need to be netted off any estimated gain, in addition to constraints from freshwater environmental limits.

It has been suggested that Māori dairying activities would improve environmental outcomes as a result of Māori " …*being genuine leaders in dairy farm environmental management, due in part to their attitudes to land ownership, business values and holistic world views.*"[243] Thus, even in the case of simple reallocation of existing dairying activities from non-Māori to Māori interests for the same use, society could see environmental gains.

[240] The method counts the employees as at March, June, September and December of each tax year and divides the number by four to get an average employee count.
[241] https://www.hortnz.co.nz/news-events-and-media/mikes-blog/where-are-the-workers/
[242] Infometrics (2020)
[243] Philips *et al* (2016)

6 Freshwater Quality

6.1 Resource Allocation Issue

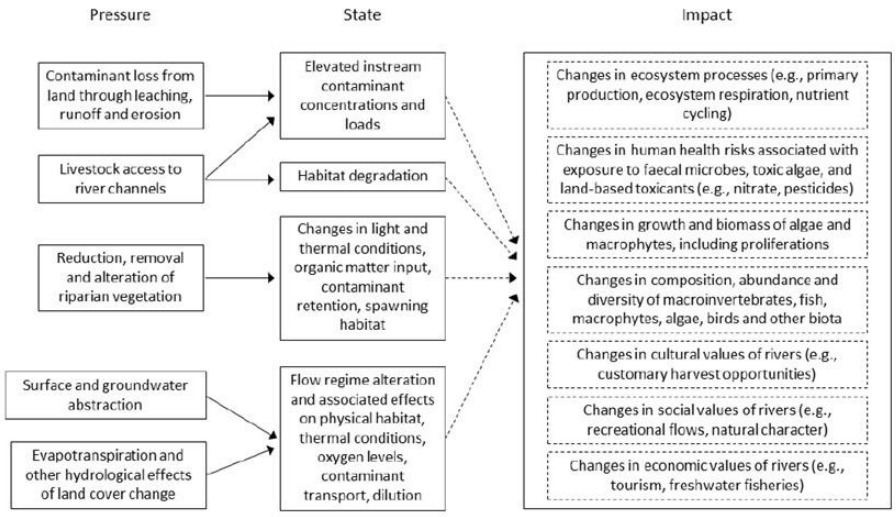
6.1.1 Sources of Discharges

Freshwater quality has deteriorated in New Zealand from factors that include run-off or leaching of nutrients and contaminants (nitrogen, phosphorus, sediment and pathogens such as *E coli*, in addition to other anthropogenic chemical contaminants such as heavy metals from industry and endocrine disrupters from wastewater). They can affect water clarity, ecosystem health, the aesthetic value of waterways, the diversity of aquatic life and the potential for recreational and commercial use, including from potential impacts on human health.

Measured data and models of catchment dynamics have been used to assess the water quality of rivers and lakes and the relationship to land use,[244] while also noting the complexity of environmental processes particularly the relationship between discharges, soil dynamics, ground water knowledge gaps and the time taken for discharges to land to result in changes to in-stream concentrations of nutrients.[245]

Overall, the effects of contaminants in waterways are to change ecosystem structure and dynamics, with consequent impacts on recreational, customary and commercial use, and on the benefits people gain from being near freshwater or even from just knowing about the reduced quality (Figure 6-1).

Figure 6-1 Impacts of Activities Affecting Freshwater Environments



Source: Larned *et al* (2018)

Water quality has been degrading or been altered because of changes in agriculture and climate, and particularly:[246]

[244] Ministry for the Environment & Stats NZ (2020; 2022)
[245] Graham *et al* (2020); McDowell *et al* (2021)
[246] Ministry for the Environment & Stats NZ (2022)

- changes in stock type – fewer sheep and more cows (and cattle excrete more nitrogen per animal than sheep);

- increases in stocking rates;

- more nitrogen fertiliser applied;

- more irrigated land (greater irrigation take can reduce water levels in rivers and streams and increase concentrations by reducing dilution with potentially increased pollution loads);

- some reductions in riparian vegetation resulting in reduced natural filtering. Reduced shading may have also caused higher water temperatures in some areas; and

- higher average surface temperatures[247] and declining natural availability of water[248] due to climate change.

In addition, the spread of urban areas has resulted in increased levels of discharge from rooves and roads, that include copper and zinc.[249]

6.1.2 Current Regulation

Current regulations include the NPS Freshwater Management 2020 (NPS-FM) and the NES Freshwater (NES-F).

NPS-FM

The NPS-FM is based around the concept of *Te Mana o te Wai*. It refers to "*the fundamental importance of water and recognises that protecting the health of freshwater protects the health and well-being of the wider environment. It protects the mauri of the wai. Te Mana o te Wai is about restoring and preserving the balance between the water, the wider environment, and the community.*"[250] It encompasses six principles (Box 6-1) and a hierarchy of obligations.

Box 6-1 Principles of *Te Mana o te Wai*

(a) **Mana whakahaere**: the power, authority, and obligations of tangata whenua to make decisions that maintain, protect, and sustain the health and well-being of, and their relationship with, freshwater
(b) **Kaitiakitanga**: the obligation of tangata whenua to preserve, restore, enhance, and sustainably use freshwater for the benefit of present and future generations
(c) **Manaakitanga**: the process by which tangata whenua show respect, generosity, and care for freshwater and for others
(d) **Governance**: the responsibility of those with authority for making decisions about freshwater to do so in a way that prioritises the health and well-being of freshwater now and into the future
(e) **Stewardship**: the obligation of all New Zealanders to manage freshwater in a way that ensures it sustains present and future generations
(f) **Care and respect**: the responsibility of all New Zealanders to care for freshwater in providing for the health of the nation.

[247] NIWA (undated)
[248] Stats NZ (2021b)
[249] Gadd *et al* (2019)
[250] New Zealand Government (2020), p5

This hierarchy in *Te Mana o te Wai* is defined as the objective of the NPS-FM. It is to ensure that natural and physical resources are managed in a way that prioritises:[251]

(a) first, the health and well-being of water bodies and freshwater ecosystems;

(b) second, the health needs of people (such as drinking water); and

(c) third, the ability of people and communities to provide for their social, economic, and cultural well-being, now and in the future.

The NPS-FM defines limits or targets for freshwater quality in the form of national bottom lines. These include attributes[252] requiring limits on resource use (Appendix 2A) and attributes requiring action plans (Appendix 2B) (Table 6-1).

Table 6-1 Attributes with national bottom lines

2A Attributes requiring limits on resource use	2B Attributes requiring action plans
• Phytoplankton (trophic state) • Periphyton (trophic state) • Total nitrogen (trophic state) • Total phosphorus (trophic state) • Ammonia (toxicity) • Nitrate (toxicity) • Dissolved oxygen • Suspended fine sediment • E. coli • Cyanobacteria (planktonic)	• Submerged plants (natives) • Submerged plants (invasive species) • Fish (rivers) • Macroinvertebrates • Deposited fine sediment • Dissolved oxygen • Lake-bottom dissolved oxygen • Mid-hypolimnetic dissolved oxygen • Dissolved reactive phosphorus • Ecosystem metabolism (both gross primary production and ecosystem respiration) • *E. coli* (primary contact sites)

Source: New Zealand Government (2020)

The policies in the NPS-FM include those relating to the involvement of tangata whenua in freshwater management, integrated management approaches, limits and targets. It also introduces the National Objectives Framework (NOF). The NOF requires regional councils to:

- identify freshwater management units (FMUs), which are areas deemed the appropriate unit for freshwater management and accounting purposes;

- identify values for each FMU (Box 6-2), identify attributes for each value and set baseline states;

- set environmental outcomes for each value and include them as objectives in regional plans;

[251] New Zealand Government (2020)
[252] Under the NPS-FM, an attribute means "a measurable characteristic (numeric, narrative, or both) that can be used to assess the extent to which a particular value is provided for."

- set target attribute states, environmental flows and levels, and other criteria to support the achievement of environmental outcomes;

- set limits as rules and prepare action plans (as appropriate) to achieve environmental outcomes; and

- monitor and act if degradation is detected.

Box 6-2 Values for FMUs

Compulsory Values

The extent to which an FMU or part of an FMU supports:

(1) **Ecosystem health** – the extent to which an FMU or part of an FMU supports an appropriate ecosystem based on:

- **Water quality**, eg temperature, dissolved oxygen, pH, suspended sediment, nutrients and toxicants
- **Water quantity** – the extent and variability in the level or flow of water
- **Habitat** – the physical form, structure, and extent of the water body, its bed, banks and margins; its riparian vegetation; and its connections to the floodplain and to groundwater
- **Aquatic life** – the abundance and diversity of biota including microbes, invertebrates, plants, fish and birds
- **Ecological processes** – the interactions among biota and their physical and chemical environment such as primary production, decomposition, nutrient cycling and trophic connectivity.

(2) **Human contact –** people being able to connect with the water through a range of activities such as swimming, waka, boating, fishing, mahinga kai, and water skiing, in a range of different flows or levels. Matters to take into account include pathogens, water clarity, deposited sediment, plant growth (from macrophytes to periphyton to phytoplankton), cyanobacteria, other toxicants, and litter.

(3) **Threatened species** – a population of threatened species has the critical habitats and conditions necessary to support its presence, abundance, survival, and recovery.

(4) **Mahinga kai** – freshwater species that have traditionally been used as food, tools, or other resources are safe to harvest, use and eat, customary practices are able to be exercised to the extent desired, and tikanga and preferred methods are able to be practised. Also, *Kei te ora te mauri* (the mauri of the place is intact).

Other values that must be considered

(1) Natural form and character
(2) Drinking water supply
(3) Wai tapu
(4) Transport and *tauranga waka*
(5) Fishing
(6) Hydro-electric power generation
(7) Animal drinking water
(8) Irrigation, cultivation, and production of food and beverages
(9) Commercial and industrial use

Source: Appendix 1A and 1B in New Zealand Government (2020)

We note that, for vegetable production, the potential for limits and targets to affect the achievement of other objectives within the *Te Mana o te Wai* hierarchy has led to some relaxation of that hierarchy. Demand for vegetables is expected to increase over time, both in response to changes in consumption preferences and population increases, but commercial production uses either natural (compost) or artificial fertiliser, resulting in nitrogen discharges. Tighter freshwater limits have the potential to limit vegetable production and to reduce food security. This is recognised currently in the establishment of specified vegetable growing areas (SVGAs) for which reduced limits might be set, at least

temporarily.[253] SVGAs have been defined for Horowhenua and Pukekohe, with the potentially lower limits applying for ten years. Whether this needs to be revisited to enable increased vegetable production in SVGAs or elsewhere will need to be monitored closely.

Allocation

The policy for allocation is that freshwater is "*allocated and used efficiently, all existing over-allocation is phased out, and future over-allocation is avoided*."

NES-F

The NES-F sets conditions that must be met for certain activities that pose risks to freshwater and freshwater ecosystems. The standards are designed to:

- protect existing inland and coastal wetlands
- protect urban and rural streams from in-filling
- ensure connectivity of fish habitat (fish passage)
- set minimum requirements for feedlots and other stockholding areas
- improve poor practice intensive winter grazing of forage crops
- restrict further agricultural intensification until the end of 2024
- limit the discharge of synthetic nitrogen fertiliser to land and require reporting of fertiliser use.

6.2 Reform Expectations

The LWF (2017) noted the objective of greater flexibility in who reduced discharges rather than assuming those with highest discharges made the greatest reductions, with a recommendation for some form of tradable allowance system, although the forum could not agree on the details, including on initial allocations and how to reduce existing allocations.

The Panel identified several ways in which FIFS could be improved or replaced, relevant both to contaminant discharges and allocation of takes:[254]

- more flexible regulatory permissions, including shorter duration consents;
- developing an administrative allocation system based on assessing the merit of uses; and
- moving to a market-based approach by better enabling trading of permits within the current system or using auctions and tenders.

6.2.1 Merit-Based Allocation

One example of merit-based allocation is that included in the Horizons Council One Plan. It allocated rights to discharge using land capability class, in which land with greater productive capacity was given a higher allocation (or maximum leaching rate). The values in Table 6-2 are updated values in proposed Plan Change 2 following updates to the Overseer model that resulted in higher estimates of leaching rates.[255]

[253] See Section 3.33 and Appendix 5 of the NPS-FM
[254] Resource Management Review Panel (2020), p339
[255] A further revised version is in the current proposed Plan Change 2 as recommended by the Independent Hearing Panel in 2021.

Table 6-2 Cumulative nitrogen leaching maximum by Land Use Capability Class (Revised One Plan Table 14.2)

Period (from the year that the rule has legal effect)	LUC I	LUC II	LUC III	LUC IV	LUC V	LUC VI	LUC VII	LUC VIII
Year 1	51	45	40	29	25	24	11	3
Year 5	46	40	35	25	22	19	8	3
Year 10	44	37	32	23	20	17	8	3
Year 20	43	35	30	21	19	16	8	3

Source: Horizons Regional Council (2018)

Table 6-3 shows estimates of the impacts of meeting these limits on vegetable growers with different crop rotations.

Table 6-3 Impacts on Horowhenua commercial vegetable growers required to meet the recalibrated Table 14.2

Crop	Controlled pathway ($/ha/yr)	Discretionary pathway ($/ha/yr)
Potatoes	-$761	-$761
Onions	-$2,174	-$1,095
Cauliflower, potato, cauliflower	-$2,160	-$2,160
Spring onion, spinach, lettuce, maize, cabbage	-$1,656	-$1,656
Maize, spinach, lettuce, spring onion, oats	-$1,465	-$1,463
Maize, spinach, lettuce, spring onion, cabbage	-$1,678	-$1,678
Oats, lettuce, cabbage, maize	-$1,071	-$1,071
Pumpkin, cauliflower, broccoli	Does not meet Table 14.2	-$2,649
Cauliflower, broccoli, broccoli	Does not meet Table 14.2	-$2,730
Oats, lettuce, cabbage, spinach, oats	Does not meet Table 14.2	-$2,017
Average	-$1,685	-$1,978

Controlled pathway means must meet Table 14.2 requirements; Discretionary pathway (Scenario 3 shown) means substantial compliance; those not complying are on an improving trend over 20 years.
Source: Jolly (2020)

Any such system has boundary effects, where the LUC system is imperfect in its grouping of farms or in the compatibility of classifications with farm boundaries. The classification is also based on incomplete and potentially outdated data. In addition, the relativities between classes do not necessarily reflect value of nitrogen to the individual land uses. The alternative using trading enables farmers to express how much they value nitrogen (and associated leaching).

6.2.2 Nitrogen Discharge Allowance Trading

Lake Taupō

A discharge trading scheme operates at Lake Taupō catchment in the form of a nitrogen cap and trade.[256] The scheme was established via Waikato Regional Plan Variation 5 – Lake Taupō Catchment (Variation 5), which was proposed in 2005 and became operative in 2011.

[256] Barns and Young (2012); Duhon *et al* (2015)

Its objective was maintaining the water quality of Lake Taupō in the face of increasing intensity of land use, while minimising economic costs and mitigating social and cultural effects;[257] a specific goal was set of returning lake water quality to the average of 1999−2003 levels (which is 70.3mg/m^3) by 2080.[258]

Activities with low nitrogen leaching (< 8kg/N/year, eg small 'lifestyle' farms and forestry) are classified as 'permitted' activities and face some restrictions on land management and cannot develop their land in ways that will increase leaching without becoming controlled activities, and meeting the requirements this entails.[259] Larger farms are controlled activities, requiring a consent to farm and an approved nutrient management plan (NMP), and they are included in the trading scheme. The scheme:

- sets a cap on total discharges from diffuse non-point sources (NPSs) of nutrients;
- defines nitrogen discharge allowances (NDAs) in kg/ha/year which allow holders to discharge a proportion of the cap;
- allows trading of NDAs amongst participants;
- requires farmers to hold NDAs equal to the discharges estimated from their farm using the *Overseer* model.[260]

The size of the cap in the Lake Taupō scheme is the sum of the individual allocations to farms. The initial council proposal was for this to be based on the average nitrogen discharges between 2001 and 2005. Farmers argued this would include the drought conditions experienced during part of the benchmarking period and would inhibit the ability of farmers to maximise profits in good farming years.[261] Instead, the approach uses a benchmark based on the farmer's choice of any single year in the 2001-2005 period. Data for 2008 suggested that approximately 1,360 tonnes of nitrogen enter the lake annually, including 510 t (c.40%) from pastoral farming. Using a highest year allocation rather than an average was estimated to increase the allocation by approximately 162t,[262] which is approximately 12% of total N and 32% of pastoral discharges.

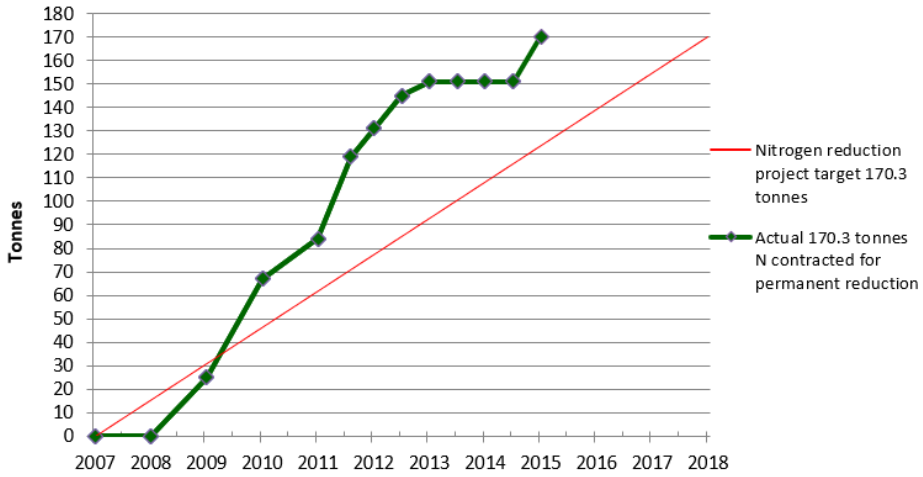
This grandparenting approach to allocation was criticised for favouring those that had developed their land while penalising those who had not, including the local iwi, Ngati Tuwharetoa.[263] A variation was introduced that allows owners of undeveloped and forestry land (particularly Māori) to increase their nitrogen leaching by 2kgN/ha/year above baseline leaching rates, adding approximately 14t to the total; this was estimated to have only a small impact on water quality.

[257] Barns and Young (2012)
[258] Waikato Regional Council (2007)
[259] Duhon et al (2015)
[260] https://www.overseer.org.nz/
[261] Barns and Young (2012)
[262] Duhon *et al* (2015)
[263] Duhon et al (2015)

No banking or borrowing of allowances is allowed, but allowances can be leased on a short-term basis or sold for the duration of the resource consent. Resource consents have a lifetime of 25 years to improve certainty for farmers.

A Lake Taupō Protection Trust (LTPT) had been established in 2007 with an objective of reducing discharges of nitrogen to Lake Taupō by 20%, initially estimated at 153t but increased to 170t in 2011. Reducing discharges was to be achieved by buying back NDAs using a public fund with revenue coming from local, regional and national governments. The Trust was funded to the tune of $79.2 million,[264] 45% from central Government, 33% from the Waikato Regional Council and the remaining 22% from Taupō District Council.[265] The reduction target was achieved in 2015, including through the purchase of NDAs and of whole farms including NDAs (Figure 6-2).

Figure 6-2 Nitrogen Reduction Contracted to Lake Taupō Protection Trust



Source: Lake Taupō Protection Trust (2015)

Outcomes

A review of performance to 2014 estimated there had been 35 sales of NDAs and three leases resulting in 17% of the cap (149t) changing ownership and covering 46% of the land area.[266] Nineteen of the sales (66%) were purchases by the LTPT as part of the achievement of the 20% reduction in discharges; this included five whole farm purchases including the accompanying NDAs.

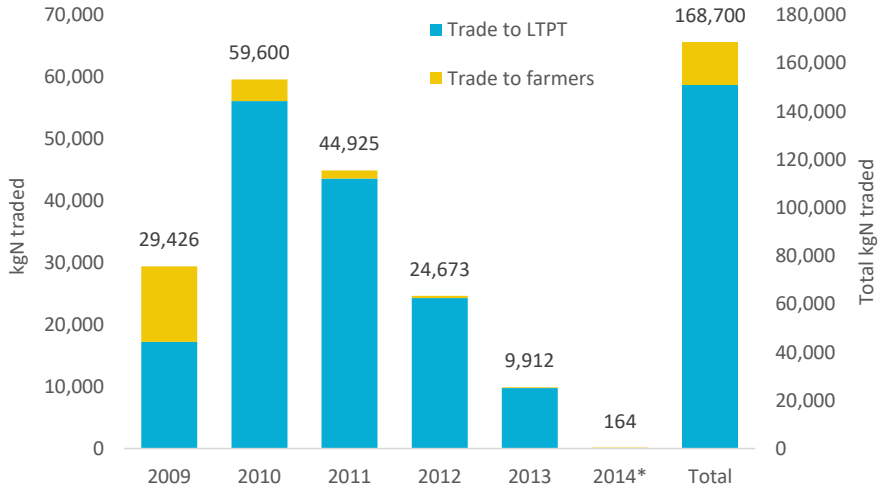
Although some farms had excess NDAs which they sold, most sales have been accompanied by partial farm conversions in which trees have been planted on less productive land, reducing demand for NDAs (and enabling farmers also to claim NZUs under the ETS). By mid-2012 approximately 5,800ha (11% of 52,500 ha of pastoral land initially included in the scheme) had been converted to forestry.

The environmental impacts include the achievement of the discharge reductions (Figure 6-2). However, the concentrations of nitrogen in Lake Taupō have not been limited to target levels (70.3 mg/m^3) as a 2017 council presentation shows (Figure 6-4).[267]A short-term

[264] The original amount of $72.4 million was increased when the target reduction was increased
[265] Her Majesty the Queen *et al* (2007)
[266] Duhon *et al* (2015)
[267] See Hammond Wagner *et al* (2020) also

improvement is not expected given the often long delays in transfer of nutrients from soils via groundwater in the catchment to the lake, in-lake nitrogen dynamics and residence time of the lake. Studies have suggested lag times could be as high as 100 years or more in some parts of the catchment.[268]

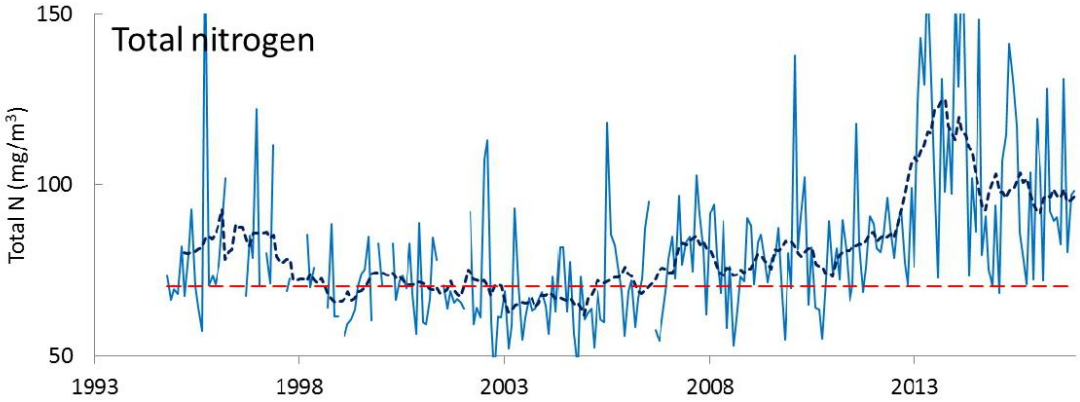
Figure 6-3 Trades in Lake Taupō N Trading Scheme



* Part year only
Source: Kerr et al (2015)

There were some reviews of the scheme using 2012 data,[269] with a limited update using 2014 data.[270] These suggested that the scheme had effectively limited discharges, while also having social and economic costs. This included transaction costs and limitations to productive capacity.

Figure 6-4 Nitrogen concentrations, Lake Taupō



Source: Waikato Regional Council (2017)

There are significant transaction costs associated with the system, including:

[268] Vant (2008) in Kerr *et al* (2015)
[269] Duhon *et al* (2015)
[270] Kerr *et al* (2015)

- Regulation costs estimated at over $100,000 per year.

- Initial benchmarking costs for all farms to establish allocation, estimated at $2,500-$10,000/farm, which would total up to $180,000 for 180 farms. However, the Trust estimated costs of $2.5 million before they had completed all benchmarks.

- Consenting costing $1,000-$1,500/farm and consent holder's fee of $400/farm per year.

In addition, each trade has costs including pre-approval by the council (and re-consents)[271] plus an update to the NMP. Total costs to the farmer are estimated at $2,000-3,000 per trade and $2,000-$8,000 for the Trust. It is not clear what are the costs for private trades although Duhon et al (2015) suggested they were lower. The transaction costs may explain why trades were largely by large farms with greater potential for efficiency gains from trade that would exceed the transaction costs.

Despite these costs, trades have occurred. Trading prices are not recorded but were estimated at approximately $300/kg N in 2012[272] and a modelled estimate for Lake Rotorua was $415/kg N.[273] More recent (May 2022) estimates for the Lake Taupō market are $400-$500/kg for sale or purchase and around $25/kg per year for leasing.[274]

The limitation on the productive capacity and development potential of farms reduces potential returns and has consequent reductions in land value. For example, it has considerably increased the cost of converting from sheep & beef farming to dairy.[275] The actual impact on land value is uncertain, with views varying from no detectable impact to values falling by 5-10%.[276] These are costs associated with the cap itself rather than the trading element.

Net Benefits

Kerr et al (2015) discuss the costs and benefits of the nitrogen trading scheme without coming to firm conclusions. They compared the costs with the environmental benefits, while also noting that alternative regulatory approaches could have been used.[277] Kerr et al used the funding provided by government and councils to the LTPT as one element of cost, although much of this was a transfer payment, ie it was used to pay farmers to reduce their N leaching. It is the costs of the farmers' actions (eg lost revenue from reduces stock numbers) not the amount that they were paid that is the true resource cost.

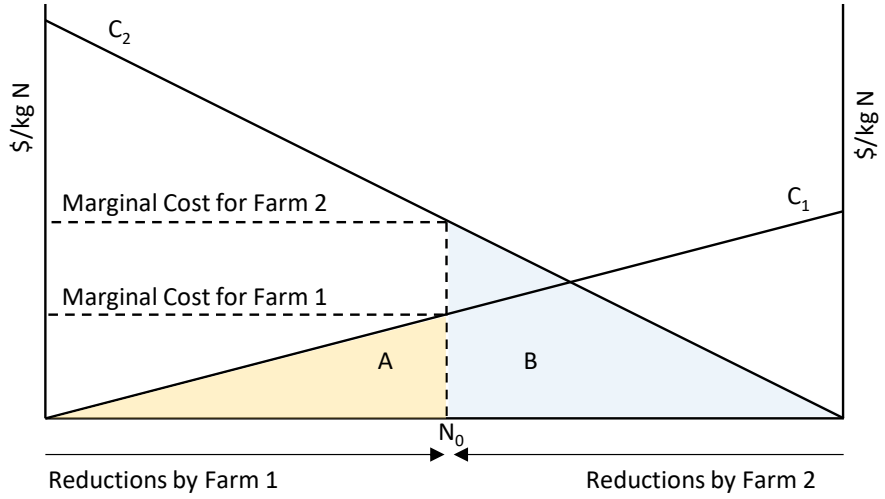
[271] Any purchase, lease or sale of NDAs needs to be authorised by a change to a condition of a resource consent under s127 of the RMA
[272] Duhon et al (2015)
[273] Timar et al (2014)
[274] Jacqui Bolton, Waikato Regional Council, pers comm (May 2022)
[275] Duhon et al (2015) illustrate this with an example: "assume that a sheep and beef farmer was assigned an average NDA of 18kg/ha/year. A dairy farm would need an allowance of approximately 36kg/ha/year. At a nutrient allowance price of NZ$300 (approximately the market price in 2012), the cost of purchasing allowances that would allow a dairy conversion would be 300 × 18 = NZ$5,400/ha. This has clearly decreased the option value of this land", p19 30n
[276] Duhon *et al* (2015)
[277] This includes "practice-based regulations with specific technology or farm practice controls" (Kerr et al 2015, p10)

Of interest is whether similar benefits (reductions in N leaching) could have been achieved more cheaply using an alternative approach without the flexibility of trading. For example, this might be achieved via a requirement for consents for farming but with limits on stocking rates. This would reduce the need for farm-specific benchmarking to establish leaching rates.

To estimate the costs of the trading scheme, we use the costs of benchmarking farms, estimated at $2.5 million above. In addition, there are transaction costs for trades themselves, which were in the order of a few thousand dollars per trade. Combining these, suggests a conservative estimate of costs of $2.6 million to reduce 170 tonnes of N per annum and a cost of $15/kg permanently reduced, approximately 5% of the estimated traded price of NDAs.

The benefits of trading are the result of heterogeneity in farms.[278] The basis for and benefits of trading is illustrated in Figure 6-5 which characterises the market as two farms with different mitigation cost curves (C_1 and C_2). Allocation N_0 is where both farms have the same allowed level of emissions; achieving this is higher cost for farm 2 than farm 1. Total costs to farm 1 are represented by yellow shaded area A, whereas costs for farm 2 are the blue shaded area B.

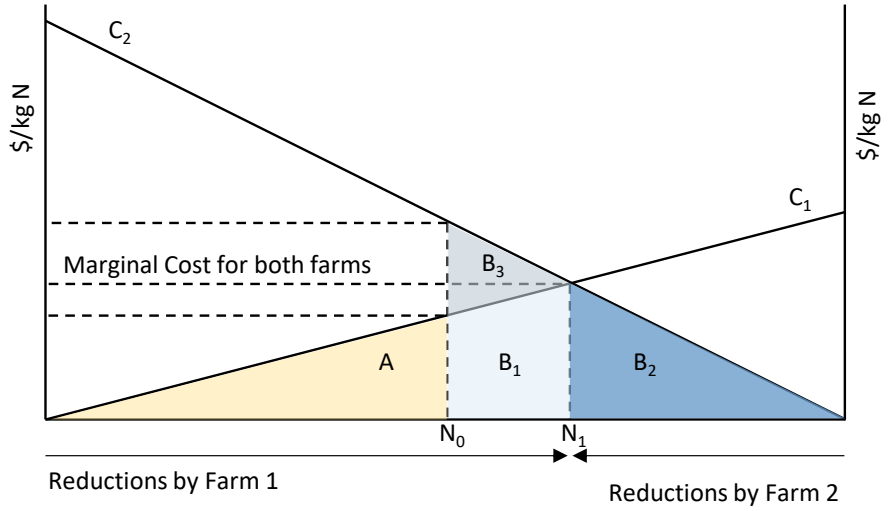
Figure 6-5 Costs of mitigation for two farms ($/kgN)



If flexibility is allowed, N_1 (Figure 6-6) is now the equilibrium point (with an efficient market) at which the marginal reduction cost is the same; farm 1 makes more reductions than farm 2 and it now has costs equal to area A plus the shaded area B_1; the costs for farm 2 are equal to shaded area B_2 only. The cost saving is equal to the shaded area B_3.

[278] Timar *et al* (2014)

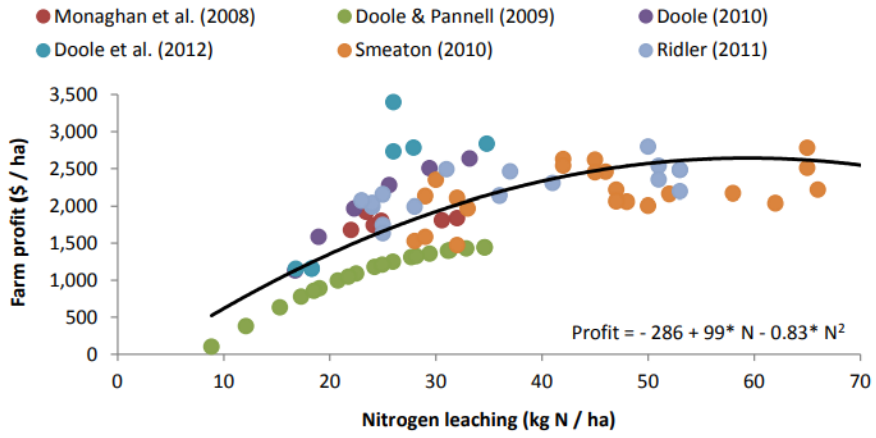
Figure 6-6 Costs of mitigation for two farms with trading ($/kgN)



Doole et al (2011) model this for the Waikato and estimate the cost with a uniform cap on discharges for every farm would cost over three times as much as with flexibility (area B_3 is more than double the sum of areas A, B_1 + B_2), ie the potential savings are over 67% of initial costs. To achieve this the equivalent of cost curve C_1 (the farms with low costs of abatement) would need to be very shallow and C_2 (the abatement costs for high-cost farms) very steep.

Anastasiadis and Kerr (2013) summarise the results from several studies from the Waikato of the relationship between profit and N leaching from dairy farms. They attempt an explanatory relationship which suggests profit rises with increases in N leaching but with a diminishing effect, while noting they could not identify how much of the observed variation is due to different modelling assumptions in the individual studies (Figure 6-7). Their own analysis of Ministry of Agriculture and Forestry (MAF) data from monitor farms found a statistically significant and positive relationship between profit and N leaching, but they concluded that increases in N use efficiency from improved management are likely to be associated with increased dairy profitability.

Figure 6-7 Relationship between nitrogen leaching and profit - various studies of Waikato dairy farms



Source: Anastasiadis and Kerr (2013)

Some estimates have been made of the marginal costs of reducing nitrogen inputs via stocking rate reductions, eg the analysis by Doole (2015) suggests profit reduction of

c.$70/kg N per year.[279] Other studies identify the relationship between stocking rates and N leaching,[280] although this is not necessarily straightforward. A recent New Zealand study found lowering stocking rate may not reduce nitrate leaching and suggested the need for a full farm system-level analysis of any management change to determine its effect on productivity and environmental outcomes.[281]

Studies in which leaching reduces with stocking rates suggest costs that are higher than the estimated sums paid for allowances to discharge N (approximately $25/kg pa for leases or $29/kg as the annual cost based on $300/kg for an allowance annualised over 15 years at 5%). This reflects the sales to LTPT being associated largely with permanent land use change from farming to forestry, such that reductions in revenue (and profit) from stock reduction is compensated by profit from forestry (including carbon credits, ie sales of NZUs).

To better illustrate the benefit of flexibility that the trade scheme provides, we calculate the marginal saving values from the scheme below. We assume that the net costs of reducing N (eg via land use change) is a maximum of $25/kg pa and that the minimum is zero. We then use the estimate of savings value from Doole et al (2011), ie 67% of costs under a uniform standard to estimate potential savings of $1.4m pa or a present value of $22 million (30 years at 5%);[282] we include a range simply using ±50% (Table 6-4).

Table 6-4 Estimate of benefits of flexibility in Lake Taupō scheme

	Quantity (kg N)	Uniform Standard Costs ($m)	Savings from Flexibility ($m)	Savings – Range ($m)
Sales to LTPT	151,066	1.9	1.3	0.6 - 1.9
Sales to farmers	17,634	0.2	0.1	0.1 - 0.2
Total	168,700	2.1	1.4	0.7 - 2.1
PV (30 years @ 5%)		23.4	21.6	10.8 - 32.4

The total surplus is the gain from trade to be compared with the estimated cost of $2.6 million, ie a benefit cost ratio of 8:1 (in a range of 4 to 12).

Lake Rotorua

A similar trading scheme is being established at Lake Rotorua via Plan Change 10 to the Bay of Plenty Regional Water and Land Plan. A cap of 435 tonnes N per year is being set, to be met by 2032; this requires a 42% reduction in the current load to the lake (Table 6-5).

To achieve the 270 tonne reductions from pastoral land uses, NDAs will be allocated to farmers equal to a smaller quantity than current emissions by 170t (to 356 t), 100t of which will then be NDAs purchased back by the regional council (at $400/kg). A gorse revegetation programme (which assists conversion of gorse to productive, low leaching land uses) will be used to reduce demand for NDAs by 30t.

[279] eg Doole (2015)
[280] Manderson (2015)
[281] Roche *et al* (2016)
[282] We use 30 years as a broad estimate of the duration of the land use in forestry

Table 6-5 Nitrogen load to Lake Rotorua (tN/year)

Source	Current input	Reduction required by 2032	Distribution of the limit
Pastoral land use – dairy, drystock and lifestyle	526	270	256
Forest and native bush	75	0	75
Urban, sewage, geothermal and rain	154	50	104
Total	755	320	435

Source: Rotorua Te Arawa Lakes Programme (undated)

Several approaches were considered for allocating the NDAs to farmers (Table 6-6). The Lake Taupō scheme was based on grandparenting using an historical year's leaching estimates, which favours those with large historical discharge levels.[283] In contrast, a sectoral averaging approach (in which all farms are given the average regardless of actual discharge levels) favours those below the average who obtain an immediate surplus. Agreement was reached on developing a hybrid allocation method based on sector averaging with ranges.

Table 6-6 Allocation approaches for NDAs in Lake Rotorua programme

Allocation approach	Explanation
Grandparenting with clawback	Allocation based on existing discharges benchmarked under Rule 11. To achieve the 14 tonne nitrogen target all properties would need to reduce nitrogen losses by 27%
Pastoral averaging	This is where the pastoral nitrogen limit is divided equally throughout the catchment. All pastoral landowners would receive a NDA of 18kg/ha.
Sector averaging	This method allocates an averaged level of nitrogen discharge for specific types of land use or "sectors". Dairy 35 kgN/ha/yr (in range of 30-40 kgN/ha/yr) Drystock 13 kgN/ha/yr (in range of 9-17 kgN/ha/yr) Forest 3 kgN/ha/yr
Land use capability	This approach assesses the physical quality of the land, soil and environment. Higher nitrogen limits would be allocated to more versatile classes of land, thus improving overall efficiency of land use in the long run.
Input based limits	Focuses on controlling inputs to and use operations by directly managing the amount of nutrients being applied on land. For example, controlling stock numbers, fertiliser and feed application rates.
Output based limits	Based on the greatest units of output leaving a property (eg milk solids, timber, kg of meat). An example would be allocating to a landowner based on how many kg of milk produced per 1 kg of nitrogen leached.

Source: Rotorua Te Arawa Lakes Programme (undated); Barns (2017)

An analysis of the expected impacts suggested costs for reducing N of $5.91/kg N pa[284] which is in the range assumed for analysis for the Lake Taupō scheme above ($0 to $25/kg). We use the same approach to estimating the cost savings from flexibility as above, assuming sales amongst farmers total 10% of the NDAs. The cost savings from flexibility are estimated at $16 million in a range of $8 to $24 million (Table 6-7).

[283] With a specific adjustment for Tuwharetoa to recognise the unique circumstances faced by Māori land.
[284] Parsons et al (2015)

Table 6-7 Estimate of benefits of flexibility in Lake Rotorua scheme

	Quantity (kg N)	Uniform Standard Costs ($m)	Savings from Flexibility ($m)	Savings – Range ($m)
Sales to Council	100,000	1.3	0.8	0.4 - 1.3
Sales to farmers	25,600	0.3	0.2	0.1 - 0.3
Total	125,600	1.6	1.0	0.5 - 1.6
PV (30years @ 5%)		24.1	16.1	8.0 - 24.1

6.2.3 Resource User Charges

Resource user charges might be imposed in the form of a charge on nitrate discharges. However, we note that nitrogen emissions in the form of N_2O (from fertiliser and urine) are included in the proposed He Waka Eke Noa GHG emissions charging scheme.[285] It is unlikely that any additional pricing would be introduced on top of this.

6.3 Potential Impacts of Reforms

6.3.1 Impacts Assessed

The potential impacts assessed are focussed on flexibility in the allocation of discharge rights, building on the Lake Taupo and proposed Lake Rotorua schemes. In addition, there is the potential for reduced duration of consents.

6.3.2 Wellbeing Impacts

We summarise possible impacts in Table 6-8 and outline this further below.

Table 6-8 Potential impacts of reforms on wellbeing from allocation of discharge rights to freshwater

Dimension	Benefits	Costs
Economic[a]	Potential cost savings from flexibility in allocation, eg more use of N-trading.	Costs for design and establishment of trading schemes.
Environmental	Environmental impacts expected to be the same but limits achieved at lower cost.	
Social	• Increased fairness of access to discharge allowances. • Social impacts will depend on land use change outcomes of flexibility, eg changes to employment.	Employment impacts are uncertain.
Cultural	• Flexibility in allocation may provide Māori with better access to discharge rights and to land development potential. • Allocation to Māori enables land management to wider objectives.	Shorter term consents reduce ability to manage for sustainability

[a] As with other resources, we use a very narrow definition of economic impacts here: that relating to impacts on the consumption of market goods, including via changes to income and wealth

[285] He Waka Eke Noa (2022)

Financial/Economic Impacts

The Lake Taupō and Lake Rotorua schemes suggest cost savings from the flexibility of trading totalling approximately $2 million per annum, with an estimated NPV of over $30 million, after subtracting costs of farm benchmarking.

These trading schemes might be extended to other areas, although the suitability would be limited by the nature of the receiving environment. The schemes at Lakes Taupō and proposed for Rotorua are largely successful because they are lakes with defined catchments. Although it will vary in the timescale of effect, essentially wherever N deposition is reduced around the lake, the water quality in the lake improves. This contrasts to a river where the location of reduction affects how much of the river is improved, in addition to the effects of flow rate that will depend on soil type or condition, slope and precipitation.

For the lake examples we might reasonably assume that the environmental benefits of regulation will be the same, with the only differences between the flexibility of trading being the reduction in costs. In contrast, in rivers the environmental outcomes will differ. Reflecting the differences in effects, discharge trading programmes in the US have adopted trading ratios that differentiate between discharge sources depending on the distance from a river and whether they are point or non-point sources.[286]

The Lake Taupō scheme was significantly assisted by the injection of Government funding, which might have set an unfortunate precedent for developments elsewhere.

To scale up to a national level, assuming the reforms encourage greater use of these flexible mechanisms, net benefits might be in the order of $100 million, equivalent to annual net benefits of $6.5 million.

Environmental Impacts

The flexibility associated with trading would be expected to yield the same environmental effects (reduced N or other discharges) but at lower cost.

Social Impacts

The use of flexible mechanisms such as trading nutrient allowances, improves the fairness of access to discharge rights.

Wider social impacts, eg on employment will depend on the land use change outcomes of any flexibility introduced (see Table 5-8).

Cultural Impacts

Any flexibility in allocation may provide Māori with better access to discharge rights and to land development potential. Associated with this, increased land development potential for Māori enables land management to support wider objectives.

[286] Lopez-Bernal (2003)

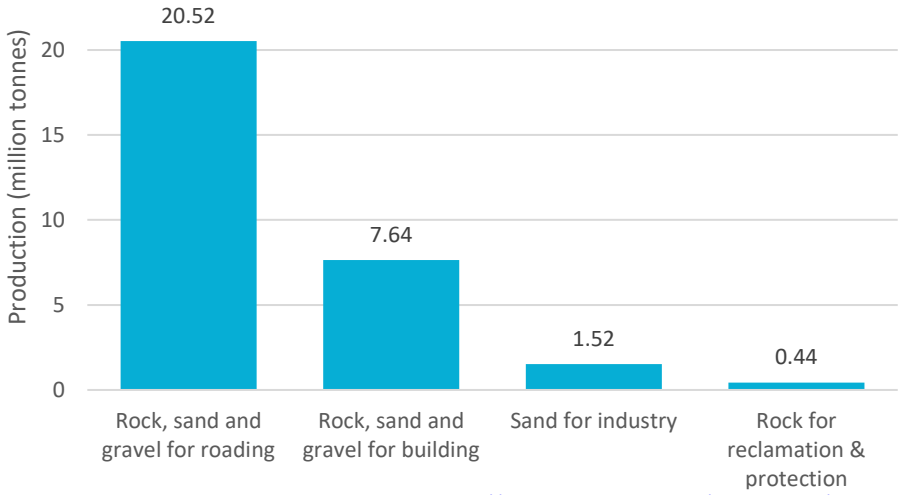
7 Sand

7.1 Resource Allocation Issue

Uses of sand and other aggregates include providing hardfill for road bases and as an input to the production of concrete. Silica sand is a specialist material used in glass manufacture and New Zealand ironsands provide inputs to steel manufacture, both at Glenbrook (Auckland) and exported for use elsewhere. In this section we focus on sand used for roads, building and general industrial uses.

A survey by New Zealand Petroleum and Minerals estimates aggregates production at approximately 30 million tonnes per year, approximately 70% of which is for roading and 25% for building (Figure 7-1).

Figure 7-1 Aggregate production (average annual 2016-2020)



Source: New Zealand Petroleum and Minerals (https://www.nzpam.govt.nz/nz-industry/nz-minerals/minerals-statistics/industry-statistics/)

Some of the allocation issues are illustrated via regional examples.

7.1.1 Auckland

The main sources of sand to the Auckland market are the Kaipara Harbour (Taporapora Sandbank) and the Mangawhai Pakiri Embayment (MPE) (Table 7-1).

Table 7-1 Sand supplies to the Auckland market

Quarry	Consented max (tonnes)	% of supply	Sold	% of supply	Spare capacity
Pakiri Offshore	270,000	18%	210,000	29%	60,000
Pakiri Inshore	136,800	9%	116,800	16%	20,000
Taporapora Sandbank	1,080,000	73%	393,367	55%	686,633
Total	1,486,800	100%	720,167	100%	766,633

Note: 20,000t of Pakiri Inshore sand is sold outside the Auckland Market
Source: Akehurst and Church (2019)

MPE has been the subject of environmental protest[287] and Auckland Council has recently rejected a resource consent application to extend extraction there because of the environmental impacts.[288] The companies involved have argued that there is significant growth in demand for sand in Auckland because of the growing population and that shipping it from other parts of New Zealand is too costly.

Alternative supply sources include:

- land-based former dunes or river alluvial deposits. There is a former (relict) dune sand deposit in the Northland region which is of suitable quality for concrete manufacture but the distance from Auckland means it is not cost effective and the resource is limited in volume; or

- river-based sands, mostly sourced from the Waikato (eg Waikato River) and Bay of Plenty. These are less desirable for construction projects because of the high levels of reactive minerals from the Taupō Volcanoes; they are mainly used for landscape purposes, domestic retail and for sports fields or where transport and distance mean marine sands are not financially viable.[289]

Akehurst and Church (2019) argue that two large land-based sand resources in the northern Waikato are already heavily allocated, such that the next closest location is from sources close to Cambridge. This means the most viable options for Auckland supply are those used currently. Akehurst and Church provide data suggesting that taking sand from Helensville (and the Kaipara Harbour) would result in freight costs equal to 54% of the cost of sand supply,[290] and total $6.1 to $7.6 million per annum[291] (or $7.2M to $9.0M if freighted from the Pukekawa Sand Plant, Waikato, a 65km trip distance). They add an additional amount (close to $0.5 million) to these numbers to account for the environmental (air emission) costs of road transport. Their calculations are presented as additional costs but do not include offsetting reductions in costs from avoiding the current freight costs (by barge) from MPE or any associated environmental impacts so the estimates are only partial.

The analysis suggests that there is scarcity in sand supply because of the limited number of potential sources and the costs of freight. In addition, where sand has been allocated to use there can be significant local impacts.

7.1.2 Hawke's Bay

In Hawke's Bay we illustrate the issues using the gravel resource. Gravel is extracted commercially and to address flood risk, eg maintaining flood channel capacity. A Hawke's Bay Riverbed Gravel Management Plan (GMP) has been developed to "*sustainably manage*

[287] https://community.greenpeace.org.nz/petitions/mangawhai-pakiri-sos
[288] https://www.rnz.co.nz/news/national/466962/auckland-council-rejects-35-year-pakiri-sand-mining-bid
[289] Akehurst and Church (2019)
[290] This is estimated using a one-way transport distance of 55km for a 30-tonne truck, a freight cost of $0.34/km per tonne and a sand price of $35/tonne delivered to a concrete plant. This means a freight cost per tonne of $18.70, 54% of the sand price. The total cost range is estimated for 326,000 and 406,000 tonnes, which is a recent production figure and the maximum production estimate.
[291] Confusingly, they present this as a 27% increase in the costs of sand by halving the $0.34/t/km figure (assuming the costs are zero for the empty return trip) but then multiplying this halved number by the one-way distance. Despite doing this, their total costs are reproducible using the full price, eg 326,000 x $18.70 = $6.1m.

gravel extraction from rivers for flood protection purposes, and to ensure community safety while allowing for economic development without compromising cultural, social and environmental outcomes and values associated with the region's freshwater resources."[292] The Regional Council notes that managing riverbed gravel resources is a 'balancing act' of multiple considerations including:

- maintaining channel capacity;
- avoiding over-extraction and destabilising protection works;
- quality of gravel resource;
- avoiding unintended outcomes of promoting land-based abstraction or importing product into the region;
- financial and practical availability for extractors (transport costs, haul roads etc);
- resource management and stakeholder management; and
- environmental and recreational values.

Extraction of small quantities of gravel is a permitted activity. Consents are required for larger quantities (>0.25m^3) with slightly different processes depending on whether it is from within established Authorisation Zones, but the key assessment criterion is whether gravel can be extracted sustainably. Sustainability is determined through comparing takes with expected supply estimated from regular monitoring of the riverbed, computer models, surveys and analysis of past trends to predict or estimate future supply.

Because the southern (Ruataniwha and the Upper Tukituki catchment) rivers have excess gravel that needs to be managed, all allocations are required to take a fixed percentage of their total annual allocation from a southern river: 20% for the first year and adjusted each year to best manage the resource, with a maximum percentage of 25%.

7.2 Reform Expectations

Sand resources appear to have limited numbers of applicants for commercial use such that resource allocation reforms would have little potential for significant improvements in allocation efficiency, eg via trading. The more significant changes might be via short duration consents and use charges.

7.2.1 Short Duration Consents

Most uses of sand do not have significant investments in equipment for extraction. Largely the equipment used is mobile and could shift to another location and/or be sold after use. This means the main effects of shorter duration consents would be to bring forward the time of consenting costs and increase their frequency, resulting in higher average administration costs.

[292] Hawke's Bay Regional Council (2018)

7.2.2 Sand Resource User Charge

Resource user charges might be applied to sand deposits to compensate communities for the adverse impacts of extraction. The recent Auckland experience would suggest that there are few alternative supplies, or that those that do exist have significantly higher costs of supply. Resource user charges would enable the council to obtain a rental from the resource at a level that would increase the costs of extraction up to just under the cost of alternative supplies.

The downside of this would be the increased costs that would be passed on to construction projects, potentially adding to the total costs of roads, infrastructure and housing. The size of these impacts will vary with the nature of the project.

7.3 Potential Impacts of Reforms

7.3.1 Impacts Assessed

There would appear to be little potential for trading of sand extraction rights. The main impacts assessed for sand are from reduced consent duration and the introduction of resource user charges.

7.3.2 Wellbeing Impacts

We summarise possible impacts in Table 7-2 and outline this further below.

Table 7-2 Potential impacts of reforms on wellbeing from allocation of discharge rights to freshwater

Dimension	Benefits	Costs
Economic[a]		Reduced consent duration brings forward the time for new consenting costs and increases investment uncertainty.
Environmental	Potentially reduced extraction impacts if consumption reduces in response to price increases.	
Social	Resource user charges enable community benefits via shifting sources of revenue	Potential increased construction costs
Cultural	No significant impact from reforms	

[a] As with other resources, we use a very narrow definition of economic impacts here: that relating to impacts on the consumption of market goods, including via changes to income and wealth

The main financial impacts are expected to be from bringing forward the time of new resource consents. This also increases business uncertainty. Costs may be passed on in increased prices of construction materials which could result in reductions in consumption (and extraction), with some resulting reduced environmental impacts.

Other effects are from the potential use of resource user charges which might enable an alternative source of community revenue. Set against this, the impacts on construction costs may have adverse community impacts.

Apart from via price-related impacts on extraction and consumption, there are no obvious sand-related cultural impacts from the reforms.

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Annex A: Wider Use of Economic Instruments

Economic instruments are policy tools that provide incentives for changes in behaviour using market signals. They either change market prices (charges or subsidies) or introduce markets where previously there were none, eg through allocating rights to use resources and allowing owners to trade these rights (such as the emissions trading scheme or a system of tradable water rights). They are assumed to have a greater role in resource allocation.[293]

Objectives of Economic Instruments

Economic instruments can be used to meet a range of objectives, including:

- **Optimal levels of pollution** – when they are used to price discharges at levels equal to marginal damage cost (internalising externalities), firms are assumed to respond to prices such that everyone who consumes a resource values the consumption at least as much as the full costs the community bears in its supply;

- **Least cost achievement of objectives** – because they (1) provide flexibility to firms and individuals in how (and potentially when)[294] they respond, and (2) provide incentives at the margin (which ensures not only is the resource used in its highest value use but a resource user also optimises the amount of resource it uses).

- **Revenue-raising** – in comparison with other ways in which the Government raises revenue (eg income taxes which can distort levels of work away from what is optimal), charges on environmental impacts can result in improvements in wellbeing.

Types of Instruments

Economic instruments come in different forms, which include:

- **Charges** that impose a cost on activities or outputs and can be used to correct externalities, incentivise changed behaviour or to raise revenue. Charges can provide incentives to limit environmental impacts, but generally they do not provide certainty over the outcome.

- **Tradable Permits** introduce markets where previously there were none. In New Zealand the most well-known example is the Emissions Trading Scheme (ETS) for greenhouse gas (GHG) emissions. Tradable permit schemes come in two main forms:
    - Cap and trade schemes which, for emissions or discharges set a total allowable quantity (the cap) and distribute allowances to emit a portion of this cap; and

[293] See a fuller discussion in Denne (2018)

[294] For example, a number of cap and trade schemes allow banking or borrowing of allowances. A firm might emit more this year through "borrowing" an allowance to emit from next year; it then will have a reduced number of allowances to emit next year when it might choose to install abatement equipment.

- Credit-based systems which might require a particular environmental outcome, but which allow obligated parties to obtain a credit from somewhere other entity, eg the UK's Renewables Obligation enables companies that generate a MWh of electricity from renewable sources to produce a Renewable Obligation Certificate (ROC) that can be purchased and used to demonstrate compliance by local electricity suppliers with renewable supply targets. **Offsets** and **Transferable Development rights** (TDRs), both of which have been used under the RMA, are forms of credit-based system.

The economic effects of charges and tradable permits are broadly equivalent. They both introduce a cost at the margin, but charges provide greater certainty over cost whereas tradable permits have greater certainty over outcome. Subsidies are less economically efficient than the other economic instruments because typically they reward activities rather than outcomes so do not provide incentives for the full range of options to improve environmental outcomes.

- **Subsidies** are payments for desirable outcomes. They have been used in New Zealand to encourage activities including purchase and installation of insulation and clean heat.[295] Grants or subsidies are used by councils routinely, eg environmental grants, tourism trust funding, iwi funding, sports clubs, cultural groups, community events, and passenger transport subsidies.

- Some instruments combine charges and subsidies. These include **deposit refund schemes** (as proposed for packaging waste)[296] and **feebates** (as introduced recently via the Clean Car Discount).[297]

Recently, behavioural economists have provided more direct input to policy design in the form of "**nudges**"[298] which try to alter people's behaviour in a predictable way without changing their economic incentives. Nudges have started to enter the policy vocabulary in New Zealand[299] but are not limited by regulation.

Negative Effects of Economic Instruments

Regressivity

Economic Instruments can be regressive. Regressive is defined as when a tax or other policy measure imposes a greater cost (relative to their income or wealth) on the poor than on the rich. This occurs when low-income households or individuals are less able to avoid the costs imposed or are more likely to be subject to it.

This is a potential outcome of instruments aimed at improving the emissions from the vehicle fleet, because older, lower-priced vehicles tend to emit more. Research in New Zealand prior to the introduction of emissions regulations identified a number of possible effects, with potentially vulnerable population groups identified as older people, families

[295] Grimes et al (2012)
[296] Deposit refund schemes (DRSs) involve the payment of a deposit when a product is purchased. The deposit is repaid when the product is returned after use (see Ministry for the Environment 2022b).
[297] https://www.nzta.govt.nz/vehicles/clean-car-programme/clean-car-discount
[298] Thaler and Sunstein (2008).
[299] https://www.dpmc.govt.nz/our-programmes/policy-project/policy-methods-toolbox/behavioural-insights

with children, low-income households, Māori households, Pacific households, people with disabilities, and young people.[300]

Similar issues apply when lower income households have older heating or cooking equipment, and other household appliances, which are less efficient than newer appliances. Households will face greater relative increases in energy costs, including the impacts of emission charges.

To counteract these effects, recent subsidy programmes have been introduced, aimed at insulation and clean heat for lower income households.

Current Use of Economic Instruments in New Zealand

General

There are few uses of economic instruments for environmental or resource management purposes in New Zealand. There is no generic legislation that enables their introduction, and the Constitution Act 1986 (Section 22) states that the Crown can only levy a tax by or under an Act of Parliament. The definitions of a tax under New Zealand law are that it is: [301]

- compulsory,
- for public purposes; and
- enforceable by law (you can be prosecuted if you do not pay).

Regardless of whether something might be defined as a fee or charge, if there is no relationship between the amount paid and a service provided, and it meets these other criteria, it is defined as a tax.[302] Thus, most examples of economic instruments introduced in New Zealand have been under new legislation, including:

- the emissions trading scheme under the Climate Change Response (Emissions Trading) Amendment Act 2008 and amendments;
- the waste disposal levy under the Waste Minimisation Act 2008; and
- the Individual Transferable Quota (ITQ) system for fish stocks, originally under the Fisheries Act 1983.

Analysts have noted that the RMA allows the use of some economic instruments, although it does not particularly encourage or facilitate these mechanisms. One example under the RMA is the nitrogen discharge permit trading scheme at Lake Taupō.[303] In addition to the RMA, the main statutory instrument that defines the ways in which regional councils can or cannot use economic instruments is the Local Government Act (LGA).

Resource Management Act

The RMA was drafted during a time in which there was considerable interest in the use of economic instruments for environmental purposes. The original Section 32 of the RMA stated that local government must consider alternatives, assess the benefits and costs of

[300] Denne *et al* (2005); Colegrave and Denne (2006); Rose *et al* (2009)
[301] Bullen *et al* (2000)
[302] Bullen *et al* (op cit)
[303] Duhon M, McDonald H and Kerr S (2015) Nitrogen Trading in Lake Taupo. An Analysis and Evaluation of an Innovative Water Management Policy. Motu Working Paper 15-07. Motu Economic and Public Policy Research

objectives, policies, rules, and other methods. Councils should have regard to other means including "… the provision of information, services, or incentives, and the levying of charges (including rates)". Although this had required regional councils to consider economic instruments, it is not clear that it empowered them to use them;[304] there were no sections of the Act that provided any clear tools. An amended version of Section 32 removes the explicit reference to charges and incentives, stating only that local government should "…examine whether the provisions in the proposal are the most appropriate way to achieve the objectives."

Under Section 24, one of the functions of the Minister for the Environment is "the consideration and investigation of the use of economic instruments (including charges, levies, other fiscal measures, and incentives) to achieve the purpose of this Act."

One more targeted channel for using economic instruments under the RMA is the provision for introducing financial contributions. This tool is discussed further below.

Financial Contributions

Section 108 of the RMA states that a resource consent may require a financial contribution to be made. This might include payment of money or a land contribution (or some combination of the two). Financial contributions may be required for various purposes, including:

- offsets—providing funding for positive measures to improve the environment to offset adverse effects; and

- compensation—to mitigate adverse effects on the environment of use and development.

This is potentially a means for their introduction locally, but financial contributions are being phased out, and will not be used after 2022.[305]

Offsets

Offsets are mechanisms that allow environmental damage in one location to be compensated by environmental improvements in another location. They are a form of transferable or tradable permit. An offset requirement might measure the level of residual damage associated with an activity, eg biodiversity loss; a project would then be required to improve biodiversity elsewhere by the same amount, in some other location, using some agreed metric. Variants of this basic approach are those that:

- required the offset to have a greater positive effect on the environment (net gain); and
- are fully tradable, eg a market for offset credits rather than being project-specific.

[304] Bullen S et al (op cit)

[305] Ministry for the Environment (2017) Resource Legislation Amendments 2017 – Fact Sheet 4. Changes to the standard planning track (and related provisions).

In New Zealand, biodiversity offsets or biobanks[306] have been the offsets discussed most, including guidance on best practice.[307] The guidance has discussed the potential use of offsets under the RMA, the Crown Minerals Act 1991and the Conservation Act 1987.

Transferable Permits

There is limited current potential for the establishment of transferable or tradable permits under the RMA. In general, consents are transferable between landowners (consents run with the land), but not between types of activity or locations.[308] Currently there are three main ways transfers can occur.

- Coastal permits allow holders to use coastal areas for specified purposes (section 12 RMA), and may be transferred to another person, but not to another site, unless the consent or a regional coastal plan expressly provides otherwise (Section 135).

- Permits for damming or diverting water may be transferred only to owners or occupiers of the same site. Other permits, eg for taking water, may be transferred only if allowed in a regional plan and approved by the consent authority (Section 136).

- Discharge permits may be transferred to other sites, if this is allowed in a regional plan, and provided the transfer will not reduce environmental quality (Section 137).

Waikato Regional Council introduced a nitrogen discharge allowance trading system by a rule which classified nitrogen-leaching farming activities as controlled activities.[309] Historical data was used to define a permitted level of discharge from a specific land area, but these permitted discharges could be traded subsequently to enable an increase in the permitted discharge at one site, balanced by a reduction at another site.

Transferable Development Rights (TDRs) have been used in some regions to allow increased land use intensity as reward for amalgamation of rural properties or for desirable environmental outcomes, including preservation of native vegetation and wetlands.[310]

Rates

The powers to set and assess rates (property charges used to raise council revenue) are derived from the Local Government (Rating) Act 2002. There are two possible ways in which rates might be used to influence behaviour: differential and targeted rates. However, neither provide a clear basis for introducing economic instruments with the characteristics as discussed above.

[306] EDS (2017) The feasibility of a pilot biodiversity bank for New Zealand. A report by the Environmental Defence Society.
[307] Ministry for the Environment *et al* (2014) Guidance on Good Practice Biodiversity Offsetting in New Zealand.
[308] Guerin K (2004) Theory vs Reality: Making Environmental Use Rights Work in New Zealand. New Zealand Treasury Working Paper 04/06.
[309] Duhon M, McDonald H and Kerr S (2015) Nitrogen Trading in Lake Taupo. An Analysis and Evaluation of an Innovative Water Management Policy. Motu Working Paper 15-07. Motu Economic and Public Policy Research
[310] See Auckland Council (2022) for example

The New Zealand Society of Local Government Managers (SOLGM) advises that differential rates might be applied where there are differences in:[311]

- levels of service – if one group receives a higher level of service, or a higher share of benefits, then it should be charged more (this is one of the main reasons that section 101(3) of the Local Government Act 2002 requires a consideration of benefit);
- willingness to pay – if one group is willing to pay more than another group, a council might determine that that group should pay a higher rate; and
- cost – if the cost of providing a service to one group is higher than for others, they should pay more.

Targeted rates can be used to raise revenue for specific purposes from specific households who benefit from a service. They cannot be easily modified into a charge that targets specific outcomes or incentivises specific behaviours.

Summary: the Role and Potential for Economic Instruments

Economic instruments can provide incentives for the optimal allocation of natural resources, including damage to the environment. This is achieved when a charge (or tax) is levied on resource use (or its associated effects) equal to the marginal external cost. This ensures the private costs of resource use (ie those borne by the resource user) are equal to the full (social) costs to the community of that resource use. This approach does not guarantee a particular environmental outcome as it is uncertain how the company (or individual) facing the charge will respond.

Economic instruments can also be used to provide incentives for specific outcomes, eg by raising a charge to a level which changes behaviour sufficiently, or by using a tradable allowance or permit scheme in which a limited number are available on the market. The number available determines the total environmental impact, while the price to achieve this outcome is not initially known.

Economic instruments can achieve targeted outcomes at lower cost than other regulatory interventions because they provide flexibility in how outcomes are achieved, including who takes action and by how much.

[311] New Zealand Society of Local Government Managers (SOLGM) (2013) Rating Knowhow A Guide to the Local Government (Rating) Act 2002.