ENVIRONMENT

REFRESHING WATER

Valuing the priceless

Eric Crampton
Foreword by Te Maire Tau

THE NEW ZEALAND INITIATIVE

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About the New Zealand Initiative

The New Zealand Initiative is an independent public policy think tank supported by chief executives of major New Zealand businesses. We believe in evidence-based policy and are committed to developing policies that work for all New Zealanders.

Our mission is to help build a better, stronger New Zealand. We are taking the initiative to promote a prosperous, free and fair society with a competitive, open and dynamic economy. We are developing and contributing bold ideas that will have a profound, positive and long-term impact.

ABOUT THE AUTHOR

Dr Eric Crampton is Chief Economist with The New Zealand Initiative.

He served as Lecturer and Senior Lecturer with the Department of Economics at the University of Canterbury from 2003 to 2014 before joining the Initiative. He originally hails from a mixed beef, grain and horticulture farm in southern Manitoba.

He is co-author of several Initiative reports, including *In the Zone*, *Decade of Debt* and *Recipe for Disaster*. He holds a PhD in Economics from George Mason University and authors the popular economics blog *Offsetting Behaviour*.

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Foreword

French records tell us that in 1842 at Akaroa the Ngāi Tahu ariki, Iwikau, charged a French whaling ship, *The George*, £3 for water it had taken while ashore. When the French said they would respond with military action, Iwikau was confident his men had the firepower to fight back.[1] And why wouldn't Iwikau take this action? Two years earlier, he had signed the Treaty of Waitangi wherein the British Empire had assured him of his customary authority to Canterbury and the Banks Peninsula. And five generations earlier Iwikau's ancestors had gained ownership of the Rakaia River by trading two patu pounamu (greenstone clubs) and 10 kakahu (cloaks). Iwikau knew and understood that water fell under his mana and that water could be traded.

At some point in our modern history, New Zealanders created the fiction that customary rights and aboriginal title represented a communal paradise, where property rights did not exist and all resources were held in-common. Historical and anthropological records tell us that this was not the case with Māori or any other indigenous people. Nonetheless, we insist on persisting with a fiction that suits our world views wherein indigenous peoples are customary guardians and western commercial interests exist to exploit. We know that the reality is much more complex. Ngāi Tahu do have customary interests and believe water remains in its aboriginal title, yet they also have commercial interests. Likewise, Pākehā New Zealanders have evolved a heritage with our waterways while struggling to balance their commercial interests. The truth is we struggle with the Faustian pact of development while holding onto our values.

We need to put aside claims that no one owns water and that we are all guardians. This is not true from an iwi position of custom and it is not the case when dealing with 'English common law', which Blackstone said "depends upon custom". Neither is it the situation as it exists now – where consents issued by Regional Councils are property rights by any other name.

We know from the Deeds of Purchase by the settler government that the Crown did in fact purchase freshwater in some areas and in other areas it did not. As a result, the logical inference is that in some areas the Crown owns water and in others it does not. Where the Crown did not purchase water, then ownership of water still rests with Māori in aboriginal title and its 'tino-rangatiratanga' remains extant. This does not imply a problem, it simply means title sits with the iwi not the Crown. The different rights that are claimed, whether they be custom or common law, are simply rights that need to be managed.

Clearly, when the settlers arrived to farm their new land – purchased for them by the Crown from Māori at a ridiculously low price – they would have naturally assumed the right to use water for domestic and agricultural purposes. It's an entirely reasonable assumption. What was unreasonable was the diversion of water for agricultural purposes from tribal lands and the drainage of lagoons and lakes despite Court orders that there was to be 'an undisturbed flow of water'.

It's obvious that iwi have rights to water. It is equally obvious that early settlers established rights to water after the land purchases. The current problem is with management – the *Resource Management Act* failed to understand a fundamental design principle when dealing with resource management and that is clarity over rights.

To this end we need to simply accept that the *Resource Management Act* has created rights to water for different sector groups in New Zealand, and it does not matter whether it is a water bottling plant in Christchurch or a dairy farmer on the Canterbury Plains. Both contribute to the New Zealand economy. But we also need to be clear that the development of an agricultural economy has destroyed the aquaculture economy that existed for Ngāi Tahu in lakes such as Te Waihora and Wairewa. It is also obvious that selling water to the French was a right that belonged to Iwikau.

How we accommodate contesting interests is our challenge. *Refreshing Water: Valuing the Priceless* draws on previous work by John Raffensperger and Mark Milke (SMART Markets for Water Resources) and helps focus debate. This work brings fresh thinking and innovative process to determining a sustainable management solution to an issue deemed by most New Zealanders as a priority for this country.

Te Maire Tau
Upoko, Ngāi Tūāhuriri Rūnanga,
Tuahiwi Marae
Associate Professor, Ngāi Tahu Research Centre

Executive Summary

New Zealand deserves far better water management. Scores of newspaper articles and rigorous reports lay out the problems in the current system. Too much water is being drawn in some catchments – to the detriment of aquifers and rivers. Management of contaminants flowing into the rivers is haphazard and too-often poor. While agricultural runoff into rivers and streams has drawn much attention, urban areas are far from blameless.

The Land and Water Forum's most recent advice to Ministers summarised the problem well. Minister for the Environment David Parker in October 2018 committed the government to a two-year agenda for creating an improved freshwater management system.

Improving water management is both good policy and politically necessary. The costs of achieving desirable environmental standards will rise if water quality is allowed to continue to degrade. Not only will the real environmental problem become more costly to solve, but the most effective policy options may also become more difficult to implement. Reactive, costly, and less effective policy will be more likely the longer we wait.

This first report of a two-part series does not seek to re-tread ground already well covered elsewhere. We here instead explore a promising option for ensuring environmental sustainability that respects Te Mana o Te Wai and the economic needs of our communities. We also believe it to be the best way for the government to achieve its objectives in stopping further degradation and loss, and reversing past damage.

The *Essential Freshwater* work programme proposed by the Ministry for the Environment includes addressing water allocation issues to efficiently and fairly allocate freshwater and nutrient discharges.

Successive governments' failure to address iwi water claims, we believe, is at the root of our water woes. Real solutions raised the spectre of costly Treaty claims, and so were avoided. Whether iwi claims can be resolved through negotiations towards regulatory solutions or a full Waitangi Tribunal processs, we believe the game is worth the candle.

Recognising iwi claims is important for its own sake. It is hard not to view rivers as taonga under the Treaty of Waitangi. Reasonable cases have been made that iwi water rights, at least in some catchments, were not extinguished by treaty, sale or contract – although we here hardly claim to resolve any of these claims. We note rather that resolving rights issues around water is an essential part of natural justice. And it can also be the foundation for a better water management system.

Water scientists can tell us the effects of drawing different amounts of water from New Zealand's aquifers and rivers. They can assess whether current rates of water abstraction are sustainable for the long-run health of aquifers, or whether they erode our resources over the longer term. Those assessments are factored into Regional Council plans and inform resource consent decisions.

But what even the best scientists cannot tell us is how best to use water drawn from New Zealand's rivers and aquifers. If a council is faced with two competing resource consents for water drawing and there is only enough water sustainably available for one of those uses, or if

a catchment is overallocated and total use must be cut back, how should it decide? First-come, first-served hardly seems the best solution.

Similarly, while freshwater ecologists can tell us the effects of any nutrient loading on a catchment, they cannot tell us whether it makes more sense to reduce the load on an overburdened catchment by reducing the number of dairy farms, by changing on-farm practices, or by improving the nearby town's wastewater system.

Science is critical in establishing the boundaries. But we need more than that to help us figure out how to achieve environmental goals, to build a self-reinforcing political consensus around sustainable outcomes, and to make sure long-term sustainability is in everyone's interest.

America faced a similar problem with sulphur dioxide emissions in the 1980s. Science showed that industrial emissions were overburdening the atmosphere, causing acid rain. It also showed by how much emissions needed to be cut to solve the problem.

But science alone could neither say which factories should close nor which chimneys should install scrubbers to remove pollutants. Policy needed to create incentives for the owners of all these factories to harness their knowledge about their own plants for the public interest in ending acid rain.

How did America end acid rain? Scientists set a cap on allowable emissions. Factories emitting sulphur dioxide were given tradeable permits within that cap. Factories able to cut their own emissions relatively cheaply did so – and sold their valuable excess permits. Other plants that found it more expensive to cut emissions bought surplus permits. And the dirtiest, hardest-to-fix, end-of-life plants could shut down earlier than planned, selling their surplus emissions permits in the process.

Giving existing emitters tradeable emissions permits transformed likely opponents of stricter environmental standards into stakeholders. Later estimates suggested it would have cost $250 million more per year to achieve the same reduction in sulphur dioxide emissions through more traditional regulation.

New Zealand's lakes, rivers, aquifers and bays deserve better management. Doing the most to improve environmental quality requires using the most cost-effective policy tools available.

In this first report, we argue that catchment-level cap-and-trade systems for water abstraction, incorporating both urban and rural water uses, are the best approach for managing water supplies in catchments where water is becoming scarce.

Well-designed and enforced cap-and-trade systems are highly effective in ensuring environmental sustainability. They can restrict water drawing to levels consistent with flowing rivers and aquifers that maintain their levels over time. And they build a constituency that helps ensure the system's sustainability in the longer term.

Our second report will examine the more technically challenging case for cap-and-trade systems for nutrient management. In principle, cap-and-trade systems can ensure emissions are within the bounds set by the catchment's community, keeping rivers, lakes and bays clean. But where cap-and-trade in water abstraction faces policy difficulty in deciding how to allocate initial water rights, nutrient management faces the additional task of defining the tradeable unit in environmentally and economically meaningful ways.

Recommendations

1. Central government should take on the initial set-up costs for system development and implementation.

2. Initial catchment-level caps should not be lower than current use, and should incorporate room for allocation to iwi. We suggest an initial trial in Canterbury.

3. Initial allocations to current consent-holders, whether agricultural, commercial, industrial or urban, can provide permanent tradeable rights, longer-term but non-renewable rights, or a bundle of non-renewable annual rights extending over the same period.

4. The burden of reductions from those initial caps to sustainable limits should be shared between water users and the broader community through a combination of Crown purchases and retirement of allocations, and by a structure of initial allocations that reduce the rights held by current users over time.

5. Sustainable catchment-level caps should be determined by the local community, iwi and hapū. They should be informed by strong environmental science, and by information revealed over time by the trading system.

6. Crown-iwi negotiations could define the minimum river flows consistent with Te Mana o Te Wai as being the self-owning river, as in Whanganui, with similar trusteeship rights. The trading system would protect those minimum river flows. Additional water rights awarded to local iwi and hapū above that minimum flow could be left with the river, or traded.

7. Effective cap-and-trade systems require binding and environmentally meaningful caps. Those require effective monitoring and enforcement activity. Appropriate structure of the initial property rights can reduce enforcement costs.

CHAPTER 1

Setting the stage

1.1 Our vision of better environmental outcomes

New Zealand deserves a clean, sustainable environment. Our aquifers and lakes should be sustainably managed to ensure our children and grandchildren are able to enjoy an abundance of clean water at least as good as our own. The deterioration in water abundance and quality in some catchments must be reversed. Water can continue to be drawn from the aquifers, but the rate of draw should, over the long term, match aquifers' replenishment rates. Nutrient accumulation in aquifers and lakes should not reach levels that compromise water quality.

Clean water should flow in our rivers. The effects of drawing water from our rivers and aquifers on water flow must be considered when setting allowable draw rates, with hard environmental bottom-lines. The effects of nearby land use on the river's nutrient loading must be weighed. And Te Mana o Te Wai, the integrated and holistic wellbeing of the water,[2] must be respected.

These ideals are hardly controversial; they are already broadly incorporated into current freshwater management practice, at least aspirationally. And they are reflected in the Coalition government's *Essential Freshwater* programme.[3] But in many places, we are far from where we need to be.

At the same time, the wishes of the community within a catchment should have standing – different communities face different trade-offs in achieving environmental standards.

1.2 Summarising the problems

New Zealand's problems in water quality and water management are hardly secret.

The Land and Water Forum, a stakeholder group with members across a broad range of interests in freshwater policy, has produced numerous substantial reports over the past decade covering the main issues.

The Forum's inaugural 2010 report, *A Fresh Look at Fresh Water*,[4] listed disputes around water scarcity, water infrastructure development, agricultural run-off and farm intensification, urban water discharge, funding of infrastructure, iwi rights in water, and iwi's role in water management. It pointed to difficulties in setting and managing limits – and who should bear the costs of any consequent reductions. And it noted the problems caused by first-come, first-served water allocation systems that make it difficult for those late to the game to make the best use of their land where Councils may simply not grant new water consents.

In the decade since, those fundamental issues have not changed.

In May 2018, the Land and Water Forum[5] responded to a request from the Minister for the Environment and the Minister of Agriculture for advice on avoiding further degradation in water quality, better managing nitrogen loadings, and on how central government could assist in regional implementation.

Box 1: Foundational steps towards nitrogen discharge allowance allocations

Before allocating nitrogen discharge allowances, other than as part of an interim management arrangement, a series of foundational steps must be taken:

1. Limits must be set that recognise and provide for Te Mana o Te Wai, taking into account the spatial variation in biophysical characteristics of waterbodies.
2. Iwi rights and interests in water need to be resolved.
3. A robust catchment accounting framework must be available that will enable councils to identify and account for all activities that individually and cumulatively make more than a minor contribution to the catchment load.
4. GMP [Good Management Practice] and extension practices must be clearly defined and understood, steps must be underway to ensure compliance with them within prescribed timeframes, and approved auditing schemes (including Audited Self-Management) must be in place to ensure adequate accountability for implementing required practice changes effectively.
5. A nationally consistent procedural framework to guide regional nitrogen allocation decisions must be available, along with a nationally consistent framework enabling the transfer of allowances between users.
6. Programmes must be underway to improve capacity and capability across land users, central and local government agencies, and sector groups.

There must be an integrated freshwater management information framework in place that, among other things, identifies and prioritises gaps, identifies opportunities to feed Mātauranga-derived knowledge into decision-making, defines agreed national data standards, and increases knowledge on nitrogen leaching and attenuation rates.

Source: Land and Water Forum (May 2018).

The Forum noted that while regional plans incorporate nitrogen management plans "to a greater or lesser extent", managing the effects of nitrogen discharge remains "ad hoc", costly and ineffective; there remains uncertainty about whether existing management plans are enough; and systems for transferring discharge permits need to be agreed upon. They also again highlighted the importance of resolving iwi rights and interests.

All of it amounts to a hard problem. The difficulties were again canvassed in the Ministry for the Environment's *Essential Freshwater* report of October 2018.

Better management requires setting catchment-level limits, or caps, on total water abstraction and on total nutrient emissions in line with environmental sustainability requirements. Setting the caps is inherently fraught where the positions of existing consent holders are threatened. In catchments where the water take or nutrient load is unsustainable, caps will be binding and require reductions. Those expecting to bear the costs of those reductions are an automatic constituency against imposing binding caps.

Even a system that perfectly protects the rights of existing water system users can denigrate the rights of others: Under a binding cap that allocates emissions and abstraction rights to existing users, owners of land without water or emissions rights will find it far more difficult, or more costly, to change their land use. They risk locking in the inequities built into existing first-come, first-served allocations,[6] often to the detriment of Māori-held land.[7]

Shifting to any management system with binding caps on water abstraction or nutrient emissions will require finding an allocation system that can balance the rights of existing users and those of potential future water users – a politically difficult problem. It will also require monitoring of dispersed emissions to ensure compliance with any catchment-level cap. And it will require reasonable modeling of how different types of land use in different parts of the catchment affect the catchment over both the short and long term.

These problems are common to all management systems that impose a hard cap on catchment-level water draw or nutrient emissions. And they are recognised in the Coalition Government's *Freshwater Management* approach. We will argue that some of these problems can be eased through our proposed trading mechanism.

Further political problems have emerged as a consequence of water's odd non-property status.

Water bottling plants cannot extract water from aquifers without resource consent, which is often tied to existing land available for purchase by potential bottlers. The value of the existing consent and expected consent renewals is then incorporated into the purchase price of the land, to the benefit of the owner who secured the drawing rights originally – or to the benefit of councils if Council-owned land with water drawing rights is sold to a water-bottling company.

Because there is no visible payment for the water by the new user, and because there will typically be no resulting royalty stream to Council or Crown, bottling is easily seen as a giveaway of New Zealand's increasingly scarce water resources. New bottling plants can then draw far more vehement opposition than dairy intensification, despite bottling plants not having downstream effects through nutrient emissions.

Finally, while some limited trading exists in the Canterbury Plains for water drawing rights, and in the Lake Taupo catchment for nutrient emissions rights, for example, the costs of trading are high. Waikato Regional Council's 2011 Regional Plan implemented a cap-and-trade system covering nitrogen emissions in the Lake Taupo catchment – to reasonable success.[8] Water trading in the Canterbury region averaged 2.8 million cubic metres of water per year from 2014 through 2017.

But buying rights requires finding a seller, then making application to Council to demonstrate that the shift in resource use from one part of the catchment to another involves comparable imposition on the system. Drawing water from the aquifer or river in one place will have different effects on the aquifer, other users, and surrounding rivers than drawing water from another place. Any trading scheme that does not automatically incorporate these effects requires more bespoke evaluation of trades. And high transactions costs reduce potential gains from trade.

To summarise the relevant problems:

- Adequate management requires catchment-level caps on water drawing and on nutrient emissions in catchments approaching or overtaking environmentally sustainable levels of resource use. The costs of reducing total nutrient emissions or total water abstraction can be high in overallocated catchments. Implementing caps has been difficult not only because the underlying science is hard, but also because caps have unresolved distributional consequences. Whoever bears the cost of a cap has reason to oppose a cap.
- Iwi water rights remain unresolved.[9] Resolving iwi water rights is important in its own right, and may be critical in shifting to any management scheme that sets catchment-level nutrient or water-draw allocations. We understand that the more that permission to draw water or emit

nutrients resembles a property right, the more likely it is to trigger litigation. We are hopeful the Cabinet Paper supporting the government's approach is correct in that these allocation issues can be resolved by negotiation with iwi,[10] and would not require a full Waitangi Tribunal approach.

- Current trading in water and emissions permits is limited by high transaction costs. Consequently, land and water may not be put to their most highly valued uses. As Chapter 2 shows, trading makes it easier to attain any desired cap on use.

We hardly pretend that these are the only problems in water management. But they are an important part of the problem, and a part we think can be improved through the proposal we here develop.

CHAPTER 2

Managing for sustainability

2.1 Managing scarcity

When water is abundant relative to human needs, and when the flow of water is high relative to any effluent discharge, environmental management is easy because there is no particular environmental problem. Water can be managed simply under riparian 'reasonable use' standards because most uses have little effect on anyone else or on the environment.

As demands on the system increase, so too does the need for catchment-level management. Riparian rights to water quality are relatively easy to enforce when pollution stems from identifiable point-sources. If an industrial plant pumps effluent into the stream from which you draw water, it is easy to figure out the cause and to seek redress through the courts. That is rather more difficult when dispersed emissions from multiple sources affect users downstream. Management then shifts from riparian systems to regulatory systems where drawing water from aquifers and rivers comes under catchment-level management plans, and diffused emissions become subject to regulatory control.

But when loading on the system becomes even more intense, regulatory approaches focusing on best-practice methods for reducing nutrient emissions or on better irrigation practice start hitting against hard walls.

A well-functioning system might be able to make sure every farm follows best practice, and that every town has the sewerage system that is right for them. But it will have a hard time making choices across competing water and land uses. It is hard for a planning system to tell whether it can do the most good for the local environment by further restricting nitrate emissions on all farms, or by encouraging different land use choices on land where nutrient emissions are particularly damaging for the broader environment, or by encouraging the local town to upgrade its stormwater system. In a dry year, for any amount of overall sacrifice that water users in a catchment collectively make to protect the aquifer, does it help more to have urban water users scale back on car washing and lawn watering, or to encourage farmers to de-stock?

When users face very different costs and opportunities in changing their practices to improve environmental quality, and when those users' circumstances are hard for a Council or regulator to discern, a different approach to environmental management is needed. Better management then requires setting a system so users appropriately incorporate environmental costs into their own decision-making, so the choices that are right for them do not damage overall sustainability.

Two basic economic approaches can then work. Environmental taxes can be used to ensure that those imposing costs on the environment bear those costs in mind when making their decisions. Quota-based systems can be used to ensure that the burden on a catchment never exceeds set limits. Both systems harness water users' knowledge of their own particular circumstances to help encourage better water use.

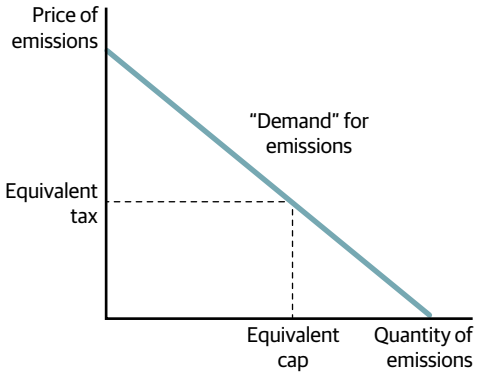
2.2 Control prices or control quantities?

Prices and quantities are two sides of the same coin. The interaction of buyers and sellers in any market will determine both the price at which

any good trades and the quantity of the good on offer at that price.

When economists think about managing externalities like pollution, or protecting aquifers by limiting the amount of water taken from them, they think of how price controls and quantity controls can achieve similar objectives.

Figure 1: Tax and quota cap equivalence



Source: Paul Krugman, "Unhelpful Hansen," *The New York Times* (7 December 2009).

If the government implemented a tax on drawing water, that tax would affect the quantity of water drawn from the aquifer; a high tax does more to reduce quantities drawn than a low tax. The amount of water drawn decreases in the tax charged, and any chosen tax will have an associated expected quantity of water demanded.

Government could equivalently set a limit on the amount of water that could be drawn from the aquifer. If the limit is tight relative to demand, then the right to draw water will attract a high price; if the limit is greater than the amount expected to be drawn, the right to draw water will be priced at zero. Every quantity cap will have an associated expected price of water – even if water is not itself explicitly traded.

If the right to draw water comes through a resource consent tied to a particular piece of land, the price of that land will increase to reflect the high value of water. If the water drawing right is instead independently tradeable, then the price of water will be set as those with consent to draw water trade those rights with others who wish to be able to draw water.

Distributional issues associated with the choice of a tax or a tradeable quota system are very important (see Chapter 4). But there are also important environmental sustainability considerations.

To put it simply, the choice between taxes and quantities depends on how easily the government can determine the levels of water abstraction or nutrient emissions a catchment can sustainably withstand, and how easily it can foresee how users would respond to different prices. Economists generally recommend taxes in cases where the cost that an activity imposes on the environment does not change much with the scale of the activity, and recommend quotas instead when environmental costs can scale up rapidly with smaller changes in use.[11] If it were difficult to predict the quantity of water drawn or nutrients emitted under a tax or royalty scheme, or if costs of use above predicted levels quickly became very high, then controls on quantity are simply more consistent with meeting environmental targets.

To put it most simply, if demand for water exceeds government expectations under a water tax, it would be easy for a catchment's total water draw to far exceed the catchment's sustainable limits. The cost of each extra litre drawn under those circumstances will well exceed the imposed tax.

Quota-based systems set an overall cap on the quantity of water that can sustainably be drawn from a catchment (or of the quantity of nutrient emissions), apportion it across users or potential users, and then allow trading of emissions or water drawing rights. Smart water markets can improve on that by ensuring a broader range of environmental limits are respected and by reducing the cost of water trading (see Chapter 3).

Box 2: The acid rain programme

Tradeable rights in sulphur dioxide emissions massively reduced the cost of abolishing acid rain in America in the 1990s.

Sulphur dioxide emissions from power plants caused acid rain; getting rid of acid rain required substantial reductions in sulphur dioxide emissions. The Acid Rain Programme, enacted as part of the amendment to the Clean Air Act in 1990, aimed to reduce emissions to half their 1980 levels. It did so using a cap-and-trade system.

During the first phase of the cap-and-trade system from 1995 to 1999, the dirtiest 263 power plants were required to participate. During the second round, the system was extended to all substantial coal-fired plants – some 1,100 in total. Plants were able to comply with the cap-and-trade system's requirements by buying additional emissions permits or by reducing their own emissions – either through improved practice, or by shutting down.

H. Ron Chan, et al. estimated that it would have cost, in 2002, between $211 million and $236 million more per year to comply with the cap on emissions if every plant had been required to make proportionate reductions in emissions rather than being able to trade in emissions permits.[11] They also note that since the cap had not yet fallen to its final level by 2002, savings in future years would have been larger; Curtis Carlson, et al. suggested that annual savings would reach more than double that level.[12]

Because the acid rain reduction programme focused on reducing the total burden of sulphur dioxide in the atmosphere, it did not guard against any localised harms if emissions became concentrated in some locations through the trading mechanism. Sulphur dioxide can also be a substantial contributor to local air pollution. Trading worked to concentrate emissions, and harm health, in West Virginia, parts of Pennsylvania, Northern Virginia, and Maryland.

The main lesson for trading in water and nutrient emissions: Trading can dramatically reduce the cost of achieving sustainability, but can require either complementary regulation if emissions come with localised harms invisible to the trading system, or better accounting for those harms within the system.

Tradeable allocations provide strong incentives for environmental improvement.

If a farm following current best-practice methods for nutrient management found cost-effective ways of further reducing its environmental footprint, it would have little incentive to do so under traditional regulation.

Under a tradeable quota system, that farm could sell some of its valuable existing permits back into the system or use the nutrient cost savings to expand its operation. If another farm imposed a heavy nutrient footprint despite following best-practice methods, it could either buy permits from the system if doing so made business sense, or shift to other land uses that imposed less burden.

These systems encourage people to change land use when the environmental benefits of doing so are substantial.

Quota systems also build constituencies of users with a vested interest in maintaining environmental sustainability. The value of every owner's water drawing right or emissions permit is eroded if the system is not adequately monitored and policed.

2.3 Tradeable permits for sustainable water use

Tradeable permit systems for water use are not a new recommendation for New Zealand water management. As early as 1995, Susan Begg recommended greater use of tradeable water permits in catchments where water is scarce relative to demand, with minimum river flows established through administrative means, and allocation of tradeable water permits as part of Treaty settlements.[14] A 2004 report to the Ministry for the Environment by CSIRO Land and Water recommended trials using economic instruments, including tradeable quota systems, to help manage water pollution.[15] Kevin Counsell and Lew Evans' 2005 "Essays on Water Allocation in New Zealand: The Way Forward"[16] surveyed the international literature and international experience with tradeable rights regimes and recommended policy changes to improve the tradability of water. The Ministry of Economic Development in 2006 recommended enhancing water tradability.[17] The Land and Water Forum's Third Report, in 2012, also highlighted the benefits of tradeable water rights,[18] as did NZIER's 2014 report on water management.[19] Finally, the government's current *Essential Freshwater* framework notes the potential for trading regimes to assist in driving change.[20]

Work by Sapere, commissioned by the Iwi Advisors Group, provided rough estimates of the value at stake in shifting to a tradeable water rights regime for drawing water. For the cost of some $50 million to implement a tradeable permits regime, and an annual running cost of some $30 million, New Zealand could expect approximately $370 million in economic benefits from better water use, and benefits of more than half a billion dollars during droughts – among other benefits.[21]

Tradeable quota systems have a distinct advantage over other catchment-level caps on water drawing or nutrient emissions: They make it less costly to achieve any desired reduction in environmental burden, or, equivalently, they allow the achievement of greater environmental benefit at the same cost.

Under a tradeable rights regime, those users with the greatest ability to achieve reductions in their environmental footprint have strong incentives to do so. A farm able to reduce its nutrient profile, even if it already owns permits for its current levels of nutrient emissions, can profit by doing so if the costs of reducing emissions are less than the value of the permits. It then can earn more by selling its nutrient emissions permits and reducing its emissions profile. Even if a farm with sufficient emissions rights *could* continue on a business-as-usual basis, it would forgo the profits it could achieve by improving its practices and selling those permits. The publicly listed price of permits would sharply illustrate the potential benefits of improving on-farm practice.

Because a tradeable rights regime provides the strongest incentive to reduce environmental burdens to those most easily able to do so, the regime can more easily achieve any desired reduction in water use or nutrient emissions.[22]

If ensuring environmental sustainability is the primary consideration, cap-and-trade systems seem best able to meet desired environmental targets while guarding against the environmental costs that might result if policymakers underestimate demand under a taxation-based system.

But as Kevin Counsell points out,[23] revenue-raising may be an additional consideration. Crown and councils face real costs in environmental management; cost-recovery from water users may be a desirable policy goal. And those viewing water as currently being unowned may see any free allocation of water or emissions rights as being inequitable. These allocation issues are important, but hardly insurmountable (see Chapter 4).

Tradeable rights offer advantages both to environmental quality and to rights-holders. While trading within existing consents is allowed in current freshwater management, it is far from simple.

Work by the Ministry of Economic Development in 2006[24] detailed the difficulties in trading in water allocations. Buyers and sellers need to find each other and ensure that the seller's consented right to take and use water for particular purposes is consistent with the buyer's intentions for the water. Their proposed trade must be approved by the consent authority. Because rights are poorly specified, sellers may worry that the sale of a limited-duration consent may hinder future consent renewals.

Better trading regimes for water abstraction seem eminently feasible and will be discussed in more detail in Chapter 3.

Cap-and-trade regimes for nutrient emissions involve more inherent complexity, as will be discussed in the Appendix and in future work.

CHAPTER 3
Smart and sustainable

Markets emerge when we need them, if we let them.

In the absence of scarcity, there is no point in incurring the cost of developing and enforcing property rights. When scarcity becomes a substantial problem, defined property rights can help manage it. If there is little need to trade, then barter arrangements and bespoke trading mechanisms can suffice; there would be little point in establishing the New York Stock Exchange to handle a handful of transactions per year. But as opportunities for trade increase, it makes more sense to invest in systems that help make trade easier.

As more New Zealand catchments face real and binding environmental constraints, restricting the amount of water that can be drawn and the quantity of nutrients that can be emitted is necessary to avoid substantial environmental harm. As those constraints become tighter, the potential gains from trading within those capped allocations increase. And it can become worthwhile to develop systems to simplify trade – at least for larger catchments like Canterbury and Waikato.

Enabling trade is most important when water becomes increasingly scarce. Reducing water use to sustainable levels is most effectively done when those with the greatest ability to reduce their own use have the strongest incentive to do so. Trading enables those doing good to do well.

America's cap-and-trade regime in sulphur dioxide demonstrates how trading can allow an environmental goal to be achieved at lower cost, or how achieving stronger environmental protection can become more affordable.

Achieving those advantages is easier when trading is simple and effective. Water and nutrient trading currently is a lot more like the old classified ads section in the newspaper than like TradeMe.

But it can be much better.

John Raffensperger and Mark Milke developed the model for a smart water market system that does more than just swap the old classified ads for Trade Me – it also bakes environmental sustainability into the DNA of the trading system.[25]

How does it work? Let us view it first from the perspective of the user, then step back to see how the model achieves environmental sustainability.

Water users within a trading catchment log into the electronic trading system. They can submit bids to purchase water allocations from others, or offer to sell water from their own allocation. A user could even offer to sell much of their water allocation if the price is high enough, or ask to buy large amounts water if the price is low enough, and scale their buy-and-sell orders at prices in between.

After the market closes, the trading system runs. Every user is informed what the price is likely to be and asked to confirm their buy and sell offers around that price. The system runs again, tells everyone the price of water at their location, and how much they were able to purchase or sell.

Running in the background are hard environmental constraints. Hydrological mapping lets the system know the effects of drawing water from aquifers and rivers at

different places within the catchment. It then incorporates the downstream effects of upstream water drawing into its workings – and generates different prices for water at different places in the system.[26] It also ensures that any trading outcome is consistent with rivers being able to meet a minimum flow constraint, with the maintenance of sustainable aquifer levels, and with aquifer pressure at sea level remaining high enough to prevent salt-water incursion.

This kind of smart-market trading can be transformational. Currently, water trading requires buyers and sellers to find each other to structure their transaction to suit their needs, and to bring the proposed trade to Council for approval. Council needs to check the proposed trade to ensure it does not result in overallocated catchments or other adverse consequences because water drawn from different places can have different effects. And all this is complicated by a water consents system that ties the right to draw water with particular water uses.

Separating the right to draw water from the right to use water in particular ways makes it easier to trade in water. With the smart market system incorporating hydrological mapping, trades do not need any separate approval process.

All substantial water use would be incorporated within the system, including water abstraction for urban residential, agricultural, industrial and commercial purposes – although not all water users would need to actively participate in the system. Councils able to reduce urban water use, for example by metering water use and repairing leaky pipes, would immediately see financial benefits because they would be able to sell their surplus water within the trading system.

As an added benefit, the system automatically creates information about the potential cost of increasing river flow above the guaranteed minimum flow.[27] Doing the most good possible for the environment and the country as a whole requires knowing where the greatest opportunities lie.

3.1 Looking out for the long term

Information on how scarcity in water is likely to change over time can be critically important for councils deciding on water infrastructure investments, farmers deciding on land use investment, and environmental managers assessing future pressures on the system.

Economist Alex Tabarrok describes prices as a signal wrapped in an incentive. The price of tradeable permits for water incorporates water users' expectations about both current and future water scarcity. Information provided by the price of water in five or 10 years, as revealed in futures markets, can guide investment decisions today. And trading in future water allocations can also help finance important infrastructure investments.

The smart-market system described here could easily incorporate futures markets that trade in future water allocations.

Consider two examples illustrating the potential benefits.

Councils face tight infrastructure budgets and difficulty accommodating urban growth. Fixing leaking water supply pipes is important for aquifer sustainability, but it might not be a particularly high priority for councils up against their borrowing limits, or for Council water bodies struggling to meet demand for a new service.

If fixing water pipes, or installing water meters at all properties,[28] meant Council needed to use less of its water allocation for the next several years, Council would have water to sell into the trading system after the infrastructure improvements were completed and water savings

achieved. Kapiti has found that metering water use reduced its draw from the Waikanae River by more than 1 million cubic metres in the first year of the scheme's operation – about a 26% decrease in water use.[29] Currently, Councils only have financial incentives to make those kinds of improvements if doing so means Council does not need to increase capacity in existing pipes. The water that leaks out of Councils' pipes costs Councils nothing, but can be costly for the aquifer.

Councils could fund some of the up-front costs of water meters or infrastructure improvement by selling some of the resulting water savings on the futures market, raising funds today from tomorrow's water savings.

Futures prices in water could also help determine whether the business case for irrigation schemes stack up.

Currently, irrigation projects like Waimea are financed, in part, by shareholders purchasing a permanent right to draw water from the irrigation scheme.[30] But it is hard to tell how to value those shares without good information about future scarcity. And water shares are lumpy: they are a permanent right to an annual portion of the scheme's available water. Some water users may only need the scheme's water in 10 or 15 years' time rather than today, and could not justify the investment.

Futures markets would make it easier for irrigation schemes to sell water rights for particular future years rather than permanent rights. Users needing water only 10 years after the project's completion could buy that water on the futures market, or sell their first 10 years' allocation from a permanent share on the futures market. All these options would allow irrigation schemes to bring forward more of the future value of the water they would provide, helping fund the construction of the project. And prices in those futures markets would help investors decide whether any proposed scheme were likely to be profitable, or to fail.

3.2 The sustainable vision

At this point, it may be worth sketching out what future sustainability could look like under cap-and-trade water management systems, to illustrate the potential.

All substantial water use, whether agricultural, industrial or residential, would be covered within the cap-and-trade systems.[31] Science and community values would together inform the catchment-level caps and minimum river flows.

Farmers developing better ways of mitigating emissions, or switching to less-intensive forms of land use, would be able to sell their nutrient emissions credits within the system, providing stronger incentives for sustainable management. Water bottling plants wishing to export water would have to purchase water drawing rights just like any other water user. If a town in the catchment were able to reduce its water use, it would have valuable credits to sell back into the system; if heavy rain meant sewage overflowed into the river and ocean, the town would have to purchase emissions credits for the outflow the same way a farm would need to purchase credit for agricultural emissions. The business case for doing the right thing would be far more obvious.

Most importantly, the system would be sustainable. The hard constraints built into the system would ensure trading helped achieve the catchment's environmental goals. While nutrient trading is left for future work, we note that in catchments like Canterbury, attaining catchment-level caps on water use has the potential to alleviate nutrient outflow from lower quality soils by encouraging changes in land use – in short, some thin soils may only be suitable for dairy use when water for irrigation cannot flow to more highly valued uses.

CHAPTER 4

Allocating for sustainability

Any catchment at or near its environmental limits faces allocation issues, whether it recognises them or not. Catchment-level caps on drawing water and on nutrient loading are the best way of achieving sustainable outcomes. But every approach capping total emissions, or total water drawn, winds up allocating scarce rights one way or another.

These allocation issues have thus far stymied reform. Existing water users, whether with current consents for water abstraction or de facto use rights, resist changes that they would view as an uncompensated taking; users locked out by historic first-come rights allocations would be further hurt by allocations that entrenched prior arrangements; and iwi claims must be recognised and settled.

Recognising all these claims would mean underallocated catchments could quickly become overallocated, and overallocated catchments would require even more substantial reductions to attain sustainable limits. Failing to recognise all these claims would harm those whose claims were not recognised.

The allocation issue then raises fundamental questions. How should the burden of achieving sustainable use be shared? And how should we think about existing use rights?

We can illustrate most simply with a concrete example.

The New Zealand government has maintained that resource consents to draw water are not property rights. They are limited in duration, and nothing requires their renewal. Councils can choose not to renew irrigation consents. In that view, consents are a public permission that can be withdrawn, rather than a right. And the *Resource Management Act* specifies that they do not have legal status as property.

But consents are being treated as property rights by those holding them. Custom and practice, including market valuation and limited trading, suggest there are property right features of existing consents. If water rights are not property, how can they currently be traded? How can banks issue mortgages predicated on farm valuations that include the value of the attached water right?

Where the right to draw water is tied to uses on particular pieces of land, the water rights form part of the value of the land when the land is traded. Arthur Grimes and Andrew Aitken found in 2010 that farms with irrigation sold for up to 50% more than similar farms without irrigation, for example.[32] That means up to a third of the value of a newly purchased farm can be the value of the irrigation rights. Mortgages will be predicated on expectations of those water rights.

While consents to draw water exist over a limited duration, they are renewable, and users have developed reasonable expectations that consents will be renewed. In principle, research building on Grimes and Aitken's work could determine market expectations of consent renewals: If a property with 10 years remaining on an irrigation consent sells at a premium relative to a property with only a year remaining on the consent, markets would have factored in a risk that the consent would not be renewed.

Unfortunately, no quantitative work exists that establishes the market expectations

of rights renewal. Interviews with sector stakeholders suggest current prices are consistent with expectations of perpetual rights renewal – the existence of an irrigation consent matters, and the consent's remaining duration does not. Those expectations may be wildly out of step with changing political realities – especially in constrained catchments. Proper empirical work should establish the true state of play.

Allocation issues then become difficult for catchments at or above sustainable levels of water extraction or nutrient outflow. A government that believes water to be unowned might set a total allocation cap for the catchment, abolish existing consents, and auction off water drawing rights within the catchment. While this would abolish the current first-come problem in existing allocations, it would also wipe out substantial capital value from existing properties where the right to draw water has already been incorporated into land prices, and quickly bankrupt many farms. It would be politically fraught,[33] and could reasonably be viewed as entirely unfair to businesses that had made substantial investments of their own predicated on their reasonable view that their water drawing rights were durable.

Similarly, if land prices incorporate an expectation of consent renewal despite there being no *de jure* requirement that rights be renewed, government could decide to reduce overall catchment water takes by directing the non-renewal of existing consents, then auctioning off a fraction of the water tied to consents as they expire. The government could believe itself to be dealing fairly with existing users in that case, as no existing de jure rights would be impeded. But it could also easily lead to bankrupting recently purchased farms with short-term consents.

In short, differences between political and participant understandings of the underlying rights can be a substantial problem. The status quo is not a blank slate; requiring farms to purchase permits for activities that they have, until now, been allowed to engage in by right or by easily renewed consents would impose capital losses equivalent to the ongoing cost of the permits.

Similarly, the actual legal status of existing consents may affect the bargaining positions of Crown and consent-holders; we hope it would not take court action sparked by summary removal of those rights to resolve the legal issue. Negotiation and playing fairly by all stakeholders is a better approach.

Regardless of what Crown Law or a later legal ruling might find about the legal status of existing resource consents, it is difficult to achieve buy-in for a shift to a better management system if existing stakeholders view it as being built on expropriation.

That hardly means grandfathering in all existing uses is a solution. Farms could be punished for prior work in reducing water use if their grandfathered allocations simply provided permits for their current use. Land held under Māori land tenure has been slower to shift to higher valued uses because changing land use for those properties is more difficult; grandfathering allocations would make it more expensive for those properties to shift into dairying or other water-intensive industries. Existing inequities that are partially due to the Crown not having resolved iwi Treaty claims around water could be locked in.

The government has viewed water as unowned or as owned by the Crown, making water taxes an appealing option for restricting use and providing a flow of royalty revenues. Chapter 2 explained the merits of a cap-and-trade system over a water taxation system. In short, cap-and-trade provides far greater certainty around improved environmental outcomes. But the government may also view it as inequitable to simply gift water rights to current consent holders under a grandfathering regime.

In pure economic terms, how water rights are allocated is almost irrelevant: as long as the trading system is efficient and trading costs are low, the catchment will be able to achieve sustainable outcomes at the lowest possible economic cost.[34] Water will be put to uses that bring the most value.

But because those allocation rights can be valuable, the distribution of initial allocations is critically important in making sustainable outcomes politically attainable. We are not starting from a blank slate; existing rights must be recognised, at least partially, in any politically feasible and equitable solution – as must the rights of everyone else.

The status quo is also far from equitable. Previous governments' approaches to water rights seem designed to avoid Treaty claims around water. Allocation issues inherent in catchment level caps were viewed as likely to trigger Treaty water claims, and shifting to well-defined property rights within cap-and-trade regimes would almost certainly do so, unless the allocation process incorporated and recognised iwi interests. Resolving iwi claims to water is the right thing to do and seems a necessary precursor to setting up the kind of system that can deliver far more sustainable outcomes. The current government's approach in *Shared Interests in Freshwater* suggests negotiated solutions with iwi are desirable where Tribunal approaches can take far too long to resolve,[35] although this may be more realistic in some catchments than in others.

Desirable solutions then must both be respectful of existing use rights and incorporate any rights that may be recognised through Treaty processes for iwi water claims. They must allow catchments to find solutions that residents view as sustainable for the environment and for their communities. While these problems are far from simple, they must be solved in any shift to binding caps.

4.1 Allocation options

We here present options for initial water allocations that satisfy different views of equity and different ancillary goals while providing a workable basis for a water rights trading scheme. Allocated rights can be perpetual or time-limited. The burden of reducing water use in overburdened catchments can be shared in different ways. Allocated rights can be provided unencumbered, or can require a royalty payment over and above any purchase price associated with the water. Negotiated iwi water rights can be incorporated up-front, or can be built up over time.

In all scenarios, we suggest the minimum river flows described in Chapter 3 be deemed to constitute the self-owning river, with kaitakitanga resting with local hapū. Additional allocations provided to iwi and hapū through negotiation could be left with the river or aquifer, used, or traded at the discretion of the rights-holders.

Option 1: Grandfathering users, recognising iwi, and sharing the burden

Option 1 begins by adding up all catchment-level water claims, then sharing the burden of bringing use down to sustainable levels.

The annual drawing rights associated with existing water consents, whether for agricultural, commercial, industrial, residential or council use, would be tallied. Added to that sum would be the annual drawing rights provided to iwi and hapū through negotiation with the Crown.

If the resulting claims exceed sustainable limits on the catchment, then claims must be reduced to sustainable limits. Apportioning the burden of reducing water use could be left to negotiation between Crown, Council and catchment users, or an apportionment could be imposed by central government.

Existing consents would be converted into two types of drawing rights. The first tranche of rights provided to grandfathered consent holders would be permanent;[36] the second tranche would phase out over time following a set schedule. Some of the phase-out would provide space for increasing iwi allocations over time; some would assist in bringing down overall use over time. If rights abatement through the second tranche were insufficient to bring catchment-level use down to sustainable levels, the remaining burden would fall with the Crown. The Crown would buy back and retire drawing rights until use rights were consistent with sustainability; if Council wished tighter limits and more water left with the river, it could buy back and retire further rights through the system.

Allocating all grandfathered rights to the first tranche would place the entire burden of reduction with Crown and Council; allocating all grandfathered rights to the second tranche would place a greater portion of the burden on existing users, and some burden on Crown or Council as well if they wished to buy back rights to achieve the required cap more quickly.

Once the allocation is in place, the system would run as described in Chapter 3. Rights-holders could trade either in permanent rights or in time-limited portions of their permanent rights.

The proportionate mix of the two tranches of rights would depend on what is viewed as equitable. We suggest the starting point should first assess what mix would involve no takings relative to the current value of water rights embodied in land prices, and that burden-sharing arrangements should begin from that point. Data on land transactions could establish the market-assessed likelihood of rights renewal. If the market prices in, for example, a 25% probability of non-renewal, then providing a mix of rights that has 25% of the allocated rights ending when the existing consent expires would involve no takings whatsoever.

Once that no-takings baseline were established, allocating a greater proportion of grandfathered rights in Tranche 2 would place more of the burden of reduction on existing water users. We suggest it would be appropriate to share the burden. The public at large benefits from a more sustainable environment; the benefit principle of taxation suggests that the burden of providing public goods should fall on the beneficiaries. But existing users' use has contributed to overburdening the catchment, and current allocations would be very different had Treaty settlements included water; the entire cost of providing fair allocation to iwi and hapū should not fall on the Crown.

While sharing the burden seems appropriate, we are in no position to offer pronouncements on what sharing of the burden would satisfy equity considerations; it is inherently contestable.

Finally, as water management itself is not costless, a funding mechanism must be established to cover the costs of the trading system and to provide the necessary environmental monitoring and modeling. We suggest attaching a royalty charge to any tradeable water right so water users would fund the system proportionate to their water use.

While taxes on *trading* would make the system far less effective in achieving sustainable solutions at relatively low cost, a royalty charge imposed on *holding* allocation permits need not have that effect. Unlike a transactions tax, this type of royalty charge applied in fully allocated catchments would not reduce the efficiency of the trading market as long as the tax were low relative to the value of the permit. Rather than substantially affecting how water is used, it would instead reduce the value of any rights allocated in establishing the system. If the value of existing water drawing rights is fully capitalised into current land prices, the royalty charge would impose losses on those with existing consents converted into tradeable

permits. But those losses would need to be set against the increase in the value of water that is possible when trading becomes simpler.

The point of a royalty encumbrance added to a tradeable permit is not to replicate the effects of a water or emissions tax but rather provide a user-charge basis for funding water management. In some catchments, a smart-market solution would work; in smaller catchments, establishing the system would impose too great a cost burden relative to the potential efficiency gains.

There are several desirable features of Option 1, as well as potential concerns.

Grants of permanent rights, or a bundle of annual rights over a long period, provide rights-holders with a long-term interest in catchment sustainability. If a neighbour cheats the system by manipulating water meters or sinking illicit bores, that would erode the value of your permanent right; this encourages catchment self-policing. These considerations may be of greater weight in future work examining the case for applying cap-and-trade regimes to nutrients.

Further, many users would find longer term and permanent rights to be far more valuable than annual rights where capital investments can require assurance of water supply over many years. And as owners of permanent rights could sell annual allotments from those rights, it would become easier for new entrants to acquire water rights. Under the current consent-based regime, would-be new water users in fully allocated catchments must purchase land with a suitable water consent. Under the cap-and-trade system, they need only purchase water rights for the necessary years – a much lower barrier to entry.

Finally, the allocation mechanism would make explicit how the burden of reduction would be shared, and is flexible enough to be consistent with many different ways of allocating that burden. Transparency is a virtue.

Conversely, allocation and trading in permanent rights could risk a small number of users effectively becoming 'water barons', especially in smaller catchments. While it is possible to set rules limiting each trader to holding no more than a fixed proportion of the water available in a catchment, policing such rules could prove difficult where firms can split into several seemingly unrelated parts to get around the constraints. This could have implications for equity and efficiency if a small number of water owners were able to exercise market power.

Additionally, while we have suggested it is equitable that the burden of reaching sustainable levels of water use is shared between current users, through rights abatement over time, and the public at large, through Crown buy-back of rights via the system, those who view current rights-holders as having rights no greater than those provided for in current consents would view that sharing as imposing an inequitable burden on taxpayers.

In that view, the entire burden should be borne by those who most profited from prior overuse of a limited but renewable resource, and that it would be inequitable to pay them for reducing their use. We note that it is possible, in this allocation system, to impose the entire burden of reduction on current users so long as new allocations on their own do not exceed the catchment's capacity. But it would come at substantial, potentially bankruptcy-inducing, cost to many water users who have played by the rules and abided by their consents.

Option 2: Sharing the burden without permanent allocations

Our second scenario addresses potential concerns about market concentration in the first scenario, and potential concerns about the desirability of permanent rights.

In this scenario, no permanent rights are grandfathered to existing consent-holders.

Instead, Tranche 1 rights awarded would consist of a bundle of annual rights extending over a reasonably lengthy period, or 25-year rights from which annual apportionments could be on-sold, with Tranche 2 rights consisting of annual rights that abate over time the same way they do in our first option. Rights to later years' water abstraction could remain with the Crown for sale in those years, or for sale on the futures markets. Crown negotiations could provide for more extensive allocations to iwi within the overall cap in those future years, dramatically reducing the fiscal cost to the Crown.

At an 8% discount rate, about 90% of the value of a 100-year right obtains during the first 30 years, 85% of the value obtains during the first 25 years, and roughly 70% of the value during the first 15 years. Long-term but non-permanent rights can be close in value to permanent rights, depending on the time horizon and the discount rate.

The baseline allocation would then involve a taking equivalent to the difference in value between permanent rights and these time-limited rights. The rest of the allocation would follow the process set out in Option 1, with similar equity considerations. Where Tranche 1 rights come with an embedded taking, a smaller proportion of rights should fall into Tranche 2 and a greater portion of reductions in use should come through Crown rights purchases.

Compared to Scenario 1, we would expect potential worsening of participant interest in long-term catchment sustainability. When participants have only a few years' remaining rights, neighbours' cheating the system imposes little cost on current rights-holders; self-governance would become weaker and the system would need to devote greater resources to monitoring and enforcement.

Markets in annual rights may be somewhat thicker in this scenario than in the first scenario, but only to the extent that transaction costs might impede carving annual rights from permanent allocations. Both scenarios would substantially ease new users' access to water resources.

Concerns about the establishment of 'water barons' would be substantially alleviated in Option 2 as compared to Option 1 if the Crown were selling new rights into the system as initially allocated rights ran out. It would be more difficult to lock up ownership of a catchment's water rights if fresh allocations regularly came into the system. This would both address equity concerns that might arise if a relatively small number of parties might come to dominate ownership of permanently allocated rights, and both equity and efficiency concerns if a small number of water owners were able to manipulate prices on their local catchment's water market.

We suggest that 25-year rights expiring in staggered years could reasonably balance these considerations. Where owners have long-term rights, they have long-term interests in the system, reducing monitoring and enforcement costs. And where new sets of 25-year rights are regularly sold into the system as old sets of rights expire, it is more difficult for the market to become overly concentrated. But shorter-duration structures would also work.

Table 1

	Option 1	Option 2
Starting point	All existing consents plus any catchment level iwi allocation.	All existing consents plus any catchment level iwi allocation.
Conversion of existing consents	Split existing consents into two tranches; provide these to existing consent-holders. **Tranche 1:** permanent drawing rights from which annual allocations can be sold. **Tranche 2:** Drawing rights that scale down over time, helping to bring total allocations down to sustainable levels.	Split existing consents into two tranches; provide these to existing consent-holders. **Tranche 1:** 25-year non-renewable rights from which annual allocations can be sold, or a bundle of single-year non-renewable rights extending over 25 years. **Tranche 2:** Drawing rights that scale down over time, helping bring total allocations down to sustainable levels.
Reducing use in overallocated catchments	Tranche 2 rights do not renew and are not re-issued. Remaining abatement achieved by Crown buy-back of water rights.	Tranche 2 rights do not renew and are not re-issued. Remaining abatement achieved by Crown buy-back of water rights.
Royalty charges	A royalty encumbrance can be placed on holding water rights to fund the system.	A royalty encumbrance can be placed on holding water rights to fund the system.
Duration of Tranche 1 rights	Permanent. Owners of Tranche 1 rights can sell annual apportionments from those rights if they wish, whether for the present year or future years.	Time-limited (we suggest 25 years), not renewable. Crown can sell new rights within the system as rights expire, or provide to iwi as part of any catchment-level settlement.
Ease of new user entry	Simpler than today. New water users could bid for permanent water rights, or purchase annual allotments from existing rights-holders.	Simpler than today. New water users could bid for longer-term water rights, or purchase annual allotments from existing rights-holders.
Risk of excessive market concentration ('water barons')	Higher than status quo. But consequent high prices would invite development of water storage or water transport options.	Reduced. Regular Crown sales of new rights into the market as old rights expire make it difficult to amass water drawing rights.
Market thickness	More risk of market illiquidity.	Regular Crown sales of new rights as old rights expire help provide liquidity.
Participant incentives	Permanent rights-holders will have strong interest in policing the trading system – cheating the system erodes the value of their rights.	As long-term rights near their expiration, there will be fewer self-policing incentives; greater monitoring and compliance costs can be expected.

4.2 Concluding considerations

Achieving environmental sustainability will require shifting to catchment-level caps. Making allocations within those caps tradeable helps make them economically sustainable for the community, and helps ensure that New Zealand does as much good as it can to improve environmental quality. But making tradability work well requires shifting from markets that look like the classified ads, to markets that look more like the electricity market's regular auctions.

The advantage of smart market systems like the one developed by Raffensperger and Milke is that environmental sustainability can be hard-wired into the system while greatly simplifying the trading process, making the system as a whole work better.

It is also a system that seems fundamentally consistent with Te Mana o Te Wai, and with the government's objectives in its announced freshwater programme. Respecting the nearby rivers requires making sure that water-intensive activities do not stop the rivers from being rivers. The amount of river flow needed for the river to be a river can be built into the trading system as a constraint, as can sustainable aquifer levels. Changes in practice that reduce environmental footprints can become profitable when they let businesses sell water rights back into the system.

Much work is required to get there, but the game is worth the candle. The alternative is worsening environmental quality, far more costly ways of trying to fix the problems, or both.

Our starting-point suggestions:

1. If this kind of cap-and-trade system is desirable, central government should take on the initial set-up costs for system development and implementation.

2. Initial catchment-level caps should not be lower than current use, and should incorporate room for allocation to iwi. We suggest an initial trial in Canterbury.

3. The burden of reductions from those initial caps to sustainable limits should be shared between water users and the broader community through a combination of Crown purchases and retirement of allocations, and by a structure of initial allocations that reduce the rights held by current users over time.

4. Sustainable catchment-level caps should be determined by the local community, iwi and hapū. They should be informed by strong environmental science, and by information revealed over time by the trading system.

5. Crown-iwi negotiations could define the minimum river flows consistent with Te Mana o Te Wai as being the self-owning river, as in Whanganui, with similar trusteeship rights. The trading system would protect those minimum river flows. Additional water rights awarded to local iwi and hapū above that minimum flow could be left with the river, or traded.

6. Effective cap-and-trade systems require binding and environmentally meaningful caps. Those require effective monitoring and enforcement activity.

APPENDIX

Nutrient trading – The work ahead

We believe the case for cap-and-trade management of water abstraction is strong. While there are obvious complexities in modeling the underlying hydrology and in developing the trading system, many of which are well-canvassed in Raffensperger and Milke's work, they are *relatively* straightforward. It is easy to define and measure a megalitre of water. Existing hydrological mapping is inadequate, but it must be improved for any reasonable effort to improve catchment-level water management.

Catchment-level caps on water use are simple when compared with catchment-level caps on nutrient emissions. That makes cap-and-trade systems for nutrient management more difficult to implement than similar systems for water abstraction.

It is relatively easy to check whether the metered water take from a bore or river exceeds the owner's allocation. But nutrient emissions are not measured; they are modeled through systems like Overseer. The quantity of nutrient emissions permits any farm might need will depend on the modeled effects of land type and location as well as on-farm practices like effluent containment, fertiliser application and stocking rates.

Worse, the same activity happening in different places can have vastly different effects. Nutrient emissions can take decades longer to reach the aquifer or lake depending on where the emissions happen.

Any system working to cap catchment-level nutrient emissions then requires at least a reporting process for activities generating nutrient outflow. If total emissions come close to the cap, then consenting processes are necessary to prevent the cap being exceeded. Any catchment-level cap will require modeling not only of the effects of different land uses on the catchment's sustainable nutrient load, but also of how that effect will perpetuate over time. Shifting activities to areas where it will take decades longer for nutrients to reach the lake or aquifer may keep things cleaner for now, but will affect longer term sustainability.

These are all difficult problems, but they are also problems that will have to be solved in any serious approach to mitigating nutrient emissions. Achieving *any* cap on total catchment-level emissions is simpler when trading is allowed; alternatively, stronger environmental quality can be achieved at similar overall cost by allowing trading.

Motu's analysis found substantial barriers to trading in Taupo's groundbreaking cap-and-trade nutrient management system.[37] Users wanting to trade nutrient allocations for limited time periods had to develop bespoke lease arrangements since the market traded only permanent allocations. Barter is more complicated when the bartered good may be split up in many different ways; futures markets in nutrient emissions could simplify trading. Smart-market approaches can make trading much easier.

Raffensperger and Milke's proposed water trading system would check the effects of water drawn from one property on water available at nearby properties, on the aquifer, and on river flow – ensuring that the system respected environmental constraints while letting water be put to its most highly valued uses.

That type of system, adapted to nutrient emissions trading, could check the effects of modeled nutrient load from a property against subsequent years' catchment-level nutrient caps, ensuring that trades did not harm sustainability over time. It would require complex modeling of location-specific effects of nutrient emissions over time, but modeling no more complex than that already needed in any catchment-level consenting system that wishes to guard against long-term effects of nutrient outflow.

Futures markets in emissions trading could also help raise the funds for infrastructure investments in nutrient emissions mitigation. If building an effluent containment system would reduce a farm's nutrient profile, the farm could sell some of its future nutrient allocations to raise the capital for building the system. If improving a Council's wastewater treatment plant reduced discharge to rivers, selling the associated future emissions rights could help fund the plant investment. Environmentally responsible behaviour becomes less costly.

If the Overseer system is sufficiently robust to form the basis for estimating nutrient outflow, farmers wishing to change land use could use that system to determine the quantity of emissions credits necessary under their intended changes, check that the change made sense given the likely cost of emissions credits, then put in bids for the necessary emissions credits. The trading system would then check the proposed purchase's consistency with catchment-level caps in the same way the water trading system would check any proposed trade's effects on river flow and aquifer sustainability.

Rather than vetting trades and land use changes, Council would instead check that land owners held sufficient emissions credit for their land use. This could be done through audit processes verifying that land use was as reported within the system, and that the emissions credits held matched those required.

But further work is needed to establish tradeable units that are environmentally meaningful and meaningful to users. A permit for one cow's worth of nitrate emissions would be economically meaningful and tractable for users, but not environmentally meaningful where land type, underlying hydrology, and farming practices matter considerably. A permit to impose one kilogram of nitrate loading onto the catchment could be environmentally meaningful, but would not be tractable for users where that loading would be associated with very different intensities of land use in different places.

The trading system would need to be able to translate the tractable units traded by users into environmental consequences, resulting in different prices at different places in the same way water prices would vary by location within the water trading system here proposed. While water pumps can be metered and monitored against tampering, the problems are more substantial because systems like Overseer rely on truthful disclosure of on-farm practice that can be difficult to monitor.

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2. Ministry for the Environment, "Changes to Freshwater NPS 2017: Te Mana o Te Wai" (Wellington: New Zealand Government, 2017).
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6. See Robert Makgill, "A New Start for Fresh Water: Allocation and Property Rights," *Lincoln Planning Review* 2:1 (2010), 5–10.
7. See Te Maire Tau, "Water Rights for Ngai Tahu: A Discussion Paper," Ka Roimata Whenua Series No. 3 (Canterbury University Press, 2017). Work presented by Sandra Cortés-Acosta showed that land held under Māori land governance structures is less likely to be used in pastoral activities than in other comparable land; difficulties in organising resource consent for irrigation under complex land tenure arrangements could explain at least some of this difference. See Sandra Cortés-Acosta, "Land cover choices in Aotearoa New Zealand: Do Māori land governance structures make a difference?" New Zealand Association of Economists (2018).
8. See Madeline Duhon, Hugh McDonald and Suzi Kerr, "Nitrogen Trading in Lake Taupo: An Analysis and Evaluation of an Innovative Water Management Policy," Motu Working Paper 15-07 (Wellington: Motu, 2015).
9. Te Maire Tau, "Water Rights for Ngai Tahu: A Discussion Paper," op. cit. points to rights that were not extinguished by treaty, contract or conquest. See also Melanie Jayne Jagusch, "Māori Property and Commercial Rights to Freshwater: The Potential for Recognition and Redress Following Judicial Decisions in 2012–2103," Dissertation (Laws, Honours) (University of Otago, 2013).
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20. See Ministry for the Environment and Ministry for Primary Industries, "Essential Freshwater: Healthy Water, Fairly Allocated," op. cit. 22. See also Ministry for the Environment and Māori Crown Relations Unit, "Shared Interests in Freshwater: A New Approach to the Crown/Māori Relationship for Freshwater," op. cit. 32 and 49. At this stage, cap-and-trade regimes seem on the table as one of a few potential options for improving water quality.

21. Kieran Murray, Marcus Sin and Sally Wyatt, "The Costs and Benefits of an Allocation of Freshwater to Iwi," Report prepared for the Iwi Advisors Group by Sapere (2014).

22. Taxation regimes have similar incentive properties, but without certainty about maximum emissions or water take.

23. Kevin G. Counsell, "Using Price Signals to Better Manage Water Use," *Resource Management Journal* April (2018), 12–14.

24. Richard Hawke, "Improving the Water Allocation Framework in New Zealand: Enhanced Transfer," op. cit.

25. John F. Raffensperger and Mark W. Milke, "Smart Markets for Water Resources: A Manual for Implementation" (Springer, 2017).

26. Note that the use of the term 'cap' is here shorthand. The system would allow a more complex set of subcatchment-specific constraints. I thank Mark Milke for the reminder.

27. Technically, inverting the value of the coefficient attached to a constraint in a linear optimisation reveals the shadow price of the constraint. See discussion in John F. Raffensperger and Mark W. Milke, "Smart Markets for Water Resources: A Manual for Implementation," op. cit. Chapter 3.

28. There are important equity issues involved in shifting to metered water use. The simplest solution is for Council to cut each property's rates bill by an amount equivalent to the average property's water charge and to strengthen the low-income rates rebate. That ensures low income households are not made worse off by the change, but also preserves incentives to conserve water.

29. Martyn Cole, "Measuring Success: The Kapiti Coast Experience," Water New Zealand 193 (March/April) (2016), 24–27. See also Controller and Auditor General, "Managing the Supply of and Demand for Drinking Water" (2018).

30. Waimea Irrigators, Website.

31. We again note that important technical problems must be solved before nutrient emissions could be brought into a cap-and-trade system – see the Appendix.

32. Arthur Grimes and Andrew Aitken, "Water, Water Somewhere: The Value of Water in a Drought-Prone Farming Region" (2010).

33. Gordon Tullock, "The Transitional Gains Trap," *The Bell Journal of Economics* 6:2 (1975), 671–678.

34. Robert W. Hahn and Robert N. Strains, "The Effect of Allowance Allocations on Cap-and-Trade System Performance," *The Journal of Law & Economics* 54:4 (2011), S267–S294. Hahn and Strains discuss the conditions under which the allocation-irrelevance principle holds, and deviations from those conditions.

35. See Ministry for the Environment and Māori Crown Relations Unit, "Shared Interests in Freshwater: A New Approach to the Crown/Māori Relationship for Freshwater," op. cit. 31–33. The Ministry here suggests developing water use rights rather than property rights at law. If the use right is sufficiently durable, enforceable and tradeable, then this option could also support the kind of cap-and-trade system we have here described.

36. Alternatively, and equivalently, a bundle of annual rights extending about 40 years into the future have roughly the same value as a permanent right at an 8% discount rate. Rights extending 40 years into the future, at an 8% discount rate, have 95% of the value of a 100-year right; rights extending 30 years into the future have 90% of the value of a 100-year right; rights extending 20 years into the future have 79% of the value of a 100-year right. This will feature in our second scenario.

37. Madeline Duhon, Hugh McDonald and Suzi Kerr, "Nitrogen Trading in Lake Taupo: An Analysis and Evaluation of an Innovative Water Management Policy," op. cit.

New Zealand deserves far better water management. Scores of newspaper articles and rigorous reports lay out the problems in the current system. Too much water is being drawn in some river basins (catchments) – to the detriment of aquifers and rivers.

Fixing the problem requires reducing the amount of water drawn in those places.

The most promising way of reducing water use harnesses the same kind of policy New Zealand is developing to reduce carbon dioxide emissions: a trading scheme. Capping the total water take within a catchment, converting existing water consents into tradeable permits, and letting permit-holders trade their drawing rights allows New Zealand to do the most good in improving environmental quality.

The solution is well-recognised. But progress has been stymied because successive governments have been unwilling to address iwi water claims.

Resolving iwi water rights is important for its own sake. But it is also critical in enabling far better environmental practice. The environmental costs of not resolving iwi claims are too great.

We propose a cap-and-trade system for managing water allocations that shares the burden of reducing water use between existing water users and the Crown, that embeds strong environmental bottom-lines into the trading system, and that recognises iwi rights in water.

We believe it is the best way for the government to progress its agenda in improving freshwater quality.

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PO Box 10147
Wellington 6143