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Review of policy instruments for freshwater management

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Abstract

As pressures on water resources increase in New Zealand, so does the need for alternative policy approaches that can adequately address the demands of competing interests. This working paper presents the array of different policy instruments available for managing freshwater quality and quantity. In doing so, the paper provides insights into how the various instruments have been used to incentivise behaviour change in the New Zealand context, and outlines the barriers and opportunities affecting their wider implementation at various scales across New Zealand. The paper ultimately aims to provide decision-makers with insights into how an economic way of thinking can help guide the selection and design of policy instruments and improve freshwater outcomes for all.

JEL codes

Q15, Q25, Q28, Q53, Q57

Keywords

Fresh water; New Zealand; policy instruments; management

Summary haiku

Managing wai, both
quality and quantity,
needs a range of tools.

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1 Introduction

Deep in the Pacific lies Aotearoa New Zealand, a land that breathes through its mountains and pulses currents through its rivers. For generations of human settlement, New Zealand remained insulated from the population and land-use pressures that imposed costs on waterways in other parts of the world (Knight 2019). However, as competition for water and land resources increased, these patterns shifted, and successive central and local governments have introduced freshwater management packages to try to address issues associated with declining freshwater health (Eppel 2014). The latest instalment, in 2018, was the Essential Freshwater reform package, which aimed to do three things: 1) halt degradation and loss of fresh waters; 2) reverse past damage; and 3) address allocation issues (Ministry for the Environment & Ministry for Primary Industries 2019). These three objectives were a response to decades of declining water quality and overallocation, revealed by declining river health and reduced flows.

In 2019, a revised national policy statement for fresh water and new national environmental standards were released, alongside further regulations designed to help address the objectives of the reform package. National policy statements and environmental standards are a core legislative requirement of the Resource Management Act 1991 (RMA), and outline how water is to be managed by local authorities and used by individuals, firms, and industry. Although the policy package provides strategic direction for local authorities, it remains unclear how behaviour change across various scales should be incentivised through policy instruments – those policy tools that can be deployed to address issues associated with the overuse and declining quality of water resources (Office of the Auditor-General 2020).

The selection of policy instruments is important because economic theory suggests that without an incentive to pay for the costs of their actions, few individuals (or firms) will voluntarily do so. Discharge abatement and the provision of environmental flows are public goods, in that everyone benefits from their provision whether they have contributed or not. Selecting and implementing policy tools that induce users to pay for the cost of change irrespective of benefit flows thus becomes a thorny problem. Thankfully, the range of policy instruments available to improve the quality or reduce the degradation of waterways is varied.

The purpose of this working paper is to provide a discussion centrepiece that explores the challenges facing freshwater management in New Zealand and present the array of different policy instruments available for managing waterways for both quality and quantity. The paper is designed to provide a stocktake of the type of methods and mechanisms available to decision-makers to incentivise behaviour change in the water context. It outlines the barriers and opportunities affecting water management in New Zealand and provides decision-makers with

insights into how they can use an economic way of thinking to meet the objectives of the new freshwater reform package.

The discussion covers both freshwater quality and quantity management, specifically extending earlier reports that have focused on quality management alone (Greenhalgh et al. 2020). Examining policy instruments for both quality and quantity jointly has the potential to leverage co-benefits and deliver more resilient outcomes for the environment, the economy, and our communities.

2 Water policy through an economic lens

Water is an increasingly scarce resource in New Zealand in terms of both quality and quantity. Government data suggest that 60% of New Zealand's rivers and lakes don't meet swimmability standards (Ministry for the Environment 2017), and at least one in five of our aquifers is overallocated (Kaye-Blake et al. 2014). Increasing demand from competing uses, as well as ongoing pressure from climate change in terms of long-term availability and short-term variability, are likely only to exacerbate these trends (Ministry for the Environment & Stats NZ 2020).

Part of the problem is that many of the issues New Zealand faces regarding water management are due to constraints associated with the human component of management, rather than technical issues (Cosgrove & Loucks 2015). This means that barriers to efficient water use and allocation are, in large part, socially constructed. In New Zealand, these barriers include weak property rights (Guerin 2003; Waitangi Tribunal 2019), insufficient data (Ministry for the Environment & Stats NZ 2020), poor monitoring and enforcement (Brown 2017), and variability in temporal and spatial allocations that are not always reflected in the design of institutional arrangements.

These barriers contribute to the further complication that water is still treated as free in New Zealand despite the increases in demand and growing variability in supply. This means that the usual price signals that shape use patterns for a good or resource do not operate in the context of water. Instead, the policy tools that are employed are highly political and value laden, and even when faced with significant shortages, local authorities in New Zealand have been reluctant to use some policy mechanisms, such as pricing, to reduce or curb demand (Gluckman 2017).

In addition, some of New Zealand's institutional water governance arrangements ignore spatial and temporal externalities and the public good element of water (Daigneault et al. 2017). For example, in some drier regions, such as the east coast of the South Island, the marginal value of water left instream to support public goods may exceed its value for irrigation and other uses (Takatsuka et al. 2009). Likewise, legislative arrangements that account for the benefits of water extraction but fail to consider the costs extraction imposes on third parties, such as the environment, are unlikely to deliver efficient outcomes (Olmstead 2010). Although there is no single preferred approach for addressing these issues, 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.

From a theoretical perspective, these shortfalls can be explained by the discrepancy between the perceived economic value of water and its economic price, as well as a discrepancy between water's economic price and its economic cost (Grafton et al. 2020). Because water is

treated as free in New Zealand, its price in terms of extraction or discharge abatement almost never equals or reflects its true value. Coupled with that, in situations where users are charged for water delivery, the prices rarely cover the true economic cost of the water. This is because the regulated prices frequently reflect the average private cost, which is low in many circumstances, rather than the marginal private cost, which reflects the extra private cost from an incremental unit of production of good or service. Although the capital costs of supplying water can often be very high for centralised distributed water supply systems, these costs are often allocated over a large volume of water supplied. This makes the average cost relatively low and means that the cost estimates fail to capture the external costs imposed on others from water extraction, supply, and treatment, or the true extent of fixed costs, such as the capital cost of water infrastructure.

In addition, "rent-seeking" behaviour by water consumers and decision-makers means that there is consistent pressure to lower prices and have others pay for the difference between costs and what rent seekers pay. Rent seeking can be observed in situations where an entity seeks to gain added wealth without providing any reciprocal contribution in productivity. In New Zealand, rent-seeking behaviour coupled with institutional constraints has caused the water price, or lack thereof, to be less than water's true marginal cost (McNeill 2016). Addressing these shortfalls in the New Zealand context requires broadening the suite of policy tools employed by decision-makers.

3 Policy instruments

As New Zealand searches for ways to achieve the objectives of the new Essential Freshwater package, it is timely to reflect on the policy instruments that have been used across the country and internationally to improve water quality and address overuse. Policy instruments – the policy tools that shape user behaviour – can be divided into two categories: demand-side management instruments and supply-side management instruments (Wheeler et al. 2017). Demand-side management refers to policy instruments that incentivise behaviour change in water users, and includes educational measures (e.g. providing information on how to decrease water use in homes/farms), regulatory and/or planning processes (e.g. legislative change coupled with restrictions), and economic instruments (e.g. pricing to discourage overuse). Supply-side management, which includes supply augmentation (e.g. dam/irrigation construction) or substitution (e.g. increasing groundwater access), has been widely used because it offers a technical and relatively rapid "fix" for demand gaps.

This section introduces the most commonly used policy instruments for water, and provides insight into how they have been used in New Zealand and internationally. Each of these policy instruments has strengths and weaknesses; these are outlined in the Appendix.

3.1 Demand-side management

Demand-side management refers to management approaches that incentivise behaviour change by altering consumer use of water or consumer demand for better-quality water. The policy instruments used to incentivise demand-side change include outreach and education, regulation, and economic measures such as pricing and market-based mechanisms.

3.1.1 Awareness raising, outreach, and education

Until recently, fresh water was not recognised as a finite resource by policy makers, industry, or the general public in New Zealand (Hayward 2006; Ministry for the Environment 2009). New Zealand was instead viewed as water-rich, which affected how the resource was managed and used (Wheen 1997). To change these attitudes, awareness raising, outreach, and education activities have played an important role in highlighting the limits of water supply, how individual actions and decisions affect freshwater health, and the trade-offs that may arise between water users (Ministry of Education 1999; Ministry for the Environment 2003).

Outreach and education have helped inform water users about management concepts central to institutional design and the achievement of policy objectives, such as efficiency, equity, and risk (Kerr 2013). For instance, a common misconception is that there is always a trade-off

between efficiency and equity, and that the use of a pricing mechanism, or increasing the price of water, disadvantages the poor and most vulnerable (Bell et al. 2016). However, due to the multi-faceted nature of trade-offs and the contextual heterogeneity around New Zealand's freshwater management, this is not necessarily correct (Rogers et al. 2002). Instead, higher water rates can allow utilities and other systems to extend services to new users who might otherwise be required to go without water or incur high costs through foregone income or lost revenue. Communicating how these concepts apply in a given context and for alternative management and governance approaches helps communities and users better understand the implications of adopting various policy instruments.

Providing easy access to up-to-date and credible information in real time raises the profile of freshwater health and its trends, and has helped incentivise changes in behaviour at low cost (Ministry for the Environment 2003). This is evidenced through Auckland's Safeswim programme (see box), as well as by organisations such as Land and Water Aotearoa, which provides some of the most up-to-date information about water quality (see lawa.org.nz). Similar opportunities exist in the freshwater quantity space. For example, the Resource Management (Measurement and Reporting of Water Takes) Regulations 2010 require all consented water takes of 5 litres/second to be reported annually. Currently, consented water users have to provide a report of measurements taken daily or weekly, either manually or automatically depending on the technology available. Rather than reporting results annually, these usage rates could be displayed in real time on web portals, maps, or interactive tools, and thus raise awareness of consumption patterns between users and across regions.

Awareness raising, outreach, and education case study: Safeswim programme

The Safeswim programme is a collaboration between Auckland Council, Watercare, Surf Lifesaving Northern Region, and Auckland Regional Public Health Service, and aims to inform the public about water-quality issues and conditions across the region (Allpress et al. 2018). In November 2017, Safeswim moved from a retrospective sampling programme to a more accessible and interactive provision of real-time water-quality forecasts for sites across the region, to enable Aucklanders to make risk-based decisions about their interactions with water. The programme overhaul occurred because the previous system was failing to inform people accurately about the true extent of water-quality problems, including from wastewater contamination, and there were widespread concerns about potential impacts on human health (Brown & Schollum 2018). The relaunch of Safeswim was accompanied by wide public communication and new on-beach signage as part of Auckland Council's broader strategy to improve water quality across the region (Allpress et al. 2018).

Auckland Council released technical reports in 2018 and 2019 that evaluated the impact of the Safeswim programme (Allpress et al. 2018; Rangsivek et al. 2019). The 2018 evaluation included online surveys before and after the launch of the new Safeswim system, of 1,034 and 1,023 people,

respectively, as well as a survey of 627 beachgoers in February 2018. The follow-up in 2019 involved 877 beachgoers and 1,034 online respondents.

Of those surveyed after relaunch, 73% believed it was important to check water quality before swimming (compared with 65% before November 2017), and 44% of respondents said information about water quality was easy to find (33% before relaunch). Of those that answered how much they would be willing to donate to the Safeswim service, there was no increase post-rollout compared with those surveyed before November 2017 (median = NZ$5, mean = NZ$19.50).

These findings were broadly echoed in the evaluation of the 2018/19 summer period (Rangsivek et al. 2019). The authors found a seven percentage point increase in the number of respondents aware of water-quality ratings (to 64%), and an increasing proportion acknowledging the importance of checking water quality before swimming (80% at the follow-up, compared with 65% and 73% in pre- and post-relaunch surveys, respectively).

These shifts, although positive, are small in magnitude, and evaluations provide no evidence that improvements in citizen awareness of water-quality issues translate to changes in their behaviour. For example, only 11% of respondents in the follow-up survey indicated that they check water quality before swimming (Rangsivek et al. 2019). There is evidence of persistent misunderstanding and mistrust in the information Safeswim provides (Allpress et al. 2018). This social barrier needs to be overcome if the policy is to induce the changes in attitudes and behaviour it set out to deliver.

Raising awareness in this way can change public perceptions, alter behaviour, and exert pressure on government, local authorities, and industry to take steps to consider more widely the impact of their decisions on freshwater health (Ministry for the Environment 2009). Conveying information strategically can also influence behaviour by "nudging" individuals towards reducing water use or activities that adversely affect water quality (Byerly et al. 2018). Even if their effects are small, nudges can be a cost-effective way to change behaviour because they can be applied at scale for a small cost (Thaler & Sunstein 2008). For example, social comparisons have been found to be effective at promoting behaviour change (Nyborg et al. 2016). Consequently, Auckland City Council has amended its household water bills to show where each household's water usage sits in comparison to households of different sizes. By demonstrating to water users how their usage patterns compare with those of their neighbours, it is anticipated that consumption levels in high-use households will fall.

Internationally, nudges have been a useful tool for incentivising changes in usage patterns (Sunstein & Reisch 2014). One of the challenges for water usage is that users are rarely made aware of their levels of consumption in real time. Posting reminders about the connection between consumption and the environment in places where water is being used, such as in the shower, has been one way to address this gap effectively and nudge users towards more

conservative water use (Tiefenbeck et al. 2019). Another challenge is in drawing connections between discharge patterns and wider environmental impacts. Changing discharge patterns by placing signs around drains has been one way this has been addressed in urban areas, such as Whangārei.

Finally, education helps shape values and raise awareness of the role fresh water plays in our economy, environment, and communities. Freshwater education can focus on teaching the inherent value of fresh water; the link between human well-being, fresh water, and the services it provides; and how human actions affect freshwater quantity and quality (Ministry of Education 1999).

3.1.2 Regulatory methods

Regulatory or command-and-control approaches operate on the premise that a penalty is incurred by users who fail to comply with rules such as those around allowed water takes, permitted discharges to waterways, or required mitigation options. Because of the relative ease with which regulations can be managed and implemented within the scope of New Zealand's policy landscape, they have been the most widely used demand-side approaches to curb use and reduce discharges to waterways (Knight 2019). However, regulatory instruments are relatively inflexible policy tools that rarely incentivise behaviour change beyond the regulatory limits. Instead, their strength lies in the fact that they provide clarity to users and are relatively equitable in terms of who they are applied to.

Although regulatory approaches imply that everyone will be treated equally, there is no guarantee that they will achieve the most efficient or cost-effective outcomes (Keohane & Olmstead 2007). Water policy is efficient when the costs are equal to the benefits – in other words, the greatest possible net benefits have been achieved. At a basic level, this is the same for both quality and quantity – for efficient quality control, the marginal benefits of pollution control should be equal to the marginal costs of undertaking abatement, while for efficient allocation, the marginal benefits of extraction should equal the marginal costs of taking water out of the system.[1] Because it is difficult to know each firm's marginal costs or accurately assess the marginal benefits of shifting from the status quo, setting regulatory limits rarely enables the identification of efficient outcomes. Similar issues arise in terms of cost-effectiveness, which relies on the minimisation of total costs and the equalisation of costs across all firms of the last unit of pollution control or water extraction.

In New Zealand, the suite of regulatory approaches adopted to manage discharge and overuse include environmental bans and restrictions, environmental standards, and environmental caps (Greenhalgh et al. 2020). The new Essential Freshwater package builds on

[1] These benefits and costs can include both market values (e.g. the cost of physically extracting water) and non-market values (e.g. the environmental benefits of keeping water in-stream).

this institutional legacy and outlines several new environmental standards that are intended to improve ecosystem health. What remains unclear is which policy instruments beyond command-and-control regulation local authorities should use to incentivise the desired behaviour change and achieve the new freshwater health objectives (Office of the Auditor-General 2020). Is the implementation of rules and regulations the most efficient way of curbing undesirable behaviour, or should a broader suite of instruments be used to ensure the targets and objectives are met? Overseas experience shows that utilising a wide range of policy instruments increases the likelihood that complex legislative objectives can be met (Greenhalgh & Samarashinghe 2018). Likewise, New Zealand's experience with other natural resources, such as fisheries and climate change, shows the value of alternative policy instruments in achieving beneficial outcomes for communities, the economy, and the environment.

Economic instruments, such as price or market-based mechanisms, are one policy tool that has the potential to be more widely adopted in New Zealand, should some of the barriers to pricing be lowered (Sharpe 2017). The following section outlines the various instruments available to policy makers and shines a light on how some of these have already been used in the New Zealand context as a complement to other regulatory policy instruments.

3.1.3 Economic instruments

Economic instruments complement or substitute for stand-alone regulatory approaches, providing entities with incentives (usually financial) to change their behaviour. Such instruments have an advantage over pure regulatory approaches in that they encourage more efficient resource use as motivated users look to find new and innovative ways to reduce their consumption. This can be achieved through implementing price-based mechanisms, such as taxes or subsidies, or through market-based mechanisms that allow for trade and exchange.

Price-based instruments use taxes or subsidies to send explicit price signals to motivate changes in behaviour. In contrast, market-based instruments use trade and exchange to determine the price paid to achieve a particular environmental outcome. Although market-based mechanisms still use prices, they encourage behaviour through market signals rather than through explicit directives, such as taxes or subsidies.

In theory, market-based instruments allow for more efficient and cost-effective outcomes to be reached than price-based instruments alone. In a market, users are able to trade their rights or permits, so that users who place a higher value on those rights or permits will buy more of them, while those placing a lower value on the rights or permits will choose to sell them. Environmental markets are underpinned by complementary regulation that assigns a limit on take or discharge to individual users. When the institutional arrangement has low levels of transaction costs and well-defined property rights, users are able to negotiate and bargain towards more efficient outcomes (Coase 1960).

However, this isn't always easy. Conflicting goals and agency conflicts, and the presence of inter-temporal trade-offs, make market efficiency difficult to achieve (Hanemann & Young 2020). An added complexity in New Zealand is the unresolved contention over ownership, rights, and control of water (Waitangi Tribunal 2019). Currently, the use of economic instruments as a policy tool in New Zealand is used only under certain conditions, such as charging user fees for the delivery of water. For economic instruments to be adopted more widely, significant institutional changes will be required at the national level of decision-making.

Taxes, fees, and levies

Taxes, fees, and levies have been used in New Zealand to incentivise users to utilise water more efficiently or protect water quality. In theory, these pricing instruments aim to "internalise" the full marginal costs (including environmental costs) of decisions that affect water use and water quality. However, ensuring that the prices cover the true economic costs, including any externalities, and that the efficiency gains do not impose inequitable burdens on some users, remains a challenge.

Some regions in New Zealand have installed water meters to charge users fees for the infrastructure costs of delivering water (Jenkins 2015). In cities and regions where charges have been applied, the goal has been to design a pricing structure that accounts for variable incomes and demand elasticity – the responsiveness of users to a change in the cost of a good or service (see box). The two main pricing structures that have been adopted are fixed pricing structures, where users are charged a fixed rate for use irrespective of their level of consumption, and volumetric prices, which charge users more as their consumption increases. Because volumetric charges respond to demand (the more you use, the more you pay), there is a clear trend away from fixed charges and towards volumetric charging globally (Grafton et al. 2020).

Economic instrument case study: comparison of water pricing in Auckland and Wellington

Across New Zealand, regional, district, and city councils employ water tariffs as one mechanism to price the domestic use of water. Water tariffs cover the cost to councils of infrastructure and maintenance in providing water services, and can be structured as fixed charges, volumetric charges, or a combination of both (Kropac & Ricato 2010). The most common structure in New Zealand for the 2017–18 period was a single fixed targeted rate applied to rating units (Garnett & Sirikhanchi 2018).

Auckland Council is one of only nine district councils nationwide to have implemented universal water metering for water charges (Garnett & Sirikhanchi 2018). Water and wastewater services are provided by Watercare, an Auckland Council-controlled organisation and limited liability company obligated to provide all water and wastewater services to Auckland under the Local Government (Auckland Council) Act 2009 (Office of the Auditor-General 2014). Watercare was given

this responsibility following the amalgamation of seven district and city councils and the regional council into Auckland Council in 2010, and from 1 July 2011 a standardised volumetric water tariff was implemented region wide.

Standardised pricing addressed inconsistencies across the region and reduced prices in all prior districts by up to 63% (Office of the Auditor-General 2014). It is unclear whether alternative approaches were considered at the time Auckland Council was formed; however, the fact that water meters had already been installed would make volumetric pricing more feasible and affordable than in a region lacking metering infrastructure. As of 1 July 2019, the council's volumetric charges were NZ$1.555 per 1,000 litres (Watercare 2019).

The Greater Wellington Regional Council supplies water to the city councils of Porirua, Wellington, Lower Hutt, and Upper Hutt, but charges the annual volume used by each city back to the respective council (Wellington Water 2019). Wellington City Council recovers costs using a fixed rate and a targeted rate on dollars per capital value (Garnett & Sirikhanchi 2018). However, about 1,200 residential properties in Wellington now have water meters, and so are charged instead for the water consumed (Wellington City Council 2020).

In the 2017–18 period, gross average per capita water consumption ranged from 316 to 378 litres per day across the four cities within the Greater Wellington region (Wellington Water 2018). In the same period, the gross daily consumption per capita in Auckland was 278.4 litres (Watercare 2018). In the 2016–17 period, both Wellington and Watercare charges were approximately 1.1–1.3% of household income; in comparison, the nationwide minimum and maximum water affordability levels for that period were 0.6% and 4 % of household income, respectively (Water New Zealand 2017).

This affordability was calculated as the sum of average annual residential water, wastewater and stormwater charges as a percentage of median household income by territorial authority (Water New Zealand 2017). There does not appear to be an obvious relationship between this measure of water affordability and water tariff structure. However, in surveys of 13 councils nationwide, Jenkins (2015) found lower rates of water use per capita in regions with universal metering and charges determined by usage, compared with those councils of comparable size that recover costs through property rates.

Aside from domestic usage, there are additional drivers that are important for commercial water use. Bint et al. (2013) used survey-level water audits of 93 office buildings in Auckland and Wellington to calculate benchmarks of water usage, and found that typical water use in Auckland was 26% lower than in Wellington, at 0.76 cubic metres of water per square metre of net lettable area per year. Further analyses of tariff structures suggest that although costs faced are fairly comparable across the two cities, Auckland tariffs provide more visual pricing incentives to induce behaviour change, with waste water being charged volumetrically rather than based on capital value, and invoices sent twice as often. The lack of visible pricing incentives in Wellington may contribute to higher water use in the capital than in Auckland.

Subsidies

Subsidies are payments to individuals or businesses that provide a financial incentive to change behaviour or adopt practices and technologies that could reduce environmental impacts. They can take many forms, including direct income support, price supports, subsidies for specific actions, and so on (Greenhalgh et al. 2020). For example, providing landowners with subsidies to undertake riparian planting or fencing has been one way to address issues associated with water quality in New Zealand (Greenhalgh & Selman 2014). Likewise, keeping water free acts as an implicit subsidy for users, and provides direct benefits to individuals, firms, and industry.[2]

Market-based instruments

Market-based instruments are market-like mechanisms artificially created to determine the price paid for an environmental outcome. Rather than setting the price on extraction or contaminant discharge, as is done with taxes or subsidies, decision-makers employ an environmental market by setting the quantity of water that can be used or the level of contaminants that can be discharged. Water users can then weigh the marginal costs of reducing their impacts by the specified amount against the cost of purchasing the same reduction in impact from another source. In this way, and assuming low compliance, information, and transaction costs, market-based instruments should be more efficient than a blunt regulatory instrument at achieving the desired results.

One of the institutional advantages of using market-based instruments for achieving desirable outcomes is the political palatability of a cap-and-trade system over a tax (Leonard et al. 2019). New Zealand is a global leader in the design and implementation of water markets for addressing non-point source pollution. In 2011, for example, a cap-and-trade system was developed for Lake Taupō as a way of managing diffuse water discharges. Although a number of policy instruments could have been used to protect the lake and improve water quality, the creation of the market was expected to provide a net benefit to farmers due to the flexibility and efficiency gains facilitated by trade (Duhon et al. 2015). Although the environmental gains are still to be fully realised, the cap-and-trade system is on track to deliver the community goal of maintaining a healthy lake (Kerr et al. 2015).

This management instrument has not yet materialised in the water quantity space, however. Water quantity markets require the identification of strong property rights and water rights that are decoupled from land titles in order to stimulate trade (Libecap 2012). In addition,

[2] A list of projects supported by the Freshwater Improvement Fund is available here: https://www.mfe.govt.nz/more/funding/freshwater-improvement-fund/freshwater-improvement-fund-projects/table-of-projects

barriers to entry and exit and levels of transaction costs must be low (McCann & Garrick 2014; Ayres et al. 2018). As few of these institutional enablers are consistently met in the New Zealand resource management context, water rights trading has emerged only informally. In Canterbury, for instance, resource consent exchange is restricted by regional and district plan rules that require each trade to be reviewed by local authorities (Talbot-Jones & Grafton, forthcoming) (see box). Likewise, a lack of comprehensive hydrological data makes it difficult to ensure that trades will avoid creating perverse outcomes (Ministry for the Environment 2019). On a deeper level, unresolved issues around Māori rights and interests continue to create tensions with regards to the type of instruments that can be implemented and who can benefit from allocation decisions.

Economic instrument case study: water trading, Canterbury

Although no formal water market exists for water allocation in New Zealand, an informal market brokered by Hydrotrader has emerged in the Canterbury region. Hydrotrader lists permits to buy, sell, or lease surface water or groundwater. For surface water, permits are listed within a catchment, and for groundwater they are listed within a groundwater zone. Since Hydrotrader began operations in 2007, 110 trades have been facilitated, with sales and leases comprising 85% and 15% of these trades, respectively (Hydrotrader 2020). Sales of water permits were, on average, 17.6 years in length (and ranged between two and 31 years), and all temporary transfers of rights (leases) traded for no more than three years.

Hydrotrader emerged at a time when constrained allocations in Canterbury and neighbouring Otago increased interest in water permit transfer (Jenkins 2005). The founders initially anticipated their trading platform would drive irrigation efficiency and simplify water transfer between users ("Irrigation: Water Trading Goes Online" 2007). They saw it as a mechanism to provide landowners with enhanced flexibility in their land and water management, where the cost to purchase or lease their required water allocation for a given year would be less than the capital investment for on-farm equipment they would otherwise require (Pascoe 2017).

However, the transaction costs involved with transferring consents through Hydrotrader are non-trivial. The process typically costs about NZ$5,000 and takes two to three months, including the decision-making process of the regional council, which includes a full assessment of environmental effects and the potential imposition of restrictions on the transfer as required under Section 136 of the RMA (Bai & Raffensberger 2012). These transaction costs impose trading barriers that may contribute to the low trade volume observed (Sharpe 2017).

The transaction costs may also help explain why the trading data show no obvious relationship between annual volume traded and lease or consent duration, nor any obvious time trends for either volume or duration (Hydrotrader 2020). Between 2007 and June 2009, Hydrotrader facilitated the trade of water consents worth more than NZ$600,000 (Davoren 2009), and between 2008 and November 2013, the highest trade was at NZ$1.62 per cubic metre of water (Davoren 2013). This

price is almost double the average price for trades greater than 100,000 cubic metres per year (NZ$0.83 per cubic metre) and for all trades (at NZ$0.88 per cubic metre) over the same period (Davoren 2013).

Establishing a water market in parts of New Zealand where competition for water is creating tensions could, in theory, allocate scarce water resources more efficiently and provide holders of water permits with increased flexibility and the ability to benefit financially from their permits (Sharpe 2017). However, the standard conditions of efficient environmental markets would need to be met, including low transaction costs, a sufficient number of active traders, low barriers to entry and exit, and so on (Keohane & Olmstead 2016).

Elsewhere in the world, however, market-based mechanisms have been considered the gold standard of water management for quantity owing to their flexibility and ability to incentivise users to innovate and adapt (Garrick et al. 2020). Some of the most renowned water markets have emerged to address scarcity issues, and lessons from their design, implementation, and evolution provide useful insights for developing markets in New Zealand (Grafton et al. 2011). In particular, lessons from cases where markets have failed to deliver the anticipated benefits are of great use. In the Murray-Darling Basin, Australia, the lack of transparency and the intrusion of politics into policy led to a breakdown in efficient and cost-effective allocation (Grafton & Williams 2019). Likewise, the experiences in early water markets in the western USA give insights into how the design of such markets can influence the delivery of more effective outcomes (Libecap 2012).

For water markets to work effectively in New Zealand, international models would need to be adapted for the local context. There would also need to be broader legislative changes to support the clear definition and defence of property rights and facilitate the divestment of rights. This will require significant negotiation and collaboration between affected parties, including government and iwi. Although this is likely to be a costly and extended process, resolving long-standing issues and enabling the inclusion of economic instruments in New Zealand's water policy toolbox has the potential to deliver greater net benefits to all (MacDonald et al. 2004; Hayward 2006; Sharpe 2017).

3.2 Supply-side management

Supply-side management engages instruments that augment the water supply using technical solutions. In many contexts such instruments have been an important component of water management, as they ensure that users can access a more regular supply of water that would otherwise be scarce and costly. In New Zealand, technical solutions such as dams and irrigation systems have been a central component of the policy response to address issues of scarcity (see box). More recently, some regional councils have been running managed aquifer recharge (MAR)

trials, which aim to inject surface water into nearby aquifers for subsequent irrigation use (Painter 2018). Internationally, MAR has been hailed as a way to increase water supply without imposing costs on water quality or the environment (Dillon et al. 2018); however, supply-side solutions such as MAR do not incentivise the type of behaviour change that encourages conservation of water over time. Delivering a steady supply at low marginal cost distorts the scarcity signals that would otherwise be operating in an environmental market. Considering how supply-side solutions can be complemented by demand-side policies is one way of overcoming these types of distortions and helps address the human component of water management.

Supply-side management case study: Central Plains Water Enhancement Scheme

The Central Plains Water Enhancement Scheme began operations in 2015. Established to increase water supply to dryland and farmland that was otherwise reliant on bore-well irrigation, it now provides irrigation water to 47,500 hectares in Canterbury from the Waimakariri and Rakaia rivers (Renwick et al. 2019). As at 30 June 2019, the scheme was valued at NZ$422 million, compared with up-front equity contributions from shareholders of NZ$92 million (Central Plains Water 2019).

The unique ownership structure of Central Plains Water Ltd enables consent ownership to remain separate from international, corporate, or commercial interests (Renwick et al. 2019). It also allows a user-pays system to operate, whereby scheme participants pay per unit of water used.

Although this mode of volumetric pricing encourages more efficient use among participants and has been attributed with the fall in groundwater take across the region, there is no guarantee that the Central Plains Water Enhancement Scheme delivers the most efficient use of water. Prior to being granted consent, the conclusion of the Commissioners at the independent hearing was that they "accept that the proposed use of water is an efficient use of the resource and do not need to determine whether it is the most efficient use of the resource" (Environment Canterbury 2010). This suggests that the needs of irrigators may have been able to be met in more efficient ways, had these been given consideration prior to approval for the Central Plains Scheme being granted.

4 Policy evaluation

New Zealand currently sits at a crossroads in the development and design of its water governance regime. Luckily, decision-makers can draw on lessons from domestic and international experiences to inform the selection, development, and implementation of policy instruments. These experiences, combined with theoretical insights, provide guidance into how water management could be improved across various scales and contexts in ways that are both efficient and equitable.

Given this objective, one of the challenges decision-makers still face is how to evaluate the relative merits of different instruments given the variation in conditions and context. This challenge is not unique to New Zealand – globally, decision-makers are forced to trade off between environmental outcomes, economic costs and benefits, and distributional or social equity impacts (Zetland & Gasson 2013). Decision-makers must also manage the path-dependency arising from historical and existing institutional arrangements, which can favour certain policies and design patterns (Garrick et al. 2020), as well as account for the level of transaction costs involved with shifting from the status quo. These transaction costs represent the friction involved in policy delivery and determine how efficiently and effectively a policy can deliver the desired policy or legislative objectives (Allen 2000).

In light of these compounding considerations, several assessment criteria and evaluation measures can be used to assess the suitability of particular policy instruments. Alongside assessing trade-offs involved with environmental, economic, and social imperatives, policy evaluation measures such as efficiency, cost-effectiveness, and the likelihood of incentivising behaviour change, as well as the general logistics associated with implementing and operationalising policy initiatives, can assist in the selection process. Table 1, for instance, shows that policy instruments vary in terms of where costs are accrued across the policy-making process. Although regulation can be quick and easy to implement, it is unlikely to deliver efficient or cost-effective outcomes or achieve the long-term benefits that can come from incentivising behaviour change and innovation. In contrast, economic instruments can be costly to design and implement, but once operating can be more efficient and cost-effective than regulation and can deliver longer-term benefits through incentivising desirable innovations.

Table 1: Criteria for evaluating the relative merits and limitations of policy instruments for freshwater management.

Policy tool		**Examples**	**Evaluation measure** Key: strong (+), medium (∘), weak (–), not enough information (?)					
			Efficient	**Cost-effective**	**Equitable**	**Incentivises innovation**	**Ease of implementation**	**Ease of monitoring/ enforcement**
Demand-side management	Outreach and education	Awareness campaigns	?	∘	+	∘	∘	–
	Regulation	Environmental standards, bans, and limits	–	–	∘	–	+	∘
	Price-based economic instruments	Taxes, levies, fees, subsidies	∘	+	∘	+	–	+
	Market-based economic instruments	Regulatory markets	+	∘	–	+	–	?
Supply-side management	Augmentation	Irrigation schemes, dams, desalination plants	+	–	∘	–	–	+

Given these trade-offs, it should be no surprise that most policy solutions end up being second-best arrangements (Lipsey & Lancaster 1956). Because decision-makers are usually operating in settings where they have imperfect information, the best they can do is identify allocation arrangements that are the most likely to improve welfare given the information available. There are also various broader constraints that can influence how and what policies are selected. In New Zealand, a series of institutional issues, as well as biophysical constraints, affect how and what policy instruments have been adopted to address issues of water scarcity or quality. For instance, the need to address Māori rights and interests, the compliance gap, and the constraints imposed through New Zealand's biophysical conditions have all affected the type of policy instruments prioritised to date. Recognising these barriers and reframing them as opportunities has the potential to place New Zealand decision-makers in a stronger position to address issues that are at the core of the country's water governance challenges. Each of these challenges is now discussed in turn.

4.1 Rights and responsibilities

The legal mechanisms defining the strength of property rights affects how efficiently and effectively various policy instruments can be used as a management tool. Property rights refer to the rules that determine who has authority to undertake particular actions related to a specific domain (Commons 1968). Yet, because all rights have complementary duties, they also specify the range of duties and responsibilities to be held by others. Property rights and their corresponding duties and responsibilities that are well defined, well defended, and divestible are more efficient than those that are poorly defined, weakly defended, and non-transferable.

In New Zealand, the RMA provides the legislative framework under which local authorities can develop plans to manage water quality and allocation, and define the property rights for use and management. The RMA grants local authorities permission to award water users a resource consent to take water or discharge to waterways through a first-come, first-served process. Although these consents can be considered a type of right, and Section 122(2–6) of the RMA brings property law to bear "as if" a consent is personal property, Section 122(1) declares such consents to be neither real nor personal property (Barton 2010). This muddles the definition of property rights and makes their enforcement more difficult and costly.[3]

The definition of freshwater rights is further complicated by unresolved issues around Māori rights and interests in water, as well as the conflation of rights and interests with

[3] Even courts have struggled to define Section 122 in a purposeful way (Barton 2016). Most recently, Hampton v Canterbury Regional Council (Environment Canterbury) 2015 [NZCA] 509 agreed that a resource consent (in this case a water permit) did not create a right to property, but instead simply amounted to a right to carry out an activity under the RMA. This decision moved away from a previous position upheld in Aoraki Water Trust v Meridian Energy Ltd [2005] 2 NZLR 268, [2005] NZRMA 251, however, which ruled that the granting of a water permit did create a right to property.

ownership. While rights refer to the rules that determine authority, ownership refers to the relationship between a person and a thing (Hume 1978). When it comes to water in New Zealand, this relationship has been interpreted in both legislation and by the courts to mean the western model of private property (Wheen 1997). However, recent Treaty of Waitangi settlements concerning fresh water demonstrate that the long-standing disagreements between Māori and the Crown are more about who has decision-making authority within a group (property rights), and how te ao Māori values and tikanga are recognised and upheld in law (Waikato-Tainui Raupatu Claims (Waikato River Settlement) Act 2010; Te Awa Tupua (Whanganui River Claims Settlement) Act 2017; Ruru 2018).

Until possession is stabilised by social rules, there is no secure relation between person and thing. For this reason, focusing on the designation of rights, as well as their corresponding duties and responsibilities, presents an opportunity to begin navigating the complex landscape around water rights independently of the complexities presented by the understanding of ownership. It also presents an opportunity to facilitate the design and implementation of rules that support a wider suite of policy instruments for freshwater governance, thereby opening up new pathways for more efficient and effective policy outcomes.

4.2 Monitoring and enforcement

One of the obstacles affecting the achievement of desirable policy outcomes for fresh water is not only the definition of property rights, but also their defence. People are likely to shift from the status quo only when they anticipate that the benefits of doing so outweigh the costs. Because discharge abatement and water conservation are both costly activities, users have little incentive to change their behaviour unless the potential costs of not complying are such that they outweigh the costs of compliance (i.e. established as the dominant strategy). Given this, both monitoring and enforcement are core components of successful policy implementation, yet both elements are inconsistently applied by local authorities in New Zealand, particularly in rural areas (Brown 2017).

A secondary issue is the question of oversight in the enforcement processes of local authorities. Much as an individual faces incentives when making a choice of whether or not to violate the rules, so governing agencies must make a choice as to whether investing in enforcement is likely to deliver net benefits for the organisation (Brown 2017). If benefits are unlikely, it is correspondingly unlikely that an agency will invest in extensive enforcement processes. Establishing a system that embeds oversight of local government enforcement into the formal water governance process has the potential to change the pay-off ratios for local governments that are considering whether or not to monitor and enforce water user behaviour. If the oversight makes it more costly for local governments not to punish violators, it is likely that cases of sanctioning would increase.

Although monitoring and enforcement is currently a barrier affecting the attainment of the Essential Freshwater package goals, it also presents an opportunity for improved policy design. Rules can be designed that incentivise individuals or groups to behave in a self-enforcing way (Greif 2013). Alternatively, "guards of the guardians" can be designated to oversee the enforcement choices of local authorities (Hurwicz 2008). This is a particularly powerful mechanism for navigating some of the complexities that can arise when politics intervenes in water policy.

4.3 Addressing biophysical conditions

Finally, the selection and implementation of various policy instruments are constrained by the biophysical and institutional contexts that shape the freshwater environment. For example, in terms of market-based mechanisms the hydrological system and topography influence the conditions under which water can be transferred. Transferring beyond catchment or aquifer boundaries can impose ecological costs that are not easily accounted for (Ministry for the Environment 2004). Likewise, transfer between upstream and downstream users can impose costs on third parties, such as the environment, which are not always internalised.

This means that the design and implementation of policy instruments need to be context and scale specific. Investing in improved hydrological mapping to understand the movement of water between surface-water and groundwater systems is one way this can be addressed. Greater investment in science and modelling can also close data gaps and provide insight into the relationship between water quality and water quantity (Parliamentary Commissioner for the Environment 2019). This is important for several reasons. From an economic perspective, it is inefficient to invest in one element of water health without simultaneously addressing the other (van Vliet et al. 2017). From a cultural perspective, Te Mana o te Wai recognises the interconnectedness of all physical and metaphysical elements of a waterway and requires its health and well-being to be considered from the mountains to the sea, rather than taking a fragmented approach to management (Kahui Wai Māori 2019).

In catchments that could support the implementation of economic instruments in terms of their biophysical characteristics, several institutional mechanisms can be leveraged to ensure the efficient and cost-effective delivery of water to users. Designing institutional arrangements that consider the needs of the community alongside environmental conditions are best placed to ensure that water policy objectives can be met.

5 Concluding thoughts

Over the past several decades, increased demand for water has placed pressure on available supplies and affected the quality of freshwater health in New Zealand. Into the future, a growing population, as well as climate change and increasing climate extremes such as droughts and floods, are expected to further exacerbate these pressures. For decision-makers, understanding the policy instruments available to help address these evolving challenges, as well as their merits and limitations, has the potential to place New Zealand in a stronger position to meet the ambitious objectives of the 2018 Essential Freshwater package.

This review has highlighted the range of policy instruments available to effect change in water management in New Zealand. By examining how some policy instruments have been used to date, as well as how others could be adapted to improve freshwater outcomes in New Zealand, the paper focuses on how local authorities could meet the objectives of the Essential Freshwater package in cost-effective, efficient, and equitable ways. It also draws attention to some of the barriers affecting the selection and implementation of certain policy instruments that will need to be overcome in order for local authorities to achieve marked improvements in freshwater management.

Should affected parties be able to successfully overcome the barriers identified in this paper, the array of policy instruments outlined should assist decision-makers in understanding the options for improving freshwater outcomes in their region. New Zealand's social, cultural, and economic well-being depends on the accessibility of clean water of sufficient quantity. The more informed decision-makers are about the policy options available, the more likely we are to reach outcomes that halt and reverse the decline of freshwater health in New Zealand.

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Appendix

Table A.1: Strengths and weaknesses of outreach and education as a policy tool for water management.

Method	Strengths	Weaknesses
Access to information	• Good access to information creates a robust evidence base that may enable better and more effective community participation and engagement – particularly if the information provided defines roles for multiple stakeholders and provides data that different stakeholders care about. • Access to information creates an informed public and stakeholder group. This can lead to better and more informed decisions and policies that are responsive to the needs of the community and the environment. • Access to information on the trade-offs (if any) relating to a decision creates more robust policy and reduces the probability of unintended and unexpected consequences of policy choices and perverse outcomes.	• Being a passive method, it relies on the target audience accessing and using the information provided. • Requires resources and processes to ensure data are updated, published regularly, and adequately maintained. • Relies on robust research/ monitoring/data collection programmes to gather, store, analyse, and report the data, which may or may not exist. • Could result in decision paralysis, whereby certain actors use the inherent uncertainty in current information to continually delay action until they have 'enough information'. • If the data do not come from a trusted source or are not tailored to the target audience, then the information may not be used. • It can be difficult to evaluate the effectiveness of this method. Targeted surveys (or similar) could be used to determine what and how the information is used.
Environmental education	• Environmental education is non-prescriptive, yet promotes understanding and awareness, allowing individuals to make informed choices. • Environmental education, particularly at a school level or for young leaders, is an excellent conduit for exposing the younger generation to	• Environmental education is not explicitly included in the school curriculum and not always financially supported. • There is no certainty that an environmental education programme or initiative will have the desired impact on behaviour.

Method	Strengths	Weaknesses
	environmental issues and building understanding of the importance of managing them as well as enhancing leadership, cooperative working skills, and entrepreneurship. • Environmental education in schools provides valuable interactions between schools and local communities, to the benefit of both. • Readily available Internet resources enable landholders and interested citizens to learn about environmental issues without specialist or expensive training.	• It can be difficult to evaluate the effectiveness of this method. Targeted surveys (or similar) could be used to determine what has been learned and how the information is being used. • If children are the target audience, it could take a long time for any behaviour changes to become evident and/or widespread.
Technical assistance	• Some solutions that have a management rather than technological basis can be relatively low in cost and have low resistance to change, meaning that uptake can be rapid and widespread. • Technical assistance can be an effective supplementary instrument to assist communication, encourage the adoption of lasting behavioural changes, and ease the burden or impact of the main method being used to address a problem.	• Adoption of new technologies/ practices can be limited in cases where technologies/practices are relatively expensive to implement, and therefore should be combined with other methods, e.g. subsidies, tax credits, loans. • People are often resistant to changing the way they operate their business or how they do things. Therefore, innovative approaches to technical assistance are often needed to achieve widespread changes, such as influencing social networks and public debates. • Dedicated funding is needed to pay technical assistance providers. A lack of funding may limit the effectiveness of technical assistance programmes if there is insufficient capacity or capability to provide outreach to the targeted communities.

Table A.2: Strengths and weaknesses of regulation as a policy tool for water management.

Method	Strengths	Weaknesses
Environmental bans and restrictions	• Bans and restrictions are most appropriate where activities, products, or technologies have negative implications for the wider public, e.g. where they are known to have severe human health or environmental impacts. • Generally, bans and restrictions provide clarity and are equitable. • Some bans and restrictions may be easy to monitor, as it is relatively straightforward to determine if an activity is or is not taking place or if a product or technology is or is not being used. • Changes in activities (or products) can encourage innovation, e.g. replacing ozone-depleting chlorofluorocarbons with less harmful substances.	• Bans and restrictions are relatively inflexible and inefficient mechanisms to achieve a desired outcome, because while they prohibit specific activities, products, or technologies, they do not cover all activities, products, and technologies that may have similar adverse impacts. • Depending on the spatial extent of the ban, there can be leakage of that activity, product, or technology to other areas that do not have the same restrictions. Therefore, the ban may not be sufficiently effective, and its use may move to countries or areas where there is less ability to monitor and enforce the use of these activities, products, and technologies. • Depending on what is being banned, these regulations can be costly to enforce, e.g. bans on tropical timber products are challenging because of the difficulty of differentiating between some plantation-grown timber and primary forest timber. • Bans and restrictions may be cost-ineffective, as they are based on controlling activities rather than outcomes. Over-regulation may occur. • As bans and regulations are mandatory/compulsory, there may be resistance to their implementation. • Bans and restrictions impose a cost to change activities,

Method	Strengths	Weaknesses
		products, or technology for those affected. • While unsustainable technologies, activities, or products are banned, in themselves they do not promote or provide incentives for the use of other preferred or more sustainable technologies, activities, or products.
Environmental standards	• Standards are widely understood by many people. • While the implementation costs can be high, the political costs of standards are generally lower compared with economic instruments such as taxes and subsidies, as setting standards does not incur direct budgetary implications for the administering agency.	• To set an economically efficient standard, both the demand for environmental improvement and the supply of actions to improve the environment must be known. However, these are not directly observable, making it challenging to set the optimum standard. • Standards provide no incentive to reduce or improve environmental conditions beyond the standard, because they tend to discourage the development of technologies that might otherwise result in greater levels of improvement. Instead, they focus on the service affected by the standard. • In some cases, monitoring, enforcement, and penalties for violating standards may be too weak. • Financial costs may be high for those affected by the standard and for the administrator to implement, monitor, and enforce. • Standards may be politically unpalatable if they are stringent and businesses are adversely impacted.

Method	Strengths	Weaknesses
Performance standards	• The common strengths of environmental standards, outlined above. • Performance standards provide more flexibility in how a standard can be achieved and are therefore likely to be more cost-effective than design standards for those affected by the standard. • These standards encourage innovation to meet the requirements of the standard.	• The common weaknesses of environmental standards, outlined above.
Design standards	• The common strengths of environmental standards, outlined above. • In general, design standards are easier to monitor and enforce than performance standards as they are based on the use of a certain technology or process. Certification standards often accompany design standards and are used to validate the implementation/application of the design standard.	• The common weaknesses of environmental standards, outlined above. • Design standards may be considered inflexible and inefficient as they are uniformly applied to all firms and regions, and as a result do not acknowledge firm variability, making them less cost-effective. • To be effective, design standards need to be revised frequently in response to rapidly changing circumstances. In general, legislation does not keep up with the pace of change. • Design standards may not promote innovation as they specify the actions, processes, design, or technologies that must be used.
Environmental caps and limits	• Caps and limits are based on performance and so provide flexibility in how the cap is achieved, theoretically making this a less costly method and more attractive to affected	• Enforcement of a cap or a limit can be difficult, especially where multiple sources and sectors are involved. One major challenge is measuring and enforcing limits on non-point

Method	Strengths	Weaknesses
	parties compared with other regulatory approaches. • Encourages new 'best practices' and innovation. • Environmental caps are one of the most effective ways of placing absolute limits on the level of environmental degradation that society deems acceptable.	or diffuse sources of degradation, e.g. sources of land-based pollution. • Setting the cap or limit at an appropriate level can be difficult from both a scientific and political standpoint. Generally, the level of the cap called for through scientific analysis and the level of cap that is acceptable politically are different. Uncertainty about the actual impact of actions on freshwater systems may further confound the process of identifying the environmental limit and setting the cap. • An environmental cap or limit may restrict economic growth (often restricting increases in production). Coupling a cap with market-based trading or an offset mechanism (see Section 3.1.3) may provide some increase in production but it will still be less than if there was no cap. • New infrastructure and resources may be required if the cap is to be implemented and managed successfully. • Additional legislation may be required if there are no existing legal means to set an effective environmental cap or limit. • Allocating a cap between sources can be difficult and contentious. A cap places a restriction on relevant sources, and all methods to allocate a cap between sources will disadvantage some sources and give advantage to others, making allocation a challenging process.

Method	Strengths	Weaknesses
		• As source limits are not set relative to an environmental cap, there is no guarantee that, in aggregate, these individual source limits will ensure the environmental threshold for the resource in question is not exceeded.

Table A.3: Strengths and weaknesses of taxes and levies as a policy tool for water management.

Method	Strengths	Weaknesses
General	• Depending on the method of implementation, taxes and levies can be difficult to evade, as they are mandatory or compulsory payments, e.g. a polluter-pays tax on fuel added at the petrol pump or to vehicle registration cannot be avoided. • When applied to few sources (e.g. the Swedish fertiliser tax, which is imposed on a limited number of manufacturers and importers), these instruments can be straightforward to administer. Taxes and fees generate revenue for the government or non-government body rather than imposing an additional cost on the administering agency/ agencies.	• Placing taxes, fees, and levies on individuals or individual businesses may decrease pollution or environmental impact at a micro-scale. However, aggregate pollution levels may increase due to new entrants or new individuals creating additional environmental impacts (especially if the externalities far exceed any costs through internalised taxes, fees, or levies). • A tax that is not targeted or structured to encourage the reduction of environmental impacts will have little effect on changing undesirable behaviours. • It is challenging to identify the appropriate price or tax level to induce behaviour change. • Taxes that could negatively affect public perception of the initiative can be considered coercive. • The cost of imposing taxes, fees, or levies based on the degradation of water quality can be higher where it is time consuming and costly to quantify the impacts of actions, and/or to administer the process. • Taxes and levies are an additional cost to the production system, which may negatively affect the international competitiveness of New Zealand producers.

Method	Strengths	Weaknesses
Polluter-pays tax/Pigouvian taxes	• The common strengths of general taxes and levies, outlined above. • Encourages the efficient use of resources and/or the use of less polluting technologies through a continuing incentive (Meister 1990). • Tax is more targeted than 'blunter', more widely imposed tax instruments. The polluter-pays tax specifically targets those organisations that create negative environmental impacts.	• The common weaknesses of general taxes and levies, outlined above. • The administrative burden of recouping the tax revenue can be challenging as it must be coupled with monitoring or estimating the level of water-quality degradation caused by an individual or business. This can be especially challenging where the impacts are diffuse.
Input taxes	• The common strengths of general taxes, outlined above.	• The common weaknesses of general taxes, outlined above.
Land-use taxes	• The common strengths of general taxes and levies, outlined above. • Applies to domestic investments as well as foreign-owned investments that might otherwise be exempt from some taxes, likely generating more revenue. • Provides an incentive to shift the emphasis from increasing or intensifying production that may negatively affect water quality, to less intensive production models that are more likely to maintain ecosystem health. The tax rate would need to be higher than the additional profit derived from intensified production (or negative impacts of intensified production).	• The common weaknesses of general taxes and levies, outlined above. • A tax on land can discriminate against those who are land rich but income poor (e.g. retirees who are using land as capital to finance their retirement). • Where land is rented or leased, there can be implications for existing long-term contractual agreements should such a tax be implemented, and the tax would need to be levied on those who are making the land-management decisions or allow appropriate signals to be sent to those who manage the land, e.g. the leaser could charge lease structure to cover the tax.

Method	Strengths	Weaknesses
Environmental tax/fee with revenue recycling	• The common strengths of general taxes and levies, outlined above. • Reduces the tax burden elsewhere in society, depending on how revenue recycling is implemented. • Likely meets less public resistance to the imposition of a new tax if the spending goals for the recycled revenue are identified and transparent (Le Grand 2003).	• The common weaknesses of general taxes and levies, outlined above. • It is not always clear what level of tax will generate sufficient revenue to mitigate the negative externality. • There is a danger that the funds generated by environmental taxes or fees are directed elsewhere rather than to the original purpose of environmental improvements, especially at times of fiscal stress.
Levies	• The common strengths of general taxes, outlined above.	• The common weaknesses of general taxes, outlined above.

Table A.4: Strengths and weaknesses of subsidies as a policy tool for water management.

Method	Strengths	Weaknesses
General subsidies	• Voluntary incentives are more palatable to individuals and businesses than non-voluntary options. • Provides a lower-risk cost option for individuals and businesses to install or implement practices or technology that reduce ecosystem degradation or improve water quality, as it provides for all, or for a portion, of the cost of making that change. • Provides a contractual agreement for an individual or business to undertake specified actions to improve environmental performance that provide a greater guarantee of the specified action(s) being undertaken. • Provides external funding for high-cost projects that local government or individuals alone may not be able to fund fully. • When payments are tied to performance (i.e. actual change in water quality) rather than a practice or technology, there are direct incentives to choose practices and technologies that are most suited to the individual or business (i.e. increased flexibility) and maximise improvements in freshwater systems (i.e. increased effectiveness). • May incentivise choosing a more effective option where that option may not be the most cost-effective.	• May be ineffective in cases where changing practices or technology to improve environmental performance may require more than a financial benefit to induce behaviour changes by individuals or businesses (i.e. social or cultural barriers to change may exist), or a higher payment than that being offered to make the required changes. • Must be carefully managed to make sure they are not supporting activities that would have occurred in the absence of a subsidy. • Programme administration can be costly, especially where a programme requires visits by technical staff before funds are awarded. Programme delivery will require sufficient funds and personnel to avoid bottlenecks and ensure the successful delivery of the programme. • Subsidies may fail to maximise environmental improvements if they do not target the implementation or installation of the most cost-effective practices/ technologies (Feather & Cooper 1995). • There is a requirement for an external source of funds from a government agency or similar organisation, such as a regional council, to make payments. • The size of the external source of funds may be insufficient to achieve the desired amount of environmental improvement. • Depending on how subsidies are implemented, there may be insufficient flexibility for the most

Method	Strengths	Weaknesses
		appropriate practices/ technologies to be implemented in a given situation. Consequently, the subsidies may not necessarily target the areas or actions where the greatest improvement in water quality can be achieved for the lowest cost. • Effectiveness will depend on how many sources participate and for what actions the funding is used. Low adoption may mean that few improvements are achieved.
Direct payments and payments for ecosystem services	• The common strengths of general subsidies, outlined above. • May be politically attractive as private funds may be used to complement public funding to achieve greater ecosystem outcomes. • Provide a direct incentive for environmental actions. • Provide non-environmental benefits in addition to environmental benefits, e.g. they may offer financial security for otherwise impoverished landowners.	• The common weaknesses of general subsidies, outlined above. • The voluntary nature of these programmes may mean there are insufficient incentives to achieve widespread adoption. • These programmes can be high risk to the private investor where they are relying on the resulting improvement in water quality to reduce their current or future costs of operation (e.g. clean water for a drinking-water plant). The risk comes from insufficient adoption by relevant individuals or businesses to achieve the required improvement in water quality.
Incentive payments	• The common strengths of general subsidies, outlined above.	• The common weaknesses of general subsidies, outlined above.
Cost-share subsidies	• The common strengths of general subsidies, outlined above. • Provide incentives for the individual businesses receiving the subsidies to implement and maintain the practice/technology in question. This is because they pay for a share of the cost of	• The common weaknesses of general subsidies, outlined above. • For high-cost-mitigation options, cost share may not cover a sufficient portion of the cost to make the practice affordable for individuals or businesses to implement/install. For instance, a

Method	Strengths	Weaknesses
	implementing the practice and if they do not implement or maintain the practice correctly it will incur a real future cost. • May be politically attractive as private funds may be used to complement public funding to achieve greater ecosystem outcomes.	technology may cost $100,000 to install; even with 50% cost share, intended recipients are still expected to spend $50,000 of their own funds, which may not be affordable. • Practice or technology-based cost-share programmes require constant updating to ensure they remain technologically relevant and appropriately costed.
Tax credits and rebates	• Administration is typically straightforward as it uses existing tax or payment systems. • Usually voluntary and more likely politically acceptable. • May not be constrained by a funding limit, as is the case with a subsidy.	• Real improvement in water quality is uncertain as the tax credit or rebate may not provide sufficient incentives for voluntary uptake. • May require initial up-front capital to undertake the actions that generate the tax credit or rebate, so may exclude the participation of lower-income individuals or businesses. • The rate of voluntary uptake may be insufficient to result in any discernible change in water quality. Setting the optimal tax credit or rebate level and determining eligibility criteria are important for providing sufficient incentives to promote participation. • Rebate systems can have a higher administrative burden as they involve refunds being given to individuals after the payment has been made.
Low-interest loans	• The overall fiscal burden to the government is likely to be smaller than other price-based economic instruments because loans are repaid over time.	• No guarantee of large-scale adoption of practices or technologies that will improve water quality. • Low-interest loans will motivate only portions of the public that

Method	Strengths	Weaknesses
	• Potentially more politically palatable to decision-makers and the public because of its voluntary nature and lower financial burden on government.	would normally have considered these actions. • Given that money has to be repaid, those with insufficient income are unlikely to participate. • There must be initial funds available to capitalise the loan fund.

Table A.5: Strengths and weaknesses of market-based instruments as a policy tool for water management.

Method	Strengths	Weaknesses
General	• Participation in markets is voluntary. Even if an entity does not meet its regulatory obligations, it can choose to pay a fine rather than participate in a market. • Markets are typically performance/outcome driven, not practice-based. This rewards the measured or estimated improvement in water quality or reduction in water-quality degradation, not the implementation of practices that leads to improvements or reduced degradation. This ensures flexibility and does not lock the markets into a specified set of practices that require updating over time. • Markets can promote innovation if they are designed to allow and promote innovation, e.g. allowing participants to test, and obtain credit for, new management practices aimed at improving water quality.	• Markets often require new infrastructure (such as registries and marketplaces) and modification of existing procedures (e.g. consents processes and databases) to operate efficiently. • The design and operation of markets is relatively new, and some up-skilling will likely be required by any party operating an environmental market. • Markets often have high transaction costs. In large part these costs are attributable to the processes that ensure the stated improvement in water quality is real, additional, and verifiable. Transaction costs may also include locating buyers and sellers where markets have few participants, programme administration costs, and the perceived risk that the purchased improvements will not generate the stated improvements. • Activities that rely on a permanent land-use or practice change and are traded in a market can pose challenges to ensuring these changes are permanent and will not be reversed in the future (e.g. forestry credits in greenhouse gas markets), especially where the supplier of the credit for the trade is not subject to any regulatory obligations.
Regulatory markets	• The common strengths of general markets, outlined above.	• The common weaknesses of general markets, outlined above.

Method	Strengths	Weaknesses
	• In theory, markets will reduce the cost of meeting a stated environmental goal, by providing flexibility in how that goal can be achieved. • Markets can be designed to include multiple sources of environmental degradation. • Markets may enable some growth under a regulatory cap by permitting new sources to purchase allowances from sources that already have an allocation under the cap. It is the regulatory or environmental cap that ensures the overall improvement in ecosystems services. • Markets may lead to faster achievement of environmental goals by providing sources with flexibility in how they meet their regulatory obligations. Therefore, instead of regulated sources being out of compliance before they have changed practices or upgraded technology, they can purchase improvements from elsewhere to meet their regulatory obligation.	• Existing regulatory legislation may inhibit the use of markets either by explicitly prohibiting them, not sanctioning their use, or specifying the use of alternative mechanisms to meet an environmental goal. • There must be a sufficiently stringent regulation to drive demand if markets are to be useful. Regulatory requirements have often been too weak or set at a level insufficient to drive demand for credits in regulatory markets. In these cases, the underpinning regulation is unlikely to make any real improvements in water quality. • Unless all relevant sectors are capped, there is risk of leakage from an environmental market. • There is the potential that markets may result in hotspots, where degradation in one area increases as a result of trades in credits, permits, or allocations from another area. This can be minimised through market design (e.g. only upstream trades are permitted). • It is likely that the establishment of any new regulation that underpins a market and allocating the cap among sources will be unpopular by those impacted. While this refers to the underpinning regulation, it can affect the implementation of the market that is aimed at increasing flexibility for regulated sources.
Voluntary markets	• The common strengths of general markets, outlined above.	• The common weaknesses of general markets, outlined above.

Method	Strengths	Weaknesses
	• Voluntary markets provide unregulated individuals or businesses that want to compensate for their environmental impacts with a mechanism to purchase environmental improvements off willing sellers of such improvements.	• Voluntary markets often lack sufficient drivers to induce participation by potential demanders of water quality (or discharge) credits. • Voluntary markets may lack the rigour of regulatory markets in terms of their additionality[4] and verification requirements, which in turn diminishes the value of these markets to create net benefits to water quality.
Auctions and tenders	• Allocates government or external funding cost-effectively where a budget constraint exists. • Auctions can engage a greater number of potential participants because of the flexibility in the amount of funding a participant can receive (Selman & Greenhalgh 2009). The amount awarded to an individual depends on how cost-effectively they can implement a practice or achieve a reduction compared with others participating in the auction. • Depending on auction rules, an auction may attract a different set of participants than traditional subsidy programmes because of flexibility in bid prices (Selman & Greenhalgh 2009). • Auctions are most often performance based, which means they are not only likely to minimise costs, but also to maximise environmental improvements.	• To operate the auction an external source of funds is required, e.g. a government agency such as a regional council. Auctions could also be financed using private funding sources such as foundations. • Auctions are a relatively new tool for allocating conservation dollars and are likely to require some up-skilling on the part of administering bodies for the successful design and implementation of an auction. • As auctions are typically performance based, the improvement in water quality associated with various actions often needs to be estimated. Therefore, robust measurement methodology or methodologies must be available for audit/ verification requirements. • Auctions are considered by some to be unfair, as larger or wealthier landowners might be able to capture more funding by putting in lower – and therefore more competitive – bids. These

[4] Additionality refers to whether an action would have occurred regardless of the policy being implemented to change behaviour. For an action to be additional, it would not have occurred unless the policy had been implemented. It is a criterion often used for greenhouse gas–reduction projects

Method	Strengths	Weaknesses
		landowners are using more of their own dollars. • There is a potential risk of price collusion, especially in cases where only a few landowners are participating.
Ecolabelling	• Provides easy identification of products and services that are produced in a sustainable manner and are often quality assured. This enables consumers to make informed choices about the purchase of products or services. • Ecolabel participants may gain increased market share, creating a positive feedback loop to incentivise joining the scheme. • Ecolabel products may command a higher price in the marketplace, resulting in higher revenues for those participating in the ecolabel scheme. • Over time, ecolabelling programmes may be a mechanism to ensure new or continued access to markets, as retailers and consumers demand improved ecosystem management. • Participation in ecolabel schemes is voluntary, so will be more politically palatable than mandatory or compulsory schemes. • Ecolabelling programmes may spur the development of best-practice criteria for production.	• Depending on the scheme, the requirements may not actually be rigorous enough to result in improvements in water quality. • Depending on the scheme, meeting the standards may be quite arduous and expensive (e.g. requiring third-party certification), limiting participation. • Environmental standards may vary between countries, which may result in consumer confusion over the benefits associated with various products. • The link between the certification standard or ecolabelling and positive environmental outcomes can be tenuous, or at best aspirational (Lewis et al. 2008). The benefits of targeted and specific actions undertaken by individual farmers for an ecolabel may be superseded by the general improvement in sustainability of agricultural practices on a larger scale. • Mandatory or compulsory requirements for ecolabelling of goods may be viewed as protectionist and a barrier to international trade. • The success of many ecolabel schemes relies on the willingness of consumers to pay price premiums for the environmental

Method	Strengths	Weaknesses
		improvements portrayed by the scheme.

Table A.6: Strengths and weaknesses of supply-side management as a policy tool for water management.

Method	**Strengths**	**Weaknesses**
General	• Provides users with sufficient supply.	• Has the potential to be more costly than demand-side options. • Does not incentivise more efficient use. • Activities require new infrastructure investments.