THE TAUPO NITROGEN MARKET: THE WORLD'S ONLY DIFFUSE SOURCE TRADING PROGRAMME

Motu Note #20

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SUMMARY: WAS IT WORTH DOING AND SHOULD SIMILAR PROGRAMMES BE USED ELSEWHERE?

The Taupo Nitrogen market was part of a water quality policy package with three components – regulation of farm nitrogen leaching, a public fund, and a market.

Observed trading activity and estimates of transaction costs suggest the market is functioning well.

The value of this package as a whole cannot easily be assessed, partly because environmental benefits are largely in the future and intangible, and partly because the learning benefits are still playing out as water quality regulation develops elsewhere in New Zealand. Total costs, many of which are also intangible, have not been fully assessed.

As a result of this policy experience, we can state with confidence that it is technically feasible to include non-point sources within a cap and trade water quality market, that such a market can function, and that once property rights are clearly established, the additional cost of allowing trading is low.

Whether this approach, or variants of it, are valuable to adopt in other catchments around New Zealand and elsewhere will depend on local economic, geophysical, and political characteristics.

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INTRODUCTION

New Zealand's Lake Taupo Nitrogen Trading programme was a bold policy experiment. It is globally unique: it is the only trading programme or market where non-point sources operate under a cap (Greenhalgh and Selman 2012). It was established as part of a policy package that addressed an emerging water quality problem, not an existing crisis. Given it is the first of a kind, what should the world, and the rest of New Zealand, learn from it? Was it a success that should be replicated or a costly and politically painful experiment where the key lesson was failure?

The paper provides some background, clarification, and history on the Lake Taupo Nitrogen Trading Market[1]. We combine interviews with key participants, official documentation, analysis of data, and our own personal experiences with this regulation, and attempts to regulate similar challenges elsewhere in New Zealand to assess the efficacy of the market, synthesise what we see as the key benefits and costs from the policy package, and suggest what lessons could be taken from the Taupo experience for other jurisdictions within New Zealand and beyond.

1. Two key documents that evaluate the system are Young and Kaine (2010) and Duhon et al. (2015).

We are grateful for support from the OECD and for input from Megan Coup from Waikato Regional Council.
Any errors and all opinions expressed are those of the authors.

We conclude that it is technically feasible to include agricultural non-point sources of nutrient leaching within a cap and trade water quality market – and that once property rights are clearly established the additional cost of allowing trading is low. Observed trading activity and estimates of transaction costs suggest the market is functioning.

The value of the water quality policy package, which has three components – regulation of farm nitrogen (N) leaching, a public fund and the market – cannot easily be assessed, partly because environmental benefits are largely in the future and intangible and partly because the learning benefits are still playing out as water quality regulation develops elsewhere in New Zealand. Total costs, many of which are also intangible, have not been fully assessed.

Whether this approach, or variants of it, will be perceived valuable to adopt in other catchments will depend on local economic, geophysical and political circumstances. As the National Policy Statement for Freshwater Management (New Zealand Government 2014) is implemented, more and more catchments around New Zealand will be facing similar questions and decisions on the policy package that will meet their water quality goals.

BACKGROUND

Water quality trading

Water quality trading is an economic instrument being used in many parts of the world to facilitate the improvement of water quality in degraded water bodies. Trading allows regulated sources to meet their compliance obligations by purchasing an equivalent improvement in water quality from other regulated and sometimes non-regulated sources. Trading provides flexibility and, in theory, reduces the cost of regulatory compliance (David et al. 1980; Sergerson 1998; Grafton 2011). It takes advantage of the arbitrage opportunities that arise between regulated sources with different abatement costs. Abatement costs vary between sources depending on their size, location, scale, management, and overall efficiency. To date, most water quality trading programmes have involved the regulation and trading of nutrients (e.g. phosphorous and nitrogen), but some programmes cover temperature and salinity (Greenhalgh and Selman 2012).

"Water quality trading.... allows regulated sources to meet their compliance obligations by purchasing an equivalent improvement in water quality from other regulated and sometimes non-regulated sources."

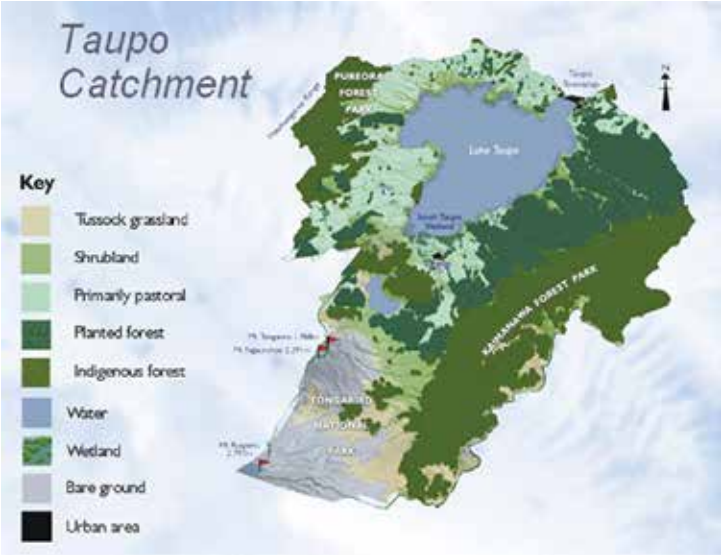
Most trading programmes focus on the regulation of point sources (e.g. industrial or wastewater treatment plants) as it is easier to measure the pollutant discharges from these sources. Non-point sources are more challenging to regulate as the diffuse nature of their pollutant losses means these losses tend to be estimated rather than measured; most of these sources are not regulated. This means that if these sources are included within trading programmes, it is through 'offsets' or credits[2]. Two exceptions exist. The first is the regulation of non-point stormwater sources in the United States, primarily related to new urban development. These sources are being given low discharge nutrient limits (VADEQ 2013). The second is in New Zealand where agricultural non-point sources are being regulated for their nutrient discharges.

Lake Taupo and the policy package

Lake Taupo is situated in the centre of the North Island, and covers an area of 61,600 hectares. It is not only New Zealand's largest lake but is iconic to most New Zealanders (Barnes and Young 2012). The Taupo catchment comprises forestry, pastoral farming, undeveloped land, and urban land uses (Figure 1).

2. Credits are where unregulated agricultural non-point sources can sell their on-farm reductions in nutrient leaching to a regulated source.

Figure 1. Land use in the Lake Taupo catchment



Taken from Barnes and Young 2012.
Note: this catchment is in the central North Island.

In the early 2000s scientific investigations by Environment Waikato[3], the regional authority responsible for environmental management in the Lake Taupo catchment, revealed that water quality in Lake Taupo was gradually declining. This decline was attributed to excess nitrogen entering the lake from agricultural non-point sources (see Table 1).

The studies also found lag times for nitrogen leached from land to reach the Lake could be greater than 100 years in some parts of the catchment (Vant 2008).

Given the importance of the Lake to New Zealand's indigenous peoples[4] and for recreational activities, Variation 5 of the Waikato Regional Plan (WRC 2011) was instituted to limit and permanently reduce the amount of nitrogen entering the lake.

3. Now called the Waikato Regional Council.
4. Ngati Tuwharetoa (iwi or tribe) are the kaitiaki (guardians) of Lake Taupo and have developed tikanga (custom, correct procedures) and kawa (ceremony) that reflect their relationship with the lake. Ngati Tuwharetoa are also Treaty partners with the Crown (i.e. Government of New Zealand) and hold legal title to the bed of the lake and its tributaries.

Table 1. Sources of nitrogen losses in the Lake Taupo surface water catchment[5] (Environment Court 2008)

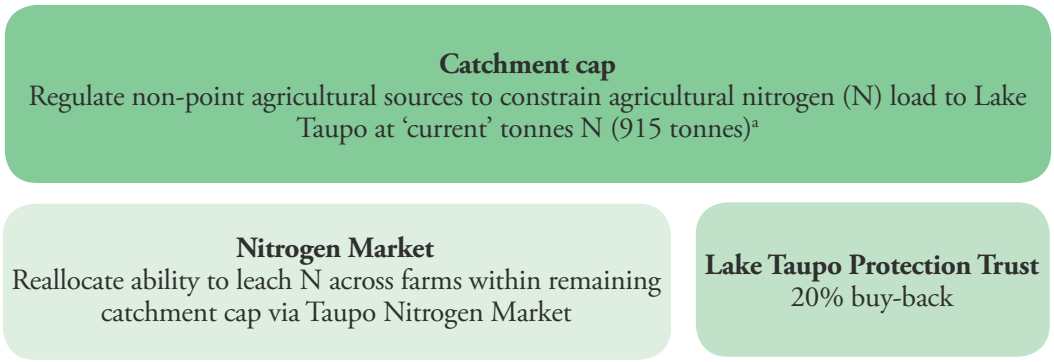
Source			Load of N (tonnes/year)	Effective Yield (kgN/ha/year)	% Total	% Sources Category
Unmanageable load (natural)	Atmospheric deposition		272	4.4	20%	34%
	Undeveloped land		311	2	23%	39%
	Pine on unimproved land		122	2	9%	15%
	Tongariro Power Development		87		6%	11%
	Pine on unimproved pasture		12	2.7	1%	1%
		Subtotal	804		59%	
Manageable load (human-induced)	Pastoral	Non-dairy pasture	442	8.6	33%	79%
		Dairy pasture	68	29	5%	12%
	Urban runoff		16	8	1%	3%
	Wastewater		17		1%	3%
	Pine on improved pasture[6]		6	4.2 - 6.0 [1]	0.40%	1%
	Nitrogen-fixing scrub		7	12	0.50%	1%
		Subtotal	556		41%	
Total			1360		100%	

Variation 5 was an 8-year legal process that culminated in the regulation of agricultural non-point sources for nitrogen discharges, the establishment of the Taupo nitrogen market and the formation of the Lake Taupo Protection Trust to permanently reduce the amount of nitrogen leaching to the lake.

The role and delineation of these three components are important to understand as they provide the context for an evaluation of the trading component. The environmental goal for Variation 5 is to restore water quality to 2001 levels by 2080. This is to protect a sub-set of community values for the lake – namely clear water in the lake, high water quality feeding into the lake, and good trout fishing (WRC 2011). Variation 5 simultaneously aimed to minimise the costs and mitigate the social and cultural effects of achieving this goal. The costs were to be spread across local, regional, and national communities.

In effect, a nutrient cap was established that reduced nitrogen losses to 20% below the 'current' discharge levels.

Figure 2. Achieving the environmental goal



a: Lake Taupo Protection Trust (2011).

5. This estimate of the breakdown of nitrogen sources and total estimated nitrogen load is a best estimate from 2008.
6. Note that pine on improved pasture is assumed to trend down to 3 kg/ha/year long-term average (Environment Court 2008).

Regulation of non-point agricultural sources: Variation 5 introduced land use and discharge controls whereby nitrogen leaching farming activities were now controlled through a resource consent[7] and agricultural land now required a nitrogen discharge allowance (NDA) to farm[8]. The allocation of NDAs to different agricultural sources used a 'grandparenting' or existing use approach. NDAs for each farm were based on their highest nitrogen leaching year between 2001 and 2005. Nutrient leaching is determined using the OVERSEER™ nutrient budgeting model (Version 5.4.3)[9]. This meant the activities on each consented farm could only leach as much nitrogen as the NDAs they were allocated. This is enforced through a requirement for approved management plans, a regular monitoring programme, and penalties for non-compliance under the Resource Management Act.

The Lake Taupo Protection Trust: A public fund, managed by the Lake Taupo Protection Trust, was established to permanently reduce nitrogen leaching in the catchment by at least 20% of current levels by 2020. The use of a fund rather than reducing the NDA allocation on each farm to below their 2001 levels, was to reduce the local cost of economic and social change from the required permanent reduction in nitrogen entering the lake. The $81.5 million fund was created with contributions coming from the Taupo District Council (22 percent), Waikato Regional Council (33 percent), and central government (45 percent) (Lake Taupo Protection Trust 2014). The Trust was set up in 2007, and has now achieved its nitrogen reduction target. This was through a mix of land purchase (and converting land use to low leaching activities) and directly purchasing NDAs (where farmers retain ownership of the land but change land use or management and receive a payment from the Trust) (Lake Taupo Protection Trust 2014). The Trust not only funded this buy back but also covered the cost of benchmarking all farms to set their initial allocation. By July 2012 when more than 90% of farms had been benchmarked, the Trust had spent $2.5m on benchmarking[10]. The Trust also committed $5m to research into low nitrogen alternative land uses for the Taupo catchment.

The Taupo nitrogen market: The nitrogen market permits the transfer of NDAs around the Lake Taupo catchment. This allows any increases in nitrogen leaching to be offset by corresponding and equivalent reductions in nitrogen leaching within the catchment. This provided some flexibility for how regulated agricultural sources could operate within the total NDAs for their farm. The nitrogen market has been fully operational since July 2011 when Variation 5 became operative. However, some trades were made before this. While the longer term function of the market is to enable the permanent transfer or leasing of NDAs between different regulated agricultural sources, the Trust has also used the market to process the permanent transfer of NDAs (and consequent change in consent conditions) to the Trust (Lake Taupo Protection Trust 2014).

HAS THE MARKET WORKED?

To June 2014, the Trust has executed 23 trades (equalling 151,066 kg N) and there have been 12 other NDA trades between regulated farmers (equalling 17,634 kg N) (see Table 2). Even by June 2012, 30 out of 180 farmers had engaged in at least one trade; 17% of the cap had been traded, and there had already been three leases (short-term trades)[11]. Since the early trades, which were dominated by purchases by the Trust, the size and frequency of trades has fallen.

The trading price in 2012 was around $300 per kilogram of nitrogen permanently removed. This was largely determined by the Trust's trades so does not necessarily reflect the long-run value of nitrogen in the catchment.

Trading programmes complement regulation and theoretically enable these regulations to be met at lower cost than stand-alone regulation. The lower costs are derived from the additional flexibility a regulated source has to meet its compliance obligations. Thus, trades are likely to occur where regulated sources find it more cost-effective to purchase NDAs either to increase or to maintain their own production levels than to meet their compliance obligations solely on their farm. The existence of a reasonable number and volume of trades, and particularly trades among farmers, suggests the nitrogen market is functioning. It is providing those agricultural sources that choose to intensify their production with the ability to do so and still be in regulatory compliance. Likewise, it rewards those farmers who, for whatever reason, reduce their nitrogen leaching and can sell their NDAs.

7. A resource consent is akin to a permit in many countries.
8. Low nitrogen leaching farming activities remain as permitted activities, meaning they do not need resource consent to farm that land.
9. www.overseer.org.nz. The currently available model version is different from the version used to allocate NDAs through Variation 5 of the Waikato Regional Plan and is being used to demonstrate regulatory compliance.
10. 89% had been benchmarked by August 2011 (Duhon et al. 2015).
11. Most data are derived from Duhon et al. (2015) or from trading records provided by the Waikato Regional Council.

Table 2. History of NDA trades in the Lake Taupo catchment

Year	Number of trades to LTPT	Amount traded to LTPT (kgN)	Number of trades to farmers	Amount traded to farmers (kgN)	Total trades	Total amount of N traded (kgN)
2009	3	17,242	3	12,184	6	29,426
2010	5	56,100	2	3,500	7	59,600
2011	4	43,614	2	1,311	6	44,925
2012	9	24,311	3	362	12	24,673
2013	2	9,799	1	113	3	9,912
2014*		0	1	164	1	164
Total	23	151,066	12	17,634	35	168,700

** This represents the period to June 2014.*

Whether the market is fully efficient is harder to assess. This is because we do not know the efficient allocation of nitrogen or farmers' expectations of the long-term value of nitrogen. The price for a permanent reduction should depend on how much demand there will be to leach nitrogen in future, which is highly uncertain. If pressure to intensify production continues, the ability to leach nitrogen will become more valuable. Individual farmers will find their initial NDAs constraining so will be willing to sell less, or want to buy more NDAs. The cap on the catchment as a whole would become more strongly binding. However, we could imagine a future with new mitigation technologies or the emergence of highly profitable but low emitting land uses. In this future, the demand to leach nitrogen falls and the price falls with it. Thus, we cannot assess the efficiency of the current price.

We can assess the likely market efficiency indirectly by considering the scale of time-of-trade transaction costs as farmers will not make some potentially profitable trades if these transaction costs are too high. Duhon et al. (2015) estimate that trades with the Trust involve transaction costs of around $4,000 – $11,000[12] (depending on how many changes the seller wants to negotiate relative to the Trust's standard agreement) per trade in addition to some costs of time. Direct costs of trades between farmers could cost less than $1000[13] per farmer. Some quite small (and therefore by definition smaller profit) trades have occurred that also support the idea that these transaction costs are not prohibitive. This can be demonstrated using the leased transactions which are likely to be the smallest size transactions. The average lease as of June 2012 was 1.2 tonnes for 3.7 years so the total payment for these leased reductions is approximately $93,000[14]. While the actual gains from trade to each farmer would be a fraction of this they must be greater than the transaction cost to make it worthwhile to trade.

Another consideration when assessing the performance of a trading programme is the potential for market power. This does not seem to be a risk in this programme as there are many small and medium-sized NDA holders in the catchment

and no dominant holders of NDAs. This was confirmed by calculating a Herfindahl index, which is a measure of market competition. This index was calculated for the initial distribution of NDAs and demonstrated that the market is highly competitive[15]. Ownership of allowances has also been restricted to landowners in the catchment, which will limit the ability of any outside investors to accumulate market power.

WAS IT WORTH IT?

Have the environmental goals been achieved?

Because the residence time of water in Lake Taupo is around 15 years and residence of nutrients in groundwater can be up to 100 years, monitoring the quality of the water in the lake cannot give any clear indication of the success of the policy package to date. In any case, the policies were implemented to avoid a potential future problem (lake water quality is currently very high) rather than to address immediate concerns. Therefore, our only indications of success are that the components of the policy package have been fully implemented, there have been no issues to date with non-compliance, and the Trust has successfully permanently retired 20% of the original NDAs[16]. Whether this will meet the environmental goal in the long term depends on both scientific and social factors. First, the farm level regulation and monitoring is based on a model so is not a perfect measure of actual leaching. Second, the adequacy of the limits on leaching to achieve lake outcomes depends on uncertain catchment modelling. These risks reflect the challenge of dealing with non-point source contributions to declines in water quality. From the social side, achieving the long-run goal will depend on acceptability of the regulations, so that they persist, and long-term compliance with these regulations. In the longer term, situations may arise that mean compliance could require stronger legal structures. For example, if farmers want to increase production in response to higher commodity prices and leach more N, then NDA prices are likely to rise. This is due to the higher demand for NDAs and an unchanged supply of NDAs. Farmers would have an increased incentive to not comply rather than purchase higher priced NDAs.

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Was the overall policy package worthwhile?

This is impossible to assess accurately. Not only do we not yet know the environmental impact but no serious attempt has been made to quantify the mostly intangible benefits. Therefore, all we can do is list the nature of the costs and benefits and briefly describe what we know about them for the three key groups that bear costs: farmers and foresters, local government, and central government.

Costs

To date, the overall loss of profit to farmers and foresters is probably relatively small because the grandparenting allocation allowed most to continue their current practices. The Trust has almost certainly provided some net gains to farmers from their sale of NDAs. However, over time as agricultural intensification pressures rise in response to rising operational costs, agricultural losses in the catchment are likely to occur because of the overall nitrogen cap. There are some

12. This covers primarily the legal costs to develop customised agreements that suited the needs of the individual landowners. This customisation was believed to be a strength of the approach given this was the first time these types of agreements had been brokered and that the Trust was purchasing these rights in perpetuity (Graeme Flemming, CEO The Lake Taupo Protection Trust, pers. comm., November 2014). Benchmarking and consent costs were additional costs and would be required even in the absence of a market mechanism.
13. This covers the cost to change consents to reflect the transfer of NDAs between parties.
14. This assumes that the annual value of a kg of nitrogen is $21. This was calculated using the $300/kgN price being paid for a permanent reduction and a real discount rate of 7%.This makes the strong assumption that the annual value of nitrogen does not change. If it is rising – which seems plausible with continued intensification of agriculture – this is an underestimate of the likely lease value.
15. A Herfindahl index value of 2.8% was calculated. The Herfindahl index is a blunt measure of the degree of market concentration and is calculated by expressing the market shares of agents as fractions and calculating the sum of squares. In this case, NDA data for those large farms that were benchmarked by August 2011 was used. The benchmarking process determined farm nitrogen leaching from which the NDAs for a farm were derived. Given the benchmarking of smaller farms was still on-going when the index was calculated, it is expected that (i.e. our measure of market power would fall) it will decrease even further (Duhon et al. 2015).
16. There have also been complementary environmental impacts, particularly carbon sequestration, from the reforestation of more than 5000 ha of land to pine plantations. However, some people have expressed concern about the changed aesthetics due to the replacement of pasture with exotic forestry.

suggestions that, anticipating these losses of future profit, some land values may have fallen. However, there has been no assessment of land prices to determine the extent, if any, of changes in land values or whether any change in land value has been compensated by the (new) value of NDAs for that land.

To give an indication of the value of agriculture affected, we estimate using the initial land use that the 2011/12 profit from agriculture in the catchment was around $12.8 million[17]. Environment Waikato (2007) estimated total potential costs from lost farm profits over 35 years of up to $116m. This was based on the target being achieved through land retirement – an expensive option. Other costs faced by farmers were the time costs associated with initial benchmarking, and direct costs of $1000 – $1500 for the up-front cost of applying for a resource consent and an annual $400 consent holder's fee (to cover the regional council's monitoring costs). One farmer also articulated some social costs related to farm families leaving the district when farming land was converted to forestry, thus weakening communities (Duhon et al. 2015). These types of social costs, however, have not been formally assessed.

For local government, the financial and political costs of establishing the different policy components were probably high but no data are available. Some of these costs could be seen as an investment in learning for regional councils should they establish similar policies or use these learning to decide not to use a similar approach.

In terms of the administrative costs associated with implementing the nitrogen cap (e.g. benchmarking farms) and the nitrogen market, these were estimated at $175,000 in 2011, falling to about $100,000 per year in the future (Duhon et al. 2014). Should future compliance be more difficult to enforce then these costs may rise. These costs relate to the regulation though not the nitrogen market. The Waikato Regional Council and Taupo District Council also contributed $44.8m to the establishment of the Trust to fund the 20% buy back of NDAs.

The main cost for central government was their $36.7m contribution to the establishment of the Trust. They also faced some costs with their involvement in the Variation 5 process. Annualised in perpetuity, the total cost of the Trust is less than $6m[18].

Benefits

The benefits can be classified in two groups: benefits from environmental gains and benefits from learning. These benefits occur both within and beyond the Taupo catchment.

The policy package was created to maintain the quality of Lake Taupo, which was facing the threat of degradation. Should the lake's water quality be preserved and there is a perception of protection that helps to sustain tourism in the region and maintain New Zealand's the clean, green image (with its associated trade benefits), these benefits could be very large. These benefits are not easily quantified as we do not know the risk of poor lake quality to tourism or New Zealand's clean green image, or the subsequent damage to the economy. As an indication of possible scales, however, one estimate of the gross value of tourism to the area is $400m per year and one estimate (Environment Waikato, 2007) of the potential benefits of the regulation for tourism over 35 years was $395m[19].

Another benefit of the policy package and the environmental certainty it provides is the ability to develop products with credible green branding. Rather than each farm making an individual sustainability case, the Regional Council certifies the Lake Taupo catchment as sustainably managed. 'Taupo Beef' is one initiative that has capitalised on this branding[20].

In terms of the value of learning, there are four aspects to consider – science, farming, policy/legal, and community. For science, the advances in catchment modelling work may have wider benefits for other catchments, particularly those with similar groundwater characteristics. The regulation of agricultural non-point sources and the need for nutrient modelling technologies and effective mitigation options has contributed to the pressure to fund additional mitigation

17. This rough estimate uses effective areas in dry stock and dairy in the Lake Taupo catchment from Waikato Regional Council benchmarking data (sheep/beef – 48,352 ha; dairy – 2,494 ha) combined with 2011/12 dairy profit data from the MPI monitoring report for Waikato and Bay Of Plenty regions and with 2011/2012 sheep and beef profit data from Beef and Lamb North-North Island (Northland, Waikato, Bay Of Plenty regions) all classes data. For comparison, McDermott and Fairgray (2001) estimated that, in 1998, agriculture in the Taupo district (with a much larger agricultural area than within the Lake catchment) contributed $31 million to GDP.

18. We have used a 7% real discount rate – which is commonly used by regional councils, though New Zealand central government often uses a 10% discount rate.

19. http://www.greatlaketaupo.com/media/1955820/Statement-of-Intent-2014-2017.pdf. A competing estimate from McDermott Fairgray (2001) suggested that in 1998 tourism contributed around $90 million per annum to the local economy. Unless tourism growth has been very rapid this is substantially lower.

20. http://www.ruralnewsgroup.co.nz/rural-news/rural-management/bartons-branded-beef-initiative

research and upgrades to the OVERSEER™ model. Combined with the legal decision on the validity of using OVERSEER™ as the basis of regulation, this significantly reduces a major impediment to regulating agricultural non-point sources for water quality in other catchments.

Farmer innovation in farm and marketing practices that increase profitability (per unit of nitrogen leached) is another benefit. Anastasiadis and Kerr (2013) show there is significant potential for improved farm practice, though there is no evidence to demonstrate that the full potential of this has been realised. A few examples worth noting are 'Taupo Beef', which was directly motivated by the regulation, and the way the Trust and Mighty River Power used the NZ Emissions Trading Scheme to co-fund the transition to low nitrogen leaching activities on some farms.

In terms of policy learning, the Taupo nitrogen market has demonstrated the feasibility of a cap and trade system for agricultural non-point sources and provided one model for such a system. New initiatives are building on this system and adapting it to local circumstances[21]. While Variation 5 generally established precedent for the establishment and operation of a nutrient trading market, the judge in his RMA Court decision only made a ruling on diffuse discharges and farming for Taupo catchment, not nationally[22].

From a community perspective, the discussions and experience in Taupo has helped inform farmers, policy makers, and researchers about the range of issues associated with regulating non-point sources for water quality. For New Zealand to benefit fully from these lessons, the expertise gained during this process needs to be retained and effectively communicated to communities grappling with their own water quality issues.

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It is not possible to assess quantitatively the overall benefits of the policy package to ascertain whether the investment by central government ($36.7M) and local authorities ($44.8M) was worthwhile. However, many of these benefits are still being realised (and will continue into the future); both for those in and those outside the catchment. To determine whether the investment, especially by central government, was worthwhile depends on how much the overall policy package was worth to people outside the catchment (these potentially large out-of-catchment benefits were cited as a justification for a central government contribution), and on whether it would have been implemented, or implemented with the same stringency without their contribution.

If the catchment target was going to be achieved anyway (i.e. the regulation and Trust were implemented), was it worth allowing trading as well?

The first two components of the policy package, the regulation and the Trust, could have been implemented without the nitrogen market. To evaluate the benefits of the nitrogen market, the costs and benefits of the market need to be separated from the other components. Once NDAs were defined and allocated and a process established to monitor and enforce compliance, the actual cost of allowing the trade of NDAs was trivial. While the presence of a nitrogen market did affect the way the regulation and subsequent consents were written, it is not clear what costs, if any, were involved. However, there were likely some political costs as well as gains related to the debate and establishment of the nitrogen market.

The benefits from trading have been largely economic, and while they are positive, given trades are being made, the size of the benefits is uncertain. The flexibility provided by trading is also likely to have affected the acceptability of the regulations for some farmers. For instance, trading allows for the intensification of land use, which is particularly valuable to Māori farmers (whose land was relatively underdeveloped) and to dairy farmers who want to capitalise on high dairy prices. Selling NDAs also allowed some farmers to retire without selling their farms during a period when selling land was difficult because of regulatory uncertainty. The existence of a trading mechanism also facilitated the Trust buy back process.

21. For example, in nearby Lake Rotorua regulation is moving in a similar direction (http://www.rotorualakes.co.nz/setting_NDAs), and Kerr et al. (2012) present a potential market design that builds on the Taupo experience.
22. This was in response to agricultural industry concerns about precedent for s15(2)b) of the RMA having a decision attached to it that said that 'all discharges that can enter water from farming in NZ require a consent or need a rule that expressly permits the activity' (Justine Young, Waikato Regional Council, pers. comm, November 2014).

Different policy instruments could have been proposed to protect the water quality in Lake Taupo – was it worth establishing a cap-and-trade system?

A number of potential policy instruments could have been used to protect lake water quality. While this paper does not attempt to assess each of these instruments or determine if other options may have provided more (or less) costs and benefits, this section outlines some of the implications for some of those other possible instruments.

If trading had not been part of the policy package, and a regulatory framework was still implemented it could have been framed quite differently. One alternative is practice-based regulations with specific technology or farm practice controls. Another alternative is voluntary initiatives to promote farm practice change. However, in the Lake Taupo catchment some practices, such as riparian plantings and effluent management systems, were being implemented through voluntary actions – but these were insufficient. One challenge with practice-based approaches is the difficulty in identifying efficient technology and practice standards given heterogeneity of geography, land use, and farm systems across the landscape. With no regulatory backstop, the use of voluntary approaches may lead to the non-achievement or very costly achievement of the target, for example, through repeated buy-out and reforestation of farms should future increases in production lead to higher nitrogen leaching.

Similarly, government funding could still have been part of the package but instead of buying out NDAs from the catchment the funding could have focused on in-lake interventions. Lake Rotorua's funding deed with central government, for example, to improve water quality in Lake Rotorua originally focused on engineering works and other in-lake interventions (e.g. alum dosing) though it has since been expanded to also include pastoral land use and management change which has now been assessed to be the most effective action to take (BOPRC 2012).

SUMMARY

The trading component of the policy package is achieving what it was theoretically meant to do – it is providing the flexibility for land to move to its highest and best use and still meet the overall nitrogen load targets to the lake.

The regulatory cap was necessary to achieve, with certainty, the community goal of maintaining a healthy lake into the future. Trading has allowed this cap to be imposed in a more efficient and flexible manner. Assuming the cap was going to be achieved through regulation, the creation of the market probably provided a net benefit to the farmers in the catchment.

Wider NZ benefits from the regulatory package as a whole, and specifically from this first of its kind market, are probably not yet fully realized. The environmental gains are still mostly in the future because the policies are aimed at protecting against declining water quality rather than improving currently poor water quality. In terms of the wider learning for New Zealand, most catchments around the country are still in the process of setting water quality caps or have not yet started. However, as these caps are being implemented the learning benefits from Lake Taupo will emerge more clearly.

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