Nutrient Trading in Lake Rotorua: Cost Sharing and Allowance Allocation

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Abstract

This paper clarifies how the benefits and costs of water quality improvements in Lake Rotorua are likely to be shared in the absence of a trading system; presents different perspectives on and principles for deciding how costs should be allocated; and then shows how different options for initially allocating nutrient allowances and achieving reductions in the cap over time conform with those cost-sharing principles. There is no 'correct' answer to the question of who should pay. The 'best' answer for Lake Rotorua will depend on what the community thinks is fair and what will be politically feasible. If the trading market does not operate efficiently, the way that allowances are allocated will affect the efficiency with which the catchment achieves its environmental goal. If the allocation of allowances provides significant capital it could also affect economic behaviour by loosening capital constraints that limit land development and mitigation.

JEL classification
Q53, Q57, Q58

Keywords
Nutrient trading, water quality, allowance allocation

Contents

1 Introduction

Deciding who should pay for improvements in lake water quality is always a politically challenging issue. Our aim in this paper is to clarify how benefits and costs are likely to be shared with no free allocation of emissions units; present principles for deciding how costs should be shared; and then show how different options for allocating nutrient allowances and achieving reductions in the cap over time conform with those cost-sharing principles. This paper provides the detail on the allocation proposal within the prototype nutrient trading system outlined in Lock and Kerr (2009).

There is no 'correct' answer to the question of who should pay. The 'best' answer for Lake Rotorua will depend on what the community thinks is fair and what will be politically feasible. Cost bearing has direct economic impacts on those affected. It also has implications for perceptions of fairness and hence support for the regulation, relationships within the community, and social well being in a broader sense. If stringent environmental targets are chosen, allowances will be valuable and allocation rules will alter wealth significantly. Any rules for sharing costs and allocating allowances need to be relatively simple and transparent so they are easy to implement and will be perceived to be fair.

The allocation of allowances will be important for the efficiency with which we meet environmental goals, but only if the trading market is not operating efficiently. This may be important in the short run as people learn how to use the market. If the allocation of allowances provides significant capital it could also affect economic behaviour by loosening capital constraints that limit land development and mitigation.

This paper is part of a series developed through a dialogue process with a group of experienced stakeholders and experts. We have drawn on these meetings and others' research to develop a prototype nutrient trading system for the Lake Rotorua catchment and assess its feasibility. The other papers in the series are available at www.motu.org.nz/research/detail/nutrient_trading.

2 What will the nutrienttrading system cost?

The costs of a nutrient trading system arise from setting up the system, ongoing administration and, most importantly, reducing nutrient loss. Similar costs would be associated with other types of regulation that achieve the same environmental outcome.

2.1 Costs of nutrient reductions

Excluding reductions from changes in land use and management, the costs of the Proposed Lakes Rotorua & Rotoiti Action Plan (Environment Bay of Plenty 2007) are expected to be on the order of $10m per year. This would achieve an ongoing total reduction of around 59 tonnes nitrogen (N) per year and 16 tonnes phosphorus (P) per year. The costs per kilo of nutrient reduction vary widely even among actions confirmed by Environment Bay of Plenty (EBOP) (Table 1).

Table 1 Indicative costs of various reduction options[1]

	Action	Cost Per kg
Lake Rotorua: confirmed actions	Rotorua Wastewater Treatment Plant upgrade	$99 (N)
	Community wastewater reticulation or OSET upgrade for Rotorua	$460 (N) max
	Storm water upgrades within urban Rotorua	$348 (N) $2,092 (P)
	Tikitere geothermal	$4 (N)[2]
	Phosphorus flocculation in the Utuhina Stream	$140 (P)
Lake Rotorua: potential actions	Phosphorus flocculation in two other streams	$140 (P)
	Hamurana Stream diversion to the Ohau Channel	$57 ('05) $33 ('55) $481 (P)
	Land use management and land use change	$6 (N) [3]

Source: Proposed Lakes Rotorua and Rotoiti Action Plan (Environment Bay of Plenty et al (2007: 15)

Landowners could incur costs from a number of actions designed to mitigate nutrient outputs. These include changes in current land use or avoiding a planned future use. The cost of land use change is the difference in profitability between the potential and actual use. Landowners may also change land use management practices, which may require capital investments and a likely loss in profitability. The costs of land-use management options vary widely. No strongly supported cost estimates are available for the additional 170 tonnes of reductions

[1] This information was removed from later drafts of the Lakes Rotorua and Rotoiti Action Plan, including the version finally released for public consultation.
2 This cost per kg-N is lower than other actions because the Tikitere geothermal flow has a high nitrogen concentration and low volume, and is close to existing reticulation infrastructure.
3 $6 per kg-N is simply a budgeted average for expected costs over 10 years. The nutrient reductions from land use/land use management changes will continue beyond 10 years, but total costs will be capped at $10 million.

sought from land use but the per tonne cost is probably much lower than for the options in Table 1.

The costs of land use management options vary widely. Landowners have the best information on the cost of these actions. If these reductions are achieved through further tightening of Rule 11 (a rule that attempts to freeze nutrient losses through farm management plans), they are likely to be very high for some properties because they will make some land uses, such as dairy farming, very difficult.

2.2 Impact of a trading system on costs

A nutrient trading system should reduce the costs of mitigation by allowing mitigation to occur in the places and at the times where it costs least. It should also encourage landowners to be innovative in seeking more profitable and less damaging land uses. The ability of the trading system to reduce costs will depend on how efficient the current farm level caps on nutrient loss are (under rule 11) relative to non-land related mitigation efforts, and how mitigation opportunities are distributed. Assessing this is an empirical question. It also depends on how successful the trading system is in facilitating and enabling innovative mitigation options. In previous similar systems, such as the US Acid Rain programme, which used emissions trading to reduce sulphur dioxide, the costs within the trading system were much lower than anticipated (Ellerman et al (2000)).

Those who have flexibility are most able to benefit from trading. Some people argue that we need to create more flexibility in the District and Regional plans to allow changes in land use and management and to facilitate compliance. It may also be useful to provide advice and technical support to those who have significant potential to reduce nutrient loss at relatively low cost. This reduces the burden on these people who may be disadvantaged in other ways and also reduces the demand for allowances thus lowering the cost for all.

The person who directly pays the cost of mitigation is not necessarily the one who ultimately bears it. Some costs can be passed on to customers, tax and ratepayers and employees. Where the products are exported, Rotorua farmers are unlikely to have a significant effect on their export price so they probably can't pass costs on except to employees (possibly by no longer employing them) and local suppliers. Costs borne by firms providing local services however are likely to be able to pass on some costs. Examples could include golf courses, and others in the tourism sector.

Costs are likely to affect the values of different land parcels so a disproportionate amount of cost will be borne by those who own the land or other affected assets at the time when the regulations are created. For example a dairy farm is worth a lot more with no regulation than once regulation is introduced.

2.3 Interactions with the New Zealand emissions trading system

The New Zealand government intends to introduce agricultural greenhouse gas emissions (methane and nitrous oxide) into the national emissions trading system in 2013. This provides important context for nutrient trading. Many of the mitigation options that will reduce nutrient loss, for example land use change toward less intensive uses and reductions in use of fertiliser, will also reduce greenhouse gas emissions. Those landowners who carry out these options could receive a double benefit because they will need fewer nutrient allowances but also fewer New Zealand emission units (NZ Units). This will lower the additional cost of nutrient management. Some nutrient mitigation options such as riparian boundaries will have no effect on greenhouse gases, while others such as straw bales to catch nutrient run-off could potentially increase greenhouse gas emissions[4].

The emissions trading system will also involve some free allocation of NZ Units, which will almost certainly affect landowners in the Lake Rotorua catchment. The form of this allocation to farmers is as yet undecided but those who own land with indigenous or plantation forests established after 1990 are already eligible to benefit.

3 Principles for cost sharing

We explore here five different sets of principles for cost sharing: those who benefit from a cleaner lake should pay; those who created the problem should pay; those who pollute now should pay; current emitters have inherent property rights; and a variety of equity concerns (cost sharing should reward existing efforts to mitigate, protect the poor and vulnerable, and treat those who are similar in a similar way).

[4] Kerr and Kennedy (2009) discuss this issue in more depth.

3.1 Those who benefit from a cleaner lake should pay

One potential principle for cost sharing is that those who benefit from the regulation bear its cost. The benefits are spread both within and outside the catchment and between people alive today and future generations. We discuss the ways in which each group receives benefit because these may clarify which groups could bear costs and what share they may bear[5]. Some of these benefits will be economic and others will be aesthetic or recreational. Still others will arise from cultural values. Non-human values are also associated with a cleaner lake but these do not have an obvious implication for cost sharing so are not discussed here. They would affect the overall environmental goal that is chosen.

Here we break the beneficiaries into those alive today, both within and outside the catchment, and future generations in order to more closely align with potential cost sharing mechanisms.

3.1.1 Within catchment

A number of groups within the Rotorua catchment would benefit from improved lake water quality. Tourists and holidaymakers benefit from recreational activities on the lake such as sports, swimming, and fishing, and through the aesthetic values they place on looking at an attractive clean lake. Property owners receive these benefits directly; they also receive benefit through higher property values. Those with views of the lake or good access to the lake will get the most value. Tourism operators near Lake Rotorua, including hotel and restaurant owners and tour companies, benefit because their business derives in part from those who come to enjoy the lake. The local community benefits indirectly from employment and other economic activity associated with tourism and people moving to Rotorua to enjoy the lake.

Distinguishing between locals and visitors to the Rotorua region is important for cost sharing reasons. Locals will bear cost either as property owners or rate payers, though tax incidence may mean that visitors also bear costs while in the catchment.

[5] For some existing analysis see Bell et al (2003a, 2003b, 2004a, 2004b, 2007)

3.1.2 Beyond the catchment

The benefits of clean lake water for New Zealand's 'clean green' image could be significant but are hard to quantify. The clean green image improves access to agricultural markets and increases product premiums and tourism demand. The Rotorua catchment has a high profile as a tourist destination, which means that activities in the area could affect visitors' perception of New Zealand water quality and our efforts to protect it. The key beneficiaries of the 'clean green' image relating to water quality are exporters (especially farmers) and the tourism sector nationwide: tourism operators, hotel owners, airlines etc.

A second group of beneficiaries outside the catchment (and potentially outside New Zealand) are those who think they might visit, or who will enjoy products (e.g. movies) that use the local environment. These values are called 'option values'.

Third, some people both within New Zealand and abroad may never visit but simply like to know that the lakes are clean and that the products they consume are not causing undue environmental degradation. This is called 'existence value' because these people need never directly use the lake. These option and existence values are the fundamental drivers for the value of our 'clean green' image.

Finally, other catchments will benefit directly from improved water quality in Lake Rotorua. Water quality in Lake Rotoiti, the Kaituna River and the Maketu estuary are heavily determined by the quality of water flowing out of Lake Rotorua.

3.1.3 Future generations

Within our lifetimes, the lake may stabilise but (unless we live a long time) is unlikely to improve significantly. Our generation could avoid the cost of a significantly worse lake. Future generations could benefit from improved lake quality.

3.2 Those who created the problem should pay

The Resource Management Act enshrines the principle of polluter pays. Section 15 states that 'there is no presumed right to discharge contaminants into the environment' and Section 17 states that 'everyone has a duty to avoid, remedy or mitigate any adverse effect on the environment arising from that person's activities.'

One part of 'polluter pays' is that those who put us in our current predicament should pay. Historical nutrient loss determines much of current water quality and quality in the near future because of long groundwater lags and a build up of nutrient in the lake sediment. Should those who were responsible for those nutrient flows pay the cost of clean up?

This is consistent with the Maori concept of 'utu', which is the need to fix historical wrongs done to others. It is very different if the harm is done knowingly rather than unknowingly but even accidental wrongs need to be corrected. Responsibility is passed on from generation to generation. Thus, if the government (the Regional Council and its predecessors, the Ministry of Agriculture and Forestry and its predecessors) encouraged farmers in the past to intensify and increase fertiliser application, the farmer is not the perpetrator, even though they may have benefited. Even if the government did not understand the effects of these policies, they still indirectly caused damage and need to fix the historical wrong. In contrast, a principle based on who benefited economically from agricultural intensification would impose costs on landowners who have been in the catchment a long time, and on New Zealanders as a whole and particularly those in the Rotorua region who benefited from the agricultural boom.

How far back do we go in assigning responsibility? That depends on groundwater lags and on how the historical emissions are locked up in lakebed sediments that contribute to current fluxes. The lake water itself has a short residence time but nitrates can stay in the groundwater system for up to 200 years. Consequently, a high percentage of current nitrates in the lake that are not deeply buried in sediments are the result of activity more than 5 years ago.

3.3 Those who pollute now should pay

Current emitters are identified in the Action Plan. Table 2 estimates current controllable exports of nutrients from different sources. The tables show that pastoral farming creates 71 percent of total N and 42.5 percent of total P exports. Of pastoral uses, dairying is responsible for 52 percent of N exports and 24.3 percent of P exports, while sheep and beef together export 40.2 percent of N and 61 percent of P. These high rates for dairying are reinforced when calculated per hectare. Dairy farms produce 50 kg/ha/yr of N, alongside 28 kg/ha/yr for the catchment as a whole (Lock and Kerr (2008)). The tables show that urban sources are currently responsible for just 6.4 percent of N and 9.6 percent of P outflows – the sewage outflows have largely been cleaned up. This was paid for by ratepayers with some national tax payer assistance.

Table 2 Lake Rotorua's nutrient inflows

Land use	N load (t/yr)	% of total N	P load (t/yr)	% of total P
Native forest & scrub	42.1	5.4	1.31	3.3
Exotic forest	28.4	3.6	0.95	2.4
Cropping & horticulture	16.9	2.2	0.56	1.4
Pasture [*p*]	**563.0**	**71.9**	**16.93**	**42.5**
Lifestyle	11.1	1.4	0.5	1.3
Urban [*u*]	**50.1**	**6.4**	**3.82**	**9.6**
Springs	-	-	1.4	3.5
Geothermal	42.2	5.4	1.4	3.5
Waterfowl	1.4	0.2	0.8	2.0
Rain	29.2	3.7	1.33	3.3
Total	**783.1**	**100**	**39.80**	**100**

Pasture [*p*] land use includes:	N load (t/yr)	% of pasture	P load (t/yr)	% of pasture
Beef	41.9	7.4	1.08	6.4
Sheep	0.5	0.1	0.03	0.2
Sheep & beef	184.3	32.7	9.22	54.4
Deer	6.3	1.1	0.38	2.2
Deer/sheep/beef	23.3	4.1	1.16	6.8
Dairy	294.1	52.2	4.12	24.3
Grassland	5.1	0.9	0.38	2.2
Other	7.5	1.3	0.57	3.4
Total	**563.0**	**100**	**16.93**	**100**

Urban [*u*] land use includes:	N (t/yr)	% of urban	P (t/yr)	% of urban
Sewage	28.0	55.9	1.00	26.2
Septic tanks	12.0	23.9	0.53	13.9
Storm water	10.1	20.2	2.29	59.9
Total	**50.1**	**100**	**3.82**	**100**

Note: These figures are not time-bound. They are exports of nutrients rather than inputs to the lake.
Source: Proposed Lakes Rotorua and Rotoiti Action Plan, Environment Bay of Plenty et al (2007: 50)

3.4 Current emitters have inherent property rights

A different set of principles comes from a more legal approach to entitlement. These are often powerful in political debate where losses in asset values as a result of regulation are sometimes referred to as 'takings'. Many argue that current emitters have an implicit property right that should be upheld.

Tighter nutrient regulation lowers the value of land that benefits from the ability to apply nutrients. In particular, dairy farms are likely to fall significantly in value. Owners of property at the time the regulation is announced will bear much of the cost of the loss of future profitability through decreased land values.

3.5 Other principles for cost sharing

Three other issues are important for deciding socially acceptable cost sharing. The first is that those who have already made efforts to mitigate should be rewarded. To many this simply seems just. It also can encourage people to continue voluntary efforts to enhance lake quality including (but not limited to) supporting widespread compliance with the regulations and efforts to find and disseminate new approaches to mitigation.

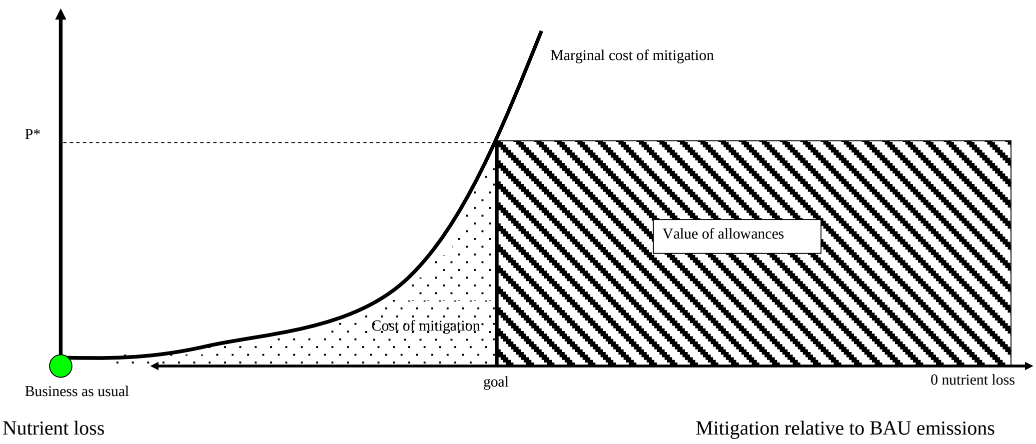
Another key equity principle is that poor and vulnerable parts of the community should be protected from harm. In the Rotorua catchment this includes low wage earners, those at risk of unemployment and poor landowners (e.g. Maori who are dependent on small land blocks). The tangata whenua are distinctive in their roles and responsibilities in the catchment but their specific interests and willingness to assume a stewardship role is very iwi/hapu specific and so the implications for cost bearing are not clear.

Finally, a commonly expressed principle is that landowners with 'similar' properties should be treated similarly. This makes sense but begs the question of on what basis they should be similar: should similarity be measured in past or potential nutrient loss, in property size or land use? More broadly this principle argues for rules that are transparent and avoid special treatment of any specific group.

4 Translating cost sharing principles into allowance allocation options

Free allocation of nutrient allowances is the key instrument for moving costs away from those who would otherwise bear them by directly funding mitigation actions, losing profit through constrained production or through tax incidence and capitalisation of losses.. Once a cap is converted into tradable allowances, those who receive them hold a valuable asset and those who need to buy them face an additional cost. Thus the questions of how allowances are initially allocated, and how the costs of reducing the cap over time are managed (e.g. by proportionately reducing the 'nutrient value' of each allowance or buying back some allowances) are critical to the final distribution of net costs. Who faces these net costs should be determined based on the cost principles discussed in the section above.

Figure 1 Cost of mitigation and value of allowances



How does mitigation cost relate to allowance values? As Figure 1 shows, they are not equal. In the market as a whole, the total value of allowances will be equal to the market price p* times the total number of allowances in the market. Every individual emitter will have some opportunities to mitigate at a lower cost per unit than the allowance price. The total cost of mitigation is the shaded area under the curve on the left. Depending on how great these opportunities are, and how many allowances they were initially allocated, each individual will then either buy some allowances at full cost or sell them at a profit. The cost to any individual in a nutrient trading system is:

Cost = (BAU Nutrient loss – free allocation) * allowance price (1)

- net change in profit as a result of changed input and output prices

- net change in profit as a result of mitigation actions

Full allocation of allowances on the basis of historical (business as usual) emissions could overcompensate all emitters – the introduction of the system could make them wealthier. This suggests that emitters should receive fewer allowances than their business as usual emissions. However, if Rule 11, which constrains current emissions, is effective, landowners are bearing some costs of mitigation even at their current emissions levels. We also cannot pass costs back to previous landowners so costs that 'should' be borne by them would have to be related to current landownership if it is included at all.

Emitters can be partly compensated for losses through some free allocation of allowances. At the same time, non-emitters who we believe should bear some costs could buy back some allowances from emitters. The balance of free allocation and buy back, plus any focused efforts to protect vulnerable groups (probably funded directly through rates rather than related to allowances) determines the final distribution of cost across current and potential emitters, those who are responsible for historical emissions, and local, national and international beneficiaries of improved water quality.

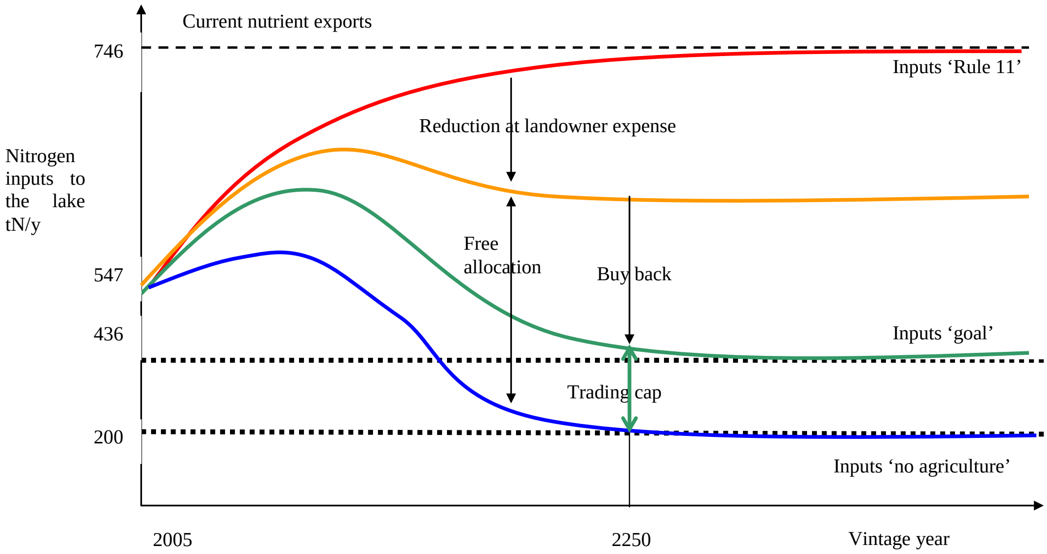
4.1 Sharing costs between emitters and non-emitters

While emitters should not be fully allocated allowances to match business as usual nutrient loss, neither should they be allocated only the target level of nutrient loss implied by the trading cap, especially if the cap is significantly lower than business as usual.

Figure 2 shows different paths of nitrogen input to the lake and illustrates different responsibilities. A similar figure could be drawn for phosphorus. The lowest line in Figure 2 illustrates the nitrogen levels possible if all activity in the catchment were stopped and land were converted to plantation forestry – emitters should not be responsible for nitrogen below this line. The peak in the three lower curves shows the effect of lags for nitrogen already in the groundwater but not yet in the lake. The second lowest curve is a possible path for nitrogen under a trading system. The difference between this and the lowest curve defines a series of trading caps on nitrogen inputs to the lake in each year.

The next curve up (second curve from top) suggests that for each vintage, emitters could be allocated less than Rule 11 levels (top curve) so that some additional nitrogen reductions are done at landowners' expense.

Figure 2 Cost sharing, free allocation of allowances and buy-back (illustrative curves)



Further reductions in allowances to get down to the level of the trading cap (the regulated level of controllable inputs allowed) would be achieved through buy-back by various groups. Imposing some cost on district and regional ratepayers and on specific local sectors (e.g. tourism, fishermen, developers), can be justified by the benefits they would receive from higher lake quality and the historical benefits they have received from the economic activity associated with historical emissions.

These groups could bear cost through local rates or through a special levy on tourists or on property owners. For example, it has been suggested that property developers should be required to contribute to lake quality above normal rates. Fishermen could also be charged an additional levy for fishing in Lake Rotorua and tourists could be charged a per night or per attraction fee.

The farming sector throughout New Zealand could contribute in recognition of the value of the clean green image to their exports. To the extent that central government policy is held responsible for historical emissions and that all New Zealand citizens benefited from the prosperity brought by the boom in farming (and fertiliser use), the central government could be expected to contribute. The Central government's agreement to pay half the costs of implementing the current action plan (NZPA (2008)) sets one possible precedent for cost sharing between non-emitters. Part of this funding could be used to buy back allowances from emitters as shown in Figure 2, though this is not the current intention.

It has been proposed by another stakeholder group that landowners should bear around one quarter of the cost of the planned programme of nutrient reduction actions through targeted rates. It may be preferable for them to make their contribution more efficiently through a tighter cap in the nutrient trading system and a fall in their allowance allocation (e.g. reduce cap and allocation to landowners by one quarter of 59 tonnes N). This translates to a reduction of just 0.75 kg per ha of pastoral land. As context, sheep/beef land currently loses a total of around 18 kg per ha each year and dairy loses around 50kg. It seems likely that relatively minor mitigation or small amounts of land conversion would achieve this reduction. If EBOP and RDC participate in the trading system, some of the planned reduction actions could be replaced by lower cost land-use related reductions.

4.2 Cost sharing among emitters

Above we discussed the total share of cost to be borne by emitters and how this relates to the total amount of allowances that would be allocated freely to them. The remaining question is how these allowances should be allocated among emitters. We need to balance four issues: long term equity in cost-bearing; a desire not to penalise those who already have low nutrient loss relative to similar land; adjustment costs; and compensation for stranded assets.

Long-term equity suggests that land with similar long-term development potential (and hence potential nutrient loss) should be treated equally. This reflects the similar loss in their land value in the long term. This leads towards allocation on the basis of potential nutrient loss: hectares interacted with potential productivity of those hectares. Allocating on the basis of hectares alone (sometimes called averaging) will not correlate well with the loss of land value, as low productivity land that would suffer small losses would receive the same allocation as high productivity, high nutrient loss, high value land.

It has been suggested that land use capability be used as a measure of potential productivity. Two difficulties arise with this: first, land use capability data is not of great quality at fine resolution; second, land use capability is an ordinal mapping and would need to be translated into potential levels of nutrients in an acceptable way. A simple alternative would be to use carrying capacity (potential stocking rate) maps and apply fixed emission rates to each stock unit. This approach still has data quality issues at fine resolution however. Horizons Regional Council have proposed a similar approach and have developed it more thoroughly (Carran et al (2007)).

For properties that will be modelled with OVERSEER for monitoring and reporting, a better alternative is available. The actual property can be modelled in OVERSEER using best management practices to produce a level of potential nutrient loss. The extra cost of doing this would be negligible, other than the definition of best management, as the model will be calibrated for the property in any case.

Allocation on the basis of any fixed land characteristics will tend to benefit the less developed land and will provide some capital for development. It will not however provide capital to those who need to mitigate – they will face the greatest initial shortfall.

Two issues argue for an alternative approach – at least initially. First, we want to smooth adjustment costs, minimise economic disruption and protect against initial market dysfunction during a learning period. Not supporting current emitters can increase adjustment costs, the costs arising from rapid changes in economic activity. Adjustments may particularly affect poor people with little access to capital and vulnerable employment.

Any allocation other than on the basis of current emissions can cause short term economic disruption if the allowance market does not work. If landowners find that they own significantly fewer allowances than their current emissions (while others have an excess) and they are unable to purchase allowances, they may have to make rapid and costly changes. Alternatively they may claim (with some justification) that they are unable to comply, thereby weakening the overall regime.

Second, we may want to partially compensate those who have invested heavily in improvements to high productivity properties. These investments may now be 'stranded assets' which have low value as a result of the regulation. For example a recent dairy conversion would lose much of its value once allowances were required to cover nutrient loss. Allocation on the basis of historical emissions, 'grandparenting', will achieve both of these goals.

A grandparenting system needs to be based on an early date to avoid strategic behaviour. We do not want people to have an incentive to overstate or even increase current emissions to increase their allocation. We want to reward people for past good behaviour rather than penalising or discouraging them. It would be possible also to alter the grandparenting rule slightly to disallow nutrient loss above a maximum benchmark set per landuse type. The rule cannot, however, be too historical or properties with non-strategic recent growth in nutrient loss would be penalised.

Any grandparenting system, and particularly one that uses a past date, has issues with data availability. In the Lake Rotorua catchment, data are already being collected for many properties through the Rule 11 benchmarking process. Accurate application of OVERSEER requires several years of historical data but the high costs of being this accurate may not be justified. One advantage of using a grandparenting approach is that initial allocations could be based on OVERSEER estimates calibrated in the same way for all farms. Any errors would affect both the initial allocation and early years of compliance monitoring – the *change* in monitored losses is what matters for the environmental goal rather than the absolute level of nutrient loss.

If the main motivation for grandparenting is to protect against allowance market failure rather than to compensate for loss in land and capital value, this could be dealt with by direct intervention in the market to ensure a readily available supply of allowances, possibly at a fixed price. This transfers some risk to government but could provide reassurance to those who will need allowances.

One final argument sometimes raised in the context of allocation is the potential use of allocation of allowances as a way to provide capital for mitigation. This would be aimed at a failure in capital markets, which means that those who should mitigate do not have access to capital. It is difficult to identify these people and this is a very crude and socially expensive way to address this issue.

Government (at all levels) has two roles in the catchment. First, they are a landowner and emitter. Second, they have a responsibility to buy-back some allowances as part of the cost sharing approach. These two roles could be completely separated, with government land allocated allowances on the same basis as any other land. Government efforts to directly mitigate nutrient loss or alter nutrient loads through approaches such as sediment capping could either be used to meet their buy-back requirement or could earn them allowances. These allowances could be used to cover nutrient loss within the cap, or retired to create a lower nutrient cap. The costs of each mitigation or offset activity should be compared with the allowance price to determine whether it is efficient.

5 Allowance allocation in other tradable emission systems

Here we briefly discuss approaches to initial allocation in four New Zealand environmental markets (actual and proposed) and common international practice.

Allowance allocation has been an extremely contested process in the Lake Taupo nutrient trading system. The system's basic approach is grandparenting to the landowners at 'recent historical' nutrient loss levels – landowners' highest reported nutrient loss for the years 2001-2005 – while government (local and central) pays for initial cuts (Environment Waikato (2007)). No mechanism for further cuts has been agreed. There has been serious argument about averaging (constant allocation per ha) as an alternative and about the perceived inequity of low allocations to relatively underutilised land, which has negatively affected foresters and Maori.

In contrast, Horizon Regional Council in the Manawatu has proposed limits on kg of N loss per ha per year on the basis of "underlying natural biophysical resources', effectively a measure of land use capability (Carran et al (2007)) In a report to the Council, Carran et al (2007) explain that this approach is independent of current and potential future land uses, and also provides landowners with greater certainty than alternative approaches. (Note that Horizon Regional Council is exploring regulations to address nutrient loss and is not currently considering a trading approach.)

In the New Zealand fisheries Quota Management System (Lock and Leslie (2007)), allowances were mostly allocated by grandparenting to vessel owners. Initially, the government purchased quota to tighten targets; later they imposed proportional cuts on all quota owners. The government bought back a large quantity of quota to settle Treaty claims related to fisheries. Some quota for new stocks entering the system were auctioned/tendered but some are still grandparented to existing vessel owners on the basis of catch history. Twenty percent of all quota for new species in the system are allocated to Maori and are shared among iwi according to rules that have only recently been agreed. All quota are fully allocated when the stock enters the system. To smooth market operation, fishers are able to pay a 'deemed value' to cover extra harvest if they are unable to purchase quota.

Allocation in the New Zealand Emissions Trading System is not yet finalised. Each sector (excluding liquid fuels because it is considered able to pass on costs) will receive some free allocation based on 2005 emissions but this will be phased out over time. Any additional units must be purchased either domestically or internationally. Methods to allocate within sectors are still being developed. Allocation in the industrial process and stationary energy sectors mostly aims to avoid 'leakage', the movement of production of trade-exposed products to unregulated countries. Leakage is less relevant for nutrient trading to the extent that water quality is a localised issue and is regulated under the Resource Management Act throughout New Zealand. In forestry, post 1989 forest owners have been given all rights to units generated in new and existing forests. Some units will be freely allocated for pre-1990 forests which face potential liabilities. The key issues are around equity, particularly for land that was part of Treaty settlements, and opportunities to develop underutilised land[6]. The allocation rules for agriculture are currently undefined but the key issues are avoiding leakage, providing compensation for losses in land value, providing opportunities to develop underutilised land, and avoiding adjustment costs.

Few overseas trading systems regulate agriculture. To the extent that agriculture is included in water quality trading programmes it is primarily through offset systems where the initial allocation is implicitly business as usual emissions (World Resources Institute (2009)). In other trading systems, initial allocation is almost invariably on the basis of historical emissions although this is sometimes altered to reflect other political or equity issues (see for example the discussion of allocation in the US acid raid program in Joskow and Schmalensee (1998)). This tendency to use grandparenting reflects political reality in most situations rather than any basis in equity or efficiency principles.

6 What share of each vintage should be allocated at what time?

The prototype nutrient trading system developed at Motu for Lake Rotorua requires allowances to be surrendered at the time nutrients are put on the ground. The specific allowances required depend on when the nutrients from that

[6] Some issues also arise because of the poor design of the related Kyoto rules, which define New Zealand's obligation. The rules are not aligned with the environmental impact of deforestation or pre-1990 forest.

property will enter the lake water. Depending on the property and its characteristics, the time from when a nutrient is applied to the land until it reaches the lake through the groundwater system can be between zero and 200 years. Allowances will each have a declared 'vintage' corresponding to the date the nutrients reach the lake, grouped into date-ranges yet to be determined (Kerr et al (2007)).

As a consequence of this design, the nutrient trading system needs to define environmental goals and trading caps for lake quality up to 200 years in advance. This does not mean that all allowances for the next 200 years should be allocated immediately, but some of each vintage needs to be allocated, because some of each will be used immediately.

In a world where governments can make binding long-term commitments, with perfect markets and rational fully-informed actors, it would be most efficient to allocate all future allowances now so that those who most want them in their investment portfolio can hold them. Investors could more easily hedge allowance price risk, futures markets would be more likely to develop, and the vested property rights would provide a strong political voice in favour of protecting the system in order to maintain the value of allowances.

In the real world, there are some reasons to issue allowances gradually. The system should issues more allowances than are immediately required, but fewer than all. There are three basic reasons for this: market efficiency, protection of people who may be less well informed, and avoiding regulatory collapse as a result of governments' inability to make binding commitments. Gradual issuing does not mean that the legal rights to future allowances are not well defined, but it does reduce the ability to use or trade them in advance.

A burst of trading each time new allowances are allocated will promote liquidity in the market by providing regular price signals. Regular issuing of allowances also provides some protection against some players accumulating a large share of any vintage and exercising market power. If some allowances are issued through an auction, small players would have greater access to allowances. In our proposed system, allowances would be available for auction only if they had been bought back from participants by government because more than the total cap is initially allocated freely to participants.

Gradual issuing has one inefficient effect: it affects who bears the risk of costs from proportional cuts in future vintages (see section 7.1). Whoever holds, or has legal right to allowances, will bear the costs of changes in the environmental goal. A landowner who holds future allowances they do not expect to need may wish to sell to avoid uncertain prices. This risk is not easily transferred away if the landowner has rights to future allowances but they are not yet legally issued.

Gradually issuing allowances in each vintage provides some protection for people who may sell their allowances early and then have regrets. This may be particularly relevant for small Maori Trusts but would also affect other unsophisticated landowners. Many owners and trustees may not understand the value of what has been granted to them. They may prematurely sell these units at lower than their long run value and therefore diminish development options for future generations. If allowances are gradually issued, the extent of these misjudgements will be limited and they will have the chance to make different decisions as they learn how the system operates.

Another option to reduce this risk for some Maori land in particular is to put Maori landowners' allowances into a central pool run by a Trust (for example Te Arawa Lakes Trust). This Trust could distribute allowances to the well-organised trusts like Ngati Whakaue but the balance of units would remain with the Trust. The Trust would allocate allowances each year to small units who want to develop and would sell off each year's surplus. The revenue could be used both to run this pool and perhaps to sponsor development or mitigation options. A similar approach has been used for managing fisheries quota (Lock and Leslie (2007)).

If all allowances for all future years were immediately issued and landowners whose nutrients reach the lake with a lag decided not to control nutrients (there will be no short term shortage of the vintage of allowances they need), at some point landowners with shorter lags would be unable to comply with the regulation without stopping all activity immediately. All allowances of the vintage they need will have been used. At this point it is not credible to believe that the government would let all these landowners stop farming.

Although the government would like to commit in advance to allow farms to be forced to stop producing, they have time inconsistent preferences and when this situation arises they will inevitably give in (as a cost benefit analysis done at that time would suggest was optimal). If landowners recognise this, they will have an incentive to use allowances too fast assuming the system will collapse. They will not plan carefully for the future. Their belief in the collapse of the system will be self fullfilling.

One way to avoid this, particularly while the system is being established, is to issue only enough of each vintage to cover business as usual needs in the next year. As the system becomes viewed as more robust and develops vested interests in favour of its continuance, the number of advance allowances that can be issued could be increased.

7 How costs can be shared as the system evolves

The nutrient trading system will need to evolve over time as new scientific information emerges and as social preferences change. The critical question here is how the distributional implications of these changes should be handled:should the same principles be applied to changes in the cap and the impacts of changes in scientific knowledge as were used to define initial allocation?

7.1 Changes to the cap

Two arguments suggest that the same cost bearing principles should also apply to costs (or benefits) from changing the environmental target. The first is that the same actors are gaining similar benefits and sharing similar costs. The second is that it is good to avoid renegotiation of distributional issues unless there is a compelling reason. Renegotiation is costly and induces strategic behaviour, which is costly to society. As an example, anticipating renegotiation could lead farmers to under-invest in mitigation in order to protect their bargaining position. They can continue to claim that they have high mitigation costs. Renegotiation also exacerbates investment uncertainty.

On the other hand, social preferences for cost bearing could change over time. Understanding the true scale of costs and benefits can also alter perceptions of how costs could be shared. Many people are uncomfortable about creating firm property rights to something about which most people have very little understanding. They fear that the powerful will unfairly benefit in the first negotiations over allocation because they better understand the value of the allowances and have the resources to fight for an allocation rule that is favourable to them. Thus renegotiation of cost sharing rules should not (and in fact cannot under New Zealand law) be ruled out.

To strike a balance, we propose that the same principles used for initial allocation and buy back are applied to future changes in the cap as the default option. An active change in policy, possibly requiring a change in the District Plan, is needed to change this. Specifically we propose that if central government bears 50% of the cost of the initial buy back, they should similarly bear 50% of future cuts. Reductions shared among allowance holders would be on the basis of proportional reductions in the nutrient loss that can be matched by each outstanding allowance of the vintage affected. The question of allocation among emitters does not need to be revisited as the reduction is on the basis of who owns the allowances, not who was initially allocated them. The price of allowances should reflect this risk.

Any changes in the caps should be publicised well in advance to minimise uncertainty. They could be incorporated in regular reviews (perhaps each 5 years). Changes in the caps could be applied with a lag so they do not affect immediate allowance needs.

7.2 Scientific developments

The other likely cause of change in the system, new scientific information on the nutrient impacts of different activities, may require a different set of principles. The driver of change in this situation is new science. This is largely outside of the control of emitters. They cannot easily influence it and cannot be expected to anticipate it. This suggests application of the principle of non-retrospective regulation. Emitters should not be penalised or rewarded for actions they have already taken. This suggests that landowners affected by changes to the model that assigns nutrient loss to particular land uses and management should be fully compensated for changes that harm them, and required to provide allowances to match the effects of changes that are in their favour. If the change in the monitoring model suggests that the catchment as a whole will no longer meet the environmental goal (or will overachieve), the standard mechanism discussed above for adjusting the total cap should be applied.

Full compensation for changes in monitoring does lead to slight overcompensation. This is because mitigation opportunities have changed for actions where the model has changed. As long as landowners cannot affect the process and so respond perversely to the promise of full compensation, this overcompensation has no efficiency impacts and the equity impacts are not likely to be too large.

Some more active participants in the market will however anticipate and cause change in the monitoring model. They will identify mitigation options and push for them to be included and they will search for and promote scientific research that reduces their obligations. The full compensation rule will reduce pressure to change rules in favour of existing land use and management practices. It will however encourage strategic delays in the adoption of mitigation actions where the rewards from mitigation are anticipated to rise – actors will thus avoid the need to give up allowances matching the improvement in their position. For example, if a landowner anticipates that wetland enhancement will be added to the monitoring model, they will wait to enhance their wetland. If they enhance it now, when the model changes it will be regarded as an existing practice and they will have to give up allowances matching the improvement in their compliance position. In contrast, if they delay enhancing it until after the model changes, they will receive the full benefit.

Similarly, anticipated rises in modelled nutrient loss will encourage strategic choices of inefficient land use and practices. Landowners in this situation will anticipate compensation for an increased allowance obligation if they wait. When the rules change they can benefit again by changing their behaviour. For example if a landowner anticipates that the emission coefficient for plantation forestry will rise, even if they would like to convert to native forest, they will delay the conversion until after they receive the compensation. Both sets of strategic behaviour are environmentally damaging and create inequitable gains to those who have inside information or ability to influence the system. One way to reduce this problem is to announce the probability of a change in rule in advance. Compensation (or additional allowance requirements) would only apply to land use and practice at that point in time . Uncertainty about mitigation rewards in the period between this announcement and the announcement of the new rule must be offset against the reduction in perverse behaviour.

8 Conclusion – tentative recommendations

To ease the economic impact of the nutrient trading system's introduction, we propose that allowances are initially allocated to nutrient sources in proportion to their current nutrient loss. Not all nutrient sources will receive the same vintage allowances. The vintage allowances that are received by the nutrient source will depend on their vintage zone: a property with a 50-year groundwater lag won't receive any allowances from the first 50 vintages, as the property will never be required to cover nutrient inputs to the lake in these years.

Maintaining current nutrient losses will not achieve water quality goals. Therefore it needs to be decided who will pay for the required nutrient loss reductions. If only the number of allowances equal to the goal were allocated, the environmental target would be achieved but most of the cost of nutrient reductions would be borne by the nutrient sources. In contrast, if sufficient allowances were allocated to cover current nutrient loss, and the government bought back and retired sufficient allowances to meet the goal, tax or ratepayers would bear all of the cost and nutrient sources would actually profit from the system[7]. Somewhere between these two extremes is likely to be ideal, with nutrient sources and central and local government each bearing some of the cost of achieving reductions. Thus, the nutrient sources are allocated fewer allowances than they need to cover current nutrient loss and central and local government must buy allowances from the market to achieve the remainder of the reduction to achieve the 'goal' level of inputs.

The share of the reduction that is paid by each of the parties should be consistent across vintages and explicitly defined. For example,

X% is through District Council buy-back

Y% is through Regional Council buy-back

Z% is through Central Government buy-back

The remainder of the reduction is a proportional cut in unused allowance holdings of the appropriate vintage. This ensures that all parties bear some of the cost but that the reductions are not too great a burden on any party.

For allowances beyond the vintages that each landowner needs in the first few years of the system, the allocation mechanism will transition to one based on potential nutrient loss, providing a more equitable system. This prevents landowners

[7] The reductions that are funded by central or local government should be used to purchase allowances directly off allowance holders. This could be done via a tender process where allowance holders submit tenders stating how many allowances of each vintage they are willing to sell and for what price. Allowances are purchased from the lowest price bids until the required allowances have all been purchased. A single buy back process could be used and the funding of the allowances split between the three funders.

becoming trapped in their current land use if they do not have sufficient capital to purchase allowances and avoids rewarding high nutrient loss properties indefinitely. To enable this to happen, a measure of potential nutrient loss needs to be determined. Some potential options are land use capability (based on slope, soil type etc) and potential stocking rates applied through the OVERSEER model with 'standard' management practices.

Both the 'grandparenting' and 'potential nutrient loss' allocation rules must be as simple as possible and based on readily available data that cannot be challenged to make it as fair as possible (and perceived as such). The same calibration of OVERSEER (with add-ons) used to monitor the system should be used for free allocation, to align allocation and obligations to surrender and to reduce participants' risk. This limits the incentives for participants to bias model calibration as increasing your nutrient loss to gain more allowances in the allocation process will also mean that you are required to surrender more allowances each year.

The allocation of allowances should be carried out in stages rather than individuals receiving all future allowances at once. For example, individuals could receive vintage allowances relevant to their first five years in the system. This would protect uniformed allowance holders from selling all of their allowances before they fully understood the system. It would also protect the credibility of the system. This would prevent all of the allowances being used in the first few years of the system, which would severely restrict future nutrient loss from the catchment and lead to increased pressure to increase the trading caps and/or abandon the system. Regular injections of allowances could also lead to periods of increased trading as individuals adjust their allowance holdings. This would provide regular price signals for the market.

Cost sharing when changing targets should be based on the same principles as reducing nutrient loss when initially allocating allowances. For example, if allowance holders fund 30% of the initial reduction in allowances that were allocated, they should also fund 30% of any future changes in the cap. Similarly, if the trading cap were increased, allowance holders would receive 30% of the newly created allowances. This could be deeply embedded in the system by defining each allowance as a share of the target for that vintage rather than an absolute level of tonnes of nutrients.

Fixing these cost-sharing rules in advance ensures that future decisions are only about the appropriate levels of the caps and not about who is paying for them. This should focus discussion on the optimal social decision rather than being biased by special interests.

When changes are made to the model used to monitor nutrient loss, landowners should not have to enter the market to purchase extra allowances to continue in their current land use/activities. Regulation should not impose retrospective penalties (or rewards) on specific properties for changes that are out of their control and which they cannot anticipate. Imposing costs on a small group of properties would create resistance to science-based improvements to the system.

We propose that landowners' allocation of allowances be adjusted to account for the increase or decrease in allowances now needed to cover their nutrient loss. This involves giving allowances to or taking allowances from landowners to ensure that they are no better or worse off. If the new model alters the aggregate level of nutrient loss, the adjustments to allowance levels to restore the environmental goal should use the same mechanism as outlined above to address changes in the trading caps.

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