IMPACTS OF WATER POLICIES ON NEW ZEALAND LIVESTOCK AGRICULTURE AND THE RUAMĀHANGA CATCHMENT

Subtheme: The role of policy in defining future farming systems

Terry G Parminter

KapAg Ltd, Paraparaumu, New Zealand

Abstract:

New Zealand communities are seeking improved water quality. Applying New Zealand's legislative framework, policy decisions to achieve these improvements must take account of a range of factors, including the sources of contaminants, and the economic implications of policy changes for resource users such as farmers. This paper outlines key components of the agricultural information being used to underpin policy decision-making in the Ruamāhanga River Catchment, and evaluates the economic impacts on farming of one potential policy scenario to achieve improved water quality.

Twelve representative farms are used in the evaluation. Based on this, 24% of the nitrogen load entering the river from livestock agriculture is from dairying, 40% from sheep and beef breeding farms, and 36% from sheep and beef finishing farms. Reducing the nitrogen load in the river from the current levels of 0.64 to 0.53mg/L, requires livestock farmers in the catchment to reduce nitrogen discharges by an estimated 700T of nitrogen per year. Such a water quality target can be achieved if improved farm management practices are adopted, and provided that other human-induced sources of contaminant are also reduced. The costs of the farm management changes required could reduce their contribution to the district GDP by over 10%.

Keywords: *Wairarapa, nitrogen, water quality, dairy, sheep and beef*

The policy framework for addressing water quality issues in New Zealand

New Zealanders have increasingly expressed concern about water quality (Ministry for the Environment, 2016). In some catchments water quality is deteriorating markedly as urban centre population increases and agriculture intensifies (Ministry for the Environment, 2016). In response, the New Zealand government has introduced the National Policy Statement for Freshwater Management (NPS-FM; 2011, 2014). The policy statement requires regional councils through New Zealand to work with their communities to understand their expectations for the water bodies in their regions (e.g. for swimming, fishing, irrigation or intrinsic purposes). The regional councils must then set limits for water quality and develop methods for achieving them within desired time frames, including constraining agriculture if necessary.

Regional councils throughout New Zealand are currently engaged in this limit setting process. In most cases communities are seeking improvements in water quality (Parliamentary Commissioner for the Environment 2015). The NPS-FM outlines a policy decision-making process that requires councils to identify the sources of contaminants, and consider the economic impact of potential limits. In New Zealand, agricultural land uses dominate many lowland catchments, so councils need information on current farm contaminant discharges, and must test the economic impact of farm management or farm system changes required to meet a particular limit. The sizes of the economic impacts are influenced by the policy implementation-methods used to achieve a water quality reduction. Some regional councils are moving from methods based on encouraging or regulating selected practices, to allocation-based approaches for each source of discharges. Allocation approaches enable land owners themselves to select the mix of practices for best achieving a limit within their own production system and farming context. They also provide the flexibility and opportunity for farmers to be adaptive and innovative.

Each implementation method has differing consequences for the way the costs of achieving a limit are shared between farmer groups and between farmers and other sectors present in the catchments. As a consequence, there are equity considerations for communities and councils in this process, as land owners have to fund most of the changes themselves without external sources of financial support.

This paper illustrates the farming and economic information required to underpin the policy process for setting and managing within water quality limits based on an example catchment. The paper also considers the scale of practice changes required and tests the economic impact on farms and the district of a particular limit, using representative livestock farms. The paper concludes by highlighting some of the issues that policy makers will need to consider when determining water quality limits and how they will be achieved in the catchment. The study draws on information contained in a research project carried out for the Ministry for Primary Industries, to which the author contributed (Ministry for Primary Industries, 2016).

Introduction to the Example Catchment for the Ruamāhanga River

The Ruamāhanga River is a wide slow moving river on the south eastern corner of the North Island of New Zealand. The river begins in the forest-covered hills of the Wairarapa district and finishes confined between the banks of a man-made channel modified to increase flood control for surrounding farms (Greater Wellington 2007). For most of its length of 124km, the river flows through farmland and past small rural towns, until it pushes into the wild waters of Cook Strait and the Pacific Ocean. Primary industry is the single biggest contributor to the local economy, contributing almost 20% to district GDP (BERL, 2008).

The Greater Wellington Regional Council is responsible for managing water quality in the Ruamāhanga River Catchment. The monitoring of water quality undertaken by the regional council indicates that there is a general decline in water quality with increasing distance along the length of the river (Greater Wellington Regional Council 2007). This decrease in water quality is associated with the cumulative effects of point source municipal wastewater discharges and non-point sources from rural landuses such as agriculture.

Monthly monitoring of the lower Ruamāhanga River has had the following results with guideline maximums shown in brackets (ANZECC 2000):

- Total nitrogen median of 0.64mg/L, with a maximum of 2.1 and a minimum of 0.05mg/L (0.614mg/L)
- Total phosphorus median of 0.04mg/L, with a maximum of 0.35 and a minimum of less than 0.01mg/L (0.033mg/L)

- *Escherichia coli* median of 110cfu/100ml, with a maximum of 3,800 and a minimum of 12cfu/100ml (100cfu/100ml).

Annually, about 1,000T of nitrogen and 65T of phosphorus are lost from the catchment into the Pacific Ocean and the ANZECC guidelines are exceeded about half the time that samples have been taken. The results indicate that there will be times when the water in the Ruamāhanga is not suitable for bathing, contact recreation, cultural activities and food gathering. This situation is of concern to the regional council which is required to manage these risks to ecological health and human activity.

Setting Water Quality Limits in the Ruamahanga Catchment

The regional council process for setting water quality limits for the Ruamahanga catchment involves catchment committees to formulate community water objectives, limits and policies. In the Wellington Region these committees are called Whaitua (a Māori word for a "management unit"). As required under the NPS-FM, the Whaitua Committee is taking an evidence-based approach to their role including information about the impact that farming land uses on river water quality and how possible policy options might in turn impact on farming (Banks 2009). The Whaitua Committee has been provided with the information on the representative farms that is outlined in the following section of the paper. The information will be used in biophysical and economic impact models, to test a range of scenarios for potential limits and how they might be managed. In this paper, the representative farm information has been used by the author to carry out a simplified scenario analysis to illustrate the potential economic impacts of one potential limit.

Research Approach

In a project led by the Ministry for Primary Industries (MPI 2016), a number of representative farms were identified to explore and understand the interactions between catchment-scale policies for managing water quality and individual farming systems. The sample was selected by three farm consultants working in the Wairarapa with input from staff at the Ministry for Primary Industries. The intention was to choose farms that could be considered a high risk to water quality and others that could be considered a low risk. While the farms were to be typical of their farming type they did not need to be "average". The selected farms were to match sixteen types to be found in the

Ruamāhanga Catchment. This paper considers twelve of the farms, covering the main land uses of dairying; sheep and beef breeding; and sheep and beef finishing. As part of the selection process, each farmer agreed to provide their management information for the 2013-14 year, for further analysis in the project. Farm information was used in two farm system models developed for each farm. These were a farm enterprise model (Farmax 7.0) and a nutrient model (Overseer Version 6.2.1) that described the pathways through which nutrients from the farms could be lost and potentially flow through into catchment waterways. The models have been used in this paper to model the changes in nutrient losses and financial costs for each of the representative farms in the catchment were compared between farms before and after the possible mitigations were introduced.

Dairy Farm Baseline Results

There were six dairy farms modelled, all of which grazed their cows outdoors year-round. The physical dimensions of the representative dairy farms are summarised in Table 1 and their production in Table 2.

The dairy farms were estimated to be losing 24-47kgN/ha/yr nitrogen into ground water or surface water, predominantly as leached nitrate from livestock urination. Nitrogen losses were not directly determined by the type of farming system and even the organic producer and the moderate intensity farms had similar nitrogen losses to the other farms. However, there was a tendency for higher stocked farms in this sample to be importing higher amounts of nitrogen fertiliser, and achieving higher levels of production and so to have greater nitrogen losses (Parliamentary Commissioner for the Environment 2015, p19). Nitrogen losses tended to be higher on those farms with coarse undeveloped soil structure and high rainfall and/or using irrigation.

Table 1. Physical dimensions of the representative dairy farms.

Farm name	Management Description	Dominant Soil Order	Rainfall (mm/yr)	Irrigation (mm/yr)	Total Area (ha)	Milking Area (ha)	Topography	Area Irrigated (ha)
Dairy 1	High intensity	Pallic	967	819	367	171	flat	100
Dairy 2	Moderate intensity	Gley	1356	887	171	171	flat	100
Dairy 3	High intensity	Pallic	1100	580	301	185	flat	60
Dairy 4	Moderate intensity,	Brown	1546	0	204	125	rolling	0
Dairy 5	Moderate intensity	Gley	915	819	426	270	flat	135
Dairy 6	Low intensity, organic	Recent	801	819	355	210	flat	159

Table 2. Production of the representative dairy farms

Farm name	Milking Area (ha)	Milking Cows	Farm Production (kgMS/yr)	Milk volume (litres/yr)	Imported Nitrogen (kg/ha)	Available Nitrogen (kg/ha)	Lost Nitrogen (kg/ha)	Operating Profit per Effective Area ($/ha)
Dairy 1	171	635	286,597	3,588,194	94	238	42	1309
Dairy 2	171	430	150,590	1,653,218	105	250	34	3277
Dairy 3	185	629	228,105	2,913,091	87	212	24	1157
Dairy 4	125	355	159,249	1,802,699	102	220	47	2413
Dairy 5	270	840	295,000	3,393,351	77	215	24	1492
Dairy 6	210	567	213,462	2,417,522	0	150	35	2428 [1708 (before premiums)]

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Farming profitability was related to having a high proportion of milking animals, a moderate stocking rate and high production per cow. The intensity of the farming systems used in the Table is based on their dependence on the use of imported supplementary feed to maintain milk production early and/or late in the milking season, as well as during the winter when the cows were dry (Shadbolt, 2012).

Sheep and Beef Breeding Farm Baseline Results

There were two sheep and beef breeding farms selected, where the dominant farm output is the production of young animals of six months age or younger, for sale to other finishing farmers.

The sheep and beef breeding farms in the sample were low intensity and had estimated losses of nitrogen lower than for the dairy farms (Tables 3 and 4). In the Table, sheep and beef breeding farm 1 was a hill farm with high annual rainfall. This farm was similar to the second sheep and beef breeding farm but it used a lot more nitrogen fertiliser and it had higher profitability and higher estimated nitrogen losses.

Sheep and Beef Finishing Farm Baseline Results

There were four sheep and beef finishing farms selected (Tables 5 and 6). These farms tended to have flatter land than the breeding farms and although they still had a proportion of breeding animals, they finished most of their young stock.

The sheep and beef finishing farms tended to have higher profitability than the sheep and beef breeding farms, but were still only half the profitability of dairy farms ($/ha). The finishing farms with the highest and lowest profitability both had similar stocking rates. The finishing farms had estimated nitrogen losses of 8-17kgN/ha per year. The highest nitrogen loss farms (farms 2 and 4) had high cattle numbers or concentrated grazing of cattle in winter, contributing towards these losses.

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Table 3. Physical dimensions of the representative sheep and beef breeding farms.

Farm name	Management Description	Dominant Soil Order	Rainfall (mm/yr)	Irrigation (mm/yr)	Total Area (ha)	Effective Area (ha)	Flat (%)	Area Irrigated (ha)
S&B Breeding 1	Low intensity	pallic	1340	0	380	360	0	0
S&B Breeding 2	Low intensity	brown	909	0	680	620	9	0

Table 4. Production of the representative sheep and beef breeding farms

Farm name	Stocking Rate (su/ha)	Cattle (%su/ha)	Breeding Ewes	Net Product (kg/ha)	Feed Conversion (kgDM/ kg product)	Imported Nitrogen (kg/ha)	Available Nitrogen (kg/ha)	Lost Nitrogen (kg/ha)	Operating Profit ($/ha)
S&B Breeding 1	9.1	22	2023	208	30	38	102	23	438
S&B Breeding 2	9.0	23	3112	202	29	8	84	8	345

Table 5. Physical dimensions of the representative sheep and beef finishing farms.

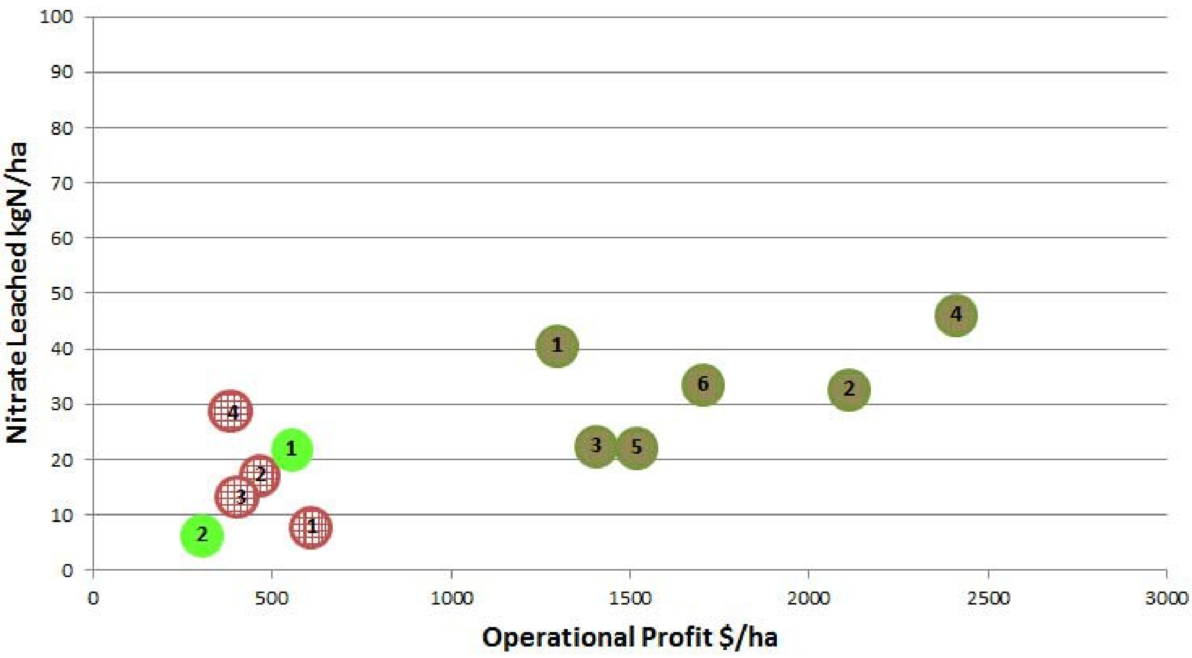
Farm name	Management Description	Dominant Soil Order	Rainfall (mm/yr)	Irrigation (mm/yr)	Total Area (ha)	Effective Area (ha)	Flat (%)	Area Irrigated (ha)
S&B Finishing 1	Moderate intensity	Brown	825	0	620	585	27	0
S&B Finishing 2	Moderate intensity	Pallic	1491	0	540	450	0	0
S&B Finishing 3	Moderate intensity	Pallic	870	0	1110	927	65	0
S&B Finishing 4	High intensity	Gley	778	814	360	350	70	84

Table 6. Production of the representative sheep and beef finishing farms

Farm name	Stocking Rate (su/ha)	Cattle (%su/ha)	Breeding Ewes	Net Product (kg/ha)	Feed Conversion (kgDM/ kg product)	Imported Nitrogen (kg/ha)	Available Nitrogen (kg/ha)	Lost Nitrogen (kg/ha)	Operating Profit ($/ha)
S&B Finishing 1	11.4	26	2,990	279	24	3	90	10	673
S&B Finishing 2	8.2	28	1,800	237	25	18	74	17	402
S&B Finishing 3	10.7	43	3979	266	19	9	68	8	329
S&B Finishing 4	11.4	48	0	320	26	44	116	15	267

The profitability of the farms and their nitrogen losses is shown in Figure 1. Due to the small sample size, there are no statistically significant relationships. On the representative farms, dairying in 2013-14 was considerably more profitable (per unit area) than sheep and beef farming. Although there was some overlap between them, the sheep and beef farms tended to have lower losses of nitrogen than dairying.

Figure 1. Profitability and nitrogen losses for the representative farms in the Ruamāhanga Catchment



Legend for Figure 1.

The olive circles represent the dairy farms in Table 1.

The green circles represent the sheep and beef breeding farms in Table 3.

The brown hatched circles represent the sheep and beef finishing farms in Table 5.

Scaling Up the Representative Farms to the Catchment-Scale

Each of the representative farm types relate to different numbers of farms within the catchment as a whole. As the farms also have different land areas associated with each of them, their contribution to catchment attributes are also different (Table 7). Table 7 shows that sheep and beef breeding farms dominate the other land uses in the catchment, followed by sheep and beef finishing farms and then dairying. There are a further 1260 owners of rural lifestyle blocks, forests and sub-economic blocks of land in the

Wairarapa, most of whom are residents of the Ruamāhanga Catchment (Statistics New Zealand, 2017). Their farms and forests cover a further 110,000ha.

In Table 7 the calculations for farming's contribution to district GDP uses adjusted gross margins as their basis (MAF, 2004). The adjusted gross margins do not include the costs of farm labour, rates, or depreciation.

Although it has the smallest area in the catchment, dairying is estimated to make the largest contribution to district GDP of any farm type, followed by sheep and beef breeding, and then sheep and beef finishing.

The sheep and beef breeding farms had a substantial number of large sized properties and so contributed most towards estimated nitrogen losses in the catchment. Sheep and beef finishing farms also contributed more towards estimated nitrogen losses than dairying. However, each individual dairy farm contributes more towards nitrogen losses than any of the individual sheep and beef farming types.

For phosphorus, dairy, breeding, and finishing farms, contributed an estimated 7%, 24% and 69% of the phosphorus load respectively.

Applying the Representative Farms to Test the Implications of Potential Water Quality Limits

Previous studies show that annual nitrogen losses in the river will have to be reduced by at least 16% or 180T if the catchment is to meet ANZSECC guidelines 65% of the time rather than the current estimate of 50% (Greater Wellington Regional Council 2007). If the 16% reduction in nitrogen discharges is carried equally by all sources, then based on the data in Table 7, livestock farming would have to reduce nitrogen losses by over 700T.

A number of policies could be used to drive this reduction, including regulating farm practices or an allocation based approach. Some regional councils are allocating nutrient discharge allowances based on "grandparenting" each farm's past discharges, adjusted to incorporate the use of good management practices. The adjusted allocation minimises the reduction required by existing land users, while recognising and rewarding farmers that have previously adopted good management practices. It is up to each farmer to choose how they will remain under the nutrient-cap imposed by the allocation method.

Table 7. Estimation of Catchment Results Using Farm-gate Results

Farm name	Number of Farms	Farm Area (ha)	Catchment Area (ha)	Gross Margin ($000/farm/yr)	Contribution to district GDP ($Mill)	Nitrogen Loss (kgN/farm/yr)	Contribution to Catchment Nitrogen Loss (T/yr)
Dairy 1	10	170	1700	656	6.6	7140	71.4
Dairy 2	40	150	6,000	601	24.0	5100	204.0
Dairy 3	30	150	4,500	468	14.0	3600	108.0
Dairy 4	40	200	8,000	943	37.7	9400	376.0
Dairy 5	40	250	10,000	925	37.0	6000	240.0
Dairy 6	4	250	1,000	1,347	5.4	8750	35.0
S&B Brdg 1	70	650	45,800	289	20.2	14950	1,046.5
S&B Brdg 2	85	1000	85,000	373	31.7	8000	680.0
S&B Fin 1	10	800	8,000	555	5.6	8000	80.0
S&B Fin 2	100	650	65,000	264	26.4	11050	1,105.0
S&B Fin 3	30	300	9,000	132	4.0	2400	72.0
S&B Fin 4	50	400	20,000	104	5.2	6000	300.0
Total	509		264,000		217.8		4,317.9

If such an approach were to be taken in the Ruamāhanga Catchment to achieving the required reduction in discharges, the good management practices included in the allocation calculation could be (Waikato Regional Council 2016):

- Changing effluent management on dairy farms by introducing storage and increasing application areas to reduce leaching and increase the use of its fertilising value.
- Changing fodder crop strategy on sheep and beef farms so that no crops are grazed by cattle over winter. Imported baleage is used as a substitute.
- Changing the use of nitrogen fertiliser to reduce annual applications below 150kg N/ha, and avoiding winter applications (in cold wet weather).
- Grazing dry dairy cows out of the catchment for eight weeks over winter.

The effect of making these changes on reducing nitrogen loads (compare with Table 7) is shown in Table 8. In the Table the largest reductions are for those farming systems where cropping for winter grazing can be replaced by importing supplementary feed or grazing cows off the property. The combined effect of introducing these mitigations is a reduction of 691 T/year, close to the target of 700 T/year. Greater reductions are possible in the catchment, but these would generally require large capital investments on livestock farms or land use change away from livestock farming entirely, e.g. expanding the area in forestry.

Dairy farmers can mitigate their losses in proportion to their contribution to the catchment. Sheep and beef breeding farmers appear to be able to mitigate less than their contribution, whereas sheep and beef finishing farmers, using the practices listed above, can mitigate more than their contribution. The farmers estimated to be currently losing more than 20kg N/ha, as a group, appear able to mitigate an estimated 4.4kg N/ha, but this, on its own would not be able to achieve the targeted reduction of nitrogen loss.

In Table 8 the proposed mitigations are estimated to cost the Wairarapa annually about $24 million (at the farm gate). The costs in the Table, average $90/ha or $34/kg nitrogen reduction. They are similar to the $95/ha calculated for a mix of mitigations modelled in Southland and the $100/ha for the cost of introducing mitigations on dairy farms in the Waikato (Vibarta et. al. 2015; McDonald et. al. 2015).

Table 8. Estimation of Catchment Reductions in Nitrogen and Gross Margin from Introducing On-farm Mitigations

Farm name	Number of Farms	Reduction in Nitrogen Loss (kgN/farm/yr)	Contribution to Catchment Reduction in Nitrogen Loss (T/yr)	Reduction in Farm Gross Margin ($000/farm/yr)	Reduction in District GDP ($Mill)
Dairy 1	10	1,118	11.2	70.6	0.7
Dairy 2	40	1,883	75.3	79.5	3.2
Dairy 3	30	242	7.3	75.1	2.3
Dairy 4	40	838	33.5	83.5	3.3
Dairy 5	40	946	37.8	113.3	4.5
Dairy 6	4	798	3.2	95.8	0.4
S&B Brdg 1	70	2,937	205.6	11.0	0.8
S&B Brdg 2	85	31	2.6	0	0
S&B Fin 1	10	1,806	18.1	32.0	0.3
S&B Fin 2	100	2,377	237.7	30.0	3.0
S&B Fin 3	30	153	4.6	102.4	3.1
S&B Fin 4	50	1,074	53.7	45.0	2.3
Total	509		690.6	23,808.9	23.9

In this study, the mitigation costs for the dairy farms were $416/ha ($85/kg N), this was largely the result of de-stocking over the winter. For sheep and beef farmers the costs were $58/ha and $84/ha for breeding and finishing farms respectively, mainly due to the extra costs of purchasing supplementary feed to replace winter cropping. It may be possible for the farmers in the Wairarapa to improve on-farm efficiencies when introducing the possible mitigations, by upskilling in a number of ways to increase their pasture utilisation and decrease their feed costs (DairyNZ 2010). Farmers may also find more cost-effective ways of reducing their discharges to meet their allocation than those outlined here. In both cases, this would reduce the net costs of reducing discharges.

Conclusion

The focus of this paper has been on using examples of farming systems to illustrate an approach to setting nutrient load limits in catchments through New Zealand. Catchment communities are making decisions about water quality objectives and limits. When they do, they often want to improve water quality and reduce the nutrient losses into catchments from agriculture.

In the example catchment, it is possible to improve water quality from achieving ANZECC guidelines for nitrogen from 50% of the time to 65% of the time. The changes required on farms involve a greater use of imported supplementary feeding of cattle during the winter on sheep and beef farms, and destocking dairy farms over winter. In a catchment such as the Ruamāhanga, the large area committed to sheep and beef farming means that even small changes to their nitrate leaching can have a big impact on the whole catchment. On the other hand, while dairying does not involve a large proportion of the land area of the catchment, the higher intensification of dairy farms means that it has an influence on nutrient losses greater than its area would suggest.

This example catchment highlights some of the difficult decisions facing policy makers to determine the water quality limits, and how to efficiently and equitably share the financial cost of improving water quality. In this example, farming was not able to fully achieve its reductions in discharges without also introducing significant land-use changes. Sharing the burden for achieving water quality targets amongst farming, urban and industrial sources is likely to be necessary in most catchments. Similarly, equity issues also arise when considering how to share the costs within the farming sector. The good management practice-based approach tested in the case study catchment resulted in dairy farms facing much higher mitigation costs per hectare than sheep and beef farms.

The New Zealand Government has recognised these difficulties facing regional councils and communities. The Government has indicated that it is working towards an allocation framework which will identify and develop acceptable options for the allocation of discharges that will increase the sustainable economic and social benefits to New Zealand. Final recommendations are to be provided by November 2017, with legislation to follow in 2018.

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