Landcare Research
Manaaki Whenua
POLICY BRIEF
Insights for government, councils and industry

Using Economic modelling to inform limit setting processes for freshwater resources

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RECOMMENDATIONS

Water limits and how they are implemented will affect economics at the farm, catchment and regional scale. As decisions on these limits get made, the impacts being sought at each scale will involve different types of analysis. Robust modelling of these impacts requires that:

1. Links between farms, catchments and regions are considered when conducting an analysis of these impacts. This includes ensuring that:
   a) underpinning data are consistent across scale, e.g., catchment and regional analyses should both use the same land-use map
   b) information derived in one type of analysis informs another, e.g., budgets and corresponding environmental impacts derived from farm-scale analysis are used in catchment analysis, and changes in land use and farm outputs estimated in catchment analysis are used as the basis for regional analysis
2. Landowners are not considered as operating in isolation and that the range of land uses, management practices, soil types, and climates that are (or could be found) in a catchment or region are included in any catchment and regional analysis.
3. When commissioning or undertaking these analyses they are staged in a manner that allows information to flow from one analysis to another. Those involved in each analysis understand how their work complements other analyses and specific processes are established for the efficient flow of information between analyses.

While this may seem straightforward, often the links and flow of information between different analyses is overlooked.

BACKGROUND: THE FRESHWATER REFORMS

Water quality in New Zealand has been declining and many catchments are considered over-allocated in terms of water takes. Central government has addressed these through a series of initiatives including New Start for Freshwater (2009), the Land and Water Forum (LWF), a National Policy Statement for Freshwater Management (2011), a Fresh Start for Freshwater Reforms (2011), and the Freshwater Reforms (2013).
The National Policy Statement provided, for the first time, a clear mandate for regional councils to establish freshwater objectives and set freshwater limits for all waterbodies by 2030. Another key shift in decisions on freshwater resources has been the indication of a move from a Schedule 1 Resource Management Act (RMA) process to more collaborative processes. The LWF's governance report (LWF 2012) laid out how collaborative processes could operate within the RMA (see Figure 1) and the Government has signalled that the RMA reforms will contain more explicit language on the use of collaborative processes for freshwater management. Even without these reforms, many regional councils are already embarking on collaborative processes to set objectives and limits for catchments.

Figure 1. Land and Water Forum recommendations for how to change RMA processes to improve freshwater management decisions

Current RMA Schedule 1 process	Alternative RMA process proposed by LWF
 Draft plan notified	 Initiate collaborative process
 Submission & Regional Council Plan hearings	 Collaborative policy development
 Negotiation of outstanding appeals	 Translate policy into plans
 Environment Court	 Submission & hearings process
 Draft Court decision	 Draft decision
 Final Court decision	 Final decision
 Appeals to High Court	 Appeals

The knowledge, science, and analysis asked for by central government, regional councils and collaborative groups to underpin these decisions are becoming more sophisticated as more knowledge is gained, tools and approaches developed and refined, and more nuanced questions asked. This policy brief explores some of the key economic questions being asked and how to address them.

THE ECONOMIC QUESTIONS ARISING

The questions about the economic impacts, in particular, are becoming increasingly important as resource constraints are reached; freshwater use faces more competition; and the costs to manage within limits increase.

Three key questions are asked:

1. What is the impact of the limit on me [my farm, my tourist operation, etc.]?
2. What is the impact of the limit on us [the industries in the catchment]?
3. What is the impact of the limit on my community [the region]?

These questions can be answered in two ways— (1) as discrete pieces of analysis undertaken by independent groups at the request of councils or collaborative processes, or (2) as an integrated package of analyses. While there may be coordination between discrete pieces of analysis, e.g., through the sharing of underpinning data or findings that can serve as key components for other analyses, it is not assured. This is because in many instances, the analyses are commissioned at different times and/or by other stakeholders.

The remainder of this policy brief outlines some approaches that can be used to answer these three questions and why it is important to ensure there are linkages between the analyses undertaken for each question. While the brief will focus on the productive land-use sector, the approaches and information flows are important for all sectors and sources (e.g., diffuse and point sources) within a catchment where water limits (see Box 1) are being proposed. This brief also uses the reduction of excess nutrients as an example of how these policy analyses could be applied at the farm, catchment, and regional level.

Box 1: Types of water limits and policy instruments to implement limits

Water limits are generally applied to point(s) of interest in a catchment, e.g., specific location in a river or a receiving water body like a lake. They are often quantitative limits such as concentration of a nutrient in a river (mg N/l) or the status of a lake (e.g., trophic level index or TLI). These limits can then be translated into a reduction (or potentially an increase) in the amount of a nutrient reaching the water body or point of interest in a catchment; for instance, to meet a specified TLI, the total amount of nutrients reaching the lake to achieve this TLI is estimated (e.g., kilograms of a nutrient loading reaching the lake). The reduction target is the difference between the kilograms of nutrient loading needed to achieve the TLI and the existing nutrient loading from the catchment (i.e., the reference or baseline).

Policy instruments are developed to provide an incentive to those nutrient sources in a catchment to change the way they manage their activities so, in aggregate, the catchment reduction target is achieved. Some policy instruments being considered and used in New Zealand include farm-level targets, cap-and-trade programmes, and mandatory management practices.

Water quantity policies are similar to water quality except the limit typically refers to a minimum flow at different points in a river. This flow is based on the flow needed to achieve an agreed or specified economic, cultural, social and/or environmental outcome, e.g., flow need to maintain a certain fish habitat or the mana of the river. These limits are then translated to water takes for individuals.

Question 1: What is the impact of the limit on me?

This question relates to how the limits will affect the different enterprises in the catchment and comes from the self-interest of landowners. Landowners in any catchment are likely to want to know what the implications are for them. The analysis to support this question can come in a number of forms ranging from confidential assessments of individual farms to identifying representative enterprises that can be used to characterise farms with similar land-use/soil/climate combinations. These assessments gather farm-level budget information (e.g., input costs and outputs produced), and estimate the nutrient losses associated with each enterprise.

How the water limit is translated to individual landowners and the choice of policy instrument will affect the actions that landowners take. Thus, a key component of this analysis should be to determine the impact of the suite of policy scenarios under consideration. This could include assessing the impact of different water limits, different ways a limit could be implemented on a farm, and the measures that a landowner can take to meet these limits.

The biggest challenge in this analysis is often accessing the financial records of individual farms. This is either because of confidentiality reasons or because farms may not maintain good farm management or financial records. The use of representative enterprises can address both these issues. Landowners particularly worried about their own enterprises may prefer to undertake/contract their own assessments. This type of analysis primarily assists landowners and industries in understanding the estimated farm-level impacts of water limits.

Where representative farms within the catchment are used in an assessment then this information can and should be used when answering the next question about what is the impact on the catchment.

Question 2: What is the impact of the limit on us?

Water limits are typically set at the catchment-level as limits are often specified based on the cumulative effect of activities in a catchment on water quality or water flows. Catchments contain a mix of land uses, soil types, climates and each combination of these will have different combinations of practices that reduce water quality impacts or efficiency of water take. The composition of land use in the catchment and the stringency of the limit imposed will have varying impacts on farm profitability. This means that the impact of a water limit on each farm or farm/soil/climate combination will differ, and the impact of the policy instrument(s) used to implement the water limit will also differ. To understand how water limits affect all landowners in a catchment, the analysis could cover the policy instrument(s) under consideration to achieve the limit, the impact of meeting the limit in aggregate and by industry, and the interaction between enterprises in the catchment as they respond to the policy signal.

This analysis typically uses representative farm budgets, feasible farm management options, and associated nutrient losses across a range of land uses, soil types and climates to assess the catchment-wide impacts. Limits will impact the relative profitability of each land use/soil type/climate combination differently, with some finding it more profitable to change management practices, others to change land uses.

A catchment-level analysis primarily assists government and industries to understand how landowners in a catchment may respond to a water limit and the corresponding changes in land use, farm income, nutrient losses and/or water use. It can also be used to explore how a range of policy scenarios may impact different landowners in the catchment, and whether a particular policy instrument is likely to result in lower (greater) costs on average than others. For example, if a cap-and-trade instrument is being considered, this analysis can be used to evaluate how many landowners may find it more profitable to increase their nutrient-leaching levels by purchasing or exchanging individual nutrient loss limits with others in the catchment who find it more profitable to reduce their nutrient leaching beyond their target levels.

At the catchment level, this analysis will provide an estimation of the land-use and management configuration (or the land-use change) that may result from imposing a limit as well as estimating the change in input demands by landowners. The information estimated in this analysis can and should be used when answering the next question.

Question 3: What is the impact of the limit on my community?

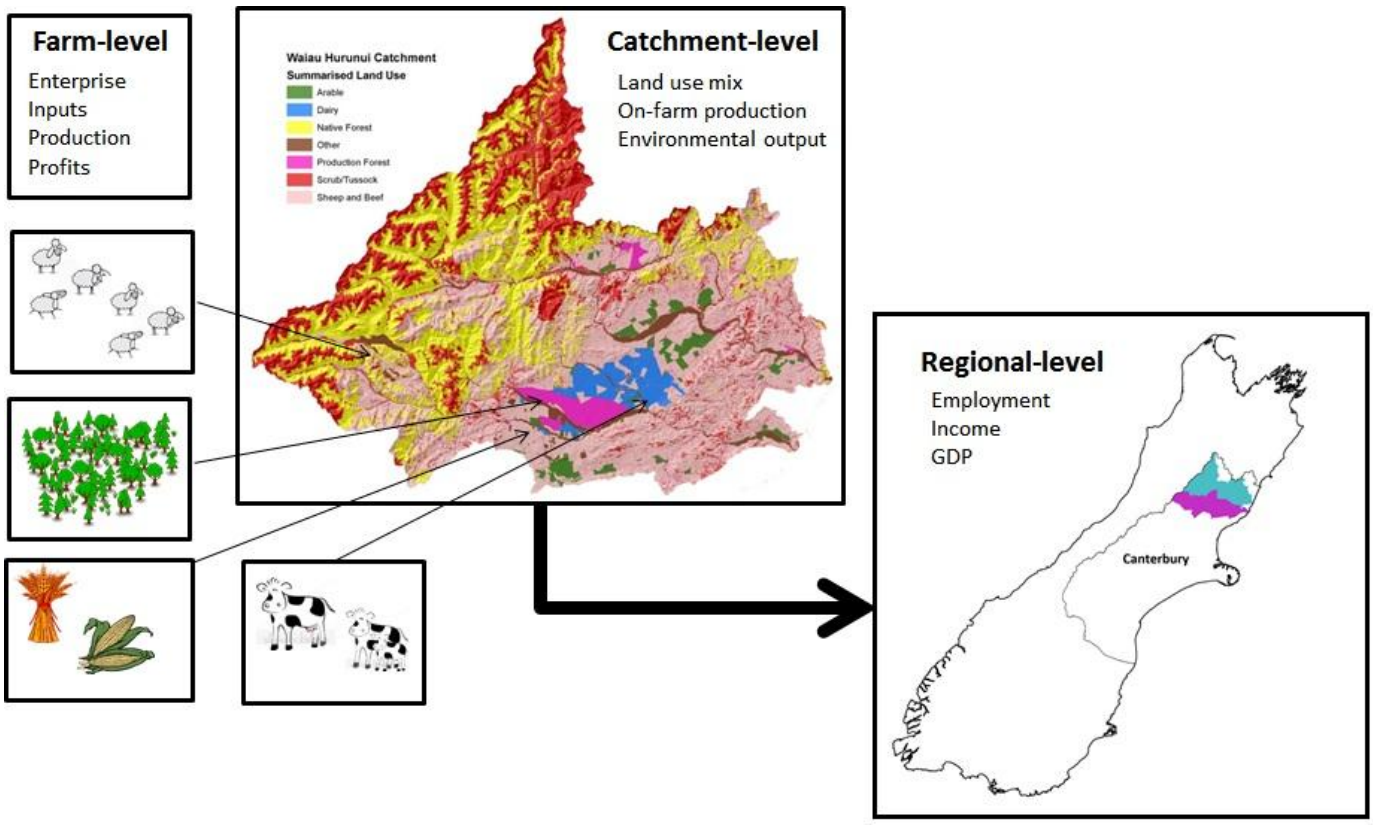
One of the key concerns of any policy is how it will affect the wider economy. Policy not only has a direct impact on some enterprises but also has indirect or knock-on effects. For example, a limit may mean a farmer converts some of his land to native forest to ensure he meets a compliance limit. As a result he uses less nitrogen fertiliser. If a number of farmers respond similarly, this could mean there is only sufficient demand for one fertiliser retailer in the local town. Therefore, those fertiliser retailers who decide to close are no longer employing people, who in turn do not eat out at local restaurants, and so on.

These analyses typically use a multiplier approach to determine the estimated impact of policy. With water limits, the change in land-use configuration and/or input use across the catchment/region resulting from the policy can be used to estimate the broader effects on employment and income. Ideally, land-use and input changes would be derived from catchment land-use analysis used to answer the second question. For example, a policy that induces a significant change in land use or land management may result in a large change in the quantities of farm outputs (e.g., milk, meat, or timber), thereby affecting the number of personnel and skills required both on-farm and in the regional processing plants. This information primarily assists government and industries to understand the wider economic effects at a regional level of water limits.

ENSURING THE COMPATIBILITY AND CONSISTENCY BETWEEN APPROACHES

While three separate questions are being asked by government, landowners, and communities regarding the impact of water limits, they are best answered using an integrated approach (see Figure 2) to the analyses where information derived to answer one question are used to answer the next question. Box 2 outlines some of the modelling approaches that can be used.

Figure 2 Flow of information for economic analyses of the impact of water limits



Box 2: Modelling approaches available to answer these economic questions

There are a number of modelling approaches in New Zealand that can be used to answer these economic questions.

1. What is the impact of the limit on me?

A number of farm budgeting tools or packages commonly used by agricultural or farm consultants can be used for these analyses. Similarly, nutrient budgeting tools are available: the most common is OVERSEER©. Others tools include SPASMO and APSIM.

2. What is the impact of the limit on us?

A range of catchment economic land-use models can be useful to answer this question. Most models have been developed for specific catchments but are relatively easy to modify for other catchments. Some of the more common ones, NZFARM, N-Manager, ARLUNZ, and MAS, have been developed to answer different questions, to model different policies, and to work at different levels of detail. As a result these models include different assumptions, use different data, and apply different methodologies. The 'best' model will likely depend on the complexity of the policies being considered as well as the time and resources available to conduct the analysis.

3. What is the impact of the limit on my community?

A number of regional and input-output modelling approaches have been developed. Some focus on a specific region, others can be used in any region.

Work is on-going to enhance these modelling efforts through the direct-linking of economic modelling to:

- hydrological modelling (as with N-Manager) to refine the assessment of impacts of the environment, e.g., water quality
- agent-based modelling (as with ARLUNZ and MAS) to refine economic models to include additional landowner behaviour (not just profit-maximizing).

SUMMARY

As water limits are being set across the country in response to the National Policy Statement for Freshwater Management, these economic questions are becoming increasingly important, especially where the availability of water and/or good quality water is becoming scarcer. These questions are relevant whether an RMA schedule 1 process or a collaborative process is being used to formulate the policy. These analyses are most useful when the links between farms, catchments and regions are established in the analyses (e.g., use of consistent underpinning data and information derived in one type of analysis should be used to inform another) and the catchment and regional economic analyses include the range of land uses, management practices, soil types, and climates that are (or could be found) in a catchment or region.

ADDITIONAL MODELLING REFERENCE MATERIAL

Nutrient budgeting models

OVERSEER©: http://www.overseer.org.nz/

SPASMO: http://tools.envirolink.govt.nz/dsss/soil-plant-atmosphere-system-model/

APSIM: http://www.massey.ac.nz/~flrc/workshops/11/Manuscripts/Sharp_2011.pdf

Catchment models

NZFARM: http://www.landcareresearch.co.nz/science/soils-and-landscapes/ecosystem-services/nzfarm; Daigneault A, et al. 2012. Evaluation of the impact of different policy options for managing to water quality limits. Report to the Ministry of Primary Industries, Wellington, New Zealand. Contract number 15564. (available on Ministry for Primary Industries website)

ARLUNZ: http://purl.umn.edu/124973

MAS: Schilling, Chris; William Kaye-Blake; Elizabeth Post and Scott Rains. 2012. "The Important of Farmer Behaviour: An Application of Desktop MAS, a Multiagent System Mode for Rural New Zealand Communities," 2012 NZARES Conference, New Zealand. Agricultural & Resource Economics Society

N-Manager: http://www.motu.org.nz/files/docs/resources/NManager_overview_final.pdf

Regional economic models:

ARDEEM: http://tools.envirolink.govt.nz/dsss/auckland-regional-dynamic-ecological-economic-model/

Irrigation model: Saunders C, Saunders J. 2012. The Economic Value of Potential Irrigation in Canterbury. Research report prepared for CDC: AERU, Lincoln University, September.

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Land and Water Forum (LWF). 2012. Second report of the Land and Water Forum: setting limits for water quality and quantity, and freshwater policy- and plan-making through collaboration.

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