WATER QUALITY AND AGRICULTURE

The 'natural capital' allocation of nutrient discharges allowances in New Zealand

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Introduction

Freshwater is at the backbone of New Zealand's economy. In addition to tourism, recreation, power generation and cultural identity, it is vital to the primary sector. New Zealand is unique amongst developed countries as nearly three quarters of its export earnings are generated from the primary industries of agriculture, horticulture, viticulture, forestry, fishing and mining. The current export goal of government is to double primary industry exports in real terms from NZ$32 billion (June 2012) to over NZ$64 billion by 2025 (Ministry for Primary Industries, 2015a). The use of finite freshwater and land resources will play a pivotal role in achieving this objective.

Pasture agriculture is the dominant land use on the approximately 13 million hectares (50% of the total land area of New Zealand) in primary production. It is the predominant land use in 43% of streams and river catchments and 40% of lake catchments (Ministry for the Environment, 2007). The country has 425,000 km of rivers, more than 4000 lakes and ~200 aquifers (Ministry for the Environment, 2007). Given the large proportion of land in pastoral farming, the link between pastoral intensification and declining water quality is increasingly being acknowledged (Ministry for the Environment, 2013a). The contaminants of greatest concern of diffuse pollution of New Zealand's freshwater in rivers, lakes, aquifers and wetlands are pathogens, sediments, and nutrients (Parliamentary Commissioner for the Environment, 2015). These widespread diffuse pollutants are linked strongly to pasture agriculture as the dominant land use and mobilised by livestock. Pathogens come from the diffuse entry of faecal coliforms from farm animal excreta leaching into waterways, sediments from erosion of steep hill land and along water courses, and nutrients (nitrogen (N) and phosphorus (P) in particular) from animal urine (N), fertilisers (N and P) and P associated with sediments.

Sediment and associated P are the major challenges from hill land environments under sheep and beef. In lowland environments, nutrient enrichment (N and P) of water bodies by diffuse pollution of surface and groundwater, particularly from dairy farming, continue to rise (Parliamentary Commissioner for the Environment, 2015). The quality of freshwater draining New Zealand's landscape is the subject of increasing public concern and considerable scrutiny and debate, with planning processes underway throughout the country at present to address this issue. The decline in water quality has been rated the country's number one environmental problem in several opinion surveys (Howard-Williams et al., 2011).

Tackling the water quality challenge

Currently, diffuse pollution management in New Zealand is receiving attention at the national and regional government levels, along with industry-promoted standards and community-led initiatives. Before the National Policy Statement for Freshwater Management in 2014 (NPS-FM 2014), the management of diffuse source pollution from agriculture was largely focused on non-regulatory, voluntary methods (Quinn et al., 2009). In recognition of the need for limits on natural resource allocation, the NPS-FM (2014) directs all Regional Councils to set limits on water quality and quantity in all water bodies by 2025. The objectives and policies in the NPS-FM direct how local authorities are to manage freshwater in their regional policy statements, regional and district plans, and in the consideration of resource consent applications. Farm- or property-scale nutrient-discharge allowances are to meet (i.e. not exceed) the limits of community-defined timeframes. A limit is defined as the 'maximum amount of resource use available, which allows a freshwater objective to be met' (NPS-FM, 2014). Central to the NPS-FM is the concept that community-defined values can be maintained or enhanced through the setting of appropriate resource-allocation limits. Below a particular level of resource allocation (e.g. river nutrient loads), the defined values are protected, while above the level, values will be adversely affected. The fundamental principle, therefore, is that limits should be set relevant to achievement of defined (pre-established) values. For the agricultural sector, systematic setting of water-quality and water-quantity limits in catchments throughout New Zealand poses both opportunities and risks.

An iterative process of limit-setting has been identified (NPS-FM, 2014) and the process is well underway throughout New Zealand. Regional Councils have taken different approaches to address the issue of setting nutrient loss limits. Catchments in the central North Island (Lake Taupo and Rotorua), Manawatu-Wanganui (e.g. Mangitainoka, Upper Manawatu River), Hawkes Bay (e.g. Tukituki Catchment), Canterbury (e.g. Hurunui-Waiau Zone) and Otago all have N-leaching loss limits set in notified or operative regional plans. In the case of the two sensitive lake catchments deemed of national significance, Lakes Taupo and Rotorua, the National government intervened to assist with the process. All these processes have been set following extensive scientific consultation advice and modelling, in conjunction with broad community consultation. The limit setting process for N, P, sediment and pathogens will affect farming businesses through (i) constraints on the expansion of current production system, (ii) cost of mitigation of current contaminant losses and (iii) influences on the land use options into the future as part of any integrated catchment management approach.

Allocation approaches

The limit setting processes in place for tackling N diffuse pollution of surface and groundwater in regional plans falls into two distinct camps, those associated with current land use (i.e. grand parenting, sector averaging), and those independent of current land uses (i.e. natural capital). For the other three contaminants (i.e. Sediment, P, pathogens) the approach to date, and into the near future, is largely around "good" or "best" management practices, due to two key factors. There is (i) good evidence to show that "good" or "best" management practices can reduce the losses of these contaminants; and (ii) limited ability to adequately calculate farm scale losses of these three contaminants with existing models. Further, in comparison with N, where leaching losses increase with increasing livestock numbers, reduction in the losses of sediment, P and pathogens can be progressed to a degree independently of the intensity of the land use activity.

In setting policy for tackling declining water quality, resource managers need to consider the implications of the policy for economic growth and land use options into the future. Land type, both soils and topography, differ in productive potential, as well as their capacity to provide a range of other ecosystem services, which impacts on how their use affects receiving environments. Policy makers and resource managers must consider all these factors in developing policy targeted at one specific issue.

Natural capital based approach

Allocating a nutrient loss limit based on the natural capital of the soil (inherent capability) in the catchment offers an approach for developing policy that is linked directly to the type of underlying natural biophysical resources in the catchment. This is a new approach, the ecosystem approach, for which direct methods to assess a soil's natural capital fitness for purpose across a range of ecosystem services are still in development. Dominati et al. (2010) has developed a framework for describing and quantifying the links between soil natural capital, land use and ecosystem services provision, based on current understanding of soil forming processes, soil taxonomy and classification, soil processes, and the links between climate and land use and services.

As a proxy for a soil's natural capital capability to filter nutrients, the ability of the soil to sustain a legume-based pasture that fixes N biologically under optimum management offers one option (Mackay 2009). A legume-based pasture is a self-regulating biological system with an upper limit on the amount of N that can be fixed, retained, cycled, and made available for plant growth. The legume pasture dry matter base provides one indicator of the underlying productive capability of the soil, taking into account the influence of new plant germplasm and the use of N, P, sulphur and potassium fertilisers, lime inputs, trace elements and technologies to control pests and weeds. It reflects the underlying capability of soil to retain and supply nutrients and water, and the capacity of the soil to provide an environment to sustain legume and grass growth under the pressure of grazing animals. Estimates of the potential productive capacity of a legume-based pasture fixing N biologically under a "typical sheep and beef farming system" for each Land Use Capability (LUC) unit in New Zealand (Lynn et al., 2009) are listed under "attainable potential carrying capacity" in the extended legend of the Land Use Capability worksheets, which are based on the capability for long-term sheep and beef livestock production.

Using the productivity indices (i.e. attainable potential carrying capacity) listed in the extended legend of the LUC worksheets as a proxy for the natural capital of soils is a new application of this information provided by the LUC survey. It reflects the evolving nature of sustainable land management, with the necessity to set limits on emissions from land to both air and water (in this case emissions to water, and specifically nitrate leaching losses beyond the root zone). It also demonstrates the potential utility of the existing information in the extended legend to advance sustainable land management. An attraction of the approach is that the extended legend of the Land Resource Inventory is already established as the basis for land development and evaluation, and the information in the extended legend is available throughout New Zealand.

The N leaching loss limit for a given land unit can be calculated using the potential animal stocking rate that can be sustained by a legume-based pasture fixing N biologically, under optimum management (i.e. fertiliser, drainage and grazing) and before the introduction of additional technologies. Using the land units listed in the extended legend of the LUC worksheets' "attainable potential livestock carrying capacity" as a proxy for the soil's natural capital, stocking rates can be transformed to pasture production and used in the national OVERSEER® nutrient budget model to calculate N leaching losses under a pastoral use. For soils on LUC Classes 1 and 2 land, the calculated N leaching loss limit was 30 kg N/ha and 27.4 kg N/ha, respectively; this decreased to 23.5 kg N/ha and 17.5 kg N/ha for soils on LUC Classes 3 and 4 land, respectively. As the limitations to use of the soil increase (i.e. Class 1 to 7) the underlying capacity of soil to sustain a legume-based pasture system declines, as does the potential N loss by leaching, since carrying capacity also decreases. The driver can be changed from a resources efficiency use to one that recognises the necessity to add greater flexibility to landscapes that have little natural capital and or lack versatility in either land use options and/or mitigation strategies.

Cost and implementation of a natural capital based approach

A detailed study to estimate the economic impacts of implementing a natural capital based approach to the management of N to address surface water quality issues was commissioned by Horizons Regional Council as part of the One Plan process (Neild and Rhodes 2009). The study included an investigation of the financial and economic impacts of any on-farm changes in meeting the N leaching limits, how the financial and economic impacts changed if the rate of implementation was changed, and the range of farm management practices that the Proposed One Plan envisaged being used on-farm to reduce nitrogen leaching and other contaminants in order to achieve the targets. In the process of establishing the direct costs associated with the implementation of Rule 13.1 of the proposed One Plan, Neild and Rhodes (2009) had to also calculate the cost of compliance with existing and other new regulations in the One Plan, because of significant overlap in actions, costs and benefits associated with not just N but also the other three contaminants (sediments, P and pathogens). For example at that time, the dairy industry had targeted actions under the Clean Streams Accord (Anonymous 2003) that were also requirements of the One Plan, which specifically focused on excluding stock from streams and regular stock movements across water courses, and the management of effluent. The focus of these actions was more on reducing P, sediment and pathogens than N entering waterways, but the net outcome was a requirement for a capital investment in infrastructure, loss of some grazing land to riparian margins and higher operational costs to deliver improved surface water quality. Removing cows from pasture grazing to protect soils from damage over the wet winter months using a stand-off pad comes at a cost, but brings multiple benefits including increased pasture growth, less soil damage, reduction in N leaching losses from urine patches and reduced sediment, P and pathogen losses from overland flow. On the one hand, this investment could be described as an investment in the production system, and on the other hand, an environmental compliance cost if the benefits accrued are limited to the potential improvements in surface water quality. In examining the economic and financial impacts of varying the rate of implementation to farms and the regional economy, Neild and Rhodes (2009) showed there were a range of different economic outcomes depending on the order and timing of adoption of the mitigation practices around the four contaminants. Of the four, the costs associated with reducing N losses were by far the highest.

The study of Neild and Rhodes (2009) drew heavily on the findings of a suite of case study farms selected from across the Region that had been commissioned earlier by Horizons Regional Council (Manderson 2008). At that time Rule 13.1 of the proposed One Plan would require all intensive farms operating within the priority catchments, or farms converting to an intensive activity in the Region, to prepare a FARM Strategy (Farmer Applied Resource Management Strategy). A FARM Strategy outlines specifically how an intensive farming operation plans to operate within the One Plan N-leaching limits determined by LUC in Table 13.2 and importantly how the farm operation plans to minimise freshwater contamination from P, sediment and pathogens, the other three contaminants impacting on surface water quality. Implementation using a FARM strategy approach allows for a customised farm scale level assessment and operational plan to deliver on the water quality outcomes that is reflective of each farms unique collection of biophysical resources and business structure and operation. In practice, it provides a vehicle for the progressive implementation of actions that might first target adoption of low cost strategies that achieve a high cost-benefit return, progressively adopting more expensive input cost options, and constraints on production as farms strive to achieve N and other contaminant targets. Further, as new knowledge and technologies become available, they can be readily incorporated into the operational plan through the FARM Nutrient Management Plan.

The One Plan became operative on 19 December 2014 (www.horizons.govt.nz/about-us/one-plan/). Rule 13.1 is now Rule 14.1 and Table 13.2 is 14.2 and the FARM Strategy has been replaced with a Nutrient Management Plan in the operative plan. The focus of the nutrient management plan is still managing N within the limits, but mindful of the implications of farm practice on sediment, P and pathogens.

It is still early days in One Plan implementation, and to date its impact on surface water quality outcomes in the priority catchments have not been assessed. Striking the balance between achieving the environmental gains set out within the One Plan, with the expectations of communities seeing tangible improvements in surface water quality, with the rate at which farmers could or should be required to comply with this environmental legislation, as also required for business purposes, ranging from conditions of supply to health and safety legislation, is still being openly debated in the Region.

Towards the future

By linking N loss limits to each landscape unit, the difficulties associated with having to define and describe land uses and associated practices are avoided. Further linking the allocation directly to soils enables recognition of the fact that soils differ in their productive capacity as well as the provision of other services such as nutrients filtering. It also aligns with land values and with soil quality indicators for soil management. It is therefore independent of current land use and places no restrictions on future land use options. It treats owners with the same land resources in the same manner. Importantly it does not place limits on inputs, but on the emissions. Another potential advantage of the approach is that in catchments with no water quality problems at the present time, land owners can be provided with an indication of the nutrient losses that would be permissible, before mitigation practices would have to become an integral part of ongoing farm development. This is a new innovative methodology and offers the opportunity for engaging directly, and in a very transparent way, with land owners and the wider community.

The Natural Capital approach also addresses one of the major criticisms of the current approach to land evaluation, the lack of stakeholder participation in defining community expectations on land uses and practices, and their impacts on other ecosystems services and receiving environments (Dominati et al., 2016). Policy that sets limits on emissions to water that are linked directly to the underlying land resources addresses this gap, by providing a boundary condition that future land uses and practices have to operate within to achieve the required water quality outcome. The concept of adding ecological boundaries (e.g. threshold on N leaching losses to limit the impact on receiving environments), within which land use must operate, moves the analysis from managing land to managing a landscape connected to water. The ability to include ecological boundaries within which resources should be managed will be a feature and capability that analytical farm system frameworks will require into the future (Mackay et al., 2015).

Conclusions

The setting and implementation of water quality and quantity limits to comply with the New Zealand National Policy Statement for Freshwater Management, and resulting challenges to existing and new livestock pastoral businesses, will be a major focus for the pastoral industry over the next decade if the current economic growth trajectory is to be realised. The limit setting processes in place for tackling diffuse pollution of surface and groundwater of N in Regional plans falls into two distinct camps, those associated with current land use, and those independent of current land uses. The former looks to protect current land use configurations, while the latter looks to encourage the optimum use of all resources in the catchment. Transitioning from policy that looks to regulate land use to one that ensures the finite underlying resources are being sustained and available for future uses is at the heart of the current debate in New Zealand. Shifting to a natural capital based approach offers a basis for assessing the capability of wider landscapes to provide multiple ecosystem services for a range of desired outcomes beyond just economic growth and water quality.

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