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Regulating agricultural land use to manage water quality: The challenges for science and policy in enforcing limits on non-point source pollution in New Zealand

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ABSTRACT

Non-point source pollution from agricultural land use is a complex issue for the management of freshwater worldwide. This paper presents a case study from New Zealand to examine how predictive modelling and land use rules are being used to regulate diffuse pollution to manage water quality. Drawing on a science studies conceptual framework, the research evaluates the deployment of a numeric regime to enforce compliance with resource limits. It shows that in contrast to claims that a quantitative modelled 'outputs-based' approach would provide certainty and clarity and remove ambiguity in the implementation of resource limits at the farm scale, the opposite is unfolding. It is argued from the case study that in the development of land use policy greater recognition and understanding is needed of the social and political dimensions of numbers and predictive models. This research highlights epistemological, institutional and practical challenges for the workability and enforceability of policy regimes seeking to regulate diffuse pollution that tightly link numbers derived from predictive models to compliance and enforcement mechanisms.

Introduction

Worldwide, non-point source pollution from agricultural production is contributing to the nutrient enrichment of freshwater and the diminishment of water quality. Management efforts are exacerbated by lag effects. In New Zealand, the erosion and nutrient leaching legacies of past and current land use change from sheep and beef to dairy farming are merging with challenging implications for science and policy (PCE, 2013). Even with extensive improvements in land use practices and expensive mitigation, authorities have to explain to communities that water quality is likely to get worse before it gets better. This is due to nutrient losses from past land practices still moving through the system into waterways and contributing to eutrophication and the growth of nuisance algae (Goolsby et al., 2001; Howden et al., 2013; PCE, 2012, 2013; Sanford and Pope, 2013; Sims and Volk, 2013; Skelton and Caygill, 2013).

This paper examines how predictive modelling and land use policy are being used in New Zealand to manage water quality by establishing and enforcing resource limits at the farm scale to regulate non-point source pollution. It focuses on the South Island region of Canterbury where 70 per cent of the country's irrigated agriculture is situated. It is also where land use for dairy farming has expanded significantly over time. For example, dairy cattle numbers increased from 312,000 to 2.1 million between 1989 and 2009 in comparison to the North Island where the numbers shifted from 3 million to 3.8 million over the same period (Statistics New Zealand, 2010). The resource limit setting approach adopted in Canterbury has become a blueprint for recent proposals from central government to further reform water management beyond a significant national policy statement introduced in 2011. Therefore, what occurs in the region of Canterbury is of national significance. In comparison with approaches adopted in Europe and the United States, it is internationally significant given its outputs-based approach to setting resource limits and their enforcement at the farm scale.

The starting point for this research is an assertion that certainty and clarity and the removal of ambiguity would be achieved under a water quality management regime that creates enforceable quantitative limits and a regulatory link between the catchment and the farm in the regulation of diffuse nutrient pollution. The analysis highlights the challenges for delivering on these claims by bringing to the fore the social-political dimensions of numbers and predictive models. The paper proceeds in five additional parts. Beyond

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this section, which provides further background, the next sets out the methodology of this research and summarises its empirical resources. The subsequent section presents the conceptual framework. The section "Limit Setting in New Zealand" provides an overview of New Zealand's limit setting regime. It includes background on, and limitations of, New Zealand's unique compliance tool, a nutrient cycling model known as Overseer®, which is the key to its outputs farm-based approach to nutrient limit setting. The discussion renders a social-political perspective on the issues challenging the implementation of nutrient limits in New Zealand and the region of Canterbury. The last section presents conclusions and makes a recommendation for a different approach to the use of predictive modelling.

The promise of numbers

A science policy framework for limit setting in New Zealand was outlined in 2009 by New Zealand's Crown Research Institute, the National Institute for Water and Atmospheric Research (NIWA). It argued in a report commissioned by the Canterbury Regional Council (CRC) that a lesson to be learned from its work on the potential and existing eutrophication of iconic lakes in the North Island of New Zealand (e.g. Lake Taupo and Rotorua Te Arawa Lakes) was that an approach was necessary to limit land intensification that would send clear signals well before ecological thresholds were reached or breached:

> It would be more certain for environmental outcomes, fairer, less time-consuming and more cost effective, if appropriate water quality objectives and related nutrient load limits were established before the assimilative capacity of a lake (or a river system) is exceeded. This would make the ground rules for land developers clear before they make investment decisions. Measurable plan objectives and nutrient load caps would clearly quantify the sustainable capacity of the lakes in terms of catchment land use (Norton et al., 2009, pp. 4-5).

In terms of how the numeric regime could work in practice, NIWA explained that the enforcement of limits was now possible given the existence of models that could calculate nutrient losses at the farm scale:

> Farm-scale models are now available to estimate the quantity of nutrients lost from land under specified landuses. Farm-scale models can be used to assist with allocating a catchment-based sustainable nutrient load cap amongst farm owners . . . Once the full allocation has been made it would be clear that the only way to intensify existing land use would be to "free-up" some nutrient credit by employing nutrient reduction measures on some other existing land in the catchment (e.g., reduced fertiliser and/or stocking rates, riparian buffer strips, wetlands etc.) (Norton et al., 2009, pp. 4–5).

It has been argued by NIWA that the quantitative approach that links catchment scale loads with farm scale compliance is the only way to achieve sustainable environmental outcomes. This was its advice on the technical and scientific considerations for limit setting to the Ministry for the Environment in 2010:

> Because of the need to remove ambiguity we propose that the desired environmental outcomes should be defined by measurable (preferably numeric) and SMART (Specific, Measurable, Achievable, Relevant, and Time-bound) plan objectives. The plan's policies and rules can then justifiably set limits to resource use, such as water quality standards, that are clearly linked to achieving those measurable objectives. Plans that contain measurable objectives *and* linked limits such as water quality standards can achieve a further five important benefits for managing regional water resources (Norton et al., 2010, pp. 3–4).

These further benefits included "increased clarity" in terms of "certainty of environmental outcomes", resource availability and conditions on users (2010, pp. 3-4). Also included were means to manage point and non-point source discharges and their cumulative effects as well as the ability to monitor policy effectiveness. To reiterate, the key components of this framework are that it seeks to manage nutrients at the farm scale as well as instituting a regulatory link between the catchment and the farm. It is this approach that is now embodied in the region of Canterbury's limit setting regime and central government's proposed amendments to its 2011 National Policy Statement for Freshwater Management (NPSFM) (MfE, 2011a). It will be argued that these claims and the consequent numeric regime fail to recognise the social-political dimensions of numbers and predictive models and the implications of these critical aspects for policy implementation. Hence, the case study highlights important epistemological, institutional and practical challenges for the workability and enforceability of policy regimes seeking to regulate diffuse pollution by tightly linking numbers derived from predictive models to compliance and enforcement mechanisms.

Methodology

This research adopts a case study methodology (Yin, 2013). It utilises a conceptual framework to evaluate the empirical resources and draw research findings. The conceptual framework draws on literature from the field of science studies highlighting the social-political dimensions of quantification and predictive modelling. The empirical resources include publically available scientific, policy and government documents, reports and statements; sub-regional committee meeting minutes, notes and attendance observations; documentation, plans, public submissions and evidence that have contributed to the development of regional plans in Canterbury between 2011 and 2013; clarification and exploration discussions with those involved; the author's observations and recordings of proceedings from attendance at regional plan hearings during October and November 2012 for the sub-region of the Hurunui Waiau; and participation in limit setting focus groups for the sub-region of Selwyn Waihora during 2012.

Conceptual framework

Anticipatory knowledge for the preventive paradigm

In contemporary resource conflicts public and stakeholder distrust and challenges over resource allocation and regulations are commonplace. Regulatory agencies rely on the numerical outputs of predictive modelling (and the notions of rules and objectivity they embody) to inform decision-making about current and potential environmental effects and warrant resource allocation decisions (Bocking, 2006; Pilkey and Pilkey-Jarvis, 2007; Sarewitz et al., 2000). For policymakers, management by numbers raises the prospect of rule by "autonomous knowledge and independent morality" (Latour, 2004, p. 4; Stone, 2002, pp. 163–187). Shifts to collaborative governance have not markedly changed this situation (Duncan, 2013a; Scholz and Stiftel, 2005).

In New Zealand, a numeric approach to limit setting is intended, where thresholds have not been exceeded, to prevent environmental effects before they occur rather than waiting until damage is done (Norton et al., 2009). While this precautionary approach is, at least in principle, conventional wisdom, it means that our understanding of environmental effects has to be addressed with "anticipatory knowledge", as do our actions (Wynne, 1992, p. 111).