CAN THE RMA TOOLBOX PROVIDE EFFECTIVE TOOLS TO MANAGE THE IMPACTS OF FARMING ON FRESHWATER QUALITY?

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Abstract

Economic contribution of farming to Gross Domestic Product (GDP) in New Zealand remains significant. It may be argued farming component is only 13% of the GDP in 2013. However, the farming input to total NZ export earnings is 1/3, which is nearly 50% of the export earnings derived from the exports of goods alone.

Farm production, particularly dairy has been increasing more rapidly in the past decade. For example, increasing dairy production is attributed to increased productivity per cow and increased expansion. Concerns had been raised by water users and environmental advocates about growing dairy expansions and the subsequent increasing pressure on water resources.

Much of the concerns have been about degrading water quality, particularly increasing nutrient levels in waterways. The paper takes the view that while nutrient monitoring is critical and useful to monitor potential adverse effects on waterways, long-term biological health monitoring of the waterways is also vital to capture actual adverse effects on freshwater habitats.

The paper analyses long-term water quality, including biological status of the rivers and lakes in New Zealand using regional and national monitoring reports results to gauge the actual impacts of farming on water quality. The overall analyses indicated that there had been compelling evidence on deteriorating nutrient levels in waterways in many agricultural catchments. Based on the sparse scientifically rigorous trend analyses such deterioration has not yet, however, fully or correspondingly manifested into significant habitat damage.

The paper nevertheless takes the view that environmental impacts, both potential and actual, have to be managed promptly and effectively. It analyses the effectiveness of a range of tools in the Resource Management Act to manage the impacts of farming on water quality.

Economic significance of NZ farming

Is it true farming is still significant to New Zealand economy?

In 2013/14 year, New Zealand farming sector (dairy, meat, wool, horticulture and arable) earned NZ$31.5 billion in exports. This was 13% of the Gross Domestic Product (GDP). GDP is a measure of goods and services produced by NZ economy. Since GDP does include the entire government services expenditure such as health, defence, transport and education, a better measure is to make a comparison within the export sector that brings real revenue to our country.

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Export includes goods and services. In New Zealand, earnings from exported goods continue to dominate our export earnings which is nearly 75%. The contribution of NZ farming to the total goods export earning is nearly 50% in 2013 and 1/3 of the total goods and services export earnings. New Zealand's reliance on farming continues with dairy sector's contribution being nearly 50% of the farming related exports.

How is it possible for farming to sustain ongoing dominance within the local export sector?
Export earnings from farming are driven mainly by global price and export quantity. While global price has been increasing for several agricultural commodities temporally, greater production has also been a key factor in increasing farming export earnings. Increasing production has been driven by greater inputs or expansions.

There is plenty of information on various farming sector expansions in the recent years. For example, dairy land use and cow numbers have increased by 214,114 effective ha (from 1.5 to 1.7 million) and 1,043,613 cows (from 3.74 to 4.8 million) respectively between 2002/03 and 2012/13 years (New Zealand Dairy Statistics 2013-14). In dollar terms, dairy export earnings increased from NZ$5 billion to NZ$12 billion between the above period with dairy export volume nearly doubling.

Apart from the 2013/14 year, global price has been a secondary factor in boosting overall export earnings. For example, between 1992 and 2012 the volume of dairy export quadrupled, while the price only increased by 15% (Statistics New Zealand, 2013) within the 20 year period.

Significance of farming on NZ water quality

Is farming expansion and increasing intensity good or bad for the water quality?
While it is clear of the ongoing and significant contribution to New Zealand economy, such a rapid farming expansion accentuated concerns of water users and environmental advocates. Dairying had been under environmental spotlight even in the 1990s, well before the expansion. Major concerns have been centred around the impacts of farming on water quality. In addition to the expansion there were concerns regarding increasing intensity of farming. Were the concerns valid?

Between 2002/03 and 2012/13, dairy stocking rate increased by more than 10% (from 2.56 to 2.85 average cows ha^{-1}) and milk-solids production per cow increased by nearly 10% (from 315 to 346 kg). This indicates a synergistic effect whereby increased cow numbers coupled with increased production per cow had resulted in increased volume. Does this mean there had been more farm inputs or farming efficiency has increased? Were the concerns over water quality deterioration valid?

Many who are interested in freshwater fishing and water quality hold a substantial amount of anecdotal evidence on the deterioration of water quality around New Zealand. Such evidences may not be useful in making a compelling case about water quality deterioration. On the other hand, there have been plenty of information collected by the regional councils and some research organisations (e.g. NIWA's National River Water Quality Network) on the state of the environment. In the absence of a national environmental monitoring strategy, regional councils' focus have been on waterways with historic water quality information or on waterways under actual or potential anthropogenic pressure. Therefore, much of the information collection and dissemination, including swimmable water quality surveys have been targeting lowland waterways where farming and urban activities have been the predominant land uses.

What is the best way to assess impacts of farming on water quality? Obviously, long term trend analysis on farming activity and water quality is ideal. Water quality monitoring must comprise necessary physicochemical, ecological and habitat quality indicator monitoring. Despite the regional councils' long-term water quality data collection, at times trend analyses may not be straight forward, owing to lower sampling frequencies (e.g. quarterly vs monthly). In terms of access of the water quality trend analyses the best sources are councils' state of the environment reports or specific waterway survey reports. If one has the time and energy to perform one's own trend analyses several councils are beginning to make raw data available online.

What do our water quality trends show?
National trends

A nationwide periphyton survey (National River Water Quality Networks (NRWQN) sites which consisted of larger than average rivers in NZ) which assessed visible beds of filamentous algae and algal mats between 1990 and 2006 at 73 sites indicated that 23.3% of the sites affected recreation and aesthetic values of the river (Quinn and Raaphorst, 2009). The study also found a strong correlation between filamentous periphyton cover and pastoral land use. However, there was a decreasing trend in annual mean and maximum periphyton cover, which surprised the workers given the increase in agricultural intensity and nutrient inputs to waterways around the sampled sites within the sampling period.

The significantly increasing trends in nutrients (total-N, total-P and oxidised-N) for the above sampling sites for the period between 1989 and 2007 were reported by Ballantine and Davies-Colley (2010). The same study also reported in improving trend in visual clarity, but found negative correlation with % pasture catchments. It is also noteworthy that the study also found increasing trend in water temperature but this did not explain the overall decreasing trend in periphyton cover. From a theoretical viewpoint, one would have expected increasing trend in periphyton given the increasing nutrient and temperature levels. Is there a possibility of increasing macroinvertebrates population which would have been grazing on growing periphytons?

From the above larger than average river sites trend analyses while the increasing trends in nutrients could be associated with the increasing intensity of agriculture, the overall decreasing trends in periphyton cover and improving visual clarity could not be explained with scientific rigour. In short, as expected nutrient input to waterways have been increasing because of farming but judging by the ecological indicator such as periphyton cover there has been no overall damaging effect on waterways.

A national water quality trend analysis and statistical modelling study commissioned by Ministry for the Environment using 10 year datasets since 2000 for 789 surface water sites showed declining water clarity in Waikato (Unwin and Larned, 2013). Same study also showed an increasing nitrate-N in Waikato and Southland and decreasing nitrate-N and total-P in the lower North Island.

Another national short-term trend analysis between 2005 and 2009 performed on 112 lakes (which is only 3% of the total of >1 ha 3820 lakes) indicated 44% sites were worse (i.e. eutrophic) and 33% were better (i.e. oligotrophic) (Verburg *et al*., 2010). Similar study assessed 155 lakes for ecological conditions and showed 33% in high/excellent conditions with 37% in poor conditions and half of the lakes in pastoral areas had poor ecological conditions. While this study was a short-term trend analysis, unlike the NRWQN study, this study showed presence of high nutrient levels and poor ecological conditions in pastoral areas. Is poor water quality issue unique to pastoral catchments?

Ministry for the Environment state of the environment reporting in 2007 (Ministry for the Environment, 2007) using dataset between 1997 and 2002 showed overall the waterways within the urban catchments had poorer water quality (nitrate-N, faecal bacteria, ammoniacal-N) than pastoral catchments. However, while faecal bacteria median level was lower in pastoral catchments, the levels of faecal bacteria were much greater in worse pastoral catchments than that of urban counterparts.

Regional trends

Taranaki Regional Council

Most regional councils' river/steam water quality trend analyses are relatively short-term, between 6 and 12 years. However, some long-term analyses cover up to 30 year dataset. Taranaki Regional Council did assess trend for 18 year period, but improving water quality trends were attributed to improving point source discharges at several sampling sites within the first several years (Taranaki Regional Council, 2009). Therefore, in order to assess the impacts of farming on water quality short term trends were also reviewed for selected regional councils, noting trend analyses would yield meaningful results in the long-term (e.g. 20 years).

Taranaki Regional Council State of the Environment 2009 report showed, of the 8 mid- and lower reach rivers monitored (4 mid and 4 lower) for12 years, median dissolved reactive phosphorus (DRP) levels were below guideline values at 7 sites and median nitrate-N, total-N and total-P levels were below guideline values at 5 sites (Taranaki Regional Council, 2009). Trend analyses indicated 7 sites with increasing DRP levels, 3 sites with increasing nitrate-N and total-N levels and 2 sites with increasing total-P levels. Much of the remainder of the sites had no statistically significant changes, except for 3 sites where decreasing levels for nitrate-N (1 site) and total-N (2 sites) were observed. The report also indicated there was an overall decrease in nitrate-N levels in shallow aquifers but it did not identify any reasons for the improvement.

However, the overall health of the river monitored as Macroivertebrate Community Index (MCI) at 51 sites involving 23 rivers/streams which included 9 rivers/streams monitored for nutrients showed no further deterioration in MCI status between 1995 and 2007. In fact, several sites improved in MCI status within the above period. Of the 51 sites monitored, 17 sites had statistically and/or ecologically significant improvement in MCI. It is also noteworthy that between 1995 and 2007 there was a 12% increase in cow numbers to 474,626 in 2007 in the Taranaki Region.

While it was difficult to offer a scientifically rigorous explanation, the above observation is similar to that in the NRWQN periphyton surveys where high nutrient levels and increasing agricultural intensity did not appear to affect the ecological status of the river, noting the difference between MCI and periphyton cover indices as ecological health indicators and the larger than average rivers monitored in the NRWQN survey. Despite no change in MCI trend in the Taranaki Region, it was clear that nutrient levels and periphyton cover (filamentous, 2002-2007) were higher in mid and lower reach of rivers and streams which were predominantly in pastoral catchments.

Environment Canterbury

Using a 10 year quarterly monitoring Environment Canterbury reported 6 lowland river sites with deteriorating water quality trend, with 3 improvements and 11 no change for a total of 20 sites for dissolved inorganic-N (DIN) (Environment Canterbury, 2008). Four sites had a deteriorating trend for DRP with one improving and 15 without any change. On the other hand, a trend survey for biotic and habitat health held between summers of 1999/2000 and 2006/2007 indicated no significant change in combined habitats from lowland (which comprised of both urban and rural) to Intermontane Basin.

Long-term trend analysis (1997-2006) on groundwater nitrate-N dataset from 212 bores showed 10 bores showing improving trends and 49 with degrading trends. Some improving trends have been attributed to improving industrial discharges.

Despite not changing trend in biota or their habitats it was clear from the overall river/stream data from Environment Canterbury that lowland (mainly with agricultural land use) and urban streams had high levels of DIN, faecal bacteria and DRP than alpine and mountain rivers. It was also clear that lowland rivers/streams were poorer in quality than that of the urban counterparts. Similarly, biota and habitat data clearly indicated that both biota and habitat were poor in the lowland rivers/streams than mountain and alpine environment. There was also degrading trends in groundwater nitrate-N in many bores within the farming areas.

Horizons Regional Council

Using a 10 year dataset between 2001 and 2011, Horizons Regional Council State of the Environment 2013 report indicated an overall improving soluble inorganic-N level in monitored rivers (Horizons Regional Council, 2013). However, 62% of the 88 monitored river sites failed to meet the target N level. DRP levels were also poor or very poor in 50% of the sites monitored with little or no change in long-term trend. Short-term trend analyses (10 and 5 year) performed on 8 selected sites did show some improving trends. The report attributes sheep & beef and dairy as key contributors of the nutrients, noting several municipal point source discharges are still having significant nutrient inputs to rivers.

Similar to other regional council monitoring observations, despite high nutrient levels in rivers, algae (chlorophyll *a*) were found to exceed the target level only in 15% of the 53 sites monitored between 2008 and 2011. A cyanobacteria (blue-green algae) study performed in 2011 at 10 sites indicated several sites were affected by this species. They appeared to proliferate in waters with high average total-N and low average total-P. A short-term (2009-2012) MCI analysis showed 42% of the 43 sites monitored failed to meet the Council's One Plan target. However, a trend analysis showed several sites with improving MCI with the exception of one site declining.

A 20 year trend analysis of the 28 bore sites indicated no significant changes in nitrate levels. While statistically not significant, 6 bore sites' nitrate-N levels improved to meet the drinking water standard. During the monitoring period dairy land use increased by 11% (95,400 to 105,500 ha) and cow numbers increased by 16% (to 287,512).

Waikato Regional Council

A trend analysis study for a period of 1993-2012 at ten historical river water sampling sites (from Taupo Gates to Tuakau) showed a highly significant increase in total-N with a corresponding highly significant increase in nitrate-N for all sites except for Taupo Gates (Vant, 2013). The total-N increase was estimated as 1.6% per year while nitrate-N increase was 2.8% per year. Much of the increase for some of the above sites was observed in the last 10 years of the sampling period, showing greater rate of degradation. There was a highly significantly improving trend in total-P at three sites with one attributed to soil conservation works around Lake Taupo catchment and the other two were as a result of ceasing sewage discharge (Ohaaki site) and improving sewage discharge in Hamilton (Huntley site).

Chlorophyll *a* also showed a highly significantly decreasing trend at 6 sites. With highly significantly increasing nitrate-N trend 9 sites and significantly increasing water temperature at 4 sites a technical explanation is difficult. The report attributed the decrease to an emerging zooplankton *Daphnia* which graze on algae.

Similar trend analysis was also performed on the remainder of the rivers and streams (109 sites) in the Waikato Region, which found highly significantly increasing total-N at 59 sites with 11 sites showing improvements. Overall, the increase in total-N was estimated as highly significant and 1.4% per year. Much of the degradation was observed in the upland Waikato and this was attributed to farming and residual historical-N. Owing to a change in total-P laboratory analysis, only 2004-2012 dataset was used, which showed a highly significant decrease in total-P at 22 sites and increase at 7 sites.

Council also monitored wadeable perennial streams (49 sites which included 40 'developed' sites 6 riparian restoring sites and 3 native bush (reference) sites) between 1995 and 2011, and short-term (2002-2011) for key macroinvertebrates (insects) using MCI (index against organic pollutants), QMCI (quantitative MCI for state monitoring) and ASPM (Average Score Per Metric for habitat quality monitoring) (Collier and Hamer, 2012). There was no degradation of habitat within the developed sites but despite this, there was declining trend in MCI. While this was considered as statistically significant, not considered as ecologically significant to breach the guideline threshold. There was, however, ecologically significant improvement in MCI within the riparian restored sites with slightly improving habitat quality. Individual site trend analyses indicated 8 sites with clear decline and 2 with clear improvement for MCI within the developed sites. However, when 14 long-term water quality parameter (nutrients inclusive) trend was assessed against MCI and ASPM for the respective sites, there was no relationship.

The above study illustrates the significance of long-term studies where meaningful trend analyses could be performed. In contrast to the above long-term study, a study held by the same council involving high gradient streams with 39 wadeable (including three native forest sites) and 10 non-wadeable streams between 1994 and 2005 indicated a 25% changing trend (Collier and Kelly, 2006). Of the trending streams, 2/3 were declining in MCI and habitat quality while 1/3 had improving trend. Water quality results also indicated there was a declining trend because of pastoral farming intensification. It was clear streams in pastoral land area had low ecological values and low water quality. Presumably, many of the sites in this study were part of the long-term study as well.

Bay of Plenty Regional Council

Bay of Plenty regional council monitored 117 surface water sites within the Rangitāiki Catchment where 20 sites had nearly 30 year long-term water quality and ecological condition datasets (Suren, 2014). The catchment was under 58% plantation forest, 2% under native forest and 18% under pasture (dairy and beef) land uses. Given the predominantly forestry catchment, it had a rich ecological condition (>80% of the sites), even in the pastorally drained areas. It was reasoned that the stable and good quality up-streams contributed to high ecological conditions (e.g. MCI) downstream within the pastoral sites. Nevertheless, there were four sites found with declining MCI (2 pasture and 2 plantation forestry).

Where low quality of ecological conditions were found much of these were attributed to land use disturbance and intensity. Despite declining water quality (>0.8 mg/L inorganic-N) there was no corresponding trend in ecological condition change at majority of the sites. It was reasoned that much of the changes in ecological conditions were inflicted >30 years ago with hydroelectricity generation and pastoral land use changes at that time and that the current ecological conditions are generally ‘stable’.

Another long-term (1992-2012) trend analysis study performed on 9 major stream inflows to Lake Rotorua indicated an increasing trend in nitrate-N and nitrite-N (NNN) concentration (Scholes, 2013). In majority of the cases it was found that the NNN levels have doubled in the past 37 years and that, the increasing trend did not appear to abate or stabilise. There was, however, a decreasing trend in DRP observed in 5 of the 9 inflows and the reasons for this were not known. The decreasing trend in NNN in one of the streams was attributed to reduction in wastewater loading to forestry in the catchment.

Otago Regional Council

Water quality trend analyses performed on 77 surface water site datasets between 1995 and 2006 showed in excess of 70% of the sites were either good or very good (Otago Regional Council, 2007). Most alpine lakes in Otago and upper catchments of large rivers fell in the above category and they had stable to improving water quality trends. About 7% of the sites had poor water quality and most of these sites were in the lower Pomahaka River catchments with intensive agriculture and with declining water quality trend. Ecological condition analyses were only performed between 2001 and 2006 for few sites and trend could not be detected. The study showed ecological conditions were generally in poor status in intensive catchments (urban and rural) and that plantation forestry and native forest sites had good ecological conditions.

Another surface water quality study compared trends for datasets collected between 2006/2011 and 2001/2011 (Otago Regional Council, 2012). Of the 372 trend analyses between 2001 and 2011, 15% degraded and 9% improved. In comparison, short-term trend analyses indicated smaller corresponding changes with 6% declining and 2% improving. Declining water quality sites were primarily from intensive farming areas. Ecological condition trend was only compared between 2001/2005 and 2006/2011 datasets and little or no trend found. The study also failed to find good relationship between Water Quality Index and MCI, i.e. not all high MCI sites were necessarily found at high water quality sites and *vice versa.*

Summary of water quality vs farming
Nationally based studies found waterways with high nutrients, low MCI and high periphyton were in pastoral and urban catchments. Median values for nutrients and bacteria for waterways in pastoral catchments were lower than that of urban. However, the severity of pollutant levels (e.g. nutrients or faecal bacteria) was much greater in the pastoral catchments. While there was significantly increasing nutrients trends, these did not appear to have affected the MCI values or the extent of periphyton's presence.

Regional studies yielded similar observations to that of national studies. Pastoral and urban catchments were more polluted. There were significantly increasing trends in nutrient levels, particularly, total-N, NNN and DRP levels in waterways in the pastoral catchments. Except for Waikato, either no trend or improving trends were found in MCI values or periphyton covers in many regions. Wadeable streams and rivers MCI values showed 25% significant trending of which 2/3 were with declining trend and 1/3 were with improving trend. However, Waikato studies could not find any correlation between water quality parameters and ecological conditions.

Overall, there was sufficient evidence for poor water quality and ecological conditions (including habitat status) within pastoral catchments. There was also increasing trends in nutrient levels but this did not appear to affect ecological conditions. Ecological conditions might have been affected significantly at the onset of land use changes many years ago. The current ecological conditions in lowland waterbodies reflect the intensive rural and urban land use catchments.

Should NZ be alarmed of the general water quality trends and information?
The answer is yes. There is compelling information on the general association of poor water quality with pastoral catchments and significantly declining water quality. The fact that the declining water quality did not appear to have corresponding impacts on habitat or ecological conditions should not result in a 'do nothing' option. Why are the water and habitat quality and ecological conditions poor in pastoral and urban catchments?

As reasoned by the Bay of Plenty regional council, many rivers and streams within intensive land use areas had already sustained habitat and ecological value losses many years ago when farming or urban activities became predominant land uses. The current signature of ecological values in these intensive catchments may be a product of historical land uses than recent intensification. Surely, the recent intensification is clearly reflecting in significantly increasing nutrient levels despite having had little or no effects on ecological conditions. While currently increasing nutrient levels appear to have no apparent impacts on ecological conditions in general, can this be sustained?

Issues such as eutrophication are known to affect ecological conditions which are primarily linked to elevated nutrient levels. There may be several other factors (e.g. N:P ratio, low water temperature, presence of zooplanktons) which may well be masking the effects of increasing nutrient levels. Moreover, global trade competition could potentially lead to comparison of water quality status between trading nations. While there are no trade sanctions associated with environmental quality, the comparisons are already being made in triple bottom lines such as environment, economy and social conditions within the OECD countries.

Another important issue is currently and in the past NZ has enjoyed a better trade advantage with the long-held 'clean and green' image. If we continue with the 'status quo' there is a danger in losing the image and losing our trade advantage. Therefore, it is sensible to take steps to reduce nutrient levels in waterways and mitigate the adverse effects of nutrients. There should also be some urgency in restoring habitat and ecological conditions in pastoral and urban catchments using best practicable options. Obviously, this means environmentally friendly farming practices have to be adopted with effective mitigation measures taken to enhance waterway habitats within the pastoral catchments.

There are only very few farmers who adopt best practicable options voluntarily to minimise farming impacts and restore waterway habitats. Many would require either some form of education, incentive or pressure from the industry, regional councils or central government. Incentives and education appear to work successfully in cases of soil conservation (e.g. Horizons) waterway restorations and riparian improvements (e.g. Taranaki Regional Council). However, reduction in nutrient output appears to be more driven by regulations (e.g. Lake Taupo management by Waikato Regional Council). The question is what opportunities the RMA offer to regional councils or to any other party with regard to land or water management regulations leading to improving and maintaining water quality.

Water quality management opportunities within the RMA

Provisions within the RMA

Regional Councils

Regional regulations

Sections 9, 13, 14 and 15 of the RMA have the provisions to **control** land, river/lake beds, water and discharges respectively. Regional council functions under s30 clarifies the above controls further. Control of land (s9) by a regional council should only be for the purpose of soil conservation and water, natural hazard and hazardous substance management. River/lake beds controls should ensure beds provide for habitat, flood control and structures. S14 will allow control over take, use, damming and diversion of water and setting minimum/maximum flows and levels. S15 will allow the control over discharges to land, water and air. In terms of discharge to land, it includes any direct discharge or the discharge and any contaminant emanating from the discharge by natural process entering water.

Regional council controls can be applied by **Regional Policy Statements** (RPS, ss50-62) and **Regional Plans** (ss63-73B), of which the RPS set the policy directions for regional planning. RPS will capture regional issues, policies and methods to achieve integrated management of natural and physical resources. Since it is policy based, RPS is not enforceable. However, regional plans can be very specific and rule based and hence can be enforceable.

Regional plans' rules will specify whether an activity is prohibited or permitted without a resource consent and if a consent is required, what type of consents are required. The following controls can be imposed by a regional plan to manage water quality:

1. Any minimum or maximum flows for streams or rivers or minimum or maximum levels for lakes or aquifers.
2. Minimum water quality standards.
3. Waterways managed for any classes specified in Schedule 3 of the Act with the corresponding standards specified in the schedule or more stringent standards.
4. Any standards imposed shall not reduce the status of the water quality.
5. Any discharge allowed in the regional plan shall not result in any visual impacts or odour, water becoming not suitable for farm animal consumption and significant impacts on aquatic life.

Land use control or discharge control?

Regional councils could choose to develop a land use plan or water plan to improve or maintain water quality. Land use plans have direct control over activities while water plans have indirect controls. Land use plans could restrict certain activities or if allowed prescribe the way in which an activity could be carried out to improve catchment water quality. Often land use plans will promote consented activities, requiring consents for any significant land use changes that may increase discharge of a contaminant into a waterbody. Minor activities could be permitted or dealt under controlled activities. If land use plans are not developed and used efficiently, they can be overly bureaucratic and costly.

Waikato Regional Plan- Variation No.5: Lake Taupo is an example of land use combined discharge plan. The purpose of the plan is to reduce ongoing nitrogen discharges to Lake Taupo to bring the N level to 2001 levels. Since the plan is primarily a land use plan it is obviously activity based than effects based. There is heavy reliance on nutrient model such as Overseer® to control N discharge to land and water. Stringent thresholds are applied to encourage consenting land use, particularly for livestock farming involving grazing. For example if dairy cow stocking rate is >0.55/ha or using N fertiliser on a farm with <0.55 cow/ha consent is required to farm. To secure consents, farms have to 'benchmark' their N status, submit a 'nitrogen management plan' and agree to certain consent conditions. Farms can increase their

N inputs provided they ‘offset’ their increased input with another farm within the catchment. Offsets will have to be approved by the council through a controlled activity consent process.

A less bureaucratic approach is to control the discharges than land use activities. However, in the absence of reliable, practical and cost effective lysimeters to monitor nitrate leaching, monitoring and enforcement of a discharge rule is not possible. Inevitably, in such cases nutrient models have to be used to achieve the desired environmental outcomes. As an example, Otago Regional Council has used Overseer® to control N discharges through permitted activities.

If land use plans are very prescriptive and heavily consent based, councils will have to deploy significantly high amount of resources to deal with the large number of consents and consents monitoring and enforcement. While part of the cost of consent process could be passed onto consent holders, a significant amount of funding has to be born by the regional ratepayers, either under targeted or general rates. Despite all these difficulties, it could be argued that Lake Taupo water quality situation may warrant a ‘heavy’ approach. The question is whether a ‘heavy’ approach is possible by permitting an activity under specific conditions without consenting.

Consented or permitted activity?
When developing regional plans regional councils have a choice of consenting or permitting any activities. The practice of allowing permitted activities vary substantially between regional councils. Generally, minor activities which are less risky to the environment and require little or no compliance monitoring may be permitted (e.g. small bridges, domestic water takes from groundwater or streams). Sometimes permitted activity is accorded as an incentive to promote environmentally sustainable activities (e.g. farm dairy effluent irrigation). Consents are warranted for activities which could cause adverse effects alone or cumulatively (e.g. treated farm dairy effluent discharges to waterways) or activities which have greater scale of adverse effects which require extensive self-monitoring and council compliance monitoring (e.g. industrial and municipal effluent discharges).

There is a general belief among the community and the regional councils that regional councils have a better control over consented activities than permitted activities. On this basis many councils favour consented activities. In reality, however, whether permitted or consented, practical, stringent, easy-to-implement and enforceable rules/conditions backed up with regular compliance monitoring and enforcement (or liaison) are the key for the successful implementation of a specific rule. If permitted activities are regularly monitored and enforced very high compliance could be achieved. For example, high compliance in farm dairy effluent irrigation in the Otago Region had been achieved with regular annual inspection backed up by infringement notices and prosecutions for breaching farms (Selvarajah, 2010).

Regional water quality standards
Regional councils can set water quality *targets* in their regional plans for degraded water bodies. Target is a timeframe or deadline achieved for a *limit* for an *attribute* (either a contaminant or other water characteristic) in a water body. A limit is a maximum allowable level for a contaminant. Different limits may apply to different *values*. Value could be ecosystem health, human health for recreation or irrigation, which is fit for a particular purpose. A value can have

a single attribute or multiple attributes. For example, attributes for ‘human health for recreation’ value could have *E.coli* and cyanobacteria and attributes for ‘ecosystem health for rivers’ value may be periphyton, nitrate, ammonium and dissolved oxygen (National Policy Statement for Freshwater Management 2014).

In addition to limits set on attributes of waterbodies, limits can also be set on contaminants in discharges. Such contaminants are generally attributes of a waterbody value. Often discharge limits set in rules apply for permitted activities. Consent limits for discharges could also be set for controlled (consents are always granted with conditions) and restricted discretionary (granting of consent is subject to certain conditions prescribed in the rule) activities. If discharge limits are set for permitted activities, there should be clear guidance for monitoring and enforcing such limits.

Any rule or water quality standard development would require a cost-benefit analysis (s32) and careful consideration of the purpose and the implication. If deteriorating water quality is an issue, there should be sufficient evidence for it. This will help community or stakeholder support for the plan change and minimise any challenges including Court appeals. Long-term monitoring of appropriate indicators and trend analyses become vital for recognising any ongoing or emerging water quality issue. Since intensive land uses impact on water quality, a trend in land use change will also be essential to deal with any control on land uses or discharges from them.

Section 35 of the Act does provide certain directions on environmental and compliance monitoring. Regional councils can commission appropriate research, perform state of the environment or resource consent monitoring and monitor the effectiveness and efficiency of plans or policies. It is important for regional councils to have clear purpose of monitoring and monitoring strategy. Appropriate and robust indicators, timeframe for monitoring (long or short-term) and sampling locations and frequencies have to be selected. There may be specific tactical or strategic research needed in addition to monitoring to understand either pressure or state.

Regional plans are a very powerful RMA tool. Use of this tool will require quality information to deploy a range of mechanisms within the plans. Judging by Variation 5: Lake Taupo, the impacts it has had on land uses in Lake Taupo catchment is undeniably significant, economically and environmentally. Any regional plan to be effective and efficient, appropriate tools have to be used by the plan, implemented and monitored regularly for achieving desired environmental outcomes.

The significance of environmental information has also been highlighted in the Office of the Audit General report following a review of four regional councils (Office of the Auditor General, 2011). The report urged regional councils to consider collaboration, sharing information, integrated management and link between planning and science. Of the above four considerations, quality information features in two: “….

- *Sharing knowledge and information- especially easy availability of nationally comparable, high-quality, scientific data and research;*

- *Strong links between freshwater management planning and using scientific monitoring to measure the effectiveness of the policies being implemented*;…"

In principle, regional plans are community owned and managed. If communities are not happy with a regional council's management of natural or physical resources, they could apply for a 'private' plan change. The processes are similar to council initiated plans, but the cost is born by the person or people initiating a private plan change.

Minister for the Environment

Under s24 of the Act Minister can

- recommend
    - to issue a national policy statement (NPS) (e.g. NPS for Freshwater Management),
    - national environmental standards (NES) (e.g. Resource Management National Environmental Standards for Air Quality Regulations, 2004); and
    - to issue water conservation order (WCO);
- intervene with an RMA proposal of national significance;
- monitor the effect of and implementation of the RMA, NPS, WCO and any matter of national significance and
- consider the use of charges, levies or incentive (e.g. significant government funding to improve Lake Taupo, Waikato River, Lake Rotorua and Lake Waituna water quality) to achieve the purpose of Act.

Under powers the Minister can

- investigate the performance of a district or regional council under the RMA;
- appoint any person(s) to take over the functions, powers and duties of that council after giving notice and receiving council's response of its unsatisfactory performance (e.g. appointment of commissioners to manage Environment Canterbury); and
- direct a council to initiate a plan development or plan change or a review of a plan.

Minister for the Environment has enormous powers to deal with environmental issues. The most important tools in the Act are NES and WCO. National Policy Statements (NPS) do not have *direct* impacts on the regions or their regional plans except for introducing certain general provisions without any plan change process. Any specific provisions including any water quality limits or targets in the NPS are not enforceable by the regional councils until adopted by them by a formal plan change process. It is well known that plan change processes are very costly and time consuming. Therefore, it could be argued that NPS is not the most powerful tool to effect water quality change in the Act. New Zealand Coastal Policy Statements (NZCPS) and National Policy Statement for Freshwater Management 2014 (NPSFM) are two existing NPSs. Of the two, NPSFM is more prescriptive, directive and likely to result in significant plan changes.

National Environmental Standards (NES) is the most powerful tool accessible for the Minister and the central government. When the NES was introduced to deal with polluted air sheds in 2004, it had a significant, positive and immediate effect on the way regional councils had been monitoring and managing their air sheds' air quality. NESs are very cost effective tools from a bureaucratic viewpoint. They can take effect soon after the enactment and should not warrant expensive plan changes.

Water Conservation Orders (WCO) are also a powerful tool. However, WCO only applies to outstanding water bodies, either in pristine status or in the pristine status under threat. Ironically, there is no national list of outstanding water bodies available despite few existing WCOs. Application for WCOs has to be lodged with the Minister for the Environment. If the application is successful and a WCO is granted by the Governor General, the waterbody may have water quality or quantity limits which have to be managed and enforced by the regional council. The problem with the WCO approach is that a plan change is still needed to control any discharge to the waterbody in question.

Conclusions

Clearly, farming continues to contribute significantly to NZ economy. However, there are historical and emerging water quality issues identified as caused by farming activities. There have been major concerns over poor water quality in many pastoral catchments and increasing nutrient levels. Unlike nutrient levels, there is limited availability of scientifically rigorous trend analyses on ecological and habitat conditions. While increasing nutrient levels appear to have little or no impacts on historically impacted ecological and habitat conditions in many monitored catchments, actions have to be taken to reduce increasing nutrient inputs to waterbodies to avoid any serious degradation of ecological and habitat conditions.

By past examples, while incentives had assisted in water quality improvements, regulatory approaches had been more effective in promoting best practices and environmental improvements. RMA has many powerful and effective tools to deal with water quality issues. Of the tools, the most effective and powerful tool is NES followed by regional plans. However, before and after deploying any tools, quality environmental information is critical.

To achieve quality information effectively, national and regional monitoring and reporting strategy is essential and inevitable. It is logical to develop and implement a national monitoring strategy before introducing a reporting strategy. While the draft Freshwater Accounting guidance for regional councils does address freshwater quantity and quality monitoring, it remains generic within the scope of guidelines rather than being specific or directive to promote national consistency in monitoring. On the hand, the proposed national RMA monitoring strategy is designed to monitor RMA processes rather than monitoring outcomes for quadruple bottom lines. It is acknowledged process monitoring is vital to assess the efficiency of the bureaucracy. However, without benchmarking and integrated monitoring of the quadruple bottom lines, it is difficult to (a) assess the effectiveness of the RMA and (b) deploying any RMA tools *effectively* to address degraded and degrading freshwater quality while sustaining farming successfully in New Zealand.

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