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New Zealand freshwater management and agricultural impacts

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In New Zealand, it is increasingly recognised, including by government, that water resource allocation and water quality are issues of national importance. Agriculture is frequently portrayed by public media as a major user of water and a major contributor to worsening water quality. We outline the water management systems in New Zealand, and the use of water by agriculture. Official reports on agriculture's impact on New Zealand water availability and quality are summarised. We report how the New Zealand public perceive water, its management, and the roles of agriculture in water issues. Data from a nationwide mail survey were analysed to determine how New Zealanders assess the state of New Zealand lakes, rivers and streams, and aquifers, the performance of three agencies responsible for management of freshwater resources, and willingness to fund stream enhancement. We provide brief explanations for the failures of water resource management in New Zealand and report on options, including community-based responses that might address some of the mounting public, scientific, and government concerns about trends in water quantity and quality. A willingness to pay proposition, concerning riparian areas, included in the nationwide survey provides some evidence that the public are willing to pay for improved waterway management. Relevant non-market valuation studies also indicate that the public places considerable value on preservation values of water in New Zealand.

Key words: agriculture, environmental economics, perceptions survey, water allocation, water quality.

1. Introduction

The ongoing ready availability of freshwater in New Zealand has until recently been taken for granted by many people. However, the effects of growing pressures on New Zealand's rivers and streams, lakes, and groundwater have resulted in a heightened awareness of water quality and allocation issues. Agriculture provides much of the pressure on New Zealand freshwater and the role of agriculture has received increasing public attention in the past decade. Agricultural irrigation has increased at a rate of about 55 per cent per decade since 1965 and is projected to increase by a further 28 per cent by 2010 (Parliamentary Commissioner for the Environment (PCE) 2004). Water quality has come under increasing pressure, particularly from (i) non-point

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Table 1 Estimated annual water consumption in New Zealand (2002)

Sector	Water use millions m^3
Households	210
Industry	260
Livestock	350
Irrigation	1100
Total	1920

Source: Parliamentary Commissioner for the Environment (2004, p. 108).

(diffuse) discharges such as nutrient runoff; (ii) access to waterways by cattle, which is seen as a cause of degradation of lowland streams; (iii) urban development; and (iv) forestry. In this paper, our focus is primarily upon agricultural pressures on water because of the amount of water used directly by this industry (Table 1) and because of the direct and indirect impacts of agriculture on water quality and quantity (PCE 2004).

The Government's Sustainable Development Water Programme of Action (Water Programme of Action 2004; Ministry for the Environment (MfE)/ Ministry of Agriculture and Forestry (MAF) 2004a,b) and numerous related and/or supporting pieces of work attest to these concerns and suggest that water management is failing to meet its objectives and that it is time to reassess the situation. In this paper, we first outline the legislation, policy, and institutional contexts under which water is currently managed in New Zealand; we then provide evidence to show that institutions are failing in the tasks defined by this legislation (including evidence from a national survey we have undertaken); potential reasons for these failures are then identified and discussed; and, finally, we suggest some solutions to address the situation.

2. Current water management in New Zealand

Rights to use water are vested in the Crown. The *Resource Management Act 1991* (RMA) guides allocation and management of freshwater in New Zealand and delegates management responsibility to regional councils. City and district councils are often also involved in water management, particularly for drinking water, storm water and sewage (MfE/MAF 2004a).

Water quantity and quality management is pursued via a tiered system of regional policy statements, regional (and or catchment) plans and resource consents. Regional Councils can develop regional policy statements and regional plans to specify how water can be allocated and to specify environmental guidelines. Unless authorised in a regional plan, discharges on land that can reach water, or direct discharges into water, require a resource consent (MfE/ MAF 2004a). Diffuse discharges may be managed under either discharge permits or land-use consents.

The RMA allows people or institutions to apply for water rights (resource consents) to take, use, dam and/or divert water subject to water availability

(MfE/MAF 2004a). These rights are allocated on a first-come-first-served basis and can be for periods up to 35 years. There are no charges levied for water usage, and there are no mechanisms within the RMA for comparing the value of competing water uses.

Water permits can, with the approval of regional councils, be transferred to new owners or occupiers of a site. If regional plans allow it, water rights can be transferred to new sites within a catchment, but few regional plans allow this and few transfers have occurred in New Zealand (MfE/MAF 2004a).

This integrated set of legislation, policies and consenting processes is intended to result in the sustainable management of freshwater, but there is evidence that it does not. In the following section we examine the scientific and perceptual evidence for water quality and quantity trends in New Zealand.

3. Trends in water quantity and quality

3.1 The scientific evidence

There is much research that tends to support the view that agriculture, and dairy farming in particular, is placing excessive pressure on water quality (MfE 1997; Meredith and Hayward 2002; EMS 2003; PCE 2004; Vant and Smith 2004).

Agriculture is considered to be the primary source of non-point source (NPS) discharges because materials used in agricultural production, such as fertiliser and pesticides, as well as discharges from the soil and animals, move into both surface and groundwater systems at higher rates than would be observed under a natural system or alternative land uses. Two high-profile examples where resources are affected by NPS pollution are Lake Taupo and the Rotorua lakes. It is estimated that 50 per cent of the nutrient load into Lake Taupo is derived from the 22 per cent of the catchment that is in pastoral agriculture (EMS 2003).

There is other supporting evidence as well. MfE (1997, section 7, p. 88) concluded that:

> Water quality is generally high around the coast, in deep lakes, and in the headwaters of most rivers, and in many cases this is maintained into lowland areas. However, water quality deteriorates in streams, rivers and lakes which drain agricultural catchments, with agricultural run-off causing elevated nutrient and sediment loads.

In a similar vein, Statistics New Zealand (2002, p. 36) noted:

> As a general rule 'lowland' rivers, whose catchments are dominated by agricultural land use, 'pull down' general compliance with nutrient criteria . . .

MfE (n.d.) commented:

> Dairying, like most intensive land uses including cities, affects water quality and aquatic environments. The ongoing intensification of existing dairy farms into regions not used to dairying has increased the importance of effectively addressing impacts on aquatic environments. (http://www.mfe.govt.nz/issues/land/rural/dairying.html)

The Ministry for the Environment *State of the Environment* report (1997, p. 7.7) stated that:

> New Zealand's 30 or so large, deep lakes appear to be of high quality. However, more than 700 lakes are shallow and between 10 per cent and 40 per cent of these are nutrient enriched (eutrophic). Most of the eutrophic lakes are in the North Island and in pasture dominated catchments. A number are subject to fish kills or are no longer capable of supporting fish life.

Many low-elevation streams are reported as having low overall water quality as '. . . median concentrations of the faecal indicator *Escherichia coli* and dissolved inorganic nitrogen and dissolved reactive phosphorus exceeded guidelines recommended for the protection of aquatic ecosystems and human health' (Larned *et al.* 2004, p. 347).

Most recently, New Zealand's Parliamentary Commissioner for the Environment (2004, p. 45) examined four regions of New Zealand where water use is high and changing rapidly (Table 2). Among the report's key conclusions

Table 2 Trends in water quantity and quality for four regions

			Region			
			Canterbury	Hawkes Bay	Southland	Waikato
Water quantity	Water allocation and abstraction	Surface water	⇑	⇑	=	⇑
		Groundwater	⇑	⇑	⇑	⇑
	Water quantity	Surface water	?	=	=	?
		Groundwater	?	⇓	=	?
Water quality	Surface water quality	Microbiological	?	?	?	⇓
		Inorganic	?	?	?	⇓
	Groundwater quality	Microbiological	?	?	⇓	?
		Inorganic	⇓	⇓	?	⇓
Future demand			⇑	⇑	?	=
Regulatory framework			Proposed plan notified 2004	Proposed plan notified 1998	Proposed plan notified 2000	Proposed Waikato Regional Plan

Key: ⇑, increasing; ⇓, decreasing; =, steady; ?, uncertain.
Source: Summarised from Parliamentary Commissioner for the Environment (2004, pp. 46–50).

was that '. . . water quality in areas of intensive farming is poor relative to the MfE microbiological water quality guidelines and Australian and New Zealand Environment and Conservation Council (ANZECC) water quality guidelines – a fact known for many years' (PCE 2004, p. 45). However, perhaps the most notable conclusion that can be drawn is the lack of reliable data against which to draw conclusions for key parameters in all regions. Of most concern here is Canterbury, New Zealand's largest user of freshwater resources. It is also notable that none of the four councils examined has an approved water (or equivalent) plan for their region. This is remarkable given the level of regional and national concern about water (e.g., Fish and Game New Zealand has run a highly effective 'dirty dairying' campaign) and that the RMA, which requires such plans, was passed in 1991.

Two specific cases illustrate the increasing scarcity of freshwater in New Zealand. Auckland City population is rapidly increasing and is accompanied by increasing demands for water. Since 2002, water from the Waikato River has been piped north to augment supplies within the Auckland city boundaries. In the South Island rights to water from the Waitaki River are the subject of competing resource consent applications. Meridian Energy proposed building a canal near Kurow and diverting about two-thirds of the flow to generate electricity in a series of six power stations. Farmers in the region have also lodged competing resource consent applications to extract Waitaki River water for irrigation and that water use would reduce the water available for electricity generation and for meeting instream flow requirements.

3.2 People's perceptions

Are the scientific concerns matched by broad public concern? This question and others over water management prompted Lincoln University researchers to include targeted questions on this topic in their 2004 survey 'Public Perceptions of the State of the Environment' (Hughey *et al.* 2004). This biennial survey is mailed to 2000 people on the New Zealand electoral roll and in 2004 achieved an effective response rate of 44 per cent. The survey is structured around a pressure-state-response (OECD 1996) format, contains a standard set of questions that are included in each survey, and includes questions targeted to a topical issue. Data from the 2004 survey are reported to illustrate how the New Zealand public perceive pressures on water, its quality, and its management. In several instances, we report whether the responses are statistically significant.

3.2.1 Pressures on freshwater

Farming was increasingly considered a pressure on freshwater in earlier surveys (Hughey *et al.* 2001, 2003). The 2004 survey split the category 'freshwater' used in the earlier surveys into two separate categories, 'rivers and lakes' and 'groundwater'. In 2004, farming was perceived as one of the main causes of damage to waters in rivers and lakes by 43 per cent of respondents and was

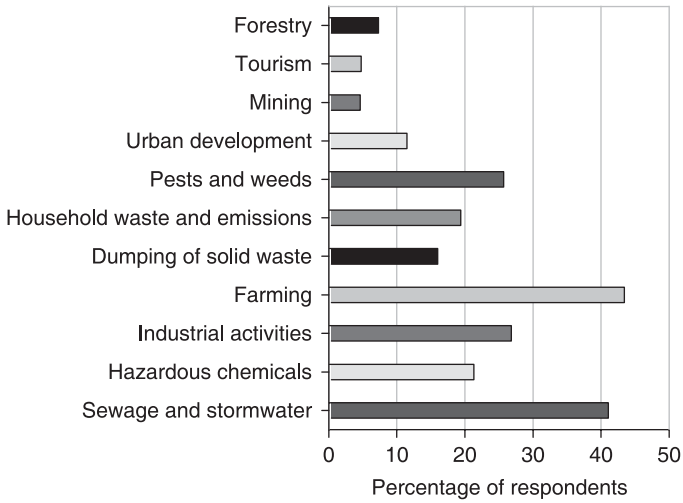

Figure 1 Public perception of main causes of damage to rivers and lakes 2004.

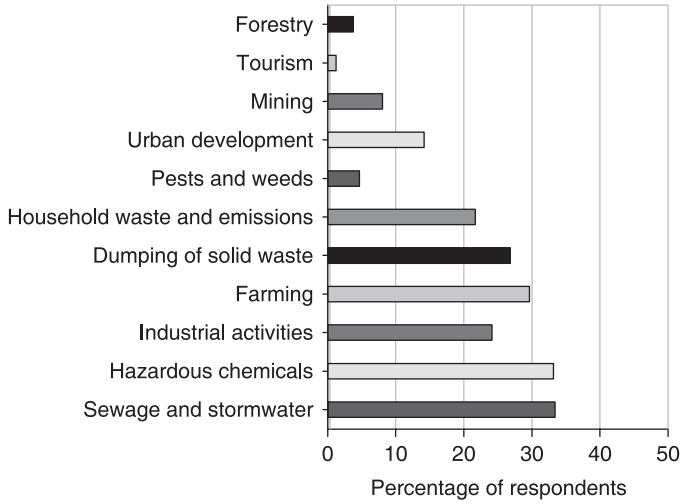

Figure 2 Public perception of main causes of damage to groundwater 2004.

ranked the second highest cause of damage (30 per cent) to groundwater, following 'sewage and stormwater' and 'hazardous chemicals' at 33 per cent (Figures 1, 2).

To investigate further the pressures on water, respondents to the 2004 Lincoln University survey were asked to respond to a series of questions about water and its management. The statement, 'Small lowland streams in my region have not been damaged by dairy farming', received a high percentage of 'don't know' responses. However, the majority felt that dairy farming had damaged their streams. This was particularly true for southern-region

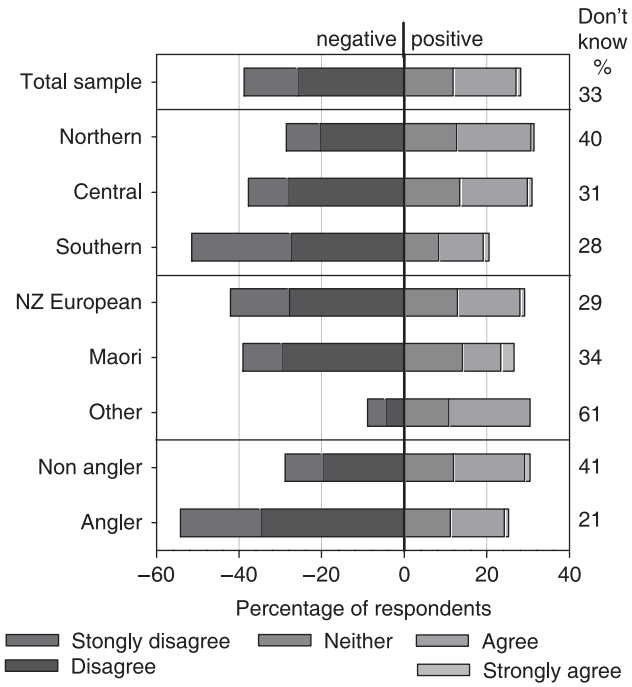

Figure 3 Distribution of responses to statement 'Small lowland streams in my region have not been damaged by dairy farming'.

respondents (South Island residents) ($P < 0.001$), anglers ($P < 0.001$) and to those classing themselves as NZ European or Maori ($P < 0.01$) (Figure 3).

3.2.2 State of freshwater in New Zealand

Most people considered the quality of water in rivers and streams and the quality of water in aquifers as 'good' or 'acceptable'. The quality of water in lakes did not rate as well, with around 32 per cent rating it 'poor' or 'extremely poor' ($P < 0.001$) (Figure 4). Water quality was considered by at least 50 per cent of respondents to be the same as 5 years ago (Figure 5). However, significant proportions of respondents considered water quality to be worse or much worse in lakes (over 40 per cent of respondents) and rivers and streams (around 35 per cent) ($P < 0.001$).

Other statements about the quality and management of streams in the respondent's region received negative responses and clearly indicated that respondents felt that the level of water taken for irrigation should not be increased (Figure 6).

The quantity of freshwater resources available was also investigated. Although almost half of respondents in 2000 and 2002 considered there to be a high amount of 'freshwater', in 2004 this dropped; just over 30 per cent felt there was high quantity of water in rivers and lakes, and approximately 25 per cent felt there was a high quantity of groundwater ($P < 0.001$). 'Don't

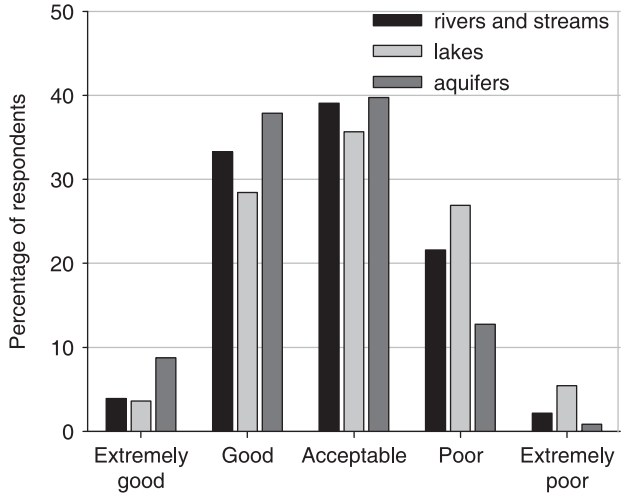

Figure 4 Public perceptions of water quality 2004.

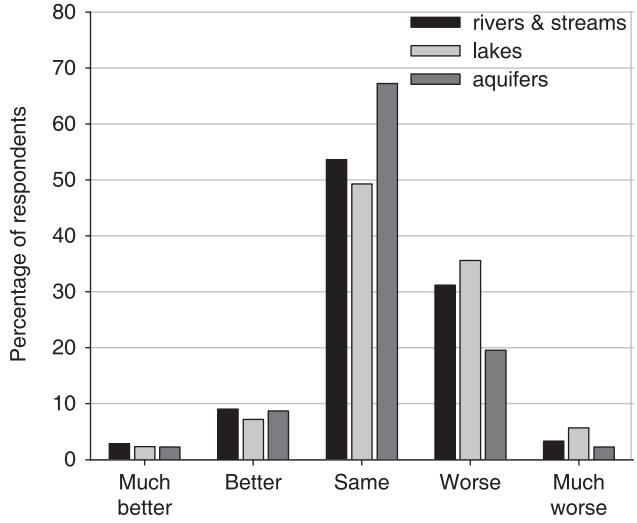

Figure 5 Public perceptions of water quality in 2004 compared to water quality 5 years ago.

know' responses were much higher for the individual resources evaluated in 2004 than for the overall 'freshwater' category evaluated in previous years (Figures 7, 8; $P < 0.001$).

3.2.3 Perceptions of resource management

Respondents to the surveys generally perceived freshwater to be 'adequately managed' (Figures 9, 10) with no difference between the 2000 and 2002 surveys ($P = 0.84$), but responses tended towards 'poorly managed' in the 2004 survey (Figure 10). Although the majority felt management had not changed compared

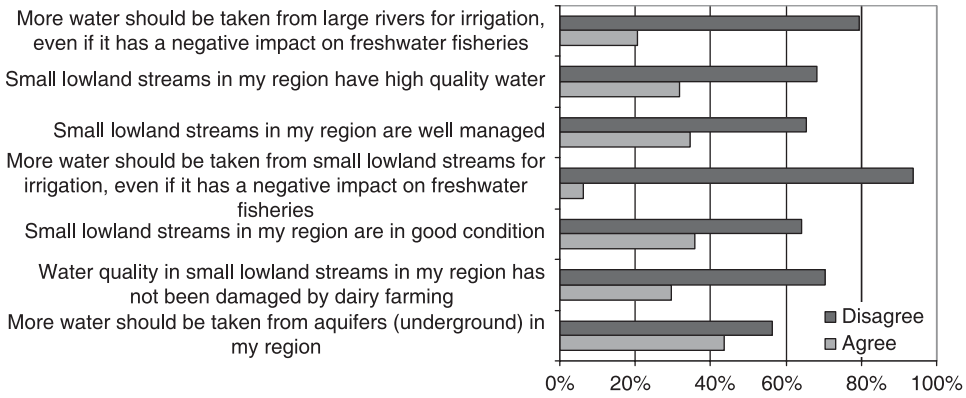

Figure 6 Public opinion on freshwater statements (excluding 'don't know' and 'neither agree/disagree').

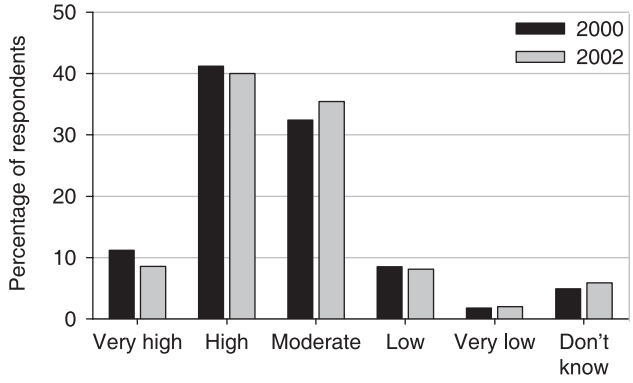

Figure 7 Public perception in 2000 and 2002 of amount of freshwater available.

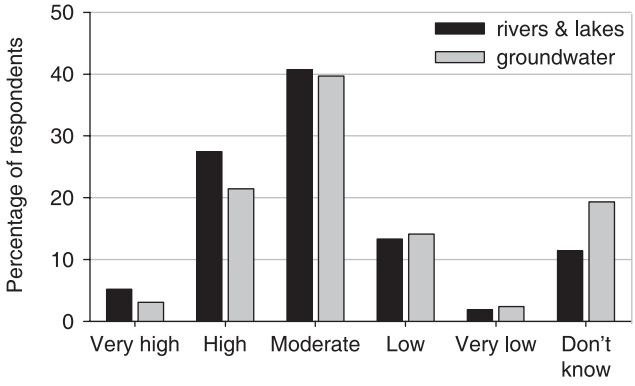

Figure 8 Public perception in 2004 of amount of freshwater available.

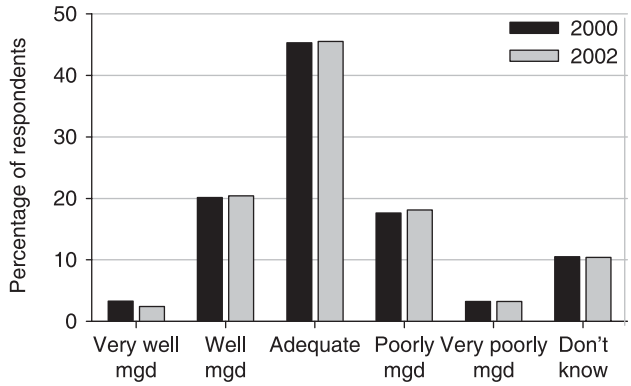

Figure 9 Public perceptions in 2000 and 2002 of management of freshwater.

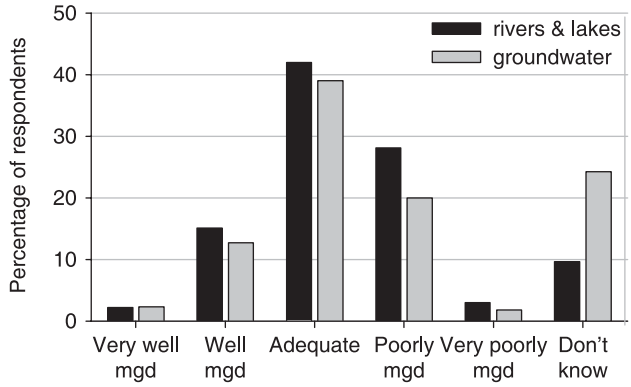

Figure 10 Public perceptions in 2004 of management of freshwater.

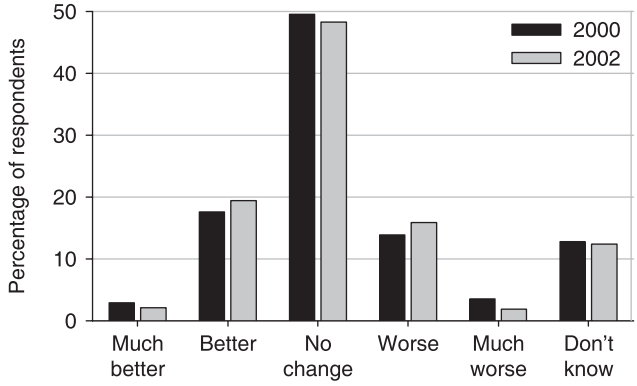

Figure 11 Public perceptions in 2000 and 2002 of management of freshwater compared to 5 years ago.

with 5 years previously, more respondents perceived that management was getting 'worse' rather than better, particularly for rivers and lakes in the 2004 survey (Figures 11, 12). There is a statistically significant difference between the 2004 perceptions of rivers and lakes management and groundwater

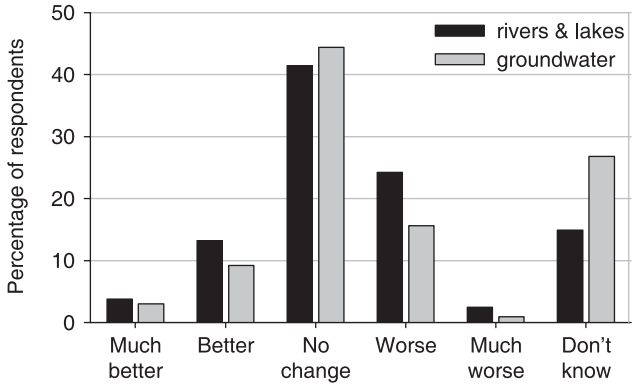

Figure 12 Public perceptions in 2004 of management of freshwater compared to 5 years ago.

management ($P < 0.001$). Because the 2004 survey asks separate questions about rivers and lakes, and groundwater, and the 2000 and 2002 surveys asked about fresh water, it is not possible to test if there are statistical differences between the 2000/2002 and 2004 results for freshwater.

Perceptions of farm effluent and run-off management, both of which are likely to impact on water quality, also worsened over the three surveys, with over 50 per cent of respondents in 2004 considering it 'bad' or 'very bad'. Figure 13 illustrates trends in public perceptions of three selected environmental management activities, all potentially impacting on the quality of fresh water. There were significant differences over time in the two improving trends, that is, sewage disposal and hazardous chemicals use and disposal, and also in the worsening-to-static trend of the management of farm effluent and run-off ($P < 0.001$ for all three trend lines).

Regional councils are primarily responsible for water management under the RMA and, perhaps surprisingly given the findings in Figure 13, approximately 75 per cent of 2004 survey respondents rated their regional council's performance as 'very good', 'good' or 'adequate'.

Biophysical monitoring data indicate, and the public and government acknowledge, that there are significant pressures on New Zealand freshwater resources, particularly from agriculture, and that the state of rivers, lakes and possibly groundwater is declining. It is widely accepted that management of water quality, allocation, and various pressures is less than adequate. There is increasing demand for fresh water and there are land-use changes occurring that adversely affect water quality. However, these are proximate factors and to understand water availability and declining water quality, deeper analysis is needed.

Concerns about freshwater have escalated to such a level that the government included fresh water as one of four core themes within its Sustainable Development Programme of Action. The following section considers what caused water issues to rise this high on the government's agenda and what can be done to progress water management issues.

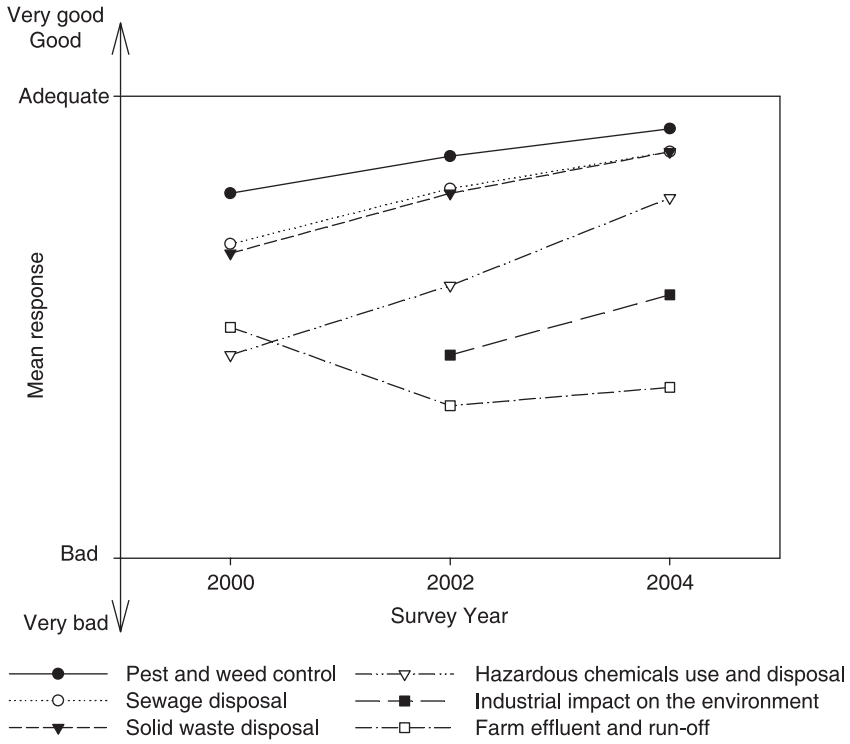

Figure 13 Trends in public perception of quality of selected environmental related management activities.

4. Causes of the water problems

The property rights associated with water are well understood, that is, freshwater is owned by the Crown with management delegated from there. However, external effects are clearly occurring and groups beyond agriculture clearly have interests in, and concerns about, water. For example, anglers, represented by Fish and Game Councils, are becoming increasingly militant as the quality of their recreation is diminished by decreased flows and poorer water quality. Here we consider what is causing these external effects to occur, especially given that the regulatory framework was designed to provide sustainable management outcomes.

Councils have frequently failed to complete statutory planning/policy requirements, that is, many have no or incomplete water plans. As shown in Table 2, none of the four councils reported has an approved water plan, despite the fact the RMA was introduced in 1991 and that water resource management has remained a major issue over that time period. These plans have not been completed because they require councils to set realistic goals and objectives, targets that are often difficult to set within political environments that must consider urban recreational and environmental requirements together with rural

economic demands. There is also an argument (MfE/MAF 2004b; Guerin 2005) that there is too little policy direction from central government.

Despite the lack of plans, councils are still required to (and do) implement resource consent and other regulatory processes for land use, discharges, and use of water. Another problem that often occurs is a lack of monitoring and enforcement. A 2001–2002 survey of dairy farmers in Mid- and South Canterbury showed that 80 per cent had breached Environment Canterbury (ECan) and regional dairy shed conditions (The Timaru Herald 2003). Until 2003 ECan monitored a third of the dairy farms in the region, but after research identified the very high number of breaches of consents ECan appointed six new staff to assist with the monitoring process. The lack of monitoring by many Regional Councils has another consequence: considerable uncertainty as to the environmental outcomes of current management practices (see also Table 2).

A technical/scientific problem also exists for which there is poor understanding and variable commitment to solving. This problem surrounds how best to deal with non-point source discharges that reach the groundwater and surface water environments. Although most point-source discharges are now managed, drainage issues are increasingly seen as the cause of many of the continuing water-resource quality problems. Lack of adequate riparian management has contributed to the scale of this problem.

There is also a lack of information on community aspirations about water. Although government and councils are well aware of industrial and farming needs there is little overall appreciation of broad community demands and expectations. This issue is exacerbated by the cultural demands of Maori and how they relate to the preferences of others in the community. Ultimately, councils (and to an extent central government) face a multitude of other priorities and in many cases there is a lack of resources, especially for research and monitoring.

Together, these factors contribute to the problems and concerns outlined earlier.

5. Possible solutions

The problems of falling water quality and competing demands for instream flows are classic resource management issues because there is no single cause of the problems and consequently no single solution is likely to correct them. Nevertheless, there is increasing recognition of the need for good management of freshwater resources and proposals for changes to water management systems are being debated. Government has funded a number of research projects in this area (Ford *et al.* 2001; Harris Consulting and the Agribusiness Group 2004; Hatton MacDonald *et al.* 2004; MfE/MAF 2004a,b) and in 2003 established the Water Programme of Action (WPA) interdepartmental working group to consider how water management might be improved. In 2004 government also passed the *Resource Management* (Waitaki Catchment) *Amendment Act 2004* to address a specific water allocation issue.

The WPA (2004, p. 14) stated that there are three key issues:

1. Not all expectations and needs for freshwater are currently being met, and demands are growing.
2. Water quality is declining in many areas and is unacceptable in some.
3. Given the range of people's interests in water (social, economic, environmental, and cultural), it is difficult under the present system to establish priorities for action.

The WPA has proposed a lengthy list of possible actions to address the three issues. These include:

- central government specifying national priorities for water
- stipulating to regional councils how they must determine water allocation limits
- identifying water bodies that are nationally important
- assisting regional government to develop strategic plans for water
- developing mechanisms for regional government to manage allocation of water such as clawback of existing resource consents
- enhancing the transfer of allocated water between users
- developing means by which regional councils could compare resource consent applications
- using auctions or tenders to allocate water and requiring water permit holders to pay a resource rental per unit of water

Although the list of possible actions is lengthy, it mostly appears plausible. However, there are gaps. Our survey indicates that most people think councils are performing well in the general area of freshwater management, yet when it comes to specific issues, they are concerned. At a general level, then, there may be insufficient public pressure on councils to improve their performance, especially in the areas of monitoring and compliance. The WPA fails to identify marginal or poor council performance as a problem but clearly needs to address this issue. Ultimately this relates to a question of responsibility and to date government seems committed to leaving that in local hands, albeit with some added direction from central government.

The 'new' *Local Government Act* (2002) requires councils, both regional and local, to prepare long-term council community plans. These plans must take account of community aspirations in the areas of cultural, economic, environmental, and social matters. The challenge for regional councils in particular will be to develop robust processes to ensure these community plans are indeed reflective of community aspirations.

Community-based responses to environmental degradation are now commonplace, both overseas and in New Zealand. The New Zealand Landcare Trust, based in Christchurch, has been associated with a huge growth in the number of these groups. The Trust had links to over 250 groups in 2000 (Trustees of the NZ Landcare Trust 2000), a figure that has climbed

to around 500 today (Shelley Washington, NZ Landcare Trust, pers. comm., 2005). Growth in the number of these groups may be a response to the power imbalance and time delays that individuals face in pursuing other solutions, and the view that groups of landowners can manage local environmental issues better without outside interference. These groups form for a variety of reasons, many being associated with water-related issues (e.g., the Te Anau, Taieri, and Rotorua lakes groups). Hughey *et al*. (2004) found that a common reason for group formation was a commonly shared problem, often linked to dissatisfaction with the statutory resource management agency. The groups take many forms, with some containing very diverse memberships and others being far more restrictive. Restrictive membership groups carry higher risks of broader community non-acceptance of their desired outcomes (see McCallum 2003, for example). The ultimate outcomes from these initiatives may be limited because of the difficulty that groups encounter in reaching agreement on solutions, and the potential for free-riding (which limits their ability to speak on behalf of the general public).

The role of bigger business, especially in terms of facilitating or promoting 'environmental management systems' and other non-statutory management initiatives should not be overlooked. Perhaps the biggest and best recent integrated example of these initiatives is that involving Fonterra Cooperative Group (New Zealand's and one of the world's largest dairying companies). Most of New Zealand's dairy farmers are contracted to Fonterra and the company (together with Regional Councils, MfE, and MAF) is a signatory to the Dairying and Clean Streams Accord. This programme 'for the first time sets understandable targets for environmental performance across all of New Zealand' dairy farming areas and it 'aims to ensure environmental considerations become an automatic part of farm development and ongoing day to day management' (Fonterra *et al*. 2004). An example of the former is:

- Dairy cattle are excluded from streams, rivers, lakes and their banks
  Accord national target: Dairy cattle are excluded from 50 per cent of streams, rivers and lakes by 2007, 90 per cent by 2012.
  Progress: Data indicate that the 2007 target has been met. Sixty-seven per cent of Fonterra suppliers currently either have total stock exclusion from waterways or no Accord-type waterways. (Fonterra *et al*. 2004, p. 2)

An example of the latter is:

- Market-focused uptake improved
  Continue to develop, promote, and implement the market-focused environment management system to assist farmers to identify key farm-specific environmental issues and to demonstrate progress towards the five priority targets.
  Fonterra has continued to promote the market-focused environment management system, with uptake rising from less than 1 per cent to 12 per cent over the last 12-month period. (Fonterra *et al*. 2004, p. 3)

None of these initiatives is likely to be successful without improved monitoring of key outcome-related indicators, that is, is the water quality actually improving as a result of these initiatives? Improved data collection and dissemination of results will be important for the public and as a check against community aspirations.

Our evidence indicates there is public support for improved water quality across the country, which may occur with the implementation of national environmental standards, national policy statements, increased involvement in local planning, and better addressing nationally important values (WPA 2004). However, it is reasonable to ask whether the public desire for improved water management is supported by evidence that they are willing to pay for it. The 2004 Lincoln University survey asked the following question: 'If my regional council proposed to increase household rates by $NZ20 per year for 10 years to pay for lowland stream enhancement work I would be: strongly supportive; supportive; don't care; opposed; strongly opposed; don't know.' Fifty-three per cent of the 771 respondents to this question were supportive of this hypothetical proposal for a rate increase and around 30 per cent were opposed (Figure 14). Those over the age of 50 were significantly less likely to support the proposition than were younger respondents ($P < 0.01$), whereas those with a university tertiary qualification were much more positive about the proposition than were those with lower-level qualifications ($P < 0.001$). Respondents were asked to explain the reasons for their responses. Of the 484 who provided an explanation, 43 per cent commented '$20 is a small price to pay for the common good', and 23 per cent commented 'rates are too high already'.

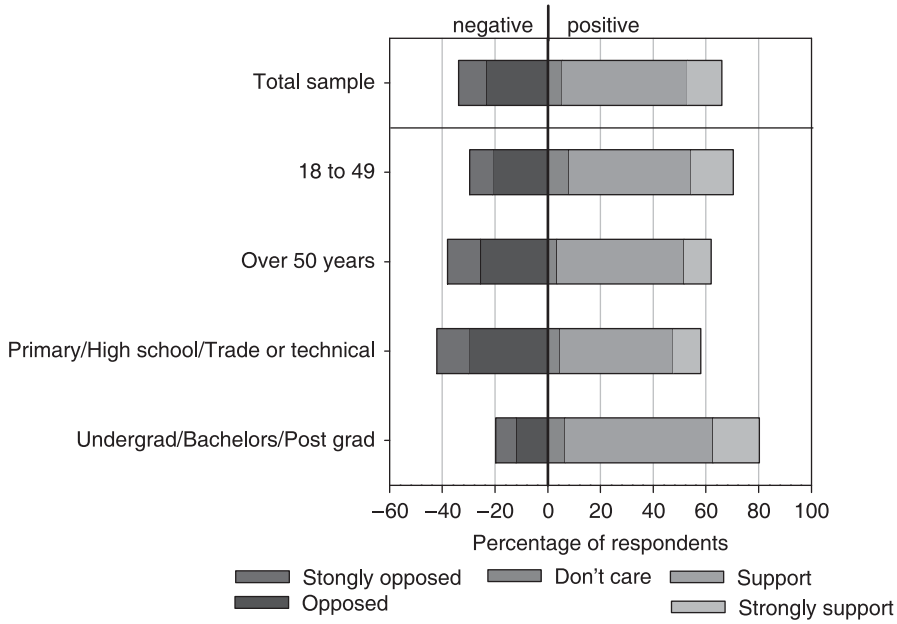

Figure 14 Support for rate increase for lowland stream enhancement.

An additional $20 per year from each ratepayer could be used to fund various stream enhancement activities. Fencing of riparian margins is one of the popular actions to improve water quality of lowland streams. Hot-wire fencing costs in the order of $1550 per kilometre to erect (Environment Canterbury, 2004). Given approximately 1 million ratepayers in New Zealand then the $20 million generated by a $20 rate increase could contribute to around 12 900 km of riparian fencing per year. Hill (2004, p. 87) reported the length of stream banks in dairy farms for the Taranaki region (16 000 km), Horizons Manawatu (2800 km) and Wellington (583.8 km) regions. 'While the total is unknown for New Zealand the three-region total here is known as well as the length remaining to be fenced (i.e., at least 10 512 km). The estimated $20 m generated from a national rate increase would finish this task for these three regions alone in less than one year' (Hughey *et al*. 2004, p. 87).

The fact that the majority of respondents are prepared to pay to enhance lowland streams provides some indication of the strength of their support for improved lowland stream management. Information on the public's willingness to pay for various other water policy options is also likely to be helpful when deciding on priorities for action. There is now a substantial portfolio of non-market valuation studies that attest to the importance of instream water values. For example, Kerr *et al.* (2004) have estimated the present value of freshwater sport fishing benefits in the Rakaia River are in the order of $5 million.

Existence values can be a significant driver of willingness to pay. Several studies address existence values associated with proposed changes directly affecting rivers or address water-related matters. Most of the river-related studies address specific stream attributes. Harris's (1984) Waikato River study and both the Sheppard *et al*. (1993) and Kerr *et al.* (2004) Waimakariri studies valued the impacts of pollution. The other Waimakariri River studies (Kerr *et al*. 2004), the Rakaia River studies (Kerr *et al*. 2004), and the Ashburton River study (Lynch and Weber 1992) valued river flows. The Auckland Streams study (Kerr and Sharp 2003a,b) addressed several specific stream attributes.

Table 3 summarises the results of relevant non-market valuation studies. The total impact of the changes depends upon the number of people over whom the results are aggregated, but it is apparent that they can be substantial. The highest value per household ($203 per year) was produced by a local study, which addressed values associated with reduced groundwater extraction on the Waimea Plains in Nelson (White *et al.* 2001). This figure was almost matched ($197 per household per year, net present value = $2 billion) by the national study of values associated with proposed Kawarau River hydroelectricity developments (Kerr 1985).

Much indicative economic research is clearly available. However, the WPA steering group should investigate further economic research, perhaps that involving tradeoffs and prioritisation, to evaluate the suite of policy options in water resource planning.

Table 3 New Zealand existence value studies

Author(s)	Study population	Item valued	$ per house hold per year†
		National study	
Kerr (1985)	NZ households	Prevent Kawarau River hydroelectricity development	$197
		Regional studies	
Harris (1984)	Households in four main Waikato urban centres	Prevent Waikato River pollution returning to 1960s quality	$93
Kerr *et al.* (2004)	Canterbury households‡	Prevent Waimakariri River irrigation development for 5 years	$37
		Preserve the Waimakariri River in its existing state	$42
		Improve Waimakariri River water quality from D to C standard	$34
	Canterbury households‡ that use the Waimakariri	Prevent Waimakariri River irrigation development for 5 years	$45
		Preserve the Waimakariri River in its existing state	$51
		Improve Waimakariri River water quality from D to C standard	$40
	Canterbury households‡ that do not use the Waimakariri	Prevent Waimakariri River irrigation development for 5 years	$15
		Preserve the Waimakariri River in its existing state	$12
		Improve Waimakariri River water quality from D to C standard	$14
Kerr *et al.* (2004)	Canterbury households‡	Prevent Rakaia River irrigation development for 5 years	$44
		Preserve the Rakaia River in its existing state	$43
	Canterbury households‡ that use the Rakaia	Prevent Rakaia River irrigation development for 5 years	$77
		Preserve the Rakaia River in its existing state	$77
	Canterbury households‡ that do not use the Rakaia	Prevent Rakaia River irrigation development for 5 years	$25
		Preserve the Rakaia River in its existing state	$25
Lynch and Weber (1992)	Canterbury households (excludes Ashburton)	Preserve Ashburton River flows	$70
		Local studies	
Lynch and Weber (1992)	Ashburton District households	Preserve Ashburton River flows	$118
Sheppard *et al.* (1993)	Christchurch Households	Improve lower Waimakariri River water quality from D to C standard	$138
Lambert *et al.* (1992)	Dunedin City households	Upgrade Dunedin sewage disposal to water	$63
White *et al.* (2001)	Waimea Plains households	Twenty per cent reduction in Waimea Plains groundwater extraction	$203
Kerr and Sharp (2003a,b)	North Shore households	Stream channel rehabilitation	$59
		Stream clarity	$67
		Streamside vegetation	$21
		Loss of one native fish species	$11

Notes: †All money values have been adjusted to December 2003 values using the Consumer Price Index. ‡Canterbury households situated between the Conway and Rangitata rivers.

6. Conclusions

Demand for water is increasing steadily in several regions of New Zealand and physical limits to availability are apparent, particularly during low-rainfall periods. Declines in the quality of water are now a frequent event for lakes, rivers, streams, and groundwater. There is increasing public concern over all of these problems, with surveys of the New Zealand public indicating respondents perceive that agriculture is the major source of pressure on freshwater and a majority of the public being firmly opposed to allocating more freshwater to agriculture if it leads to environmental degradation. New policies are required to ensure that environmentally sustainable flows, in terms of both quantity and quality, are attained.

Agriculture is a major cause of declining water quality, particularly because of the growth of dairy farming and intensification of agriculture. Diffuse, non-point sources of nitrates have caused nitrification of several New Zealand lakes, many streams, and some major aquifers. Management of diffuse pollution is poor in New Zealand. Despite the fact that they have not caused the problems in the first place, a majority of the public is willing to pay to enhance lowland streams. This willingness to pay should prompt policymakers to investigate alternative policy instruments, perhaps ones leading to outcomes that represent the public's desire for high-quality water and suitable flow regimes. Environmental economics has a role to play in designing and testing some of these policy instruments but has only been used to a limited extent to date. Given that people want better water management, they are willing to pay for it, the system is showing signs of stress, and changes may be irreversible in many cases, a substantial and expedited response seems warranted.

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