Regional Water Strategy for Canterbury, New Zealand

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Bryan Jenkins

Sustainability Strategist, Adelaide, Australia

Abstract

Irrigation expansion in Canterbury New Zealand resulted in cumulative effects of water extraction reaching sustainability limits, and land use intensification compromising water quality. Analysis of future requirements indicated that weekly demand from run-of-river irrigation schemes could not be met from available flows. Annual demand could be met but required storage. However, there were concerns about impacts of dams on rivers. Groundwater depletion was reducing flows in groundwater-fed streams degrading ecological health. Environmental flows in rivers were being compromised by water extraction. Modelling of nitrate leaching from land use intensification predicted groundwater nitrate levels exceeding drinking water standards. Lake modelling indicated catchment contaminant loads exceeding water quality criteria.

A regional sustainability strategy process was developed based on collaborative governance and nested adaptive systems requiring new approaches to consultation, strategy development and sustainability appraisal. Strategic thinking shifted from water for irrigation to ten water management issues reflecting all stakeholder interests. Improving water use efficiency of existing allocations was found to be more effective than storage in increasing water availability. Proactive programmes to address biodiversity, water quality and Māori concerns were introduced. To address cumulative impacts constraints on allocations from rivers to protect environmental flows and limits on total abstraction from groundwater basins were defined, improvements in land use practices were introduced, and solutions packages for addressing water quality in lakes were developed.

1. Introduction

This paper first outlines the growth in irrigation that is occurring in Canterbury. Then the cumulative effects associated with increased water abstraction and land use intensification are identified. Next the failure of project level assessment to manage cumulative effects is described. This is followed by initial strategic investigations: firstly, the regional supply/demand analysis which indicated water availability could be improved by storage, secondly, the adverse effects of storages, and thirdly, the water quality impacts of further land use intensification. This led to the development of a new water management paradigm in Canterbury through the development of a regional sustainability strategy based on collaborative governance and nested adaptive systems. This demonstrated the need for proactive interventions and implementation rather than the reactive regulatory role defined for regional government in the New Zealand legislation. The final section looks at the implications of the regional scale approach. The paper demonstrates the need to develop a new regional sustainability strategy approach because of the failure of traditional environmental impact assessment to address the problems of water availability and land use intensification.

2. Growth in Irrigation

The conversion of dryland farms to irrigated dairy farms in Canterbury has seen a significant increase in dairy production from 6 million kilograms of milk solids (kgms) in 1984-5 to 385 million kgms in 2015-6 (LIC and DairyNZ 2016). There has also been a significant increase in irrigated land. Based on census data, the area irrigated has increased from 287,168 ha in 2002 and detailed mapping in 2015 indicated 507,468 ha (Brown, 2016).

3. Cumulative Effects

The regional irrigation expansion led to cumulative effects primarily associated with the impact on river flows (both in terms of quantity and variability) from abstraction, drawdown of groundwater lowering groundwater levels and reducing flow in groundwater-fed streams, and, the effects on water quality from land use intensification (especially nutrients, bacterial contamination and sedimentation). Reduction in the magnitude and duration of low flows reduced freshwater habitat and reduced connectivity to other habitats. Reduced flow variability reduced streams' ability to move fine particles and algae diminishing freshwater habitat quality. Reduced flood flows decreased river bed mobility needed to maintain the braided character of Canterbury rivers (Biggs et al 2008). In addition to concerns about local drawdown effects on neighbouring wells, there were larger scale cumulative effects concerning the total volume that can be abstracted from a groundwater zone and still maintain adequate flows in groundwater-fed streams (Scott, 2004).

Coastal lakes have highly degraded water quality but this is not a recent change. Analysis of sediment cores from lakes show significant changes in trophic state from the early pastoral period of land use change involving forest clearance and pasture grass establishment (Kitto, 2010).

4. Failure of Project Level Assessment

The Resource Management Act (RMA) is the prime law for natural resource management in New Zealand (New Zealand Government 1991). The legislation is effects-based and concentrates on the environmental effects of activities rather than the activities themselves. There is an Environment Court which has the ability to review the technical merit of decisions. This has made resource management in New Zealand a highly legalistic process. It has also led to an adversarial style of decision making. Environmental impact assessment of new development proposals is a major process under the RMA. While project-specific effects can be addressed by the RMA, the Act was not designed to deal with cumulative effects of multiple activities.

Sustainable management is the purpose of the RMA – allowing the use of resources subject to environmental bottom lines. However, the Act provides no elaboration on how decision makers can apply this purpose. Court interpretations have defined an "overall broad judgement" of balancing resource use and environmental effects (Skelton and Memon, 2002). This overall broad judgement approach has allowed the Environment Court and commissioners hearing development applications to approve further development despite limitations on water availability or degraded water quality (Environment Court, 2005; Milne et al, 2010).

5. Regional Supply/Demand Analysis

The dominant form of abstraction in Canterbury is direct withdrawal from rivers. One of the early strategic regional studies was the assessment of the reliable supply for current (2001) and future (2012) water demand (see Table 1). For run-of-river supply the critical parameter is the weekly minimum river flow (175 m^3/s – the 7-Day mean annual low flow). The allocable flow from groundwater (16 m^3/s) can be added to give the total allocable flow (191 m^3/s). With the current (2001) peak weekly demand estimated at 290 m^3/s, there is inadequate water available for current demand, let alone the forecast future demand (2021) of 569 m^3/s. However, if the average annual flow is considered, then the allocable flow from surface water (594 m^3/s) together with groundwater allocation (16 m^3/s), provides a total allocable flow (610 m^3/s) that is greater than the current (2001) annual average demand (81 m³/s) and the forecast future annual average demand (229 m³/s). Thus, on an annual basis water is potentially available to meet future demand but would require storage (Morgan et al 2002).

Weekly Minimum Flow Supply		**Annual Average Flow Supply**	
Allocable from surface water		Allocable from surface water	
- under mean annual low flow	175 m³/s	- average annual flow	594 m³/s
Allocable from groundwater	16 m³/s	Allocable form groundwater	16 m³/s
Total Allocable Flow	**191 m³/s**	**Total Allocable Flow**	**610 m³/s**
Current (2001) Peak Weekly Demand	**290 m³/s**	**Current Annual Average Demand**	**81 m³/s**
Future (2021) Peak Weekly Demand	**569 m³/s**	**Future Annual Average Demand**	**229 m³/s**

Table 1: Regional Water Supply/Demand Analysis for Canterbury (Morgan et al 2002).

6. Impacts of Storages

The initial response to the supply/demand analysis was to consider storage options (Aqualinc, 2008). However, there are significant sustainability issues with storages on the mainstems of Canterbury's alpine and foothill rivers (Jenkins, 2007). These include:

- Impacts on the naturalness of high country areas of landscape, ecosystem, habitat or amenity value;
- Reducing flood flows thereby decreasing the number of braids in braided rivers;
- Sediment entrapment reducing the bedload downstream of dams and sediment supply to the coast leading to increased coastal erosion;
- Reducing flushing flows resulting in greater frequency and persistence of algal blooms;
- Temperature stratification in reservoirs inhibiting oxygen diffusion to the hypolimnion leading to deoxygenation in bottom waters;
- Nutrient retention in reservoirs from land use intensification resulting in the occurrence of aquatic weeds; and
- Reduced instream recreational opportunities for whitewater sports and fishing.

Concerns about these effects led to significant opposition to storages on the mainstems of rivers.

7. Water Quality Impacts of Further Land Use Intensification

One of the major regional concerns of increased land use intensification associated with irrigation was further water quality impairment. Regional modelling of the impacts of increased nitrate leaching to groundwater and catchment modelling for water quality of degraded lakes have predicted significant increases in nutrient levels. Groundwater is the major source of drinking water in Canterbury. Monitoring indicated that 11% of sampled wells in the Central Canterbury Plains exceeded the maximum acceptable value for drinking water of 11.3 mg/L (Hanson and Abraham, 2009). Modelling of nitrate leaching if all potentially irrigable land was irrigated using existing land use practices indicated substantial areas exceeding the drinking water standard (Bidwell et al 2009). Catchment modelling for degraded lakes indicated the need for reduction in existing contamination to achieve water quality targets. Further intensification with current land use practices would exacerbate water quality contamination (Canterbury Water 2013, 2014a, 2014b, 2014c, 2015).

8. New Water Management Paradigm

For Canterbury it was recognised that there was a need for a paradigm shift in water management which (a) addressed the sustainability limits of water availability, (b) managed the cumulative effects of water takes and land use intensification, and (c) shifted from effects-based management of projects to integrated management based on water management zones (Jenkins 2018). Success at the tributary and catchment scale of using collaborative approaches for resolving water management issues led to the development of the Canterbury Water Management Strategy (CWMS) (Canterbury Water, 2009) based on Ostrom's principles for governing common pool resources (Ostrom, 1990) and Gunderson and Holling's approach of nested adaptive systems (Gunderson and Holling, 2002).

Facilitated by the regional council, the Strategy was led by a multi-stakeholder Steering Group with oversight by the Canterbury Mayoral Forum. There was extensive stakeholder and community engagement on water uses and strategy options (Jenkins and Henley, 2014). Strategic investigations of likely options informed the strategy selection process and informed a sustainability appraisal based on environmental, economic, social and cultural criteria (Jenkins et al, 2014). Based on stakeholder input, the Strategy established targets for ten community water uses not just water availability. The Strategy demonstrated that improved water-use efficiency of existing users was a more cost-effective and sustainable way of improving water availability compared to storage. Dams on the mainstems of alpine rivers were precluded, and, alternative forms of storage were identified (e.g. off-river storage, managed aquifer recharge, on-farm storage) to improve supply reliability for irrigators. Projects aligned with the Strategy were not controversial in the consenting process. Further land use intensification would require existing users to improve water use efficiency and land use practices, however their existing approvals gave them legal rights to continue current practices.

9. Need for Proactive Interventions and Implementation

With water resource abstraction and the effects of intensification from water use at or beyond sustainability limits, reactive measures such as limiting resource availability or mitigating the effect of resource use of new developments are insufficient to achieve sustainable management. Rather there is a need for proactive measures (i.e. management interventions) to achieve sustainable outcomes. However, the legislative and management tools in New Zealand are not designed to facilitate management interventions that address the cause of the problem. The RMA is designed for government to have a regulatory role through defining regional rules, impact assessment of proposals, and enforcement of rules and conditions.

New governance arrangements were established in Canterbury with multi-stakeholder Zone Committees established to generate Zone Implementation Programmes for the Strategy's ten target areas: (1) drinking water, (2) irrigated land area, (3) energy security and efficiency, (4) ecosystem health and biodiversity, (5) water use efficiency, (6) kaitiakitanga (Māori stewardship), (7) contribution to regional and national economies, (8) natural character of braided rivers, (9) recreational and amenity opportunities, and (10) environmental limits.

10. Implications of the Regional Strategy Approach

The initial impetus for a regional strategy approach was the inability of project-level impact assessment to deal effectively with the cumulative effects of water extraction and land use intensification associated with irrigation. However, the adoption of a regional sustainability strategy was more than regional impact assessment. Rather it was a systems approach to achieve environmental, economic, social and cultural outcomes, and not just a regional scale assessment to address adverse environmental effects.

The regional strategy did lead to setting environmental flow requirements to control extraction from rivers and to groundwater zone allocation limits to control groundwater extraction. However, it also led to defining "solutions packages" to address lake and river water quality degradation at the catchment scale, and, defining contaminant load limits for land use both at the property and catchment scale. The focus was not only on assessing new development but also on improving practices of existing development, especially in relation to water quality contamination and water use efficiency. There was a need for proactive interventions to address cumulative effects related to water management, and to address other areas of community concern, such as biodiversity deterioration through restoration projects and Māori engagement in water governance and management.

The regional strategy approach also generated issues relating to equity and affordability of interventions. Equity issues arose among existing users in adopting improved practices (for developments that already had environmental approvals), and, between existing users and new users when creating headroom for further developments. Affordability issues arose in relation to the cost of implementation to achieve water quality outcomes.

Different methodologies were needed for a regional sustainability strategy. A collaborative governance approach was needed to find new solutions that were accepted by the multiple stakeholders with an interest in water. This required moving away from the adversarial style of regulatory approaches to impact assessment. Stakeholder involvement in not only deciding among strategic options but also in framing the strategic options was needed. Furthermore, evaluation techniques based on sustainability appraisal not just impact assessment were required. A key component was establishing a new institutional framework based on self-governing communities as the basis for decision making for managing water as a common pool resource.

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