Recent Trends and Innovations in Water Management for Agriculture: The situation in Canterbury Region of New Zealand

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Resume

Robert Johnston graduated from Lincoln University with a Diploma in Valuation & Farm Management. He has spent a lifetime as a sheep, beef and cropping farmer on 1800 hectares, and also has an interest in forestry. Robert was involved in the wool industry for 10 years during which time he was a director of the New Zealand Wool Board, a Board member of the International Wool Secretariat based in London, and the Wool Research Organisation in Christchurch. Robert has been an Environment Canterbury Councillor since 1998.

Abstract

The Canterbury Region contains 70% of New Zealand's irrigated land. The area has grown significantly in recent times from 150,000 hectares in 1985 to 540,000 hectares in 2005. There is suitable land in Canterbury to increase irrigated area to 1,000,000 hectares. However, Canterbury is reaching its sustainability limits of water extraction using run-of-river offtakes and groundwater withdrawals.

As the water manager, Environment Canterbury has been involved in

- establishing extraction volumes from rivers ("A blocks") to provide for reliable water supplies while meeting environmental flow requirements;
- defining the sustainable supply from groundwater systems and identifying groundwater zones where allocated volumes have reached conservative estimates of aquifer recharge ("red zones").

In addition, Environment Canterbury is coordinating a strategic study of potential storage sites in a sustainability framework to determine if further water can be made available. It is also examining economic drivers to encourage more productivity from existing water allocations.

The paper describes the establishment of sustainability limits and the strategic initiatives for water management in the Canterbury.

1. Introduction

Canterbury is the largest region in New Zealand (4.22 million hectares). Agricultural exports are the key driver of the economy. Although there are substantial areas of flat land on the Canterbury Plains, the area is in the rain shadow of the Southern Alps. Land use intensification has increased economic output but has required irrigation. The growth in water extraction has placed greater demands on available water resources and land use intensification has increased impacts on water quality.

The increased demand for water has led to consideration of how to manage the resource so that sustainability limits are not exceeded. This has led to the definition of "A Blocks" – the volume of water that can be withdrawn from a river that meets a specified level of reliability for use and that has no material effect on instream values associated with river flow; and, "red zones" – groundwater zones where maximum average use in a dry season has reached a conservative estimate of groundwater recharge.

This paper describes how these sustainability limits are set (Section 2) and provides the results of specific examples of setting these limits (Section 3). Some of the key implications from setting such limits are also described (Section 4).

2. Methods of Setting Sustainability Limits

Setting A Blocks for Rivers

For run-of-river irrigation schemes, there is a need to protect the instream flows that support ecological, recreational and other values that relate to environmental sustainability. There is also a need to ensure that a reliable supply is available for productive use for extractors. The volume of water that can be withdrawn from a river and meets a defined level of reliability and also leaves an instream flow which maintains environmental values is defined as the A Block. This volume is the limit of water which can be provided sustainably with high reliability. A minimum flow is determined to protect environmental values and extraction is not permitted if the river is drawn down below this flow. Consents for water takes with high reliability are limited to the volume in the A Block. Further allocations (B Block) can only be granted at higher river flows that do not reduce the reliability for A Block allocations.

Defining Groundwater Red Zones

Groundwater allocation limits and effective groundwater allocations were estimated for groundwater zones in the Canterbury region. This involved:

- defining groundwater zones for the region
- estimating groundwater recharge
- estimating the amount of water allocated based on the consented volume of water.

The boundaries of the groundwater zones were defined based on:

- the extent of permeable gravels that form the Canterbury plain and
- the major river systems as hydrogeological system boundaries.

Two methods of estimating groundwater recharge were used. The first was based on 15% of average annual rainfall for the zone. This recharge rate had been determined by applying half the 30% of average annual rainfall for the zone which our science shows is the recharge volume. (Here we are applying a precautory approach.) The second was based on 50% of land surface recharge based on soil type, rainfall and evapotranspiration.

Monitoring of groundwater takes for irrigation has shown that actual groundwater usage in a dry year was on average 60% of the consented volume over a 120 day irrigation season. This was used initially to estimate water use but has now been replaced with a more detailed assessment of seasonal water demand, land use and soil type.

3 Results of Introducing Sustainability Limits

Examples of setting sustainability limits for run-of-river and groundwater withdrawals are outlined below. The examples relate to the setting of the A Block for the Ashburton River in Mid Canterbury, and defining the status of the Rakaia-Selwyn groundwater zone as a red zone.

A Block for the Ashburton River (a smaller Canterbury river)

The first key part of setting the A Block was defining the appropriate minimum flow for the period of maximum demand for irrigation water. This included an analysis to estimate the natural flow regime and the flows needed to maintain critical habitat requirements for fish. This gave a minimum flow of 6 cumecs at the flow monitoring site for the catchment.

The reliability requirement was defined so that the full allocation was available in 3 years out of 5. The effective allocation amount is derived as an average daily rate. Analysis of river flows indicated that the flow that is achieved 3 years in 5 during peak irrigation demand is 17.8 cumecs. With 6 cumecs as the minimum flow, then the A Block was set at 11.8 cumecs (the difference of river flow at the reliability criterion and the minimum flow). Further allocations (i.e. the B Block) were restricted to periods when the river flow was above 14 cumecs.

Current effective allocations are 14.5 cumecs, which means that the A Block is fully allocated. A process is in place to increase the efficiency of certain takes to reduce the allocated withdrawals but to sustain the current uses.

Rakaia-Selwyn Red Zone (131,493 hectares between Rakaia and Selwyn Rivers)

The current status of groundwater zones in the Canterbury region is shown in Figure 1. One area identified as a red zone is the Rakaia-Selwyn zone. This zone is located between the Rakaia and Selwyn Rivers. The estimated groundwater recharge based on the first method, i.e. rainfall recharge, is 208 million m3 per year. The effective allocation based on the consented volume of water is estimated to be 226 million m3 per year. With effective allocation greater than the conservative estimate of recharge, the zone is defined as “red” or fully allocated.

The estimates are based on the best available knowledge but it is recognised that further information may refine these values. The estimates of recharge are conservative, i.e. it is expected that further information will demonstrate that additional water is available. A precautionary approach has been taken.

In zones where the allocation limits is already fully allocated, consent applications for further extraction are declined, unless further information is provided to indicate that further taking of groundwater would not result in adverse environmental effects. Thus the approach represents adaptive management.

4. Discussion of Implications of Sustainability Limits

Constraint on Water Extraction Using Traditional Mechanisms

The introduction of sustainability limits for surface water takes and groundwater withdrawals is changing the perception of water availability in Canterbury. For many years there appeared to be an abundance of water. However the rapid expansion of irrigated agriculture has led to sustainability limits from current methods of extraction to be reached. This has created a "gold rush" for the remaining water. With a precautionary policy of declining consents when conservative estimates of sustainable yields have been reached unless further information is available, there has been a substantial investment by applicants in providing additional information, thereby enhancing our knowledge base of water resources.

Search for Storage

A Strategic Water Study for Canterbury is being undertaken in a series of stages. The first stage identified that in principle there was further water available in the Canterbury region but not at the time of demand. It would require further storage to harvest the water. A second stage that is well advanced is determining whether it is practical to meet environmental requirements and potential water demands through the use of storage as part of integrated management of surface and ground water in the Canterbury region. The third stage which is about to commence is a multi-stakeholder evaluation of practical storage options in a sustainability framework.

Push for Greater Water Use Efficiency

As sustainability limits are being reached in run-of-river and groundwater withdrawals, water is becoming the critical resource both for agricultural production and for maintenance of environmental values. While storage provides an option for harvesting more water, stored water comes at a higher cost. With water as the constraint, there is now an opportunity cost for water. There are now greater incentives from a regional resource management perspective to improve the water use efficiency of current water allocations. Environment Canterbury is considering economic drivers to encourage greater efficiency and penalties for discouraging inefficiency.

5. Conclusions

In Canterbury, water availability has become the critical resource for both continued economic development and environmental sustainability. It has been necessary to define sustainability limits for run-of-river and groundwater withdrawals. This has led to a gold rush for the remaining water in the region, a strategic investigation for storages for harvesting more water and a push for greater water use efficiency for current allocations.

6. Key References

Aitchison-Earl, P, Scott D, and Sanders R (2004), Groundwater Allocation Limits: Guidelines for the Canterbury Region; Report No. U04/02, Environment Canterbury.

Horrell, G A (2001), Ashburton River Low Flow Regime; Report No. U01/26, Environment Canterbury.

Canterbury Regional Council (2004), Proposed Natural Resources Regional Plan Chapter 4 Water Quality; Report No. R04/15/4; and Chapter 5 Water Quantity; Report No. R04/15/5.

Figure 1. Map of groundwater zones in the Canterbury region.