INFRASTRUCTURE EVIDENCE BASE 2015 Refresh

Productive Water

March 2015

NATIONAL INFRASTRUCTURE UNIT

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EVIDENCE BASE

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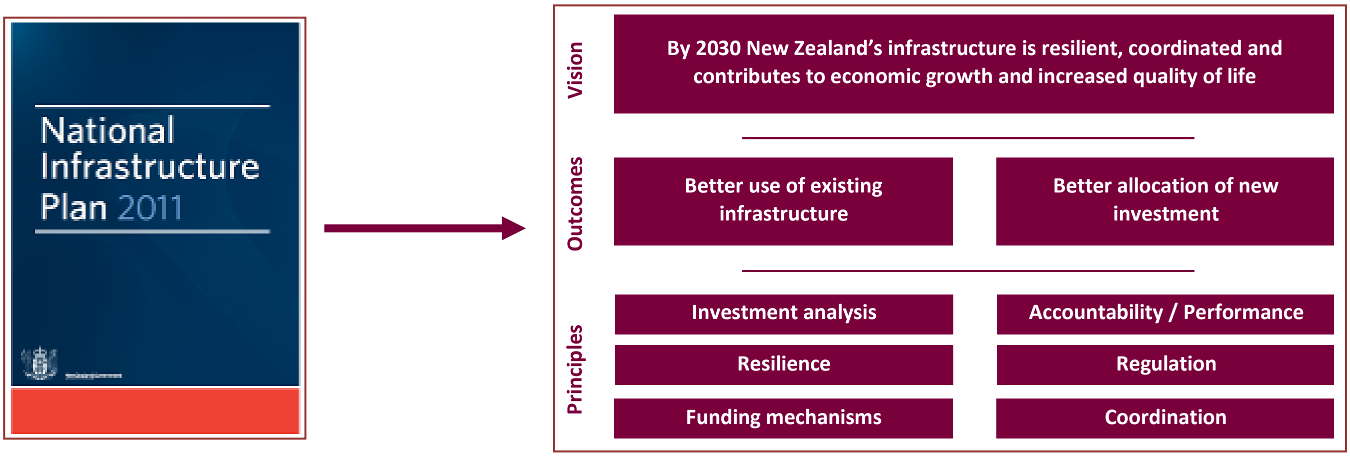
Introduction

Infrastructure is a crucial part of the New Zealand economy. It supports the day to day activities of New Zealanders, helps to improve living standards for all, and can be a driver for economic growth. As such, it is vital it is managed as well as possible. The National Infrastructure Plan 2011 sets out a long term vision for New Zealand's infrastructure and seeks to provide a common direction for how we plan, fund, build and use all economic and social infrastructure.



To support this, in 2014, the National Infrastructure Unit published the first New Zealand Infrastructure Evidence Base, working with owners and providers across all sectors to provide quantitative data where possible, and good quality qualitative analysis where the data is not yet available.

This document provides an update to the 2014 Evidence Base, providing the latest in time series data where appropriate, and reiterating and evolving key messages where required. It draws together work on performance indicators (the current state of the infrastructure), scenario and trend analysis (the future pressures or drivers of demand), the national resilience picture, and the second 10-year Capital Intentions Plan (what is known about indicative future spend). As before it has been compiled in collaboration with sector representatives and we believe it is an accurate representation of the current state of New Zealand's infrastructure.

The timing of this iteration of the Evidence Base is aligned to provide a common understanding of the issues faced by New Zealand's infrastructure, to act as a strong platform for the next New Zealand Infrastructure Plan due to be released later in 2015.

This document forms the substantive component of the Evidence Base for the productive water sector, defined by NIU as irrigation with a focus on the main irrigation schemes and some passing comment on water used for electricity generation. Most of the data and commentary relate to irrigation schemes, which reflects the availability of data despite irrigation schemes only making up 34 percent of total irrigated hectares. However, many of the risks and asset management issues facing irrigation schemes also apply to non-scheme serviced or independent irrigators.

This chapter follows from the overview document, which can be found on the NIU's website. The updates included focus on resource consent data and the capturing of some of the broader issues within the sector such as those around water quality and regulation. The scenario trends and analysis have not been altered.

Where data has been provided, this is publicly available information, and has been provided with permission of the information owner.

EVIDENCE BASE 2015: PRODUCTIVE WATER

Overview messages

Although New Zealand has plentiful water compared to other countries, it is not always in the right place at the right time. Irrigation infrastructure including storage can help to enable the sustainable use of freshwater in areas where water demand is high. Irrigation can be found throughout New Zealand but is concentrated in a small number of regions, particularly Canterbury (62 percent) followed by Otago (13 percent). Irrigation schemes serve 245,000ha of the 721,700ha of total irrigated land.

There is a large variation in asset condition, age and efficiency, which is reflected in the wide range of water cost – a factor of 10 between lowest and highest in one Canterbury analysis, and productivity varies across schemes.

There is also a wide range of asset management practices from immature through to comprehensive asset management programmes. Improvements are being made, driven by increasing liability, changing management structures, increasing regulatory reporting/monitoring, requirements to access Irrigation Acceleration Fund support and investor scrutiny where capital raising.

However, for new irrigation there remains significant investment uncertainty driven by a wide range of due diligence factors, not least of which regards future management expectations for contaminants, including nutrients, which have implications for the ability to intensify land use as well as mitigate costs for existing land use. Irrigation infrastructure often increases the area available for agricultural intensification, and this also has the potential to increase nutrient discharges.

All irrigation, including new developments and their associated land use, will have to perform within tight commercial and community expectations to a higher environmental standard than has been previously required, raising short-term affordability issues. Water from new irrigation schemes or schemes undergoing modernisation will be expensive to deliver; it is widely recognised that reliable and efficient infrastructure to get the most value out of the water available is costly. Add to this the additional cost of environmental mitigations on-farm and the initial capital investment has now considerably increased. This will require future consideration of the intergenerational nature of irrigation development, and a better understanding of where the costs and benefits sit.

Another risk for the sector is that sub-optimal infrastructure development may occur if inefficient processes are adopted to address the necessary iterative cycle of uptake, design, finance and consent considerations within business case risk management. Although, there is an opportunity to collaboratively build on the lessons learnt from each scheme development and utilise existing capital infrastructure development processes. This is an area that should be considered further.

Resilience assessments within the sector could also be developed further. The risk-based decision-making processes commonly adopted in other infrastructure sectors can be utilised in the productive water space to ensure robust and supportable investment decisions are made.

Irrigation has significant interdependencies with the wider infrastructure network – increased pressure on the electricity lines network, synergies and conflicts with hydro-generation assets, changed requirements of the transport network, and an increased need for a modern telecommunications network (RBI) are all integral to operational efficiency for modern schemes and their shareholders' enterprises. There are also indirect links to increased need for social infrastructure as irrigated farms employ more people per hectare.

Context

Large-scale irrigation in New Zealand began in the late 19th century, particularly in the Central Otago region. During the Great Depression of the 1930's, several large-scale irrigation projects such as the Rangitata Diversion Race were built using government funding. The majority of major schemes were constructed between 1960 and the mid 1980's in the Canterbury and Otago regions.

In 1988, central government began to transfer ownership of the Crown schemes to farmers. No schemes remain in Crown ownership.

In 1991, responsibility for approving scheme development was devolved to local government under the Resource Management Act 1991. Central government re-focused its interventions on funding science and technology development, and in later years on better facilitating the planning and proposal development process through initiatives such as the Sustainable Farming Fund and the Community Irrigation Fund.

EVIDENCE BASE 2015: PRODUCTIVE WATER

A limited number of schemes have been developed since devolution, including Opuha Dam (1998, 72,000,000m^3), Waimakariri (1999, 18,000ha), North Otago Stage 1 (2006, 10,000ha), and the Wai-iti Valley Augmentation Dam (2006, 800,000m^3). Each of these projects had significant backing from territorial authorities. More recently, Barrhill Chertsey (2010, 10,000ha) and Acton Farmers Irrigation Cooperative (2011, 6600ha) are operating, Rangitata South is constructed and Central Plains Water (60,000ha) are on track to commission stage 1 (20,000ha) in September 2015.

As captured in the Business Growth Agenda, the Government is committed to improving both the urban and productive water sectors and delivering a sustainable approach to water infrastructure management into the future. This recognises that water resources are critical for the primary production sectors and water is New Zealand's competitive advantage for our export industries. Recent initiatives include:

- The Irrigation Acceleration Fund. First announced at Budget 2011, it has allocated $28.1 million to agreed project work programmes – supporting 18 projects including the Hurunui Water Project, the Ruataniwha Water Storage Optimisation and Tukituki Strategy Implementation, Hunter Downs Development Company Limited, and Central Plains Water Limited Stage 1. The primary focus of the fund is to support the development of rural water infrastructure proposals to the investment-ready prospectus stage.
- The establishment of Crown Irrigation Investments Ltd. Created in July 2013, the company acts as a bridging investor for regional water infrastructure projects, helping kick-start projects that are commercially viable in the longer term and manage the initial uptake risk period. The Government set aside $80 million in Budget 2013 and a further $40 million in Budget 2014 for this purpose. CIIL has made its first investment of $6.5million to Central Plains Water Limited Stage 1.

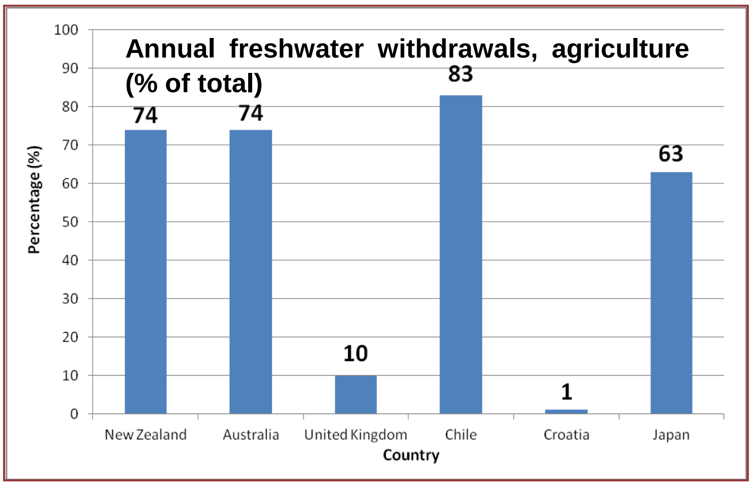
What do we have?

According to the World Bank, 74 percent of New Zealand's freshwater withdrawals go towards agriculture. Internationally, this compares similarly to Australia but much higher than countries like the United Kingdom.

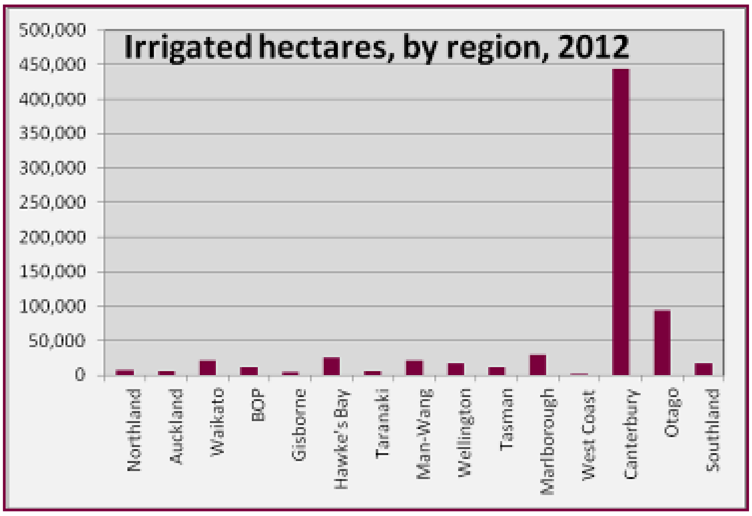
Statistics New Zealand data shows that in 2012, there was a total of 721,700 hectares of irrigated land. The majority of this is in Canterbury (444,800 hectares or 62 percent) with Otago the second largest region (93,900 hectares or 13 percent). The largest North Island region was Hawkes Bay with 26,000 hectares or 4 percent.

The 721,700 hectares in 2012 is an increase of 16 percent over 2007 (619,300 hectares). The majority of this growth was in Canterbury with a further 59,500 hectares, Manawatu-Wanganui with 10,000 hectares and Waikato with 4,400 hectares.

Most of the following data and commentary relate to irrigation schemes. This reflects the availability of data, despite irrigation schemes only making up 34 percent of total irrigated hectares. However, many of the risks and asset management issues facing irrigation schemes also apply to non-scheme serviced or independent irrigators.



Source: World Bank



Source: Statistics NZ

Key features from Irrigation NZ irrigation scheme data show:

- Irrigation schemes currently account for 245,000ha of the national irrigated area. There is approximately another 250,000ha at varying stages of development.
- There is a wide range of scheme size in New Zealand. Whilst the median scheme irrigated area is 4,400ha, the largest (schemes supplied by the Rangitata Diversion Race) currently irrigates 66,000ha and there are a number of irrigation schemes irrigating under 1,000ha (Maungatapere in Northland, for example).
- The average number of shareholders per scheme is 118 with the range from under 10 to over 350. Shareholders are typically irrigators operating within a cooperative company structure.
- The vast majority of schemes are run of river with few currently having any significant storage (excluding buffer ponds and tanks serving operational purposes) and are consequently subject to water supply reductions that may compromise reliable water application. The particularly dry summer during 2014/15 is a case in point. Opuha is an exception with 72 million cubic metres of storage servicing 16,000ha of irrigation, but it still has a risk of supply shortfalls in dry summers.
- The irrigation schemes have extensive distribution networks, the largest having over 100 kilometres of piping or 200 kilometres of open channels.
- The ten largest schemes' water takes on average equate to 0.62 litres per second per hectare (l/s/ha) but range between 0.45 and 0.85 l/s/ha. Their combined take allows the extraction of 130 cubic metres per second.

Alongside irrigation, water is fundamental to the generation of New Zealand's electricity supply with over 75 percent of New Zealand's electricity coming from power stations that are dependent upon freshwater; 60 percent from hydro stations, and 17 percent from freshwater-cooled thermal stations.[1]

Is it where it needs to be?

The location of irrigation schemes is driven by the need for irrigation to enable a range of land uses where rainfall is insufficient and/or unreliable. Factors include: climate, soil water characteristics, the availability of irrigable land (plains and gently sloping land), and the practicality of conveying a reliable water supply to it. As a result the vast majority of irrigation is located upon the plains and foothills of New Zealand's East Coast (approximately 87 per cent of irrigated hectares), particularly where rivers provide a ready source of water as they flow from New Zealand's mountain ranges to the sea.

Where the natural climate and soils are able to underpin a range of land uses, there is less value in developing irrigation. However recent drought events have demonstrated the value of irrigation for risk management in these areas, particularly for high value crops.

Unlike other infrastructure sectors, irrigation directly increases the production base. It therefore requires a comparable increase in the level of service from other infrastructure sectors, both directly, particularly energy and transport, and indirectly, where irrigation results in greater employment and thus an increased need for social infrastructure associated with supporting growing populations. 80 percent of irrigated hectares are in regions that are serviced by New Zealand's five largest export ports (by value).

Alongside transport, a key infrastructure dependency associated with irrigation is the need for a secure electricity supply. The growth in irrigation has changed the electricity demand profile with the summer demand from irrigation now higher in some areas than the traditionally higher winter demand (driven by space heating). For example, Electricity Ashburton report summer demand as more than double the winter period demand. Network capacity has grown at 10 percent compounded for the last ten years and maintenance/capital upgrades requiring equipment outages must be scheduled around peak irrigation periods.

Energy generation can be either synergistic or competitive with irrigation for water supply, depending on the specific situation; for example, the Waitaki storage system enables high reliability of irrigation water to some schemes but competes for water with others. There are opportunities to develop infrastructure in future which can be operated to better utilise capital and water for both purposes.

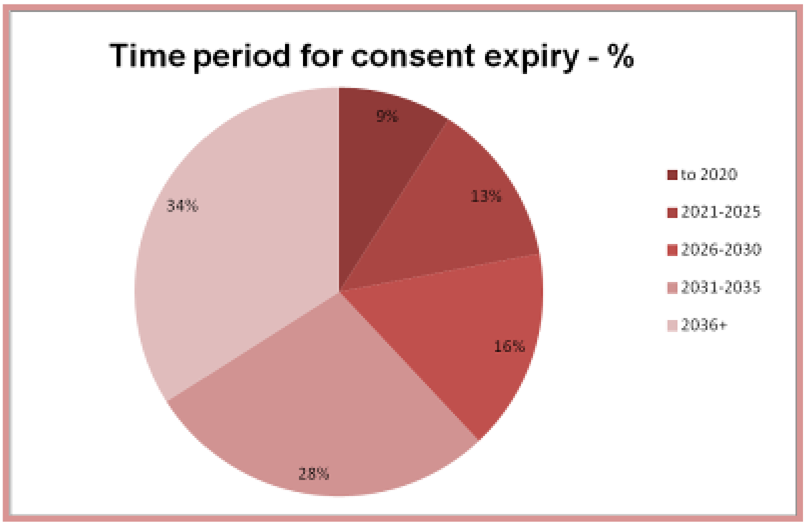
[1] Information prepared for the Land and Water Forum, 2010

80 percent of irrigation is located in or next to regions that generate significant amounts of New Zealand's electricity (Southland, Otago, Canterbury and Waikato).

An understated but now emerging role for irrigation infrastructure is to provide for the recreational and environmental wants of the community which are themselves undersupplied by the more variable climate. Opuha Dam was an early result of the recognition that lack of rainfall was affecting fishing and recreational values in the Opihi River as well as irrigation reliability. Many more instances of realising multiple benefits are likely to emerge throughout New Zealand as communities become involved in collaborative approaches to optimising outcomes from water.

What quality is it?

Reliability of supply has been identified as essential to enable efficient application of water which is required to minimise nutrient loss and avoid over-build of infrastructure. It also enables a wider range of land uses including some very high value (and relatively low-discharging) crops, whereas low reliability water tends to favour pastoral uses. Many schemes were built when water allocation favoured minimising production losses in droughts over in-stream and high value productive uses, exemplified by the low number of schemes with storage. Irrigation NZ data shows reliability typically ranging from 70-95 percent with a number of smaller 'run of river' schemes being as low as 50 percent.



Source: NIU analysis of Irrigation NZ data

A number of schemes are investigating options to increase reliability through the addition of storage. The universal expectation is that reliability needs to increase above 90 percent to encourage on-farm water efficiency and broaden the range of potential uses.

Water use efficiency is becoming a critical strand of infrastructure planning. The cost of additional storage and the need to minimise nutrient losses resulting from inappropriate water application practices are leading to innovative approaches to water use and to making better use of water already available, whether run of river or from existing storage.

Understanding the amount of allocable resource and having hydrologically and environmentally sensible limits will help reliability and investment certainty. Allowing use beyond a limit (or having no upper limit) decreases reliability and investment certainty for all users (because the consented water is effectively spread too thinly).

The process of understanding the science underpinning water quantity and quality limits, associated allocations and nutrient discharge limits, and the role of infrastructure in managing these is a complex and challenging task. The productive water sector has invested heavily in continually trying to improve its understanding of river flows, groundwater and the fate of nutrients as they leach beyond the plant root zone or run-off into rivers and streams; however what happens between the bottom of the root zone and a particular water body is not well understood and can be very location-specific. Irrigation scheme development adds a further level of complexity to this, as they often drive farmers to intensify their land use to make a scheme financially viable and can have implications for the quality of a water body if, for example, the water take will alter the pattern of river flows. This makes it difficult to fully understand the implications of achieving nutrient discharge limits for irrigation companies and individual farm business decision makers, and limited practical experience in applying, and managing, nutrient limits at individual farm level is impacting upon investor confidence.

Nevertheless, under the requirements of the National Policy Statement (NPS) on Freshwater Management 2014, regional councils must have limits and objectives in place by 2025 for water quality and quantity in freshwater in their regions. The objectives and limits are based on community values, the requirement to maintain or improve overall water quality within a region, and national bottom lines for water quality. The period of greatest uncertainty associated with limit setting is confined by the NPS's requirement for initial limits to be set by 2025.

Developing our understanding of how changes in farming practice effect leaching out of the root zone alongside what can be achieved through implementing on-farm good management practice is crucial to understanding the true impacts of irrigation schemes. There are a number of promising developments underway to progress this such as Environment Canterbury's matrix of good management (MGM) for water quality, which is a collaboration between Environment Canterbury, central government, primary sector organisations and Crown Research Institutes.

A further area of focus for irrigators is the duration of resource consents, particularly considering the large upfront capital costs required. Consents for the majority of the significant schemes run through to at least 2031 with many issued for the maximum of 35 years. There are issues for large schemes that experience long gestations following consenting and are of a more staged nature, because of the lack of certainty provided to financiers beyond the 35-year term; a scheme expansion part way through the 35-year term, for example, may be required to repay outstanding debts within the remaining timeframe of the consent. The duration of a consent can also provide the basis for determining the depreciation rate of irrigation assets, which can have accounting implications. However, the Resource Management Act (RMA) does require councils to consider existing investment when considering consent "renewal" applications and the government has also committed to review the duration of consents.[2]

In parallel to the issue of consent duration is the funding mechanisms being utilised, including a combination of debt and equity investment from public and local government sources and may need reviewing. The expectations on return on investment and the rules surrounding public share floats may be causing limitations on the ability to fund schemes that essentially have intergenerational benefits and financial return profiles. The issue of the uptake hump seems to still be a dominant issue yet to be resolved.

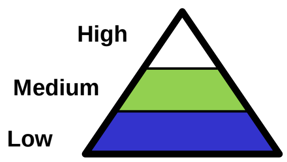
What capacity is it at?

The capacity of water infrastructure has two components – the ability to supply peak flows to farms during in the hottest weeks (peak), and the ability to deliver sufficient water to the desired reliability during the season (volume). As a general rule, most irrigation schemes are running at or just below their current peak flow capacity, i.e. all of the peak flow allocated from rivers above environmental flows under consent requirements is committed to scheme shareholders. But most do not have sufficient storage for reliable supply in drier years (volume), meaning that in many years, the volume allocated is not able to be utilised.

This means that through on-going efficiency gains at both the scheme and farm scale, better co-ordination of peak water takes at the catchment scale, and the development of strategic storage for volume reliability, there is much capacity for irrigation expansion from within existing water take allocations. This is reflected by the number of existing schemes with plans for modernisation and subsequent expansion without increasing allocations or in some cases taking any more water, particularly in Canterbury and Otago.

Truly 'greenfield' irrigation scheme developments are mainly in areas such as the Wairarapa and Hawke's Bay where scheme development was not previously considered.

Key: Levels of Resilience



How resilient is it?

Required levels of resilience will vary depending on perspective. This assessment is made at a national level and for productive water is yet to be developed with robust supporting evidence. NIU defines the resilience of infrastructure to include not just the physical or hard assets but also other aspects such as how infrastructure organisations function, capacity and capability to fund, and community awareness.

Water	Resilience Expectations	Assessed Resilience	Desired Movement
Natural			
Lakes	Low	Low	–
Rivers	Medium	Medium	–
Rural Water			
Irrigation	Low	Medium	–
Reticulation	Medium	Low	↑

To provide an assessment of resilience, the water sector (urban and productive) has been disaggregated and qualitative methods applied to compare resilience expectations (from a national perspective) with the assessed level of resilience to identify desired improvements. These tabulations have been publicly available and presented in various forums through 2012 and 2013 and continue to evolve as new information comes

[2] *Freshwater Reform: 2013 and Beyond*

available.

At this stage the resilience assessment for the water sector has largely been in the urban water component including some exercises looking at specific district water services. Ideally similar work would be undertaken in future for specific irrigation schemes.

In the table to the right productive water is largely encompassed under "Rural Water – Irrigation". The rationale for a low rating (blue) for resilience expectation is that from a national perspective there are numerous schemes with considerable diversity across catchments and across production types. Clearly from a local perspective a medium or high level of resilience would be desirable.

As noted earlier there are significant interdependencies of productive water, both being dependent on other elements of infrastructure to function and being a major contributor to demand on other sectors. This is probably the most important aspect going forward to improve resilience.

How productive is it?

Analysis undertaken by the New Zealand Institute of Economic Research (NZIER) in 2010 for the Ministry of Agriculture and Forestry (MAF, now the Ministry for Primary Industries (MPI)), concluded that the net impact of irrigating an additional 347,000 hectares would be $2.43 billion in added farm gate production, an increase of approximately $7,000 per irrigated hectare.[3] The study also suggested that new irrigation infrastructure could add approximately 400,000 hectares more irrigation, which would add $4 billion per annum in additional exports from a capital investment of $9 billion. In June 2014, an Economic and Social Impact Assessment prepared for the North Otago Irrigation Company for the scheme since Stage 1 was commissioned in 2006 suggests the scheme has added 4.5 percent to Waitaki District's GDP.[4]

Inefficiencies exist with the large scale use of open races/channels to carry water. For example, Ashburton Lyndhurst Irrigation Company calculated water losses from open channels were in excess of 15 percent. An $8 million piping development enabled a further 550 hectares to be irrigated by the 15 percent efficiency gain[5] - stage 2 of this piping development is currently underway.

A survey undertaken in 2012 for Ashburton Electricity Ltd shows the effective price of water supplied by the schemes, once the data set was normalised, ranged from approximately $130-1,250/ha/year or $0.02-0.23/m^3. The mean cost of water supplied by the schemes was calculated as approximately $830/ha/year or $0.15/m^3.[6]

Technology offers a number of promising opportunities to improving on-farm water productivity; some case studies suggest that a combination of electromagnetic (EM) soil surveying to classify areas beneath irrigators into soil zones, ground-truthing to determine available water holding capacity, soil moisture sensor networks and variable rate irrigation can often stretch a water allocation out by up to 30 percent in areas with varying soil conditions.[7]

How well are we managing it?

Nationally, making any statement about overall asset management is difficult due to the lack of a consistent set of data across all irrigation schemes that can be easily aggregated.

Anecdotally, asset management practices have been historically immature; there has not been a formalised annual process for accountability and performance. In part due to the age of many of the schemes, the capital costs have been paid. This is gradually changing, driven by a number of factors including:

- increasing liability – the significant investment that efficient irrigation and its resulting land uses requires has created an increased level of shareholder debt which the irrigation scheme water supply performance underpins;

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3 NZIER 2010, p13.

4 Rationale Ltd, 2014.

5 Irrigation NZ article – John Van Polanen, ALIL Chairman.

6 Aqualinc, 2012.

7 Case study data from Agri Optics New Zealand Ltd.

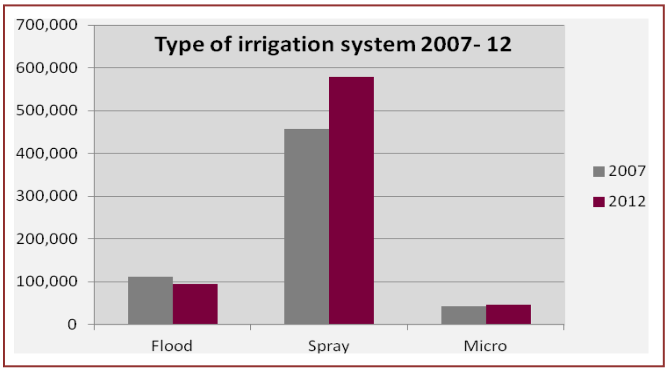
- changing management structures – the majority of large schemes have recently employed skilled general managers with specific responsibilities for the operation of the scheme, which has inevitably resulted in the gradual introduction of more formal asset management systems;
- increasing focus on regulatory factors with water use under increased scrutiny due to scarcity in some catchment areas and also new dam safety requirements (larger races are also captured by the same legislation);
- a number of newer schemes and proposed schemes that need to raise capital, requiring greater discipline; and
- the standards and requirements needing to be met to access the Irrigation Acceleration Fund.

Other factors have also worked to limit the incentives to improve technical, allocative and dynamic efficiencies – most obvious of these is that many schemes' charges have not covered the full operational, maintenance and particularly depreciation costs, and are levied on a per hectare basis rather than a fixed per annum charge per irrigated hectare plus a variable charge per unit of water delivered. All of these signals can and are being improved via current and new infrastructure.

There also remain unexploited collaborative opportunities between irrigation companies that could benefit from economies of scale to improve their asset management practices, such as through the collaborative procurement of telemetered technology. This would also more easily enable the better management of multiple takes from the same water body.

Due to the water measurement and reporting regulations 2010, the overall understanding of national water use and consent data is rapidly developing and has been a key focus of the freshwater reforms. The 2010 Aqualinc analysis covering actual water use assessments showed that for all regions except Gisborne, water use is generally around 50 percent of the consented amount. However, there is large variation between regions from below 30 percent to nearly 200 percent.

The 2012 data also shows a trend towards more effective irrigation methods. Between 2007 and 2012, flood systems have decreased from 18 percent to 13 percent, conversely, more efficient spray and drip-micro systems have increased.



Source: Statistics NZ

In addition to asset management, there are issues around how well we are managing the overall regulatory environment within which irrigation schemes operate. Much of this relates to the inherently complex discussions that occur at the local level over a community's willingness to support an irrigation scheme and difficulties in understanding the science behind nutrient limit setting (as discussed under "what quality is it?"), which can sometimes lead to protracted planning processes and legal challenge and can undermine investor confidence.

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