The Administration of New Zealand Irrigation:

History and Analysis*

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Abstract

The sharply contrasting ways in which community irrigation schemes in New Zealand were developed and managed before and after 1990 illustrate the operation of decentralised vis-à-vis centralised (planning) industry governance systems. While the evidence is not easily quantifiable, what evidence there is suggests that the shift to a decentralised system that took place about 1990 coincides with improved irrigation efficiency. NZ irrigation thus provides an example of the global move away from centrally planned systems and illustrates the important elements of well functioning decentralised systems. Today, farmer owned companies – rather than State owned - are responsible and accountable for scheme development and management. In combination with the RMA - which enables a decentralised approach to resource use - this has facilitated innovation in scheme design, more efficient management, and better water use. It has also revealed more precisely the value of water in irrigation.

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1. Introduction

Irrigation "supplements and augments rainfall to remove or reduce the influence of climatic variability on the land's productive capacity" (MAF, 2004, p.6). And supporting this view, the productivity of an irrigated farm in New Zealand is three times that of a dryland equivalent. Approximately 4% of New Zealand farmland is irrigated, contributing around $1 billion net per annum for the national economy. Atkinson (2006) notes that irrigation accounts for over three quarters of all fresh water allocations in New Zealand. In sum, irrigation makes a very significant contribution to the New Zealand economy.

Although New Zealand has a history of irrigation schemes beginning in the early 1900s, the institutional arrangements under which these have operated have not remained static. Prior to 1990, community irrigation schemes were developed, owned and controlled by the government in a centrally planned manner. Beginning in 1990, existing schemes were sold to farmer owned companies and irrigation schemes have subsequently been developed, owned and controlled in a relatively decentralised setting.

This paper (i) describes critical institutional features of the pre-1990 and post-1990 administrations, (ii) undertakes some qualitative comparisons of community irrigation scheme organisation across the two periods, and (iii) identifies particular factors that affect the relative performance of the two

institutions.[1] As Kornai (1992), and McMillan(2002) point out, there are substantial differences in defined rights and ability to transact that enable a decentralised system to better utilise information and perform relatively well.

Section 2 details the contrasting administrations in New Zealand irrigation. The focus then turns to selected areas of difference. Section 3 compares irrigation scheme design and innovation across the two administrations. Section 4 discusses expectations and decision rules for investing in a scheme. Section 5 analyses property rights to water and the developing water market. Section 6 comments on political economy in irrigation. Finally, section 7 offers some tentative conclusions.

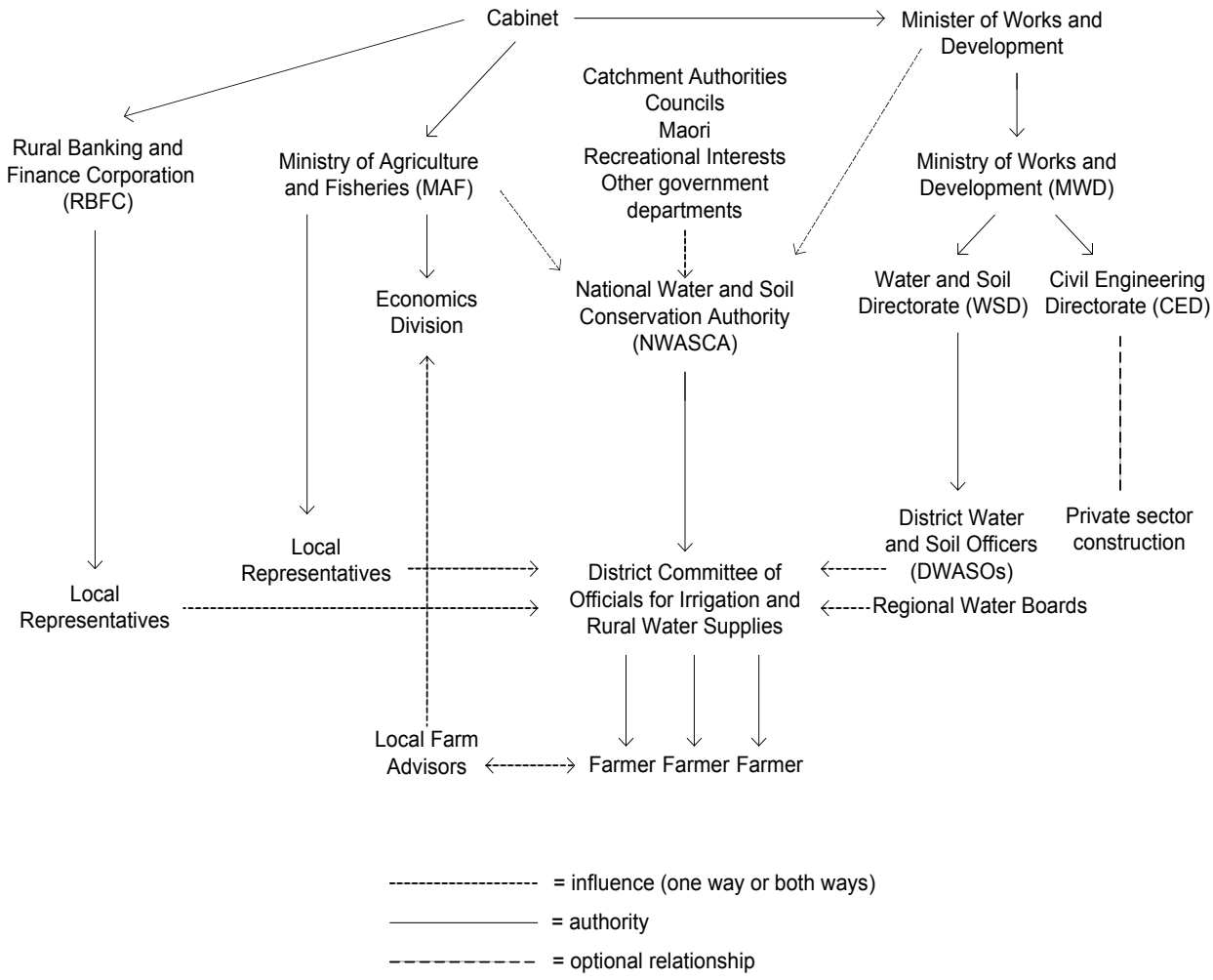
2. Centralised and Decentralised Administration

Centralised Administration

Although centralised administration of NZ irrigation dates back to the early 20th century, the focus here is on the 15-year period immediately preceding the switch to a more decentralised system. Between 1975 and 1990, irrigation scheme development in New Zealand took place within the administration system outlined in Figure 1:

[1] A community irrigation scheme is one with shared headworks that provides water for at least two farmers.

Figure 1. Irrigation Scheme Administration 1975-1990



Farmers would propose a scheme to the District Committee of Officials for Irrigation and Rural Water Supplies, who undertook initial analysis as to whether irrigation was required to supplement rainfall.[2] The National Water and Soil Conservation Authority (NWASCA) would further investigate a proposed scheme, for example by polling all farmers in the community to assess the level of support for the scheme.[3] The Economics Division of the Ministry of Agriculture and Fisheries (MAF) then applied cost-benefit analysis

[2] The District Committee of Officials for Irrigation and Rural Water Supplies included local representatives from MAF, WSD, MAF and regional water boards.
[3] NWASCA involved the input of many groups including MAF, MWD, catchment authorities, councils, Maori, those with recreational interests and other government departments.

(CBA) to assess scheme proposals.[4] Overall administrative responsibility lay with two directorates of the Ministry of Works and Development (MWD): the Water and Soil Directorate (WSD) formed irrigation policy, investigated scheme proposals and provided funding for approved schemes; the Civil Engineering Directorate (CED) was responsible for the design and investigation of a scheme, organising scheme construction, and owning and controlling the scheme once it was constructed.[5]

Funding of irrigation projects reflected the centralised nature of the administration. Table 1 shows the percentage of community irrigation scheme costs covered by the government during the period 1975-90.

Table 1
Government funding of irrigation schemes

	Headworks (%)	Off-farm distribution works (%)	On-farm distribution works (%)
1975	100	50	33.3
1978	100	50	50
1982	70	70	0
1984	35	35	0

Source: Lewthwaite & Martin, 1987, p.5.

Table 2 shows the total cost of off-farm works and the amount funded by the government for four schemes developed during this period:

[4] Now known as the Ministry of Agriculture and Forestry.
[5] A Design and Construct model was used for irrigation schemes in New Zealand during this period. MWD would fund all design and investigation costs and, subject to approval from the necessary bodies, would seek tenders from private sector companies for the construction of the schemes. At the conclusion of construction, schemes were then passed back to the CED to operate and maintain.

Table 2
Government Funding of Off-farm Works

Scheme (date construction began)	Total Cost ($)	Govt. Funding ($)
Maniototo (1975)	5,000,000	3,500,000
Waiareka Downs (1975)	115,000	72,500
Loburn (1977)	232,000	142,100
Kerikeri (1980)	7,437,000	6,507,000

Source: Distortions Committee Report, 1981, pp.8-9.

Together, Tables 1 and 2 reveal that the contribution of government funding to irrigation schemes was substantial, albeit variable over time and across the three key components of a community irrigation scheme. Finally, for any costs not funded through WSD, the Rural Banking and Finance Corporation (RBFC) would provide long-term, concessionary (heavily subsidised) finance to farmers.

At the very top of the hierarchy was the government of the day. Although long-standing, this system was not universally accepted. Critics argued that irrigation schemes were used for political aims, in that those farmers living in marginal electorate seats were more likely to receive funding from the government for a scheme proposal. In addition, centralised government control allied with the ability to politicise decision-making sometimes led to abrupt changes in policies (see section 4 for an example).

The ongoing administration of the schemes was plagued by the absence of rights, and the concomitant responsibilities, that farmers had in them. Part 19 of the Public Works Act 1981 gave the Minister of Works and Development

wide powers over the irrigation schemes and associated activities. Further, information flows through the hierarchy were poor resulting in weak accountability for the funds expended and for the performance of the schemes. Scheme prices were set not on the basis of the willingness and ability to transact but at a level that was politically acceptable (usually below the true cost of the scheme). No value was placed upon water (Ministry for the Environment, 1988), and water transferability was generally limited by its availability being tied to the land.

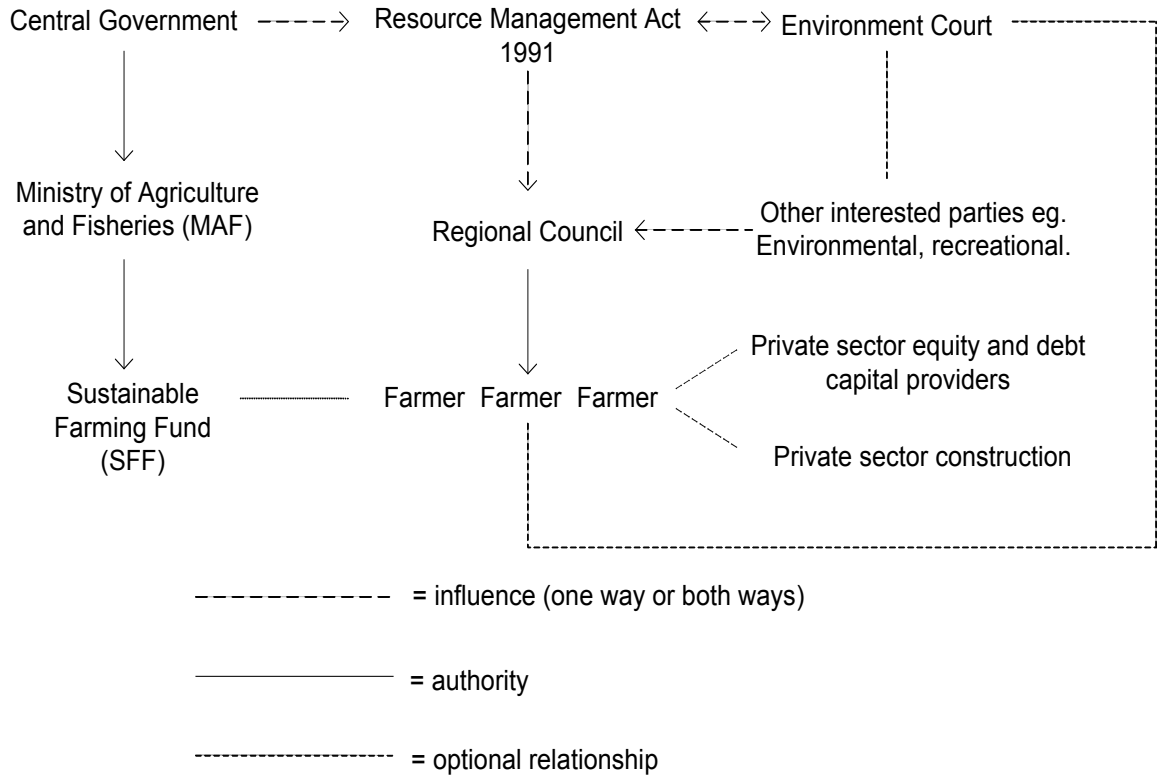
In sum, community irrigation scheme development between 1975 and 1990 involved the input of many local and central governmental bodies. Once developed, schemes were owned and controlled by the central government through the WSD; by 1990 there were 53 schemes administered centrally. This structure was very hierarchical and implied a high degree of centralisation. At the New Zealand Irrigation Association conference in 1978, historian H.A. Morton labelled the New Zealand irrigation sector a "bureaucratic maze". Morton was particularly concerned with the balance of numbers between those involved at the ground level with irrigation (farmers) and those involved in the hierarchy: if the balance was tipped far away from farmers, he feared that the efficient water use could be stifled.

Decentralised Administration

The *Irrigation Schemes Act 1990* was passed to allow the government to dispose of the schemes it owned and end direct involvement with the sector.

The vast majority of schemes (47 out of 49) were sold to farmer groups.[6] Since 1990, the process of developing a new community irrigation scheme has been very different from that prevailing previously, as summarised diagrammatically in Figure 2:

Figure 2. Irrigation Scheme Administration 1990-present



A key feature of today's legislative environment is the *Resource Management Act 1991 (RMA)*, which was passed "to restate and reform the law relating to the use of land, air and water" (*RMA, 1991)*.[7] Administration and implementation of the RMA is vested locally and therefore is consistent with a decentralised economic system. The *RMA* itself provides for the management

[6] Some of the 53 schemes administered by the government were unable to be sold due to a lack of demand.
[7] For further detail on the *RMA* see Hawke (2003).

of activities that affect the environment and gives councils the responsibility to grant water for a period of up to 35 years. However, councils have wide-ranging powers to review consent at any time, which can have a "significant impact on a scheme's access to water" (Gamble, 2002, p.30).[8]

Central government remains directly involved in irrigation only through the Sustainable Farming Fund (SFF) of MAF, which supports projects designed to enhance land-based sectors.[9] The fund provides grants of up to $200,000 per project per year and has an annual budget of around $9.5 million. Private sector finance is required to fund the remainder of the costs of a community irrigation scheme. Central government funding is therefore substantially less today than it was in the earlier period, and its control is negligible.

The design and construction of a scheme today is undertaken privately. Once a community irrigation scheme is constructed, the most common form of ownership is that of a farmer-owned company in which farmers typically own shares entitling them to take water for irrigation from the scheme.

Currently, no scheme is owned by outside investors. One possible reason for this is the potential for hold-up: on-farm and off-farm investments are both sunk and therefore there is potential for the water supplier or demander to exploit the 'locked in' status of the other party. One solution to this problem is to contract by ownership, as is sometimes occurring: typically the shares are not tied to land, but rather to water, and thus allow for tradability.

[8] The *RMA* provides for interested parties to have a say in how water is used, as well as legal redress through the Environment Court for interested parties and/or farmers.
[9] The fund also supports projects outside the irrigation sector.

Under present arrangements, the irrigation companies are accountable to their shareholders and subject to relevant company statutes. This and the fact that water is now valued by farmers - since it (normally) can be transferred by means of the transfer of shares – means that there is direct local interest in the performance of these schemes and in the application of water to its most valued use.

In summary, community irrigation scheme development since 1990 has been relatively decentralised. The sector is now characterised by a rather flat hierarchy that is more local in nature, with a large degree of irrigator independence, particularly in terms of design, ownership and control of schemes. The next section considers scheme design in more detail.

3. Design and Innovation

In the earlier centralised administration period, scheme design was the responsibility of the Economics Division of MAF (economic perspective) and the CED (engineering perspective). Although the two organisations were supposed to work closely together to determine the optimal design, this often failed to occur due to the separation of the organisations. For example, the Economics Division of MAF would often simply “rubber-stamp” project evaluations made by the CED, without having any real involvement in scheme design (Sorrenson, 1977, p.33).

Moreover, Sorrenson (1977) finds that only 2 out of 63 irrigation reports looked at by MAF between 1952 and 1975 considered more than one project design alternative. At the 1984 NZIA conference, NZIA President John Morris criticised this lack of competition in ideas for the design and construction of irrigation schemes, which resulted in a bias towards large, costly, "Rolls Royce" schemes (NZIA, 1986, p.12).

The method of irrigation is important to scheme design. Over time the popularity of spray and trickle irrigation methods has risen relative to more traditional irrigation methods, such as border-dyking and controlled flooding.[10] In schemes developed before 1969, 55.5% of irrigation was through border-dyking methods, 30.5% through controlled flooding, while only 13.9% employed spray and trickle methods. For community irrigation schemes developed between 1970 and 1990, 26.6% of irrigation used border-dyking methods, with 73.4% using spray and trickle methods.[11]

Border-dyking was adopted in approximately one quarter of all schemes developed from 1970-90 despite its widely perceived lower efficiency levels. Experience from early community irrigation in the Canterbury Plains, with its flat country and pastoral farming, showed that border-dyking was effective in

[10] Spray irrigation uses high velocity sprinklers, typically with pumps to power the water through them. Trickle irrigation involves the laying of perforated plastic piping, through which water is then propelled. Border-dyking utilises headworks that collect water from waterways - the water is taken through control gates and down a main race. Lateral races distribute water across the breadth of a scheme, with supply races coming off them. Along these supply races are steps, which can be opened or closed to distribute water along the 'borders' of the fields. Controlled flooding involves simply flooding land (Painter & Carran, 1978).
[11] See Appendix 1 for details of these calculations.

these conditions, and MWD apparently believed that border-dyking could be transplanted onto other, less favourable, terrain with similar success.[12]

These views were apparently reflected in funding for the irrigation methods. For example, the RBFC grant was not available for pumps and motors - major costs in a spray or trickle irrigation system - but *were* available for costs associated solely with border-dyking, such as land grading. This could have perverse consequences: in 1987 the Audit Office found that 65% of farmers involved with the Balmoral scheme would have chosen spray irrigation over border-dyking if financial treatment of the two systems had been neutral.

Since 1990, irrigation sector design decisions have been the responsibility of farmers involved with the scheme. Typically, tenders are sought from firms for the design of a scheme and the best option from those made available is chosen. For example, a feasibility study undertaken in 2006 on the proposed Galatea irrigation scheme in the Bay of Plenty considered five design alternatives, which used variations on water sources such as rivers, dams and groundwater.[13]

As a result of more design alternatives being looked at today, greater incentives for innovation in design exist. The Waimakariri irrigation scheme is a 18,000 ha scheme in Canterbury that was officially opened in 1999. When the scheme was being developed in the late 1990s there was concern about

[12] The government's low, even zero, valuation of water, elaborated on in Section 5, may also have affected decision-making on the relative merits of irrigation methods with differing irrigation efficiency levels.
[13] Based on personal communication with Bob Rout, Aqualinc Research, March 6, 2006.

the characteristics of subsoil along the terrace, as well as the intake being able to handle the Waimakariri River in full flood. Doug Hood Limited won the tender for designing and constructing the main race contract through developing a revolutionary all-in-one fish screen and intake boat.

Prior to 1990, few scheme design alternatives were considered and the adoption of more efficient irrigation methods was stifled. With farmers now being accountable for scheme costs and revenues, the incentives to consider multiple design options and consequently adopt innovation in scheme design have been sharpened.

4. Expectations and Scheme Investment

In the 1975-90 period, farmers were polled by NWASCA under the relevant *Public Works Act* to determine their support for a proposed irrigation scheme. If at least 60% provisionally agreed to a scheme then that scheme's development would proceed to the economic evaluation stage.[14] This involved the Economics Division of MAF using cost-benefit analysis (CBA) to evaluate a scheme design proposal - the decision rule for investing in a scheme was that the net present value (NPV) of its cash flows be positive at a 10% discount rate.[15]

[14] Once a scheme was developed all farmers in the irrigation scheme's boundaries were forced to pay a basic irrigation charge whether they wanted the scheme or not.
[15] There was controversy over the use of a 10% discount rate, with some arguing that a lower rate may have been more applicable so that the benefits and costs experienced far into the future were not down-weighted in CBA analysis (Meister, 1985). The project's cash flows were often adjusted – for example, for a perceived over valued exchange rate – to better measure social, as opposed to private, costs and benefits.

The choice of the threshold discount rate demonstrates how vulnerable farmers were to political decisions. In December 1979, Cabinet decided that from March 1980 all potential community irrigation schemes would be required to show a positive NPV at a 15% discount rate in order to be approved - a decision intended to cut expenditure on irrigation in the presence of a significant budget deficit. Moreover, the decision was made hastily: water and soil representatives from NWASCA were only able to put forward their view on the decision - which they opposed - at the Cabinet meeting where the decision was made. Furthermore the rate was reduced to its former level after only a short period - suggesting an intimate link between centralised administration and political decisions.

Consonant with the decentralisation thrust of the New Zealand economic reforms of the 1980s (Evans, Grimes, Wilkinson and Teece, 1996), the government decided to opt out of irrigation scheme ownership and administration. This resulted in the Economics Division of MAF, in conjunction with Treasury, developing a model that saw irrigation schemes offered to farmers at the present value of their expected cash flows, discounted by 7.5% to the date of sale, less any accumulated debt.[16]

Table 3 provides NPV values calculated by MAF for a selection of schemes developed between 1976 and 1985, as well as subsequent sales figures for these schemes during 1990-91. Seven schemes are included in the analysis:

[16] See MAF (2000) for more details.Note the discount rate used for the sale of schemes (7.5%) was different from the discount rate used to assess scheme proposals (10%). The choice of 7.5% is especially interesting given the high interest rates of the late 1980s and early 1990s.

Amuri (comprised of Balmoral, Waiareka Downs and Waiau), Glenbrook, Glenmark, Kerikeri (also including Kapiro-Pungaere), Loburn, Te Kauwhata and Waimea East. Although six further schemes were developed between 1975 and 1986, *ex ante* CBA for these schemes was either never undertaken or was not available. Interestingly, three schemes were approved for development when initial analysis showed negative NPV figures: Balmoral (part of Amuri) at -$2.3 million; Glenmark at -$0.77 million; and Loburn at -$42,301. The development of these three schemes suggests some deviation from the stated economic rationale for the approval process.

Table 3
NPV Calculations and Sales Figures for Seven Schemes

Scheme	Date of NPV estimation	NPV ($)	Date of Sale	Sales Figure ($)
Amuri[1]	Jan-77	-959,649	Sep-90	717,538
Glenbrook	Jan-85	1,900,000	Sep-90	23,619
Glenmark	Dec-79	-772,200	Sep-91	-177,582
Kerikeri[2]	Dec-78	42,131,140	Sep-90	-282,245
Loburn	Jan-76	-42,301	Dec-90	1
Te Kauwhata	Dec-82	1,970,000	Sep-90	8,232
Waimea East	Jun-79	11,147,434	Sep-90	-190,669

Sources: Hadfield (1980, 1985), Le Page (1980, 1984), MAF (1976, 1977, 1979, 1983, 1992a, 1992b, 1994, 1995, 2000) OPUS (2005) & Wilson (1983).

1. The Balmoral and Waiau schemes' initial NPV figures were both weighted for overseas exchange content while the Waiareka Downs scheme's figure was unweighted.

2. Initial NPV information on the Puketotara scheme, now part of the Kerikeri scheme, is unavailable.

The sales figures are not directly comparable with the NPV calculations, as economic circumstances changed during the intervening period and by 1990 much of the investment was sunk. Nevertheless, from Table 3 it does appear that scheme prospects were commonly not as positive at the date of sale as at the date of implementation. This may indicate that scheme performance frequently failed to live up to initial forecasts made by MAF.

Since 1990, a scheme has proceeded if and only if sufficient farmers expect that scheme to be beneficial to them, subject to attracting finance and gaining the necessary resource consents. Every farmer makes his own rational calculation.

A key factor in scheme development today is garnering sufficient support from the community in which the scheme is to be located. Sometimes, attempts to acquire such community commitment have failed. One example is the North Waihao irrigation scheme proposal in the Waimate district of Canterbury, which was to provide water for up to 20,000 ha of farmland. With estimated capital costs of less than $2,000 per ha and operating costs of less than $100 per ha, it seemed to be “highly economic” at this size (Walsh et al, 2000, p.48). But the scheme only received support for approximately 8,000 ha of the total 20,000 ha and thus did not proceed.

What might cause farmers to reject seemingly-profitable irrigation schemes? While a positive NPV is a necessary condition for a scheme to be developed it is not a sufficient condition. Other considerations need to be taken into

account when deciding whether to invest, especially as an irrigation scheme is a substantial and irreversible investment. Pindyck (1991) argues that the simple rule of investing in a project when its NPV is positive is incorrect when investments are irreversible and can be postponed. Even though an investment is profitable, it may nevertheless be desirable to delay and thereby gain new information that can then be used to make a more informed decision.

However, waiting for new information and technology is not without its own risks, particularly where there are alternative uses of the water. Just south of Blenheim, the Awatere Valley scheme provided the opportunity for farmers along the riverside to have access to irrigation and thus convert from dry stock at approximately $10,000/ha to grapes at around $100,000/ha.[17] The local community rejected this offer. A group of farmers living one valley over quickly acquired the consent for the water, proceeding to pump it past the farmers who had turned down the scheme.

The Waimakariri irrigation scheme demonstrates how learning may play a significant part in recent decisions. Development of this scheme was slow with feasibility studies taking place over ten years. Eventually the scheme was constructed in 1998-99 to meet demand at that point in time, with structures and delivery systems thereby being at or near capacity as soon as water started to flow from the scheme. Soon after the completion of the scheme farmers in the area were demanding more shares and, as a result, there have

[17] From personal communication with Stuart Ford of the Agribusiness group on March 31, 2006.

subsequently been expansions in each of 2000 and 2002, involving the partial re-engineering of the scheme as well as further water share sales. Throughout its life the scheme has been characterised by significant excess demand.

The Waimakariri scheme could have been constructed on a much larger scale initially if community support had been more forthcoming in pre-feasibility/feasibility studies. But the staggered development as seen in Waimakariri may indeed be quite efficient. Expectations necessarily have a degree of uncertainty. To reduce uncertainty, one can invest incrementally as occurred in Waimakariri: it may be socially desirable to do this even in the presence of economies of scale in investment (Evans and Guthrie, 2005). By developing incrementally those involved with the scheme retained more investment options.[18]

Development of both the South Canterbury and Downlands irrigation schemes may demonstrate similar periods of learning. In the South Canterbury scheme, investors purchased up to 30% of shares, since farmer support would otherwise have been inadequate for the scheme to take place.[19] In the Downlands scheme Meridian Energy purchased 25% of shares to pick up the slack in farmer demand. But in both instances farmer demand increased substantially once the schemes neared completion.

[18] See Dixit & Pindyck (1994) for a literature review on incremental investment (ch.11.4).
[19] These investors were themselves farmers involved with the scheme.

Nevertheless, the issue of coordination of independent rational parties does pose coordination issues and, particularly where some parties' participation is essential, may not admit a simple solution. The opportunities for social welfare enhancing coordination are expanded by outside investor participation – as in the case of South Canterbury and Downlands..

To reiterate, there is a different pattern of investment under current arrangements than under the former centralised administration. Schemes are now only adopted if sufficient accountable parties - farmers and outside investors - consider that they are sufficiently profitable. A scheme may grow iteratively in stages, and there is competition in design and construction: all three factors should generally advance efficiency.

5. Property Rights to Water and the Water Market

Access to a reliable, ongoing supply of fresh-water is a necessary condition for a successful irrigation scheme. Property rights to water therefore need to be well defined and enforceable so that the certainty of water supply can be ensured. Investment in water infrastructure and the allocation of water rights to their most productive uses will be adversely affected where such rights do not exist.

Traditionally, water has always been viewed as a public resource in New Zealand, to which no private claims could be made. Throughout the country's

history, the government acted as though it had these rights “in perpetuity” (Farley and Simon ,1996)

But property rights to water were also implicitly tied up with land. If a farm belonged to a community irrigation scheme, the farmer expected to have access to water from that scheme and paid a nominal associated fixed charge. When land was sold, the value of water rights was typically capitalised into the value of the land.[20] The tying of water rights to land effectively precluded the trading of any water rights independently of land. This reflected the general control that the Government had over all aspects of irrigation schemes, and its view that water did not have a price and that charges for water should reflect only the cost of water storage and distribution infrastructure. Consequently, following the 1971 review of irrigation policy by the Working Committee of the Water Allocation Council, irrigators had to pay for the costs of storing and distributing water, but water itself was not priced.[21]

In 1991 the *RMA* came into force. The *RMA* defines a property rights structure for resources, providing constraints and incentives for resource users. In terms of water, the *RMA* allows councils to grant consents to take and use water for up to 35 years. The 35 year period of resource consent is intended to provide adequate certainty for those undertaking an irrigation scheme to gain returns on the significant investment that irrigation requires.[22]

[20] This was the case for both publicly funded and privately funded irrigators.
[21] See Appendix 2 for how water charges were set by MWD.
[22] At least a 35-year period is needed to provide for this certainty (Counsell & Evans, 2005; Martin, 2003).

The *RMA* allows regional and district councils to change consent conditions at any stage. Section 128 of the *RMA* states that consent authorities can review the conditions of resource consent if there are adverse effects on the environment. The *RMA* also allows for consents for water to be altered to be brought into line with a "regional plan" or "national environmental standards" that are made after the granting of the consent (*Resource Management Act, 1991*).[23] Such legislation induces uncertainty for all water users, including those in the irrigation sector.

In a report on irrigator views on the *RMA* and water rights undertaken by Harris Consulting in 2003 for MAF and the Ministry for the Environment (MFE), Canterbury irrigators felt that the 35-year term for water extraction was "meaningless" due to the ability of the council to change conditions. In particular, irrigators expressed concern over "clawback" where the council may take back water rights granted and return them to the common pool. One interviewee went as far as saying they would not undertake another irrigation development due to such insecurity of rights to water. This hostility towards the unilateral nature of clawback was also commonly expressed in personal communication with those involved with irrigation during my research.[24]

[23] RMA Section 128(1) A consent authority may, in accordance with section 129, serve notice on a consent holder of its intention to review the conditions of a resource consent: (b) In the case of a water, coastal, or discharge permit, when a regional plan has been made operative which sets rules relating to maximum or minimum levels or flows or rates of use of water, or minimum standards of water quality or air quality, or ranges of temperature or pressure of geothermal water, and in the regional council's opinion it is appropriate to review the conditions of the permit in order to enable the levels, flows, rates, or standards set by the rule to be met; or (ba) in the case of a water, coastal, or discharge permit, when relevant national environmental standards have been made.

[24] There are, of course, some justifiable reasons for modification of rights, e.g., learning about the aggregate state of catchment water availability.

The *RMA* thus defines a property rights structure for water in post-reform New Zealand that is enforced by councils. However, rights to water may be constrained by council clawback. Further constraints are placed on the trading of water rights, which is allowed for in section 136 of the *RMA*.[25]

Firstly, transfers must take place within the same "catchment, aquifer, or geothermal field" (*RMA, 1991*). This stipulation restricts the number of water users able to trade in water. Secondly, resource consents are granted for specific water uses. For example, Waimakariri Irrigation Limited's Resource Consent CRC952569 states that water is to be used solely for "stockwater supply, irrigation water supply, augmentation of groundwater supply". As such, this water cannot be traded across different uses. Thirdly, trading must be "expressly allowed" by a council's regional plan or else must be approved by the consent authority; The vast majority of regional plans do not include the necessary provisions to allow for trading in water rights (MFE, 2004).

The cooperative companies that own irrigation schemes are nevertheless able to overcome some of the RMA s.136 impediments to water rights exchange. Since these companies hold the rights – rather than individual owners - use and purpose does not change when ownership of the company changes.

[25] Section 136(1) A holder of a water permit granted for damming or diverting water may transfer the whole of the holder's interest in the permit to any owner or occupier of the site in respect of which the permit is granted, but may not transfer the permit to any other person or from site to site. (2) A holder of a water permit granted other than for damming or diverting water may transfer the whole or any part of the holder's interest in the permit (a) To any owner or occupier of the site in respect of which the permit is granted; or (b) To another person on another site, or to another site, if both sites are in the same catchment (either upstream or downstream), aquifer, or geothermal field, and the transfer (i) Is expressly allowed by a regional plan or (ii) Has been approved by the consent authority that granted the permit on an application under subsection.

Since water rights are tied to share ownership in the cooperative company, ownership share trades duplicate water rights trades.

Trading of shares, and thus trading of water rights within community irrigation schemes, has been increasing in recent years. For example, trading has occurred within Ashburton-Lyndhurst Irrigation Scheme (ALIS), Irrigation North Otago Limited (INOL), Mayfield-Hinds Irrigation Scheme Limited (MHISL), South Canterbury Farmers Irrigation Society (SCFIS) and Waimakariri Irrigation limited (WIL), among other schemes.[26]

Irrigation companies typically facilitate trading by registering supply offers and demand requests from farmers, leaving it to the individual farmers to arrive at a price for a trade. In 2004-05 200 shares were traded in ALIS. The water cost to irrigate one hectare ranged from $2,000-$4,000 and is continuing to rise. Trades are not as common in MHISL. Nonetheless the cost of irrigating a hectare in MHISL too is rising over time, approaching $4,000 today after beginning at $1,500 in 2002. The cost of irrigating a hectare in SCFIS was $62.5 when the scheme was first established in 1999. Today the cost is as much as $3,250, with an average price of around $1,500. Trades in SCFIS occur once or twice a month. Trades in WIL have also been taking place - the cost of irrigating a hectare was $364-510 from 1999-2002 when shares were first issued. Today prices are approximately $1,000-1,200. Significant excess demand for shares is evident: as at March 2006 15-20 shares were being offered but over 900 demanded. Share prices do not necessarily reflect

[26] Background information on these schemes is available in Appendix 3.

excess demand due to many trades not being physically possible. Consequently water rights are frequently still capitalised into land values in the WIL scheme, much as used to occur in the centrally administered period.[27] In INOL, Meridian Energy purchased excess shares from the initial offering, amounting to 25% of the scheme, and is now selling them to farmers at the initial price plus interest and holding costs.[28]

Bilateral trading of water is therefore increasingly taking place within community irrigation schemes. The ownership and governance structures of the cooperative irrigation companies overcome *RMA* impediments to exchange.[29] However, trading *across* water uses has not yet occurred due to the *RMA* requirement that councils grant water consents for specific purposes.

Under the current decentralised administration, irrigation water is being priced and water prices are rising to significant levels in accord with water scarcity. The market for irrigation water in New Zealand may be considered 'thin' as there are not that many trades, but such markets are not typically 'thick' anywhere, and anyway need not be hugely liquid in order to allow sufficient flexibility for water to travel to the most productive irrigation scheme user.

[27] Information on scheme water trading is from personal communication in March and April 2006 with ALIS Chairman Rupert Curd, MHISL Chairman David Keeley, SCFIS Chairman Tom Henderson and WIL Chairman Gerry Clemens.

[28] From personal communication with Stuart Ford of the Agribusiness group on March 31, 2006.

[29] While it may be feasible for non-farming investor participation in irrigation schemes and there may be advantages in terms of availability of capital and scheme establishment coordination; the cooperative form does solve the specific asset contracting problems that attend on-farm and off-farm irrigation infrastructure investment. The cooperative form also facilitates water trading.

6. Political Economy

As previously mentioned, the 1975-90 period was characterised by direct central or national political oversight of irrigation investment decisions and of the processes of scheme administration, including pricing. By contrast, today there is limited central government involvement in the irrigation sector. Instead, political input is more apparent at the local government level, with district and regional councils increasingly being involved in the funding of schemes. The Waimakariri, Timaru, Mackenzie, Waimate, Canterbury and Christchurch City councils have all offered some form of financial assistance to community irrigation schemes, including the offer of financial guarantees, the provision of equity or debt financing, and the underwriting of revenue streams. Typically the council expects to receive their financial contribution back once a scheme is up and running, so their primary interest is in assisting the initial coordination phase.

The financial involvement of councils in funding the development of community irrigation schemes raises two potential conflicts of interest. Firstly, councils have an obligation to the wider district or region that they represent. Consequently, they may encourage the expansion of community irrigation schemes on distributional grounds, so that more voting members of their area receive the benefits of irrigation. In this context, the Christchurch District Council and Selwyn District Council provided the majority of funding for the development of the Central Plains irrigation scheme, which amounted to a loan of several million dollars. The council wanted the scheme to service

80,000 ha of farmland in the region, despite the optimal size being arguably much smaller.

A second potential conflict of interest is raised by councils' dual roles. Regional and District councils are responsible for approving and enforcing resource consents under the RMA. These consents are necessary for a scheme's construction, as well as for the taking of water. If councils become major financiers of projects that also require council permission to proceed, the potential for politicised decision-making is obvious. Local government involvement in financing community irrigation schemes therefore needs to be viewed with caution.

7. Conclusions

New Zealand's irrigation sector has been through significant change. Prior to 1990, the sector was highly centralised and characterised by extensive government involvement, a large bureaucracy, and little role for farmers or other investors. The economic reforms of the late 1980s resulted in a decentralised framework with a much-reduced role for central government. Existing schemes were placed under private ownership in 1990-91 and a relatively decentralised sector resulted.

While the benefits and costs of the change are difficult to quantify – a task that has not been attempted here - available indicators of performance suggest that centralised administration of the sector exhibited significant shortcomings.

Efficient scheme design was not sought and proper criteria for investment were often not adopted. The lack of accountability arising from non-existent ownership rights and the associated inability to respond to interplay of supply and demand meant that the schemes - and water allocation generally -were not managed efficiently. Consequently, the value of water in irrigation was not revealed or priced on its own merits.[30] By contrast, today's schemes reveal the value of water applied in irrigation and to a considerable extent the value of irrigation water in its best use. These improvements may partly reflect changed supply and demand conditions for water since 1990, but it is difficult to envisage how the earlier centralised system could have performed any better in the later period than it had earlier.

Irrigation scheme management in the New Zealand economy would seem to provide clear evidence of the benefits of accountabilities, incentives, and proximity of information to relevant decision makers that are attributed to a decentralised relative to a centrally administered economic system, consistent with the conclusions of scholars such as Kornai (1992) and McMillan (2002) who emphasize the general advantages of decentralised systems.

[30] Discovery of the value of water in its different uses enables more efficient water allocation. The discovery of its value in irrigation and – from the electricity market (see Counsel and Evans (2004)) – the value in electricity production facilitates the socially beneficial use of this increasingly scarce – relative to demand – resource.

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Appendix 1. The Method of Irrigation in Pre-1990 Irrigation
Source: Adapted from table 4.1 in MAF (1990).

For each community irrigation scheme, the method/s of irrigation were contained in the Historical Accounts. In order to quantify this qualitative information, the following approach was taken.

1. Each scheme has 1(=100%), which must be allocated towards an irrigation method or methods.
2. Where the word "some" preceded the irrigation method in the Historical Accounts, a value of 0.1 was allocated for this method.
3. The remaining proportion was divided among the major methods of irrigation used for that scheme.

For example, if a scheme used "border-dyking, wild flooding, some spray", then some spray is allocated 0.1 and border-dyking and flooding are each allocated (1-0.1)/2 = 0.45. If a scheme used "trickle", trickle is allocated 1.

Central Otago (pre-1970)	Border-Dyke	Spray	Trickle	Wild Flooding
Ardgour	0.1	0	0	0.9
Arrow	0.4	0.1	0.1	0.4
Bannockburn	0.1	0	0	0.9
Earnscleugh/Blackmans	0.25	0.25	0.25	0.25
Galloway	0.5	0	0	0.5
Hawkdun	0.5	0	0	0.5
Ida Valley	0.45	0.1	0	0.45
Idaburn	1	0	0	0
Last Chance	0	0.1	0	0.9
Manuherikia	0.9	0.1	0	0
Omakau	0.5	0	0	0.5
Pisa Flat	0.9	0	0	0.1
Ripponvale	0.5	0	0.5	0
Tarras	0.5	0	0	0.5
Teviot	0.33	0.33	0	0.33
	6.93	**0.98**	**0.85**	**6.23**

Mid Canterbury (pre-1970)	Border-Dyke	Spray	Trickle	Wild Flooding
Ashburton-Lyndhurst	0.9	0.1	0	0
Mayfield-Hinds	0.9	0.1	0	0
Redcliff	0.9	0.1	0	0
Valetta	1	0	0	0
	3.7	**0.3**	**0**	**0**

1960s schemes	Border-Dyke	Spray	Trickle	Wild Flooding
Hawea	0.45	0.1	0	0.45
Lower Waitaki	0.45	0.45	0.1	0
Morven Glenavy	0.9	0.1	0	0
Upper Waitaki/Ext	0.33	0.33	0	0.33
	2.13	**0.98**	**0.1**	**0.78**

Post 1970 schemes	Border-Dyke	Spray	Trickle	Wild Flooding
Balmoral	0.9	0.1	0	0
Eiffelton	0.1	0.9	0	0
Glenbrook	0	0.5	0.5	0
Glenmark	0	0.5	0.5	0
Kapiro-Pungaere	0	0	1	0
Kerikeri	0	0	1	0
Levels	0.45	0.45	0.1	0
Loburn	0	0	1	0
Maerewhenua	1	0	0	0
Maniototo[31]	0.8	0.2	0	0
Pukerimu	0	0.5	0.5	0
Puketotara	0	0	1	0
Tablelands	0	0	1	0
Te Kauwhata	0	0.5	0.5	0
Tebbutts Road	0	0.5	0.5	0
Waiareka Downs	0.9	0.1	0	0
Waiau	0.9	0.1	0	0
Waiaua	0	0	1	0
Waimea East	0	0.5	0.5	0
	5.05	**4.85**	**9.1**	**0**
Up to 1969 (raw)	**12.76**	**2.26**	**0.95**	**7.01**
Beyond 1970 (raw)	**5.05**	**4.85**	**9.1**	**0**
Up to 1969 (%)	**55.5%**	**9.8%**	**4.1%**	**30.5%**
Beyond 1970 (%)	**26.6%**	**25.5%**	**47.9%**	**0.0%**

[31] In the Historical Accounts the Maniototo scheme was the only scheme for which irrigation method percentages were provided.

Appendix 2. The 'Basic' and 'Availability' Water Charges as set by MWD

The *Public Works Amendment Act 1975* set out how to calculate the 'basic' and 'availability' charges for water from community irrigation schemes.

The basic charge was levied on farmers associated with a community irrigation scheme whether they took water or not. The basic charge per hectare was set as follows:

$$\text{Basic charge (per hectare)} = (c.p.f)/h$$

Where c = estimation of capital costs (not including headworks), p = proportion of cost to be recovered by the government (not more than half), f = factor to allow for the repayment of the proportion of capital costs and interest over a 40 year period and h = estimated total number of hectares of land in the proposed irrigation district. MWD (1978) state the basic charge was designed so that the government could recover the farmers' share of a community irrigation scheme, including on-farm costs, non-headworks off-farm costs and interest over a 40-year period. The basic charge varied considerably across schemes. At the commencement of supply, for example, the charge was $46.75/ha in the Balmoral scheme, $13/ha in the Eiffelton scheme and $607/ha in the Glenbrook scheme.

The water availability charge was levied on farmers once they took water from a community irrigation scheme. The availability charge was set as follows, per hectare:

Water Availability charge (per hectare) = {[c.p+(o.k)]f+o+r}/h[32] [33]

Where c, p, f and h are defined as before, o = estimated amount to cover operation and maintenance costs, k = present value factor for seven years operation expenses and r = annual estimate to cover planned renewal of off-farm water supply works. MWD (1978) state the aim of the availability charge was to cover not only the capital costs of a scheme, but also seven years worth of expected operation and maintenance costs, spread over a 40-year period and including interest. Additionally, the expected annual operation and maintenance costs and expected annual renewal costs for off-farm works were covered by the availability charge. The water availability charge also differed substantially across schemes: the charge was $62.3/ha for Balmoral; $13/ha for Eiffelton; and $920/ha for Glenbrook at the commencement of supply.

[32] $o.k = o/1+r + o/(1+r)^2 + \ldots + o/(1+r)^7$

[33] Some schemes had their availability charges levied per unit of water ($1000m^3$) rather than on a per hectare basis.

Appendix 3. Background Information on Schemes with Trading

Ashburton-Lyndhurst Irrigation Society (ALIS)

The Ashburton-Lyndhurst irrigation scheme has 50,000 shares covering 25,000 ha of land, with trading taking place over the past four years. Water is provided to the scheme by the Rangitata Diversion Race (RDR). The Rangitata Diversion Race is 67km long, diverting water from the Rangitata River to irrigate 66,000 ha of farmland in mid-Canterbury via three community irrigation schemes: Ashburton-Lyndhurst, Mayfield-Hinds and Valetta.

Irrigation North Otago Limited (INOL) [34]

After a lengthy period of development, the 20,000 ha North Otago irrigation scheme is about to be commissioned in two equal stages, with the first water expected from the scheme late in 2006. In order to raise capital for the first stage of the scheme (10,000 ha), Meridian Energy underwrote 25% of the scheme, or 2,500 ha. Meridian's involvement followed from their prior involvement in the nearby (but aborted) Project Aqua hydroelectric development.

Mayfield-Hinds Irrigation Society Limited (MHISL)

Sourcing water through the RDR in mid-Canterbury, MHISL initially sold 64,000 shares, with two shares irrigating a hectare. Necessary constitutional changes to allow for trading delayed the development of a water market in the

[34] The North Otago irrigation scheme is also known as the Downlands irrigation scheme.

scheme. Nonetheless trading has been taking place now for approximately two years.

South Canterbury Farmers Irrigation Society (SCFIS) [35]

The South Canterbury Farmers Irrigation Society was established in 1999 to administer irrigation around the Opuha dam project. 4,000 shares were sold to farmers at $250 each, with no further issues of shares having occurred. Each share covers 4 ha of land and thus the total scheme is 16,000 ha in size. The SCFIS was one of the first large-scale community irrigation projects to be implemented in the decentralised administration (DA).

Waimakariri Irrigation Limited (WIL)

The Waimakariri irrigation scheme in Canterbury has 268 shareholders holding 18,000 shares, with each share being the equivalent of one ha irrigation. The scheme was developed in the 1990s and officially opened in 1999, making it too one of the first large scale schemes in the DA period.

[35] The SCFIS is also known as the Opuha irrigation scheme.