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Achieving Efficiency in Water Allocation:

A Review of Domestic and International Practices

Kevin Counsell[*]

New Zealand Institute for the Study of Competition and Regulation

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Abstract

As populations grow and demand for clean water increases, managing and allocating scarce water resources is becoming an increasingly important task. A vital part of this task is establishing the appropriate framework for the water sector, which includes establishing effective property rights to water and the appropriate institutional arrangements to allocate these rights. In this paper we outline the current framework for water allocation and management in New Zealand. We identify a number of issues with the current framework and argue that these issues are significant enough to warrant consideration of possible alternatives. The obvious first place to look for alternative approaches is at overseas arrangements, particularly in countries with recent experience in the reform of their water sectors. We outline the arrangements for a number of countries and establish lessons for New Zealand. Although there is no single model of best practice that fits all countries, we identify some basic principles of good water management that will generate benefits for New Zealand.

1 Introduction

> "If the wars of this century were fought over oil, the wars of the next century will be fought over water"
>
> Ismail Serageldin, World Bank Vice President, 1995.

Wars over water are not as unlikely as they may seem. In many countries, particularly those where water flows across international boundaries, water is so scarce that conflicts over its allocation and management can, and do, arise. In such countries, the efficient allocation of what limited water resources there are is crucial to the well-being and health of its people. In contrast, as New Zealanders, we often take our water resources for granted. New Zealand is relatively well endowed with rainfall and water resources. Despite this, increasing demands on water from competing in-stream and abstractive users, and an uneven distribution of both rainfall and water resources, combine to make the efficient allocation of water an increasingly critical issue.

As an initial look at this issue, this paper considers the approaches taken by New Zealand and other countries towards the allocation and management of water. Section 2 explains in detail the current practices for water allocation in New Zealand and discusses problems that exist with these practices. In section 3, the approaches of a number of other countries are outlined. These countries were selected as they have a range of different experiences in water allocation and management and offer a number of areas for New Zealand to learn from. Many have also recently reformed their water sectors

or are in the process of doing so. Section 4 determines the lessons for New Zealand from overseas experience and thus highlights some alternatives for New Zealand to consider in addressing some of the concerns with its current water arrangements. Concluding comments are provided in section 5.

2 Water Allocation in New Zealand

Achieving economic efficiency[1] and best practice in the management and allocation of water resources in New Zealand has never been a high priority, perhaps due to the abundance of water in comparison to other countries. However, more recently, growing populations and competition amongst uses are putting an increasing strain on New Zealand's water resources. Examples include the Auckland water crisis in 1994, the drought affecting many farms and vineyards over much of Marlborough in 2001, the effect of low lake inflows on the generation of electricity in 2001 and 2003, the recent water shortage on the Kapiti Coast in the summer of 2003, and the current competition for Waitaki river water between irrigation and hydro-electric generation uses in South Canterbury. It is therefore becoming increasingly more important to consider the issues currently facing New Zealand's water sector.

However, before considering these issues it is useful to start with an outline of the current arrangements for water resource management in New Zealand. The defining aspects for the operation of any resource allocation

[1]See appendix A for an outline of the definition of economic efficiency and why the current system for water allocation in New Zealand does not achieve a high level of efficiency.

regime are property rights and institutional arrangements. In terms of water, a property right is a claim to the use of water and the benefits that accrue from its use.[2] Such a claim is usually protected by the state or legal system. Institutional arrangements are the social institutions that are formed to manage and allocate resources. They may be markets, where buyers and sellers interact through decentralised decisions to allocate resources; government institutions, with either nationwide or local decision-making; private profit-making companies; or various combinations of these and other types of institutions. The key point is that property rights and institutional arrangements are complementary and vital to the functioning of an effective water allocation system.

This section considers the aspects of property rights and institutional arrangements for water allocation in New Zealand. We first briefly outline New Zealand's current water environment, and the sources and uses of water. We then outline the legislative framework that defines and enforces property rights for water. We also outline the institutional framework for the allocation of water rights and explain the current practice of allocating and supplying water to final users. Following that, we identify some issues that exist in the current arrangements, and it is argued that these issues are significant enough to warrant consideration of alternative water allocation methods.

[2]See appendix B for the basic economic theory of property rights.

2.1 Sources and Uses of Water

New Zealand's water environment is fed by an abundant rainfall, with the total amount of precipitation estimated as anywhere between 300 billion and 600 billion cubic metres per year (Ministry for the Environment, 1997). However, this rainfall is not evenly spread, geographically or throughout the year. Some areas are particularly dry, such as Central Otago, which is a rain shadow area and has an average yearly rainfall of only 350mm. Other areas receive substantial rainfall, for example Westland, which has an average rainfall of more than 6000mm per year. Intertemporal rainfall variations also occur frequently, resulting in droughts and water shortages in some areas, and flooding in others.

Rainfall collects in both surface waters (such as streams, rivers, lakes and wetlands) and groundwater deposits. New Zealand has around 70 major rivers, over 770 lakes, a huge number of streams and numerous underground aquifers. These include a number of relatively small catchments that have little or no connection to other catchments.[3] New Zealand draws its water from both surface water and groundwater resources. Rivers and lakes provide about 60 percent of the water we consume with the remainder provided by groundwater sources (Ministry for the Environment, 1997).

Water is used for a number of competing activities in New Zealand. The largest volume of water used is for hydro-electric generation purposes, with

[3]This is in contrast to many overseas examples, such as Australia and the Western United States, where large rivers with a significant catchment area are more common.

over 100 billion cubic metres per year flowing through hydro station turbines to meet the country's electricity needs (Statistics New Zealand, 2002). Other in-stream uses of water include recreational uses and environmental uses (such as the preservation and sustenance of aquatic life, flora and fauna). A number of lakes, rivers and wetlands are also preserved for conservation or due to their location in national parks. Consumptive uses of water include irrigation, livestock consumption, household consumption and industrial use. Excluding hydro-electric generation, water use for such activities is close to 2 billion cubic metres per year. Water for irrigation purposes is by far the largest use. Some estimates have put irrigation water at around 57 percent of total consumptive water use (Statistics New Zealand, 2002). Others, such as an analysis of resource consents to use water (excluding hydro-electric generation) by Lincoln Environmental (2000), estimated that as much as 77 percent of water allocated is for irrigation purposes.

2.2 The Legislative Framework

The main legislation governing the management of water, and in fact all natural and physical resources, is the Resource Management Act 1991 (RMA). The RMA came into force on 1 October 1991. Before then, numerous statutes and regulations relating to the environment existed. The RMA set out to integrate these into one major piece of legislation.[4] The RMA created a

[4]Prior to the RMA, the main legislation governing water management was the Water and Soil Conservation Act 1967 and the Town and Country Planning Act 1977.

framework for decentralised decision-making: that is, decision-making at the individual company and local government level rather than the central government level. A key advantage of this over centralised resource allocation is that there is no need to achieve a national consensus on allocation, which would obviously be difficult given the variety of competing interest groups. Rather, decentralised decision-making can take into account the needs and preferences of smaller, local groups (Hawke, 2003b).

The overall purpose of the RMA is "to promote the sustainable management of natural and physical resources" (part 2, section 5). As defined in the RMA, sustainable management means managing natural and physical resources to provide for current needs while:

> "(a) Sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and
>
> (b) Safeguarding the life supporting capacity of air, water, soil, and ecosystems; and
>
> (c) Avoiding, remedying or mitigating any adverse effects of activities on the environment" (part 2, section 5).

The RMA focuses on the effects of our activities (as opposed to the activities themselves) and ways to reduce or eliminate any of these effects that may harm the environment.

Along with the purpose of the RMA, the other key part of the Act is

the identification of some important principles that decision makers need to recognise and provide for when making decisions under the Act (part 2, sections 6 to 8). These principles are:

- Matters of national importance: such as the protection of the natural character of our environment, and the protection of natural features and landscapes.

- Other matters: included here are a number of distinct issues such as the exercise of guardianship of an area by tangata whenua, the efficient use of a resource and the recognition and protection of heritage values.

- Principles of the Treaty of Waitangi.[5]

Decisions on whether or not to authorise a particular activity must recognise and provide for these principles.

At the national policy level, the responsibility for administering and managing the RMA lies with the Ministry for the Environment. The Department of Conservation also has a role at this level, although only relating to New Zealand's coastal water environment. The main role of decision-making under the RMA, particularly with regard to water allocation, is played by the 12 regional councils and 4 unitary authorities[6] (hereafter collectively termed

[5]In terms of the RMA, one of the main principles of the Treaty of Waitangi is a duty to consult with Maori on resource management decisions (Parliamentary Commissioner for the Environment, 1998).

[6]Unitary Authorities exist in areas where there are no regional councils and are endowed with the responsibilities of both a regional council and a local district or city council in the particular region.

councils). The councils were developed with the role of water management in mind, as their boundaries are broadly defined in terms of the major water catchments.

The RMA effectively requires a strategic planning approach to water allocation. It provides councils with a number of tools to use for water allocation and management, namely: plans and policy statements, resource consents, and enforcement mechanisms.

Plans and policy statements are issued in a hierarchical fashion, where those at the lower level must be consistent with those higher in the hierarchy. At the highest level, the RMA allows the Minister for the Environment to issue national policy statements and national environmental standards, relating to matters of national significance. However, since the inception of the RMA there has been little use of these in relation to water resources. At the next level are regional policy statements, which all councils must prepare. Regional policy statements present an overview of all the natural and physical resource issues in the region. Councils may prepare regional plans (although the RMA does not require these as a necessity) and most councils do. A regional plan describes the objectives, policies and methods used to manage the region's water resources. Regional plans must be consistent with regional policy statements. At the lowest level are district plans, which district and city councils must prepare. Like regional plans, these detail the objectives, policies and methods used to address resource management issues for the particular district or city.

Along with plans and policy statements, the RMA provides councils with both enforcement mechanisms and resource consents to guide regional resource management. Enforcement mechanisms include abatement and infringement notices that can be issued to ensure a specific action is addressed and complies with the RMA. However, the main tools used by councils in resource management are resource consents. Resource consents are required to use or develop a resource and/or undertake an activity that has an effect on the environment. The consent means that the activity can proceed provided any adverse effects on the environment are avoided, remedied or mitigated.

Whether or not a resource consent is required for a particular activity will be specified in the council's regional plan. This is done by classifying an activity into one of five categories (permitted, controlled, discretionary, non-complying and prohibited).[7] For example, many councils classify the taking of small amounts of water (generally around 10 to 20 m^3 per day) as a permitted activity that does not require a resource consent. Taking amounts above this threshold is often classified as a discretionary activity that requires a resource consent.

Applying for a resource consent is a complex process that has been criticised by some as being too time-consuming, with consents being "bogged

[7]A permitted activity may be undertaken without a resource consent; a controlled activity requires a resource consent, which the council cannot decline, but they can impose conditions on the activity; a discretionary activity requires a resource consent which the council can decline or impose conditions on; a non-complying activity does not comply with standards in the council's regional plan but the council may grant a consent; and a prohibited activity may not be undertaken and no resource consent will be granted.

down in objections" (Kerr, 2002).[8] For an applicant, the application process includes consultation with council staff and affected or interested parties, preparing an assessment of environmental effects,[9] and preparing an application detailing the proposed activity. Once the council receives the application they may decide to publicly notify the consent. The public are then able to make submissions and objections on the consent and a hearing is often held to resolve any issues arising.[10] A decision on the consent is usually made by the hearings panel. After the decision is made, the applicant (or an objector to the application) may lodge an appeal with the Environment Court if they are unhappy with the decision or the conditions attached to the decision.

The Resource Management Amendment Act 2003 implemented changes intended to (among other things) reduce costs and delays in obtaining a resource consent under the Act. Among the changes were a change to the notification process for activities with only minor adverse effects. In these cases, complete public notification is now not necessary and only those parties that are directly affected must be notified. Also changed is the test used by councils to determine if the effects of an activity are minor or whether a person is adversely affected.[11] Prior to the amendments it was mandatory

[8] See Trow (2003) for some further criticism of the process being slowed by objections.

[9] An assessment of environmental effects identifies any actual or potential effects of the activity on the environment, and the ways in which the applicant will avoid, remedy or mitigate these effects.

[10] The public is widely defined: section 96 of the RMA states that *anyone* can make a submission on a publicly notified consent, although an unfounded submission may not always be in a party's best interests, as costs can be awarded against a party if it proceeds to the Environment Court.

[11] This is known as the 'permitted baseline' test. For more information see the Ministry

for councils to disregard an adverse effect of an activity if their regional plan permits other activities with that same effect. The changes to the Act allow these effects to be considered on a case-by-case basis and councils may choose to disregard them, but it is not mandatory.

Before turning to how water is allocated in practice, it is useful to consider how the legislative process outlined above defines property rights. Resource consents are effectively property rights to water. However, as Hawke (2003a) notes, the RMA process does not explicitly identify property rights but rather sets down some general principles for councils to use in deciding who is entitled to a property right. Hence the entire process, including the preparation of plans and policy statements, defines property rights to water. This minimises the role of central government in allocating property rights and, as noted earlier, allows local government to consider the needs of local users in making water allocation decisions.

2.3 Water Allocation in Practice

As noted above, regional councils and unitary authorities play the main role of water resource managers and allocate water through an administrative process.[12] The first step in the allocation of any water from a resource is the preparation of regional plans. Councils use plans to set out objectives,

for the Environment webpage http://www.mfe.govt.nz/laws/rma/amendments-permitted-base.html.

[12] As water resource managers, councils are also responsible for monitoring the state of their region's water resources, such as river flows and lake levels.

policies and methods relating to water allocation, which guide the issuing of resource consents. Methods in regional plans used to aid water allocation decisions include the setting of minimum flows for surface water and minimum levels for groundwater. These are set to protect environmental factors such as fish habitats and natural character, and to ensure adequate provision of water for recreational opportunities. Regional plans specify other important factors such as allocation limits (how much water can actually be taken from a resource), how water is rationed in periods of scarcity and the ability to trade water rights (resource consents) in the region.

Organisations or individuals wanting to take, use, dam or divert water apply to the council in their region for a resource consent. Applications are analysed to ensure compliance with the information set out in the regional plan, such as ensuring minimum flows and allocation limits are not breached. The assessment of environmental effects provided by the applicant is also analysed to ensure any adverse effects on the environment are avoided, remedied or mitigated. Councils undertake a consultation and decision making process to assess an application for resource consent, however they are generally issued on a first-in first-served basis, often creating a 'gold rush' situation when a water resource becomes available (Lincoln Environmental, 2001a). For example, Environment BOP (Bay of Plenty Regional Council) specifies in its Proposed Regional Water and Land Plan (2002, p.59) that their allocation policy is "[t]o allocate water on a first in first served basis, subject to efficient use." Most councils do consider efficiency in making al-

location decisions, although this only extends to the technical efficiency of individual takes rather than the allocative efficiency of the resource allocation (Lincoln Environmental, 2001a).[13]

Councils have varying approaches for dealing with an over or fully allocated resource. If a water resource is fully allocated some councils operate a waiting list approach, where the applicant will wait to gain an allocation of water if it becomes available. For example, Tasman District Council (a unitary authority) operates an informal, unadvertised waiting list for fully allocated resources (Lincoln Environmental, 2000). If a water resource is over-allocated most councils will use some type of rationing scheme where existing consents are reviewed and adjusted to reduce allocations. Councils use similar rationing schemes to reduce extraction in periods of water scarcity or droughts. Hawkes Bay Regional Council, for example, gives priority to domestic, stock water and fire fighting needs as river flows fall towards or below the minimum flow, while other extractors have their takes reduced, or even stopped altogether (Hawkes Bay Regional Council, 2000). Similar priority allocations are also common among other councils.

The RMA (Section 136) allows for limited transfer of water rights. The requirements for a transfer are that the water is transferred to a user within the same catchment, aquifer or geothermal field. Furthermore, the transfer must be provided for in the regional plan and approved by the appropriate council. Although some councils do provide for transfer of rights in their

[13]See appendix A for further details on technical and allocative efficiency.

regional plans, to date there has been very little trading (Lincoln Environmental, 2000).

All councils charge consent holders for the processing costs involved in issuing the resource consent. Once a consent is issued, some councils also levy an annual charge for the ongoing monitoring of the consent and the water resource. This is sometimes a fixed charge but in other cases it is based on the volume of water extracted. Most councils use water meters to monitor water usage on consented takes.

2.4 Supplying Water to Final Users

There are two aspects to consider in outlining the supply of water to final users: wholesale supply and retail supply. In addition to holding the role of water resource managers through the issuing of resource consents, some councils are involved in the wholesale supply side of the water industry. In particular, in Wellington a separate business unit of the Wellington Regional Council is responsible for the wholesale supply of water to the regions' four city councils. In Auckland, a similar role is played by Watercare Services Ltd. Watercare was separated from the Auckland Regional Council and set up as a Local Authority Trading Enterprise (LATE) in 1992.[14] It is the wholesale water supplier to the six city and district councils in the Auckland region and is owned by these six authorities. Such wholesale water supply

[14] A Local Authority Trading Enterprise is a separate organisation, usually owned by the council itself and run as a company. LATEs are legislated by the Local Government Act 1974.

arrangements are currently not widespread in New Zealand. Most regional councils and unitary authorities maintain the sole role of issuing resource consents for water without venturing into water supply arrangements.

The retail distribution of water to urban users (that is, supplying water to household, commercial and industrial users) is managed for an area by the incumbent district or city council (known hereafter as a territorial authority).[15] Most territorial authorities set up separate internal units to manage water supply, although in some cases they may set up as a LATE. For example, Metrowater is a LATE owned by the Auckland City Council and operates the retail water supply across Auckland City. In other arrangements, Papakura District Council has franchised its water supply operations to United Water, a private water supply company operating in parts of Australia and New Zealand. In November 2002, United Water was also awarded a similar type of contract to manage the water supply operations of Ruapehu District Council. In Wellington, the Wellington and Hutt City Councils announced in December 2002 the formation of a joint council-owned business unit to manage water supply services in the two cities.

Territorial authorities hold consents with the regional council in their geographical jurisdiction to extract water from various sources,[16] and they own

[15]District and city councils are defined in the Local Government Act 2002 as 'territorial authorities'. Included in this definition are unitary authorities. The term 'local authority' covers all authorities: district and city councils, regional councils and unitary authorities.

[16]Note however that this is not the case for unitary authorities, as they operate both the resource management and water supply functions generally held separately by the regional council and territorial authority respectively.

a network of pumping and treatment stations, pipes, reservoirs for storage, and other infrastructure assets to deliver the final product to the consumer. Residential customers usually pay water charges on the basis of a fixed levy as part of their annual rates. In some cases this is a uniform annual charge, although in others it is based on the capital value of the property. Some territorial authorities (particularly those in the Auckland region) use metering.[17] Charges in this case are usually a two-part tariff with a fixed component and a variable component based on usage. For industrial and commercial users that obtain their water supply through the territorial authority, charges are usually based on metered usage plus a fixed charge. Industry users obtain about 33 percent of their water requirements through public supply systems and the rest from their own sources via the resource consent process (Statistics New Zealand, 2002).

In addition to territorial authorities, irrigation companies are also important in the retail water market, as they operate water supply services for farmers for irrigation purposes. Large-scale irrigation schemes are typically co-operative companies, owned by the farmers who use the irrigation water. Examples include Waimakariri Irrigation Ltd, operating on the Waimakariri river in North Canterbury; and Burrhill Chertsey Irrigation, a developing irrigation scheme on the Rakaia river in South Canterbury. The RMA relates

[17]Metering is now becoming more common. For example, all residencies in Nelson are metered and Wellington City has voluntary metering. The Christchurch City Council has recently installed meters in many residencies, although they are mainly only used to identify leakages and high use customers. Pricing is not yet based on metered usage.

to irrigation companies in the same way as for any other potential water user. Irrigation companies must apply to the regional council or unitary authority for resource consent to take water from a resource in the usual manner. Farmers do not necessarily have to belong to an irrigation scheme, and may apply directly to their council for a resource consent to extract water.

2.5 Issues with the Current Arrangements

Despite New Zealand's relative abundance of water compared with other countries, there are still some significant issues with the current arrangements for water allocation and management. Drawing on the outline of New Zealand's current property right and institutional arrangements in the previous sections, and problems identified in reports by CS First Boston (1995) and Lincoln Environmental (2001a), the following list identifies the main issues with the current arrangements:

- The first-in first-served approach is an ineffective way of allocating water from a resource. Furthermore, there is limited trading of water rights to reallocate water, which often results in water rights being assigned to low valued uses at the expense of high valued uses.

- Urban water systems are often in poor condition and water losses from pipelines are high in some areas.

- Metering and usage-based pricing is not widely used giving no incentives for users to conserve water.

- There are issues with the RMA regarding the consultation process and the limited use of available tools.

These issues are explained in more detail in the following sections. Alternative arrangements that could help resolve some of these problems are addressed later in the paper (section 4).

First-in first-served and limited trading of water

The first-in first-served approach is ineffective because it provides almost no criteria for a council to use in making decisions over competing water users. If a potential water user can show that their extraction does not harm the environment, and all objections are satisfied, a council generally has no alternative but to grant a water right. This may lead to water rights being granted to a particular use when other uses that have a higher value to society are missing out.

The first-in first-served approach would not be so flawed if a mechanism for trading water rights existed so that water could be reallocated to higher value uses. As noted earlier, the RMA does allow water rights to be transferred between users, and some councils also allow it in their regional plans. However, limited trading of water actually occurs. The benefits of establishing water markets to facilitate trading in water rights have been well documented by many authors.[18] These benefits include:

[18]See for example Simpson (1994), Holden and Thobani (1996), Thobani (1997) and Dinar, Rosegrant and Meinzen-Dick (1997).

- Achieving allocative efficiency[19] by moving water from uses that have a low value to society to uses that are valued more highly.
- Encouraging efficient use of water by providing users with incentives to sell unused water.
- Removing political favouritism in making allocation decisions.
- Delaying possibly expensive new infrastructure to increase water supply by allowing extra water to be purchased.
- Encouraging investment in projects that are water intensive.

These benefits are not always readily apparent in functioning water markets overseas. Often cited disadvantages with water markets include: the potential for monopolies to form by one user buying up all water rights; externalities may be imposed on third parties who utilise return flows which are subsequently sold;[20] transaction and set up costs can be high; and there are often difficulties in rigorously defining property rights for water when it has public good elements.

In New Zealand, a number of barriers to the trading of water rights exist. Recent research by Lincoln Environmental (2001b) found that, although

[19] Allocative efficiency is achieved when water is allocated among users in such a way that any reallocation could not make anyone better off and people made worse off can be compensated. See appendix A for further details.

[20] For example, suppose an upstream user on a river extracts $50m^3$ of water per day but returns $20m^3$/day, and a downstream user extracts the entire amount returned, $20m^3$/day. If the upstream user's water right was sold, a new user may extract the full $50m^3$/day and return nothing, thereby affecting the water available for the downstream user. See appendix C for a more detailed description of the problem and possible solutions.

a survey of water users showed 74 percent were in favour of water being transferred between users, significant barriers to transfer suggest little water will actually be traded. These barriers include infrastructure costs, small and illiquid markets, uncertainty over future water and land use, a lack of information on where there is additional water and the general view (mainly amongst irrigators) that water is directly tied to the land it is used on.

A further barrier to the trading of water rights is that the time length on the rights themselves may be too restrictive. The RMA restricts the duration of resource consents for water to a maximum of 35 years, although in practice most councils review or renew water rights at 5 to 15 year intervals (Lincoln Environmental, 2000). A short duration and uncertainty over renewal will generate further uncertainty over a water user's future water supply and possibly cause users to delay and restrict investment in water intensive uses. This uncertainty may limit a water user's willingness and ability to transfer their water right, particularly as the date of renewal approaches. McLellan (1998) notes that if a water right in New Zealand is exercised appropriately it is likely to be renewed and so effectively has an unlimited time-limit. However the renewal process, like the process for the actual application for a water right, can become overly administrative, generating even more uncertainty.

Poor infrastructure

CS First Boston (1995) noted that, in the early 1990s, there were significant deficiencies in the infrastructure assets used to supply water to final users.

Problems included high water-loss rates, sewerage system breakdowns and inadequate water quality in some areas. More recently, in a report by Parliamentary Commissioner for the Environment (2000), it was noted that there is a lack of investment and deferred maintenance in many urban water systems.[21] This has led to problems such as inefficient delivery of services, an increased risk of infrastructure failure, inadequate or excessive water flows and contamination of water resources.

There are two main reasons that could account for the current state of the water supply infrastructure. The first is that the current ownership arrangements may not be conducive to good asset management. CS First Boston (1995) suggest that the provision of water supply services by departments within a territorial authority can lead to problems with accountability and commercial performance. They argue that corporatisation or even privatisation of water providers may lead to more efficient outcomes.

The second reason is that it is unlikely that the current pricing regime allows water suppliers such as local authorities to recover full costs from operating a water supply service. Full costs include costs of operating and maintaining the water supply system, the cost of asset consumption, cost to the environment and capital costs. Full cost pricing would allow and encourage water suppliers to cover maintenance and invest in better and more efficient supply networks.

[21] The report does, however, note that asset management is improving.

Usage-based pricing

The current method of charging fixed fees for many residential users gives no incentive to conserve water. As a result, droughts and water restrictions are common in many areas in summer. Such restrictions are often based on the goodwill of the water user, although the RMA does allow infringement notices to be issued for violations of the restrictions. For example, during the water crisis on the Kapiti Coast in summer 2003, the Kapiti District Council implemented water restrictions on almost all water use activities except reasonable household use. Anyone caught wasting water was issued with an infringement notice and charged a fee. However, this required costly patrols by council officers to catch offenders.

With metering and usage-based pricing, prices will increase to reflect water shortages. Users would then have an economic incentive to reduce water consumption which does not rely on their goodwill or the enforcement of restrictions.

Furthermore, fixed charges or charges based on property value create distortionary cross-subsidies, whereby low volume water users are subsidising high volume users. For example, two water users with similar property values but very different water consumptions will pay the same for water. Although in some situations those in similar sized properties are likely to use similar amounts of water, this will not always be the case. A usage-based pricing regime is more equitable in this sense as residential users only pay for what they use, without subsidising others.

RMA issues

It has been noted that there is limited use of available tools under the RMA in making water allocation decisions other than resource consents (Lincoln Environmental, 2001a). The RMA does provide a number of other tools to aid in allocation decisions. The obvious ones are the hierarchy of plans and policy statements and the ability to trade water rights (albeit in a rather limited form, as noted above.) Other tools include the ability of councils to impose conditions on resource consents. Section 108 of the RMA allows the granting of conditions, such as including financial contributions by a consent holder to offset any adverse effects of the consent on third parties. Councils are also able to impose fines or imprisonment on anyone who commits an offence against the restrictions of the act.[22]

The other major issue with the RMA, already noted earlier, is that the consultation process on resource consents is often criticised as being too drawn out. This may have adverse effects such as imposing additional costs on investment projects, delaying investment, or even preventing potential projects altogether. On the other hand, a lack of consultation with affected parties on environmental issues is likely to be inefficient. Furthermore, recent statistics show that 82 percent of all resource consents are processed within statutory time limits and 69 percent of publicly notified consents were processed within these limits (Ministry for the Environment, 2003).

[22]For example, the Wellington Regional Council issued an infringement notice and fine to one water user contravening the water shortage direction issued on the Kapiti Coast during the 2003 drought.

The process of rigorous consultation with affected parties is not confined to New Zealand. In many of the western states in the U.S the potential transfer of a water right involves a similar process of consultation and negotiation with affected parties, hearings and even court action to resolve longstanding conflicts. Hence the transfer process can involve significant transaction costs. However, Colby (1995) presents an argument to suggest that the presence of these costs does not necessarily lead to inefficiencies. Colby argues that the ability to impose transaction costs through the threat of a long costly legal battle gives potential water users an incentive to negotiate with affected parties and reach a settlement. Hence a more efficient reallocation of water may occur as the social costs and externalities to affected parties are taken into account when they otherwise may not be.

The argument applies equally to the New Zealand context. While not applying to an actual water transfer, transaction costs are imposed on a potential water user in their application for a resource consent to take water. The possible costs of the application becoming drawn out and proceeding to a hearing or the Environment Court may give the potential user an incentive to consider the views of third parties. If the views of third parties are considered then the water allocation may be more efficient in the sense that more complete costs to society are taken into account. The conclusion here is that a protracted consultation process, or at least the threat of one, can also have advantages. Resolving the issue is not as simple as reducing third party objections, but reducing unwarranted objections does have some merit. The

recent RMA amendments have gone some way towards addressing this.

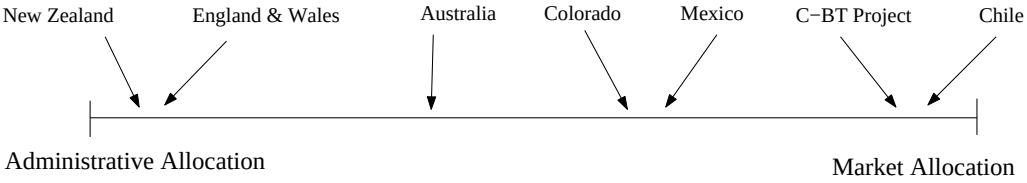
3 International Experiences

A variety of arrangements exist in other countries for the allocation of water to those extracting or using water directly from the resource, and in supplying that water to final users. A common mechanism for water allocation in most countries is a simple property rights system, whereby a potential water user must obtain a right to use water from a particular resource. However, the actual definition and allocation of such rights differs considerably across countries. The two common allocation procedures used are administrative allocation and market-based allocation. Administrative allocation is where decisions on how water is to be allocated are made by a public agency. In contrast, market-based allocation methods allow water rights to be transferred between users, effectively allowing the water users themselves to make decisions on how water is to be allocated. This decision-making autonomy is considered one of the key features of a market (McMillan, 2002), as participants are free to make their own decisions reflecting their own preferences, information and expectations.[23]

Most allocation mechanisms operated around the world are neither purely administrative nor purely market-based but are some combination of the two.

[23]McMillan (2002) notes that although a market-participant's decisions may be constrained by their resources or the rules of the market, they are nonetheless free to make these decisions themselves.

Figure 1: Administrative-Market Allocation Continuum



They are on a continuum reflecting the degree of autonomy held by water users. This is illustrated in Figure 1, where at the left side of the continuum water is allocated solely by a government decision-making process. Moving to points further to the right signifies water users have increasingly more autonomy in their ability to make decisions, until reaching the right-hand side where the government has no involvement at all and water allocation is entirely market-based.

This section considers a small sample of countries at varying points on this continuum and analyses the way they define and allocate property rights, and their institutional arrangements for water. In some countries, such as England, Wales and New Zealand, water allocation is almost entirely administrative with little scope for market-based transfers of water rights. In Figure 1, these countries lie towards the administrative end of the continuum. At the other end of the continuum, Chile has very little government involvement in water allocation. Chile's system is probably the closest any country has come to operating a pure market-based system for water allocation (Bauer, 1997). Australia lies more towards the middle of the continuum. Recent reforms

have led to a mixed system of both administrative and market allocation, but the administrative system still dominates. The following sections elaborate further on the allocation mechanisms and institutional arrangements for the countries shown in Figure 1.

3.1 England and Wales

The government, through the Environment Agency (EA), manages water allocation in England and Wales. Property rights to take water are defined by an abstraction license. Water users wishing to extract water submit a formal application to the EA for an abstraction license, giving the right to take water from a specific source at a specific rate. A license also specifies the land that the water must be used on (except when the water is for the public water supply). The current system requires potential water users wishing to apply for a license to either occupy the land associated with the abstraction, or have a right to access it. The majority of existing licenses also have no expiry or renewal.

The allocation of property rights to water is done by an administrative system with similar features to the system used in New Zealand. In making an application for a license, the applicant is often required to assess the abstraction's impact on the environment and must also publicly notify their intent to extract. Interested or affected parties can make submissions to the EA. In deciding whether to grant an abstraction license, the main issues the EA takes into account are: water availability, effects on the environment,

the rights of existing water users, public objections, the applicant's need for the water and the impact on stream flows (DEFRA, 1998). New or revised licenses to extract water have both an application charge and an annual charge based on licensed volume and a number of other factors.[24]

There is scope within the current legislation for trading of water licenses, although very little trading occurs, possibly due to the requirement for most traded licenses to be tied in with the land they are used on (Risk and Policy Analysts Ltd, 2000). Trading a license requires an application to the EA, who assess the trade through a similar process to that described above for applications for new or revised licenses. However, the Government has recently consulted on the licensing system. The result is a draft Water Bill that is currently before Parliament, which aims to introduce a number of new measures to update the framework for the system. The Bill includes measures designed to simplify the rules for trading licenses in an attempt to facilitate more trading and allow a more market-based allocation system to develop. For example, the Bill removes the requirement for licenses to state the land they will be used on so that there is no restriction on where a license can be transferred to.

Another key feature of the Bill is the time-limiting of licenses, with the renewal period for most new licenses to be 12 years. The renewal strategy

[24]In particular, the annual charge is made up of five parts: a standard unit charge for the amount taken, which varies across regions; a licensed volume charge; a factor based on the water source, which is higher if there has been capital investment in the source; a factor based on the season, which is higher if the water take is in summer; and a factor based on water loss, which is higher for uses with little or no return flows.

is handled by another new initiative (although not one implemented by the Water Bill) of Catchment Abstraction Management Strategies (CAMS). A CAMS for a catchment is a strategy to manage water extraction at the catchment level. It is a plan developed by consultation that lays the foundations for dealing with new or revised licenses on a catchment. The strategies for renewal of licenses are based around environmental sustainability, continued justification of the use of water and efficient use of the water (Environment Agency, 2002).

The EA are a key player in the institutional arrangements for water allocation in England and Wales. Also involved are a number of fully privatised water companies, who supply water to final domestic and industrial users. Ten large companies supply water and wastewater services with a further 16 providing water only services. These companies are area based monopolies and are regulated by the Office of Water Services (OFWAT). OFWAT regulates prices charged by each company by setting a price cap based on the Retail Price Index plus a factor based on the particular company, their costs and environmental obligations.

Pricing by the water companies to household users is not widely based on usage. Metering penetration is only at about 20 percent of households (DEFRA, 2003) although most new properties are metered. Charges for unmetered households are based on the rateable value of the home.

3.2 Australia

Australia is currently in the midst of a period of significant reform of its water sector. Reform began in some areas over the 1980s and 1990s but became more firmly grounded in 1994 when the Council of Australian Governments (COAG - consisting of the Prime Minister, state Premiers, territory Chief Ministers and the President of the Australian Local Government Association) agreed to a framework for water reform at the national level. The framework consisted of a number of directives that states and territories were required to follow in the reform of their water sectors.

The primary responsibility for implementing the reforms lies with the state and territory governments. The key elements of the reforms, due to be fully implemented by 2005, are:

- Pricing: must be based on usage-based pricing, full cost recovery and making any cross-subsidies transparent.
- Water allocation: clear allocation systems are to be established, including separating water licenses from land, and allocating water to the environment.
- Trading: trading of water licenses must be made possible.
- Institutional reform: the roles of water service provision must be clearly separated from those of regulation and resource management.

- New investment: any new investment in irrigation schemes must be viable both economically and ecologically before it is undertaken.

As state and territory governments progressively implement the reforms, water allocation is moving towards a mix of administrative and market-based methods. A state/territory government department is responsible for issuing property rights to water (licenses) to potential water users. The reforms have ensured that water licenses are clearly separated from land. They are typically defined by the volume of water that can be extracted and in many cases have a 5 to 15 year tenure before renewal.

The state or territory government department issues licenses through an administrative approach. This involves using plans to set out (among other things) minimum flows for environmental purposes, reallocation rules in times of low flow and rules for the trading of water licenses (such as the requirement that transfers do not have an adverse effect on third parties). Licenses are then allocated by an administrative process involving application, assessment and notification similar to those previously described for New Zealand, England and Wales. Most states in Australia adopt a catchment management approach similar to the CAMS in England and Wales, rather than the first-in first-served approach used in New Zealand. For example, in Queensland, Water Resource Plans are prepared for each catchment. These plans develop methods of consultation and modelling to determine the best way to allocate water between competing users.

Once allocated, trading of licenses is also possible. Although markets for

the trading of water licenses have existed in some areas since the early 1980s, the COAG reforms have ensured all states and territories now use water markets to facilitate trading. In the case of New South Wales, an embargo on issuing new licenses means administrative allocation is largely redundant on many fully allocated resources, and the only way to obtain a water license is by trading with another user (DLWC, 1997).

Although trade in water markets is increasing in parts of Australia, the markets are considered by some to be quite thin in terms of the number of trades (Pigram, 1999; High Level Steering Group on Water, 1999). Another problem with the creation of water markets is that the exercise of 'sleeper' licenses (previously unused water licenses) can have a negative impact on the environment through increased extraction (McKay and Bjornlund, 2001).[25] It is perhaps because of some of these problems that administrative methods still dominate in most parts of Australia, placing Australia more towards the left-hand side of the continuum in Figure 1. Nonetheless, water markets have shown significant benefits, including the movement of water from low valued to high valued crops (McKay and Bjornlund, 2001). More recently, as Bjornlund (2002) notes, Australian water markets are maturing[26] and are beginning to generate more efficient outcomes.

Other areas of the reforms, such as institutional and pricing reform, are

[25] On the positive side, the sale of sleeper licenses means they are at least reallocated to a use that is more highly valued.

[26] According to Bjornlund (2002), the main indicators of a mature water market include less price dispersion, easing of trade restrictions and an increase in market activity.

showing more progress. Water supply services are now clearly separated from the role of resource management and regulation. In many states, urban water suppliers have been corporatised. Examples include the government-owned Sydney Water Corporation and Melbourne Water Corporation, who supply water to the cities of Sydney and Melbourne respectively. Adelaide has gone one step further by franchising its water supply operations out to the private company United Water. In some states (such as New South Wales and South Australia) irrigation schemes have been fully privatised. Independent price and competition regulators are also an important part of these institutional arrangements in all states and territories.

Australia has also made significant progress with implementing usage-based pricing. Metering penetration in single-family homes in 1998 was between 95 and 100 percent (OECD, 1999). All states are also meeting the requirements of the reforms for the urban sector by charging by way of a two-part tariff with a fixed and volumetric rate. However, pricing reform in the rural sector is not so well developed, possibly due to the strength of the opposition to reform in this sector (Musgrave, 2000).

3.3 Colorado

Much of Colorado is in a drier region of the United States and as a result has a long history of developing efficient methods to deal with the allocation of its scarce water resource. Water rights in Colorado are defined by the doctrine of prior appropriation, which rests upon the principle of 'first in

time, first in right'. The first user in time to obtain a water right from a particular water resource is the senior right holder for that resource. In periods of water shortage, senior right holders are given first priority to ensure their allocation is satisfied and more recent, junior, right holders will have their allocation reduced. Water rights do not have any time limit, and some priorities on major streams go back as far as the 1850's.

Allocation of water rights in most of Colorado is done administratively, although market mechanisms do exist to facilitate transfers. In order to obtain a right to extract water in Colorado, a potential water user submits an application to a district water court and the application is publicly notified. Objections are heard by the water court before they make the final decision on the granting of the right. This decision is based on recommendations by a state engineer in accordance with the applicable water laws of the state. Once granted, a water user must prove that their water allocation is being put to beneficial use or they risk having their water right revoked.

Transfers of water rights are made by application to the water court.[27] The transfer will be publicly notified and a hearing often results. Where there are effects on third parties that the court deems to be of concern, the court will determine the appropriate remedies or compensation. If there are no objections to the transfer and it is considered reasonable, the court typically grants the transfer. Hence this system allows market-based transfers

[27] A transfer that does not change the use or point of diversion of the water, or does not have an effect on third parties, can often be done without court approval (Simpson and Ringskog, 1997).

of water rights in Colorado, however there is still a significant role played by administrative allocation mechanisms. This places Colorado towards the middle of the continuum in Figure 1.

In one part of Colorado water allocation mechanisms differ slightly from the rest of the State. A different mechanism applies for water from the Colorado-Big Thompson (C-BT) project, a major water supply scheme in northeastern Colorado. Allocation of all water from the C-BT project is the responsibility of the Northern Colorado Water Conservancy District. Water from the project is used to supplement the existing supplies that users obtained from other sources in Colorado. The key feature of water allocation in the District is that trading of water rights (termed 'allotments') is widely used to reallocate water from the project.

The initial allocation of water allotments was made in 1959 at no charge to users and was based on future needs and the ability to make beneficial use of the water. Each year, the Board of Directors of the District decides how much water is available and establishes a quota to be made available for the following year. Since water from the C-BT project is supplemental water and significant quantities of C-BT water can be stored, the quota will be higher in dryer years when water from other sources is scarce. A water user's allotment will be adjusted in proportion to changes in the quota.

These annual quota changes do not have an adverse impact on users, as holders of water allotments are able to make both temporary and permanent transfers of water. For temporary transfers, the two parties (the buyer and

seller) agree on a rental price and notify the District simply by sending them a postcard with the relevant details of the transfer. Upon verification the water is credited from the seller's account and debited to the buyer's account. The District does not charge any administration fees for this process. The process for a permanent transfer of a water allotment is also reasonably straightforward. After the two parties have agreed on a price, an application for transfer is made to the District along with a small administration fee. The application is reviewed to ensure it complies with the District's policies and procedures, and if approved by the Board of Directors of the District, the transfer is allowed to proceed. Transfers are instigated by a variety of methods including brokers, newspaper advertisements and direct contact.

As a result of the market, there has been significant transfer of water resources from low-valued (mainly agricultural) uses to higher-valued (industrial and urban) uses (Kemper and Simpson, 1999). This places the water allocation mechanism in the C-BT project a lot closer to the market end of the continuum.

In addition to the Northern Colorado Water Conservatory District (a public agency), a key feature of the institutional arrangements for the C-BT project is the existence of 'ditch companies'. Ditch companies are farmer-owned collectives that run irrigation schemes. Ditch companies have the important task of internally distributing and managing water allotments from the project. As Kemper and Simpson (1999, p.30) note, "their existence greatly facilitates the transactions taking place in the market". We will see

later how similar user-based associations are an important aspect of water markets in other parts of the world.

3.4 Mexico

Mexico has recently undergone a significant period of water reform following the implementation of the National Water Law in 1992. The law decentralised water resource management and instigated a market-based system to allow for the transfer of water rights (termed 'concessions' in Mexico). The responsibility for implementing the reforms and granting water concessions lies with the government's National Water Commission (CNA). The water law also transferred the responsibility for operation and maintenance of water supply schemes (particularly for irrigation schemes) from the CNA to resource-specific Water User Associations (WUAs).

Under the water law, the initial allocation of water concessions was based on historical use, with concessions granted to individuals, WUAs[28] and public or private water utilities (who supply water to urban and industrial users). CNA approval is required for a new or renewed concession and holders are charged a fee based on the volume of water delivered to cover the management, planning and administration roles of the CNA.[29] Concessions are defined volumetrically but in times of scarcity the CNA may impose reduc-

[28] Once water is allocated to WUAs, they may make their own decisions on how their water is allocated. WUAs typically allocate water by either a rotation system on a prearranged schedule or an arranged demand system where farmers make daily requests for water (Hearne and Trava, 1997).

[29] Agricultural users are exempt from this fee.

tions on some water users.[30] Concessions have varying time-limits of between 5 and 50 years, although according to Thobani (1997), the typical maturity is 30 years.

Concession holders may temporarily or permanently transfer their water concession. In many cases a transfer between irrigators can be managed by the appropriate WUA, with the transfer only requiring notification to a public registry of water concessions. However, if a transfer is outside a particular river basin, to another water use sector or has an effect on a third party, the transfer requires approval from the CNA.

The water market implemented in Mexico is reasonably new, and the CNA still maintains a significant role in the allocation of water, placing Mexico near Colorado in the middle of the continuum in Figure 1. Kemper and Olson (2000) note that although markets are functioning in Mexico, there have not been a large number of transfers. They suggest that the mechanisms to support the proper functioning of market transfers are still being set up, particularly the establishment of a complete public register of water concessions. Such a register assists with the monitoring of water resources and ensures the concessions system is managed fairly. Nonetheless, there have been some benefits noted. For example, Thobani (1997) describes how some small farmers with high levels of debt have been able to sell water rights in order to pay off debt, without actually having to also sell the land they

[30]For example, Hearne and Trava (1997) document a case in one region of Mexico where, in the drought of 1995-1996, the CNA mandated that only cotton crops were able to use irrigation water.

own. It is anticipated that as acceptance of market instruments increases, and demand for water resources rises, there will be much greater use of the market to facilitate transfers of water concessions (Simpson and Ringskog, 1997).

3.5 Chile

Although water markets have been operating in Chile for a considerable time, the defining legislation occurred in 1981 with the passing of the Water Code, which formalised a market for water rights. The Water Code created tradable water rights that are clearly separate from land. Rights are granted free of charge by the General Directorate of Water (DGA), a division within the Ministry of Public Works. Water users wishing to obtain new or unallocated water rights apply to the DGA. If there are enough water rights to satisfy the demand, the rights are allocated as required free of charge. If there are competing demands for the water rights they are allocated to the highest bidder by auction. Water rights have no time-limit, and the DGA cannot cancel them once they have been granted. Rights holders may freely sell, mortgage, or lease water rights for any purpose, at a price negotiated between the parties to the transfer. Regardless of the nature of the transfer (and who it may effect), parties to a transfer do not require approval from the DGA. Rights holders also have no obligation to put their water to beneficial use.

Water rights are designated as either permanent or contingent. Permanent rights allow the extraction of water without restrictions, except during

times of low flow. Contingent rights can only be exercised if there is excess water available from a resource once the requirements of permanent rights holders have been met. Rights may also be designated consumptive (where the holder has no obligation to return any water) or non-consumptive where the entire allocation must be returned to the water resource - such as in the case of hydro-electric generation. Water rights in Chile are required to be specified by the volume of flow per unit of time, but will be defined proportionately as a share of the river flow if the amount of water available is not enough to meet all the volumetric rights. In periods of low flow, permanent rights holders will have their shares of a water resource reduced proportionally. Some rights, however, are designated priority rights (for example, water companies serving urban communities) and are not reduced in times of scarcity.

A key feature of the institutional arrangements for water allocation in Chile is the existence of water user associations that are owned and operated by their members. There are more than 300 000 water users in Chile and these are grouped into around 4 000 user associations (Simpson and Ringskog, 1997). These associations are often set up to serve irrigators but there are also a number that administer all the water users for a common water source or river. Water user associations have the important role of managing and maintaining the infrastructure with which to deliver water to their members. Although the DGA is responsible for issuing water rights to users, the water user associations are responsible for recording, managing and enforcing rights

and rights transfers.

Another feature of the institutional arrangements is the recent privatisation of water utilities serving urban and industrial water users. The privatisation regime followed a law passed in 1998 putting a number of major utilities in private hands. Some are now owned or partially owned by major UK water companies.

The decision-making role of government in Chile's water allocation systems is very minor, with allocation based on market instruments such as transfers and auctions. Opinion is divided on whether the Chilean water market has been a success. Simpson and Ringskog (1997) argue that the market has generally been a success, and Hearne and Easter (1995) showed that there were substantial gains-from-trade in some areas of Chile where market transactions were common. However, Bauer (1997) argues that the empirical evidence on the success of the water market is mixed. He suggests that, among other factors, confusing price signals and high transaction costs are limiting trading in water rights in many areas of Chile. Nonetheless, Bauer does agree that there are some strengths in the Chilean system. The following section collates these strengths and those of other countries to discern the lessons New Zealand can learn from overseas experience.

4 Lessons from Overseas Experience

There are a number of areas where New Zealand can learn from the way other countries approach the allocation and management of their water resources. These can be broadly summarised into four categories: defining property rights to water, allocating property rights to water, institutional arrangements and usage-based pricing. These categories fit broadly with some of the problem areas identified for New Zealand in section 2.5. Hence in looking at how other countries have dealt with similar issues, we consider possible alternative arrangements for the water sector in New Zealand.

4.1 Defining Water Rights

A key aspect in defining water rights in many countries is the use of a priority system. Such a system is most notably used in Colorado (and some of the other western states in the US) although other countries often designate public water supplies as a priority use. The system is used in New Zealand with some regional councils defining priority water rights, although this often only applies to public water supply users and does not extend to all water users.

A priority system allows water users to manage their risk. For example, a user who consistently needs a large volume of water (for example for the public water supply or feeding livestock) bears a high level of risk if they were not to obtain their desired water allocation. Such a user can manage

this risk by obtaining a high priority water right. Equivalently, a low risk user can tolerate a water right that is of a much lower priority and does not necessarily guarantee them their desired water allocation all of the time. Young and McColl (2002) note that if water markets exist and transaction costs are low, a priority system may not be needed, as users can manage their risk by trading water. In New Zealand's case, there are currently no water markets and if water markets were to form transaction costs may be high in the early stages of the markets. Hence a priority system would be one approach for users to manage the risk associated with the uncertainty in water flows.

When flows are too low to meet all volumetric rights, priority systems will eliminate use by low priority users, but they still do not provide a means by which to allocate water amongst high priority users.[31] Defining rights proportionately provides a mechanism to do this. Examples of proportionate systems include Chile and the Northern Colorado Water Conservancy District. An allotment in Northern Colorado entitles the holder to a share of 1/310 000th of the total water allocated each year. The advantage of proportionate rights is that, in times of extreme low flow, high priority users will have their extraction amounts reduced proportionately. This eliminates the need for administrative-based decisions on what high priority uses water should be allocated to when it is scarce. Since water trading is relatively

[31] Unless of course the system is similar to Colorado's, where even high priority users are ordered in priority based on the date of their water right.

straightforward in the District the system is efficient, as users can trade to offset any changes in the amount of water they are allocated.

Another issue that relates to defining water rights to ensure security for water users is the time-limit on the right. An indefinite time-limit, such as is used in Chile and Colorado, is ideal in terms of ensuring the user will have continued access to water. However, given that changing environmental conditions and resource use affect the availability of water, it is more appropriate to periodically review water rights. This is the case in England and Wales, where abstraction licenses are issued for a period of 12 years, accompanied with a presumption of renewal if certain environmental and resource-use criteria are met.

4.2 Allocating Water Rights

A general trend in many overseas countries is a move towards at least some form of market-based allocation system to facilitate trading in water rights. Although there is still a significant role played by government administration, these countries are realising the benefits of moving some way down the continuum to market-based allocation. For example, in Australia, McKay and Bjornlund (2001) note that the benefits of the reforms are being realised in Victoria, South Australia and New South Wales, where water has moved to irrigators producing higher value crops and with more efficient irrigation technology. Bjornlund's (2002) study of the data in South Australia indicates that those with more efficient irrigation methods generally have a higher will-

ingness to pay for water. Benefits have also been realised in the Northern Colorado Water Conservancy District. Kemper and Simpson (1999) show that water has shifted to higher value uses, particularly urban and industrial use, and that water markets have led to more efficient water use amongst farmers.

However, facilitating trading through water markets does not always result in desirable outcomes. As Thobani (1997, p.177) notes: "tradable water rights are not a panacea, and an effective system is not easy to introduce." Problems faced overseas are common. In Chile, Bauer (1997) identifies problems such as an infrastructure that is too inflexible to shift water between users, uncertainty over the legal title to some water rights, and poor administration and recording of rights transfers. While in Mexico, a major problem is the restrictions imposed by the CNA in times of scarcity, which generates significant uncertainty as to the security of water rights (Hearne and Trava, 1997). Note however, that these are not necessarily problems that will exist in any market-based system due to the nature of water. They can be solved by specifying well-defined and enforceable property rights to water and creating the right institutional arrangements to administer water rights and allow investment in infrastructure to occur. In contrast, in South Australia for example, there are problems that are more fundamental to the nature of water, such as significant third party externalities, whereby trading of water rights to upstream users has a detrimental effect on the return flows downstream (McKay and Bjornlund, 2001). Dealing with externalities is likely to be a

difficulty in any market-based regime.

The key lesson that New Zealand can take from overseas experience in water markets is that markets may generate better outcomes and resolve some of the shortcomings of the current allocation system, but there are a number of pitfalls that need to be avoided. Some of the important aspects in establishing effective markets are:

- Establishing effective institutional arrangements, including an effective legal framework.
- Developing the appropriate infrastructure to facilitate water trades.
- Defining water rights effectively to deal with the uncertain nature of water resources, including specification of priorities and proportional allocations, and in dealing with return flow issues.
- Deciding on the most appropriate means of initially allocating water rights - whether by auctioning or 'grandfathering'.[32]

It is possible that moving more towards a market-based allocation system will bring benefits for New Zealand, but there still remains a role for administrative intervention in the allocation of water.

[32]Allocation of water rights by grandfathering refers to an allocation based on users' historical use of water. The decision of whether to auction or grandfather may not be too important if tradable rights allow water to be reallocated amongst users.

4.3 Institutional Arrangements

A key feature of the institutional arrangements in some countries is the corporatisation or privatisation of water utilities. The best example of this is in England and Wales, where water and wastewater services have been provided by private companies since 1989. There have been some positive changes as a result of this privatisation. Emery (2000) notes that significant investment in infrastructure has been undertaken, resulting in improved water quality, reduced leakage, fewer interruptions in water services and a reduction in customers with low pressure. These improvements in customer service have largely been accompanied by significant price increases.

The corporatisation or privatisation of water supply services in New Zealand is controversial.[33] However, as noted earlier, some councils and territorial authorities have implemented arrangements such as business units, LATEs and franchising operations. Such arrangements may be more desirable amongst the community than the full-scale privatisation of England and Wales but may still generate more efficient outcomes such as improving the infrastructure assets for water supply.

The other important aspect of many overseas institutional arrangements, particularly in countries with functioning water markets such as Colorado, Mexico and Chile, is the existence of water user associations (WUAs). WUAs

[33]See for example Parliamentary Commissioner for the Environment (2001) who note that in submissions to their earlier report on urban water system issues (Parliamentary Commissioner for the Environment, 2000) there were strong objections to the commercialisation of water and the potential for privatisation.

offer a number of potential benefits, with a major advantage being that they allow flexibility to adapt water allocation to meet users' needs (Dinar *et al.*, 1997). Moreover, WUAs allow users to actively participate in the allocation process and may, if endowed with responsibilities of recording and enforcing rights transfers as in Chile, facilitate trades and reduce transaction costs.

In the New Zealand context, it has been suggested that a major difficulty faced by councils in making water allocation decisions is in gauging the cumulative effects of extraction on a resource (Lincoln Environmental, 2001a). Creating resource-specific WUAs may alleviate this problem to some extent. Giving user associations the responsibility of monitoring consents on a particular resource may put them in a better position to assess the cumulative effects of water rights on that resource.

4.4 Usage-Based Pricing

New Zealand is one of few countries that makes very little use of metering and usage-based pricing for residential water users. An OECD survey indicated that about two-thirds of OECD countries meter over 90 percent of single-family houses, although New Zealand only meters about 25 percent (OECD, 1999). Table 1 shows metering penetration rates for a sample of OECD countries. New Zealand, along with the United Kingdom, significantly lag behind in their use of metering and usage-based pricing.

Water pricing reform in Australia has had a positive impact in some areas - particularly in reducing consumption. Between 1990-91 and 1995-96,

Table 1: Metering penetration in single-family houses

Country	Metering Penetration Rate (%)
Australia	95-100
Canada	55
England and Wales	20
France	100
Germany	100
Ireland	0
Japan	100
New Zealand	25
Northern Ireland	0
Scotland	Near 0
United States	90

Source: All OECD (1999) except England and Wales - DEFRA (2003)

pricing reforms, demand management programs and community education resulted in a decrease in consumption per property in Australia of 19 percent (High Level Steering Group On Water, 1999). CS First Boston (1995) also report that, along with reductions in consumption, water metering by the Hunter Water Corporation in New South Wales has led to reductions in its unaccounted-for water. Although metering leads to improvements in efficiency of usage, differential incidence occurs, such as that cited by Sieman (2000; cited in McKay and Bjornlund, 2001). Sieman found that price changes in Victoria have had a negative impact on rental tenants and larger low-income families.

In some areas of New Zealand with abundant water supplies and low

consumption, the cost of installing meters and implementing usage-based pricing is likely to exceed the benefits. Furthermore, as household consumption makes up such a small proportion of total water consumption, reductions are unlikely to make a significant impact. Nonetheless, as with the use of water meters in Christchurch, metering can be used to identify leakages and high-use customers. 'Selective metering' is also a concept that has generated interest overseas (OECD, 2003). Examples of selective metering include metering only where water is scarce, where consumption of water for discretionary use is high or in new houses.[34] Selective metering for New Zealand may be more appropriate than following the experience of other countries and implementing universal metering.

5 Conclusion

Although rainfall and water resources are plentiful in New Zealand, these are not evenly spread over time or space. Coupled with a multitude of competing users of water resources, this makes the issue of the efficient allocation and management of water an important one. The current arrangements for water allocation in New Zealand are based around the legislative framework provided by the Resource Management Act. The Act requires a strategic planning approach to the allocation of water. In practice, most councils end up allocating water resources on a first-in first-served basis, despite the

[34]The latter case occurs in England and Wales where most new houses have a water meter installed.

amount of planning and consultation that goes in to the allocation process. The result is a number of deficiencies in the current arrangements, including inefficient pricing of services, the poor state of many water systems, the lack of trading in water rights and issues with the application of the RMA. It is clear that there is a strong case for consideration of alternative arrangements for water allocation in New Zealand.

A number of other countries have experienced similar problems in their water sectors for many years. As a result they have developed other methods for the allocation and management of their scarce water resources (or at least have made progress in reforming these methods). New Zealand can learn from these methods, particularly in the areas of defining water rights to ensure security in supply, market-based allocation, institutional arrangements and, to a lesser extent, usage-based pricing.

The right framework for water allocation in New Zealand will never be found by exactly replicating overseas arrangements. New Zealand's water environment has its own distinct features that limit the application of a universal model of best practice. However, New Zealand can go some way towards developing the appropriate framework by learning from international experience and establishing effective institutional and legal arrangements. This will facilitate trading to reallocate water to uses that are more highly valued by society, encourage investment in water supply infrastructure and provide incentives for water conservation. Although achieving efficiency in water allocation is a difficult task, establishing these basic principles of good

water management will make it more achievable.[35]

[35]Research by the author is proceeding on these basic principles, particularly in the areas of property rights for water and institutional arrangements.

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Appendices

A Economic Efficiency

The standard definition of economic efficiency as it applies to water resources has three different dimensions: allocative, technical and dynamic efficiency. Allocative efficiency refers to the way in which scarce water resources are allocated amongst competing users. There are two common types of allocative efficiency. The first, and more strict version, is Pareto efficiency. This defines an allocation of resources as efficient if it is not possible to reallocate the resources in such a way as to make anyone better off without making someone else worse off. The less stringent version is Kaldor-Hicks efficiency, where an allocation is efficient if those that are made better off could compensate those that are made worse off and lead to a Pareto efficient outcome.

The Pareto and Kaldor-Hicks definitions of efficiency refer to the ability to make someone better or worse off. In this sense, they consider the value of a resource allocation to society. In particular, both the Pareto and Kaldor-Hicks definitions of allocative efficiency are effectively based on allocating resources in order to maximise the total value of the allocation - including both economic and social values. If, for example, water resources could be shifted to a use that is more highly valued, then a more allocatively efficient outcome is possible.

Technical efficiency refers to the way water is actually used, be it in a

production process or by a household user. This concept of efficiency embodies the principle of water wastage. Cai, Ringler and Rosegrant (2001, p.5) describe technical efficiency for an irrigator as "the fraction of water beneficially used over water withdrawn." Indeed, for a given production process (such as a farmer producing crops or a hydro-generator producing electricity), the process would use water in a more technically efficient manner if the producer were able to produce the same amount of goods using less water. For a household, technical efficiency is also related to reducing water wastage. A household uses water in a technically efficient manner if any and all water that comes from turning on a tap is put to beneficial use.

While allocative and technical efficiency relate to efficiency at one point in time, dynamic efficiency considers the efficiency over time. Evans, Quigley and Zhang (2000) define dynamic efficiency as the efficiency of future decision-making relating to allocating resources and the production process of firms. It effectively embodies both concepts of allocative and technical efficiency in an inter-temporal setting.

It is an implied premise in this paper that the current system for the allocation and management of water in New Zealand could achieve a higher level of economic efficiency. We briefly outline why this is the case at all three levels of economic efficiency.

Firstly, the allocation of water rights in New Zealand is based on a first-in first-served approach with no comparative assessment of competing applications for water. As a result the system does not achieve a level of allocative

efficiency that is possible because the economic and social values of a particular use are not taken into account. Hence there is no criteria for determining if resources are allocated to their highest value use. Furthermore, once water is allocated, there are barriers to trade that prevent rights being reallocated to a higher valued use. This is where creating the right institutional structure and reducing barriers to allow the formation of water markets will achieve a more efficient allocation of water.

The current arrangements are also unlikely to achieve a high level of technical efficiency, particularly at the household level where there are no incentives to conserve water. Indeed, while there are few economic incentives (such as usage-based pricing), there is also limited use of social incentives, such as education programmes or social norms towards water wastage. At the rural and industrial level it is difficult to argue that there is a low level of technical efficiency. Usage-based pricing is typically used, giving an incentive to conserve water. Furthermore, there is evidence to suggest that farmers and irrigation schemes aim to use efficient irrigation methods.[36]

Finally for the case of dynamic efficiency, Evans *et al* (2000) note that the crucial aspect of dynamic efficiency is that decision-making is decentralised, meaning that there is competition in decision-making. In the case of water allocation decisions in New Zealand, decision-making is decentralised in the sense that it is at a local (rather than national) level. However, there is little

[36]See for example McKendry (2002) who notes that the developing Barrhill Chertsey irrigation scheme aims to introduce a modern and efficient system.

competition in decision-making in that users can't compete for water on a value basis. A market for water would introduce such competition, as would privatisation of decision-makers. However the nature of water is likely to encourage a natural monopoly situation which will require regulation. Evans *et al* (2000) also note that dynamic efficiency requires limited regulation. Hence dynamic efficiency, while not currently at a high level, may still be difficult to achieve in the case of water.

B Property Rights

A property right is a claim to the uses (and the stream of benefits accruing from this use) that a scarce resource can be put to by the holder of the right (Demsetz, 1998). Clearly property rights play a more important role where resources are scarce and their are competing users. A resource with an abundant supply will not be so reliant on property rights as users can easily derives benefits from the use of the resource without affecting the amount available to others. As resources become more scarce, that nature of property rights will change. This process is apparent with water resources in New Zealand, where the increased scarcity of water is causing problems in the way property rights are defined and allocated. The current arrangements for property rights in New Zealand evolved at a time when scarcity of water was not a major issue.

Ownership of a property right does not necessarily convey ownership of the resource. Indeed, ownership of water resources in New Zealand is vested in the Crown, but potential water users are able to obtain a property right to generate benefits from the use of the water. In fact, ownership of a property right entitles the holder to a bundle of three separate rights: the right to use the resource, the right to exclude others from its use, and the right to transfer these rights to others (Demsetz, 1998). If property rights are well-defined, then holders will have security in their use of the resource and their ability to exclude others, plus they will have the ability to freely transfer their bundle

of rights to others.

Although water is an inherently uncertain resource, which will inevitably create insecurity in property rights, Livingstone (1998) notes that uncertainty can be dealt with by a combination of technical and institutional arrangements. The technical aspect involves developing storage to store excess water when it is available to be kept for periods when water is scarce. Livingstone also notes that important institutional aspects to the issue of security are in defining water rights proportionately rather than volumetrically and establishing priorities for water rights, both of which are considered in section 4 of this paper. The definition of rights may include specifications of water quality.

C Water Markets and Return Flows

It is an oft-cited disadvantage with water markets that trading can have effects on third parties through the sale of return flows. To see this, consider the following example, adapted from Holden and Thobani (1996). In Figure 2 (a), a water user (A) extracts 50 units of water from a river with a total of 100 units of flow. The user A only physically consumes 30 units, resulting in 20 units of return flows. A user downstream (B) then holds a right to extract 60 units, and they are required to leave 10 units in-stream. Consider then in Figure 2 (b), if A sold their water right to another user (A') who consumes the entire 50 units of water leaving no return flow. The problem arises as this affects B's extraction. B can now take only 40 units of water in order to leave 10 units in-stream.

The solution to this problem, proposed by Holden and Thobani (1996), is that A can only trade the consumptive portion of their water right. Thus, in Figure 2 (c), the new user (A') only holds the right to extract 30 units of water (the consumptive portion of A's water right), allowing B to take out their full allocation of 60 units.

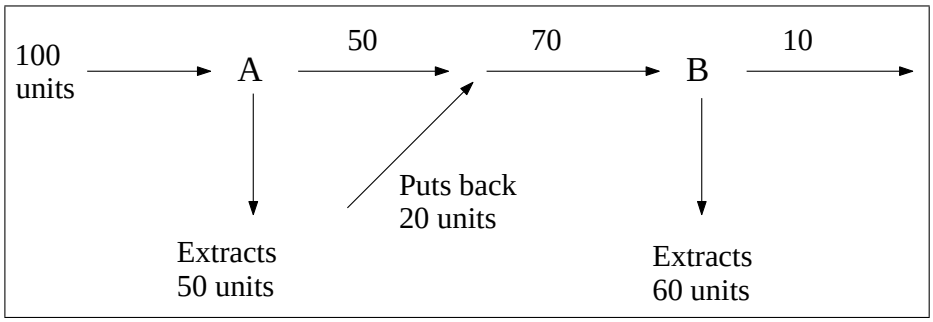
While such a system may work for countries where return flows are small, it may not be useful for New Zealand due to the large proportion of hydro-generation giving significant return flows. Such a system may restrict trading, as hydro-generators would not be able to trade any of their non-consumptive water rights. An alternative solution may be to split water rights into con-

sumptive and non-consumptive portions as above, but endow the user with the right to their non-consumptive water, which may also be traded.

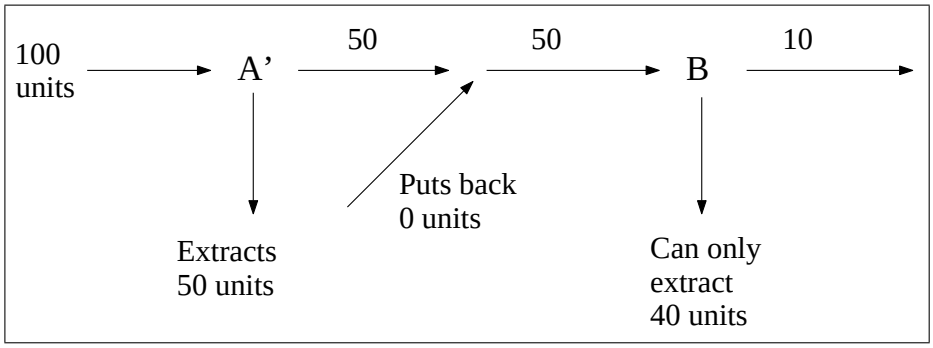
This is shown in Figure 2 (d), where A has the right to their 20 units of return flow, which they can readily sell. The downstream user B cannot simultaneously hold a right which utilises these flows. They can only hold a right for what is left over - 40 units. B could use the extra 20 units of return flows, but they have no legal right to them so cannot object if they are sold. This is similar to the method used in the Colorado-Big Thompson project. In this case, rights to return flows are held by the Northern Colorado Water Conservancy District. A downstream user can certainly utilise return flows but they have no legal right to those flows so must be prepared to relinquish that water if the flows are subsequently sold.

Of course if a water market existed and B did wish to obtain more water, they could buy the non-consumptive portion of A's water right. This would mean that A is only entitled to the consumptive portion of their water right of 30 units of water. In the case of a hydro-generator and a downstream user it would mean the generator has an obligation to release water to provide to the downstream user. However, it would be expected that the price charged to the downstream user for this non-consumptive portion would cover the costs to the generator of releasing water when it may not be optimal to do so from the generator's perspective. While the practicalities of implementing such a system have not been fully worked through, the proposed system may be one that helps solve the return flow issue that is worth further consideration.

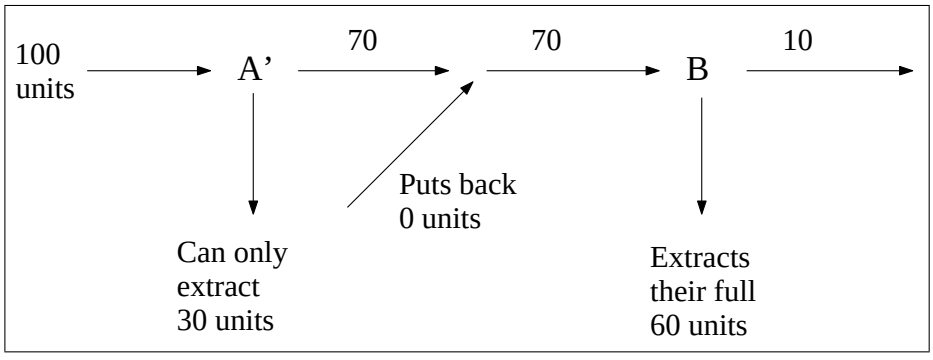
Figure 2: Dealing with return flows in a water market



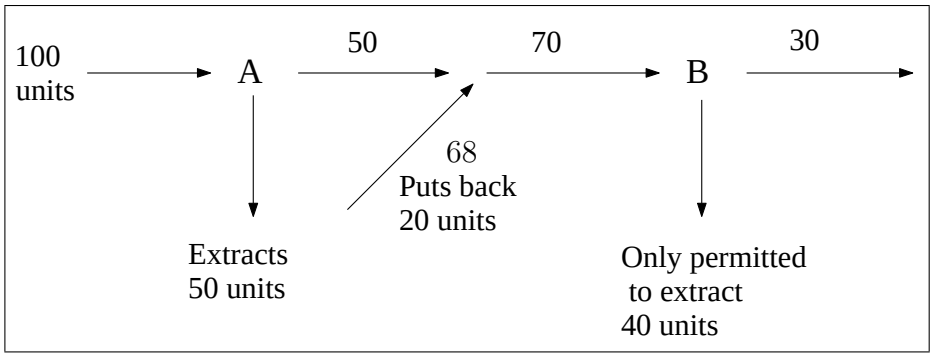
(a) Initial situation



(b) Following water trade



(c) Holden and Thobani (1996) solution



(d) Alternative solution