



KELLOGG
RURAL LEADERSHIP
PROGRAMME

Water sharing in a water-short catchment: Experiences from the Upper Taieri



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Kellogg Rural Leadership Programme

Course 37, 2018

I wish to thank the Kellogg Programme Investing Partners for their continued support:

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Unique Taieri scroll plain on a frosty winter's morning in the Maniototo.

EXECUTIVE SUMMARY

In New Zealand (NZ) freshwater management has become a top political issue with most New Zealanders having an emotional attachment to freshwater and how it is managed. The question is, how do we manage freshwater and respect diverse interest and complex environmental interactions? The aim of this study was to gain an understanding of freshwater management, and identify successful policies and management structures that can meet the needs of rural communities. This project includes a review of the literature around environmental governance and unstructured interviews with regulators, industry individuals and those involved with water governance.

New Zealanders are unlikely to respond to authority unless they understand why. Catchment specific limits around water quality and quantity, empowers rural communities, allowing flexibility for methods to solve issues and giving ownership over solutions. This approach and other bottom up approaches such as Maniototo Pest Management have developed a high level of social capital in the Upper Taieri Catchment, meaning compliance limits set by the Otago Regional Council (ORC) are often bettered by local initiative.

The Resource Management Act 1991 (RMA) set NZ on a different path allowing meaningful recognition of environmental and social values. The RMA is based around sustainable management, principles with an integrated approach to environmental management. Agreed principles give the opportunity for groups to identify shared values. If groups agree in principle, this enhances the opportunity to build trust. If trust is not built between water users, stakeholder groups and regional authorities it increases the likelihood of resource consent applications ending up in the environment court. This adds significant time and cost, and the opportunity to create win-win scenarios is lost.

In California, ownership rights and a strict priority system of 'first in first served', means water is unevenly distributed between communities and can result in significant geographic differences in wealth. Ownership rights to water encourage competition between users and 'Tragedy of the Commons' where individuals are unlikely to preserve the resource because they expect another will take it. The user group structure being achieved in the upper Taieri reduces competition between users by giving top priority to the environment.

Efficiency of water use is the net value of outputs generated from inputs. Individual catchments around NZ, like the Upper Taieri are all unique so best use of a water resource is appropriately established at community level with an integrated catchment governing body such as the Upper Taieri Group. This gives opportunity to harness the valuable social capital and local knowledge.

In conclusion, good environmental policy will alter behaviour in a way that is appropriate to the needs of communities. While freshwater interests in NZ must always be respected, the implications of ownership rights or top down policies will likely have negative implications for rural communities. NZ has a chance to be world leaders in freshwater management by using social capital to reduce compliance costs and achieve policy goals. This is reliant on central and regional government recognising the value of community engagement. Transparency, face to face communication and compromise are needed and should be encouraged to achieve policy goals.

ACKNOWLEDGMENTS

First and foremost I have to thank the Kellogg's Rural Leadership Team, Scott Champion, Lisa Rogers and Anne Hindson, and the selection panel for giving me a spot in Kellogg Course 37. It has been a very rewarding experience for me and I have enjoyed every moment. A very special thankyou to Patrick Aldwell for your encouragement and ongoing support with this project.

My husband Kyle, for your ongoing support and the extra hours of farm work done in my absence and for being the super dad you are sometimes single parent these last few weeks. To my children (thank goodness for their independence), happy school days to my eldest who starts school the same day this project is due, and my 3 year old, for continually keeping us entertained.

To my parents, for providing the flexibility in our farming business, that has allowed me to take some time for Kellogg's. Also for ensuring our children are still loved and for ensuring they have a balanced diet of late. A special mention to dad for your patience with me, I know you don't understand the logic of applying so much literature to what you see as the basics of fresh water management.

To Graeme Martin, our initial discussion in early February highlighted some very important considerations the discussion was a very valuable reference when writing this project.

A special thankyou to Hamish Mackenzie for not only providing knowledge about the Kyeburn Catchment, but your interest in the whole project. For being a great sounding board and proof reader. Others that have been great support include, Francine Hore, Susie McKeague, and Matt Hickey. Thanks to you all, this goes for your general support in the stormy world of water governance that predates Kellogg.

Sandy Sullivan for being so wonderful to my children, and Jim Sullivan for your tips on writing. Others that have been a great help in the proof reading of this document are Nick and Carol Mackenzie, Spiro Anastasiou, and Deb McNally. Thankyou!

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FOREWORD

I joined the Kellogg Rural Leadership Programme to expand my knowledge and understanding of freshwater governance. With knowledge comes confidence, and this is what is required when collaborating with a group encompassing a wide diversity of thought and vested interests. When the Maniototo Irrigation Scheme was commissioned in 1984 I was two years old. Some of my earliest memories of this time are playing in the dust created by the Ministry of Works scrapers and the muddy coloured water flowing over the sills out of the new headraces.

I have been a Maniototo farmer for nearly nine years, and I can't imagine what it would be like to farm here without irrigation. I have also been privileged to experience and enjoy career roles that involved roles in central Wellington and the agricultural sector across New Zealand. This was an opportunity to identify with a diverse range of New Zealanders and a range of different demographics. Water politics are stormy, emotive and at times unforgiving. Throughout this project I hope to apply balanced thought to some of the issues relating to freshwater governance that everyone will find informative.



The first irrigation water arriving at Puketoi in the Maniototo 1984.

INTRODUCTION

Globally, freshwater plays a fundamental role not only in supporting the environment, but also society and the economy. It must be managed to address competing demands although this is becoming more difficult as the world's population increases and demand grows. As this problem intensifies, there is an ongoing search for the most effective solutions to manage resource scarcity and United Nations recognises access to water and sanitation as a human right (*United Nations, 2018*).

New Zealand has an abundance of freshwater, but the nature of our climate makes supply an issue, particularly in areas such as Hawkes Bay, Canterbury and Central Otago where typically dry summers put pressure on freshwater resources. In New Zealand, An Environmental Defence Society survey on the state of the environment found fresh water ranked the poorest, behind marine, public and private land (*Brown, Peart & Wright 2016*). A 2017 election News Hub poll found environmental issues to be rated as third most important, behind health and housing and above education (*Bracewell-Worrel, 2018*). This indicates obvious public concern for the state of our freshwater resource and how it is managed.

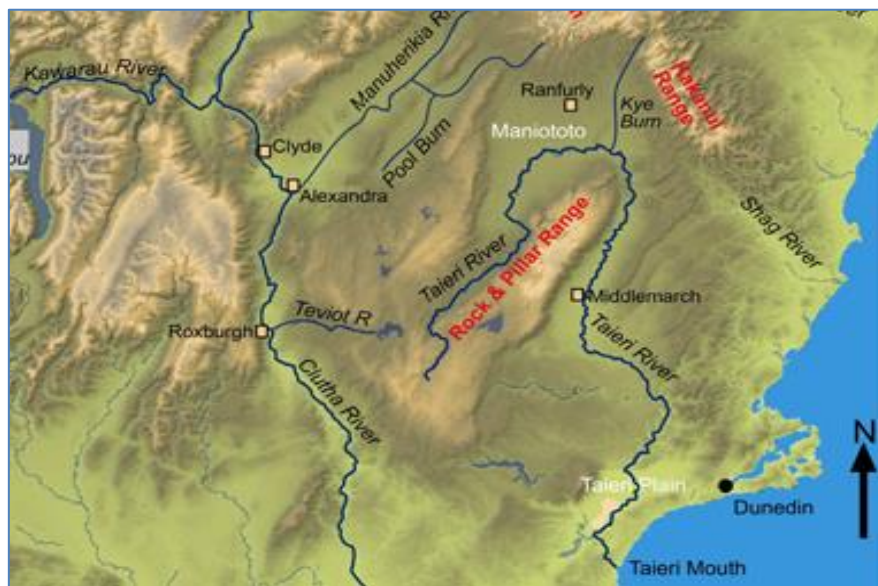


Figure 1 Topographic map of east and central Otago, showing the contrasting courses of the >200 km long Clutha and the Taieri Rivers (*Craw, 2018*).

The Taieri River is the second largest river that drains the Otago landscape at over 200km in length (*Craw, 2018*). The Upper Taieri Catchment includes the Loganburn Dam, Styx Valley, the Maniototo Basin and the Strath Taieri (Middlemarch) area. The main catchment is the Lammerlaw Range; upper tributaries include the Loganburn Creek, the Styx creek, Sow Burn, Pig Burn, Kye Burn and Swin Burn. Average rainfall for lowland areas of the Upper Taieri Catchment is 350-500 mm/annum. Some smaller tributaries join the Taieri from the north. Upon exiting the Maniototo Basin the river veers south through Strath Taieri. The river provides residents with drinking and irrigation water and is an important recreational resource (*Tyson, Panelli & Robertson 2005*). Although the area is described as one of the driest of New Zealand, the catchment supports over 150 irrigators (*Lees et al., 2012*).

AIMS

The aim of this study is to:

1. Gain a better understanding of the issues surrounding water resource management in a water short catchment such as the Upper Taieri Catchment.
2. Apply understanding to help determine optimum policies and structures required to meet the needs of rural communities.

METHODOLOGY

Part I of this project is a literature review of environmental policy providing insight to inform the next two parts of the project.

Part II, provides a background to policy implemented in the Upper Taieri Catchment and outlines some of the issues that are relevant to our catchment. This is done by reviewing policy documents and discussions with individuals previously involved with freshwater governance and policy in Otago.

Part III, Investigates international examples to see if there is an alternative model that might be applied to NZ. This is done by researching overseas literature talking to contacts overseas. This section also includes investigations into how to calculate efficient water use. In conclusion this section investigates a governance model that might be suitable for the Upper Taieri Catchment

'Here lies a land who's life is written in water' – Thomas Hornsby Ferril

1 PART I – LITERATURE REVIEW – ENVIRONMENTAL POLICY

Part I is a review of literature associated with environmental policy highlighting where different types of policy can be successful. This review focuses in detail on the important factors that need to be considered by authorities such as the Otago Regional Council (ORC) when applying regulation.

1.1 Common pool resources

Freshwater, forests, and fisheries are often referred to as Common Pool Resources (CPRs) that benefit a group of people or a community. There are three different methods used to regulate CPRs (*Ostrom 1990*) & (*Gunningham 2011*).

1. State centralised control (SCC), government regulation or hierarchy.
2. Market-based governance or the assignment of individual private property.
3. Collective actions or collaborative governance.

Ostrom (1990, p14), noted that some scientists believe SCC is the best option because they fail to see individuals acting for anyone but themselves. This is known as ‘Tragedy of the Commons’ where resources are exploited in self-interest for short term economic gain rather than for long term sustainability. Assignment of individual private property (privatisation) refers to common land being divided up so everyone has a private section (*Ostrom, 1990*). An example of freshwater privatisation would be the historical mining licences in Otago which permitted an irrigator to abstract water from a river with no environmental or neighbour constraints. In these situations, individuals were able to pursue their own self-interest within a set of well-defined property rights. Market-based governance seeks to change behaviour by changing price signals to which rational and economically driven actors are expected to respond in their own self-interest (*Gunningham, 2011*). Market based governance is discussed as a case study in Section 3.1. Collective action is a community group working together to achieve a common objective, creating their own rules.

Ostrom (1990 p 14) argues that ‘many solutions exist to cope with many different problems’. Issues associated with CPRs are often defined as ‘Wicked’ or problems of such scale, persistence and complexity as to defy solution (*Gunningham, 2011, p13*). Their complexity ranges across ecological, economic and social diversities and shocks and disturbances are common (*Duitt & Galaz, 2008*).

For example, it is difficult to know how much water is being used compared with total allocated amounts, and the complex relationships between groundwater and surface water extractions that can occur over many distances. The nature of water resources is that they are complex and unpredictable. There is also a wide range of interests and diversity of thought about the ‘facts’, ranging from central government, regional government, lobby groups, Non-Government Organisations (NGOs), communities and resource users. In New Zealand everyone has an emotional attachment to freshwater and an interest in how it is used and managed.

1.1.1 Collective action verses state centralised control

This section explains some of the reactions to the different methods of regulations, and when they might be effective.

Cardenas, Stranlund & Willis (2000) investigated the behaviour of villagers in Columbia who rely on local forests for firewood, and noted that if they extorted the resource for short term gain it affected water quality. There was a strong relationship between water quality and forest cover and villagers were very aware of this problem. This was a simulated experiment on villagers from three rural villages to determine how much time they would spend collecting firewood with (1) no communication between villagers, (2) allowing communication between villagers and (3) regulatory control, (that wasn't necessarily enforced). It was found that with no communication villagers were more likely to act in their own best interest assuming that if they did not utilise what was available, another would simply take it. However, if villagers were allowed to communicate they exhibited a much stronger group orientation, meaning they took collective action for mutual benefit.

More regulation (or SCC) developed in the hope of resolving environmental and social dilemmas pushed individuals to act more in self-interest with less regard for fellow villagers, again creating 'The tragedy of the commons'. This is because enforcing a rule changed the mentality of villagers to expect responsibility would be taken by authorities. This research assumes that the regulation will only be weakly enforced as is common in developing countries. It should be noted that while enforcement is more likely to be effective in developed countries, it implies a significant cost in terms of financial loss and in the alienation of those using the resource. A high amount of government policy has the potential to accelerate resource destruction if it is poorly enforced (ibid).

The research also identified that the crowding out of public spiritedness by regulations can make it harder for communities to deal with other environmental issues because they are seen as the responsibility of regulatory authorities. Interventionist methods (such as government regulation) can also result in the unnecessary deployment of resources to policing those who would be quite willing to police themselves (Gunningham & Sinclair, 1998).

One of the threats to sustained collective action was the effort by central government to impose a single set of rules on all governance units in a region (Ostrom, 2000). Such rules can fail to identify catchment specific rules like instream and out of stream water use and trigger self-interested behaviour as local water users no longer see the need for collective action. Efforts by central government, if enforced, will inevitably come at a higher cost than a community self-organising to manage a resource. This can cancel out the welfare gains that the regulation is intended to achieve (Ostrom, 1990).

Rouillard and Spray (2017, p1878) noted that top down (SCC) policies can work where authorities are very balanced and have strong roots within their communities. This is because the authorities 'strong roots' give them a better understanding of local catchment specific issues. Where there is a serious risk of irreversible damage to the environment, SCC may be the best option to quickly halt undesirable behaviour. Gunningham & Sinclair (1998, p3) mention that self-regulation (collective actions) can be cost effective but can also have low reliability when used in isolation.

1.2 Policy engagement – examples from health and safety initiatives

Health and safety management is another area where change has been driven by emotion and lessons can be learned from these examples. There are two main approaches to health and safety management, behaviour change, or culture change. Behaviour based safety management is ‘bottom up’ where behaviours may be identified, and then goals set that are specific and tailored to the setting in question (*DeJoy, 2005*). Culture change approaches are more ‘top down’ with policies coming from management. This research identified that these strategies could be complementary.

The effectiveness of health and safety strategies also depends on the culture where they are being implemented. Brookes (2012) investigated ‘How National Culture Influences Worker Attitudes towards Workplace Safety’. The aim of the study was to enable a better understanding of how national culture influences the views and attitudes of workers in developing countries towards workplace safety. In this research Fonterra Cooperative Group employees from nine different countries world-wide were surveyed to assess differences in culture.

It was found that developing countries showed a high level of ‘power distance’ and a low level of ‘individualism’. Power distance is the acceptance of power by less powerful members of society, and individualism is the preference for individuals to look after their own needs. This means that in developing countries, rules, policies and procedures are effective at influencing change in behaviour that will result in better workplace safety outcomes. Low individualism means high collectivism; this means workers are less likely to speak up about workplace safety issues. This is because they do not accept the need for worker participation. This supports a culture change approach that is more ‘top down’. In western cultures the opposite was found. Low power distance and high individualism meaning that workers need to understand the reason behind these procedures and decide whether they should be obeyed.

New Zealanders showed the lowest power distance result of all nine countries surveyed. This means they don’t passively receive messages or instruction from an authority figure without understanding why. This is combined with a high level of individualism; which indicates a preference to solve their own problems. The survey also showed that when it comes to safety requirements at work New Zealanders need to be emotionally engaged (*Brookes, 2014*). This could mean that New Zealanders need to ‘buy in’ to policy changes for them to be effective, and ‘top down’ culture change approaches are unlikely to work unless they are accepted through a high level of consultation. New Zealanders are unlikely to follow instructions unless they understand the reason for the instruction.

‘We pride ourselves on Kiwi ingenuity, having a number eight wired attitude, a love for DIY and the unfailing sense that everyone should be given a fair go’ (Brookes, 2014)

1.3 Integrated catchment management

New Zealand's Resource Management Act 1991 (RMA) allows for integration of different methods at a regional level acknowledging that regional differences require different solutions.

'Regional councils are responsible for the establishment, implementation, and review of objectives, policies, and methods to achieve integrated management of the natural and physical resources of the region' (New Zealand Government, 2017)

Integrated management involves recognising, social environmental and economic values. These three values are known as the triple bottom line, also defined in New Zealand as the quadruple bottom line when incorporating cultural values under the Treaty of Waitangi 1840 (Hughey, 2011). Approaches of integrated management can be bottom up or top down, SCC control is top down, and collective actions are bottom up. A mix of the two is defined as Integrated Catchment Management (ICM). It can also be known as co-regulation (Gunningham & Rees, 1997). ICM is defined as a process which involves building up a collective of scientists, resource managers, policy makers, stakeholders and community representatives (Harrison, 2013, p22). It is a multidisciplinary approach that integrates top down central or regional government policy with bottom up governance or collective actions of a community.

'Integrated catchment management comes with the creation of a vision of a catchment and its capacity to provide ecosystem services to many interests, together with a shared vision amongst all stakeholders about how to deliver the vision with equitable sharing of the ecosystem services.' (Lerner and Zheng, 2011, p2640)

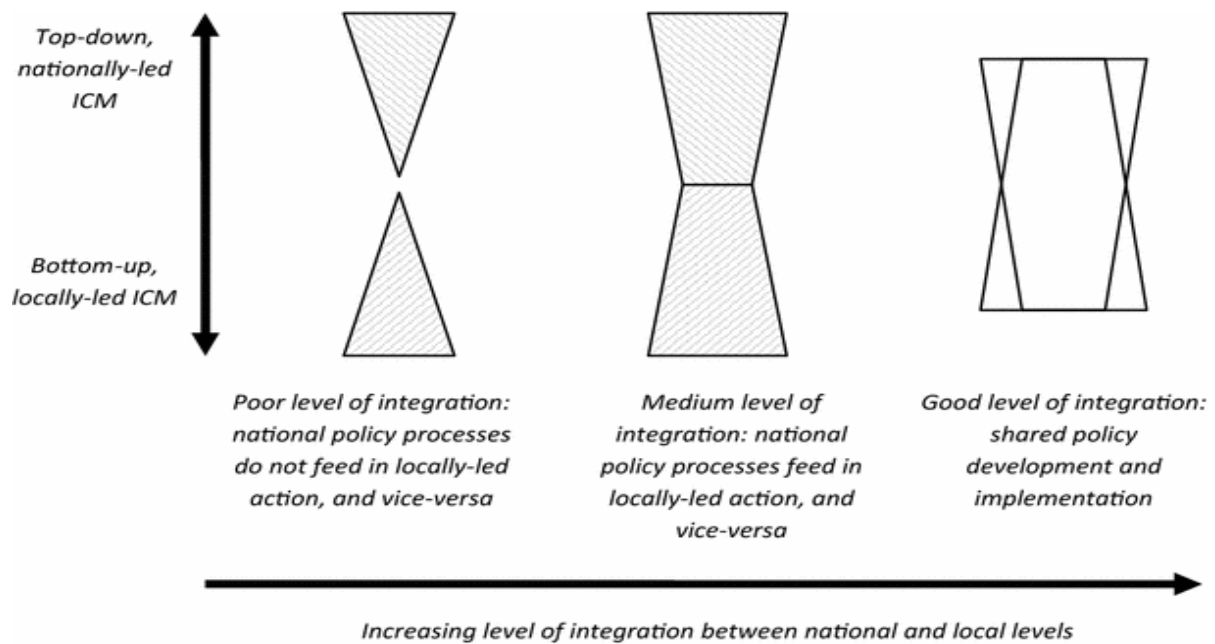


Figure 2 Integrating top down and bottom up (Rouillard & Spray 2017, p1871).

Bottom up governance, also known as Participatory Catchment Organisations (PCOs) are community based in response to an issue (Cook et al., 2013) & (Rouillard & Spray, 2017). Bottom up groups are most successful when aligned and integrated with top down regional or central government policy (Rouillard & Spray, 2017). This means that regional authorities recognise the values of the individual catchments and are willing to work with groups and supply resources. Communication between regional authorities and resource users (the level of integration) is critical to the success of the group (Figure 2). There are common themes to successful ICM explained below.

1.3.1 Integration from Regional Authorities

It is crucial that self-regulation operates in the shadow of rules and sanctions created by the general law (Gunningham & Rees, 1997). Rules can create the issue required to drive collective action. However as discussed above too many rules provides fewer incentives for actors to organise new institutional structures (Lubell et al., 2002). Limits rather than rules allow for the development of local solutions that are particularly suited to that environment. Limits set need to be enforced so that if parameters are breached, penalties send a powerful message to others to comply.

The threat of sanctions if they fail to deliver on performance targets may also substantially reduce the risk of free riding (Gunningham & Holley, 2016). Free riding is when some individuals contribute less to group action but gain the full benefit of being a member of the group. Free riding is less likely when individuals are aware that there will be consequences for noncompliance.

“The more the laws, the less justice.” Marcus Tilius Cicero

1.3.2 Trust and leadership

One of the main themes in the literature for collective action, PCOs, and ICM is trust or a trusted leader (Cook et al., 2013), (Memon, Painter & Weber 2010), (Harris, 2017), (Deitz, Ostrom & Stern, 2003) & (Vollan & Ostrom, 2010). A leader should be someone who identifies with all stakeholders, resource users and regional authorities (Rouillard and Spray, 2017). The trusted person should not

be too closely aligned with national policy or they risk being seen as a 'pressure group' or a 'campaign voice'. For a larger group, trust can take more time to build. This happens when the group extends outside the direct community, and people are less well known. The leader needs to have sufficient prestige to influence the social norms of the group (Vollan & Ostrom, 2009).

Leadership of common pool resources requires a special set of skills that sets it apart from a business leader. Leaders need to be able to set apart their own self-interest for community good, and be able to identify with a wide and diverse group of people. They need to be able to inspire and listen carefully to consider a large diversity of thought to get a sense of what people want and what they value (Dunne, *pers com*, 2018). Issues based ICM structures have a shelf life. They respond to an issue, and then fade (Memon, Painter & Weber, 2010). Also described as when a group identifies a common enemy (Martin *pers com* 2018). When that issue is solved the group can often fade, until another issue is identified. This highlights the importance of size. A group needs to be big enough to continually identify new issues; however it is quite acceptable for groups to go through active and passive stages over issues and solutions (McKeague, *pers com*, 2018).

It is also important to consider trusted intermediaries. If farmers don't trust the person or organisation that supplies them with information then it is unlikely to be acted upon (Fisher, 2013). If information is supplied through a trusted intermediary such as a consultant, then it is more likely to become knowledge. In a trusted relationship there is longevity, consistency and regular contact (*ibid*). This means that a leader does not have to be a farmer; they can be another trusted person such as an industry person or a consultant.

1.3.3 Communicate and compromise

If individuals are given the opportunity to communicate, it increases the likelihood that they will shift from self-interested decisions to group decisions (Ostrom, 1990). This process takes time to build trust and is dependent on users sharing moral and ethical standards in the groups that they form (Ostrom, 2009). This means that members must respect the values and legitimacy of claims from all members in the group and be prepared to compromise. Long term progress requires all stakeholder groups to participate through ICM processes at a level that leads to mutual accountability for outcomes (Memon, Painter & Weber, 2010). This means that groups must have buy-in from all members and be prepared to be accountable for decisions made.

If there is no compromise, mutual respect and continued cooperation between all stakeholders, regional authorities and resource users, the success of the group will be detrimentally affected. This can be challenging because of the wide ranging interests, diversity of thought, and individualism involved with freshwater. Frequent face to face communication increases the potential for trust (Deitz, Ostrom & Stern, 2003). This is because it allows for people to see emotional reactions, and allows parties to discover shared values as well as conflicts. Alternatively experiments show that when communication occurs via a computer terminal, there is much less cooperation (Ostrom, 2000).

"Technology is nothing without the human spirit." (Ian Taylor, 2018)

1.3.4 Time and resources

Communities need time to digest information and build trust. If this process is rushed it can break down the group and deliver poor end results (Lees *et al.*, 2012). Time is required to build trust in a

leader within the group and in information. Trust in information requires qualified scientific resources with which the group can identify. Stakeholders and authorities also need time to build trust in communities and with water users. Trust is important from all interested parties and is required for the commitment of financial resources.

1.3.5 Short term gain (short termism)

Gunningham & Sinclair (1998, p11) discuss the argument that “it is in a business’s own self-interest to move beyond compliance with existing legislative requirements and adopt a proactive stance exceeding minimum performance standards”. They can enhance corporate image, and realise new environment related market opportunities. However this was a rare occurrence for corporates, most likely because investors and others focus on short term performance. If they cannot generate economic gain in the short term, there may be no long term to look forward to (*ibid*). By giving the opportunity for stakeholder input into decisions around resource use, it is possible to create a new level of social norms, to influence a culture of short termism. Over time this can create an industrial morality creating a culture that recognises long term sustainability.

Lubell et al., (2002, p153), ‘population stability leads to a sense of place that may enhance support for environmental protection’. Quality of life depends heavily on access to local resources. People with a sense of place also have local knowledge of natural systems that can be integrated into institutional rules (*ibid*). In New Zealand this is often multi-generational farmers who have been members of the same community for generations.

1.3.6 Social capital

Social capital is created when communities build social networks based on trust and reciprocity, therefore cooperate to solve issues. Prior experience in cooperative management increases the likelihood of groups successfully managing the resource (*Vollan & Ostrom, 2010*). In these situations trust has already been established between parties, and they can identify to previous success.

Options for governance need to be adaptable to changing social, economic or ecological processes this can include floods and droughts, disease epidemic or an economic crisis (*Duit & Galaz, 2008*). Management needs to be flexible and responsive to changing circumstances. If rules and regulations are enforced with a top down approach the feedback from changing processes will be much slower, making regulations clumsy. Social capital is adaptive to changing pressures because it is linked directly to the community. A wide range of invested parties that can continually bring new issues to the table creates social capital that can adapt as situations change.

1.4 Conclusions

The characteristics of good environmental policy are that it alters behaviour in a way that is cost effective and appropriate to the needs of communities (*Brown, Peart & Wright, 2016*) When policy is being designed it needs to consider the social and cultural environment where it is being implemented. The culture of New Zealanders is suited to an approach that allows communities to solve their own issues, where they are given limits that define an issue and are empowered to develop a solution. Success is dependent on rural communities, stakeholders and regional authorities being able to communicate and compromise. Once this level of social capital is

established in a community, it is a cost effective tool that can adapt quickly to ever changing interactions in the environment.

2 Part II – AN EFFECTS BASED APPROACH TO WATER GOVERNANCE

This section outlines the changes to freshwater policy over the past 30 years in Otago and some of the community responses that have occurred as a result of the policy measures in the Upper Taieri Catchment. In 1991, water takes in the Upper Taieri were mainly individual deemed permits and the Maniototo Irrigation Scheme (MIS) which is described in Appendix 2.

2.1 Resource management in Otago

When the RMA was implemented in 1991, it replaced or amended more than 50 existing laws relating to town planning and resource management (*Ministry for the Environment, 2017*) and previous legislations such as the Water and Soil Conservation Act and the Soil Conservation and River Controls Act. The RMA aims to promote the sustainable management of air, land, freshwater and marine areas. It is a holistic approach to resource management, encouraging public participation in decision making, integrating the values of communities and stakeholders, recognising equity, and everyone's right to freshwater.

The RMA is based on the principles set out in Sections Six and Seven which enable people and communities to provide for their social, economic, and cultural well-being. It focuses on managing the effects of activities rather than regulating the activities themselves. Intervention is only necessary where activities are likely to result in unacceptable environmental impacts (*Environment Foundation, 2018*). Another important aspect of the RMA is the reference to the Treaty of Waitangi. All persons exercising functions and powers under the Act must recognise and provide for "the relationship of Maori and their culture and traditions with their ancestral lands, water, sites, waahi tapu, and other taonga" (*New Zealand Government, 2017*).

Principles allow a much more flexible, imaginative and innovative form of social control which seeks to harness not just governments but also business and third parties (*Gunningham & Sinclair, 1998*). An effects based approach recognises that threats to the natural environment can take many forms so the sort of policies or methods that will work will depend on the characteristics of the environmental issue under consideration (*ibid*).

Sustainable management also means that decision making must consider needs of future generations and the wider effects on other natural and physical resources. This framework, allowed the ORC to identify strengths and weaknesses in the region. In 1998, a Regional Policy Statement (RPS) was implemented in Otago to provide an overview of the resource management issues of the region using the principles of the RMA. This outlined policies and methods required to achieve integrated management of resources in Otago (*Otago Regional Council, 1998*).

"The RPS fostered a broader environmental thinking in us all for social, productive and sustainability values. It initiated public discussion on regional issues, social, cultural and environmental values" (Graeme Martin, 2018).

2.2 Freshwater considerations in the Upper Taieri Catchment

The following are some of the considerations and issues that were identified in the original RPS that are of significance in the Upper Taieri relating to water quality and quantity. The RPS was reviewed in 2015. For this project I have focussed on three issues acknowledging that they interrelate with a much wider range of environmental considerations.

2.2.1 Environmental flows (minimum flows)

To recognise environmental and cultural values of fresh water in Otago, minimum flows were set on water ways. They are intended to provide for the maintenance of the aquatic ecosystem and natural character values of water bodies, while providing for the sustainable taking of water for use (*Otago Regional Council, 2016*). The Taieri Catchment is protected by five minimum flows; Paerau (850 l/s), Waipiata (1,000 l/s), Tiroiti (1,100 l/s), Sutton (1,250 l/s) and Outram (2,500 l/s) (*LAWA 2018a*).

Resource consents for takes upstream of a minimum flow point include conditions that users cannot take water once levels drop below the nearest downstream minimum flow. The Maniototo Irrigation Company (MIC) has consent conditions that require it to maintain flows by using stored water when required.

2.2.2 Mining licences

Mining licences/privileges or deemed permits, arose from the goldfield history in Otago. These water rights were issued by the Wardens Court constituted in the 1860s for the purpose of gold mining. Around the turn of the century legislative amendments allowed the water to be used for irrigation purposes. Deemed Permits implied ownership and this made them a fiercely protected property right (*Farley, 2013*). The priority system meant that the oldest permit had the first access to water in times of water shortage. They override rules and policies in regional plans and there is no restriction on water take as river or creek flows drop. When the RMA was passed in 1991 an expiry date of 2021 was set for all existing mining privileges. RMA 1991 Sec 413 (3):

‘Every deemed permit resulting from a mining privilege under subsection (1) (c) or (d) shall be deemed to include a condition to the effect that it finally expires on the 30th of the date of commencement of this Act’ (New Zealand Government, 2017).

Water use past 2021 for owners of deemed permits, requires them to apply for a replacement resource consent. Resource consents consider sustainable management recognising social and environmental values, requiring community and stakeholder participation. In 1991 there were 2000 deemed permits in Otago, at the time of writing there are 368 left (*Weaver, pers com, 2018*).

This was of particular relevance to the Kye Burn, where gold was discovered in 1860. Dredging for gold in the late 19th century and early 20th Century ploughed the Kyeburn riverbed and is responsible for most of the altered landscapes. Taieri Lake was drained using explosives because sludge from Naseby and Hamilton diggings had clogged up the lake (*Mackenzie, pers com, 2018*). This resulted in a large volume of water being allocated for agricultural uses, creating fierce competition for water during times of shortage, at the expense of environmental, social and cultural values (The Kyeburn Catchment is discussed more in Section 3.3).

2.2.3 Water quality

The Maniototo basin is prone to severe drought and low flow conditions. A reduction in the quantity of water in a lake or river can affect its capacity to assimilate contaminants and can lead to higher water temperatures under low flow conditions (*Otago Regional Council, 2016*). During severe droughts and low flows, increased bacterial contamination of rivers occurs in agricultural and pastoral catchments in Otago (*Caruso, 2001*). This is due to greater stock use of waterways and the lack of dilution and flushing flows, as well as return flows from flood irrigation. There is a connection between land use, irrigation and water quality in the Upper Taieri Catchment, though concentrations of most contaminants are generally low relative to recommended guidelines (*McDowell & Kitto, 2013*). McDowell & Kitto (2013 p261). “With the forecast land use change for the catchment, strategies should be employed to mitigate further water quality deterioration”.

2.3 Regional policy in Otago

Otago Regional Plan: Water for Otago, became operative in 2004. It was designed with a principle-based framework. Principles were set and used by the ORC for all actions and functions internally and externally (*Martin, pers com, 2018*). When published, it was found that where resistance was faced the principles were acknowledged. The purpose of this Plan was to provide a framework for the integrated and sustainable management of Otago’s water resources, addressing the issues outlined in the RPS (*Otago Regional Council, 2016*). The plan incorporates the principles of the RMA, international agreements that have a direct influence on the management of New Zealand water resources, and the principles of the Treaty of Waitangi (*ibid*).

The Otago Water Plan (OWP) applies catchment specific limits and rules around water quality and quantity, focusing on methods to achieve these limits. It is based on a low level of intervention, allowing communities, and water users flexibility in their responses and giving them ownership over the solutions.

“In some aspects of resource management there is insufficient flexibility and too much prescription with a focus on activities rather than end results.” (Sir Geoffrey Palmer, 2015)

In 2011 the Government issued a National Policy Statement for Freshwater; to provide regional authorities with guidelines on how to implement the RMA. Central Government was identified as failing to give guidance to regional authorities and regional councils were said to be slow to enforce their regional plans under the Act (*Harrison, 2013*).

Martin pers com (2018) “the slowness was about evolving executive, community and political attitudes, obligations and approaches”. Regional Councils were formed in 1988 with the intention that they would implement the RMA when it was finalised. They were born from the combination of former authorities including Catchment Boards and Regional Water Boards. These authorities were reliant on grants from central government. This created a culture with authorities and landowners that nothing was done unless grants were made and it took time for the culture to change (*ibid*).

In 2014, the ORC water quality plan change rules became operative. (Plan Change 6A) These were farm scale discharge threshold limits for all farms for leaching and surface runoff that were developed in consultation with the community (*Hickey, pers com, 2018*). A transition period was agreed on so that these thresholds would not be enforced until 2020. This gives landowners time to adjust management practices to meet these thresholds limits. This approach was taken to empower rural communities to take responsibility for sorting out any issues they find (*ibid*).

2.4 Integrated catchment management in the Upper Taieri Catchment

2.4.1 The Taieri Trust

In July 2001, a catchment wide project called the Taieri Trust was formed. It evolved from a community-orientated research project undertaken as part of a doctoral dissertation in the Taieri Catchment (*Parkes, 2003*). It involved a group of Taieri catchment residents given support from the Otago University to form the Trust. It was hoped it would help improve awareness, knowledge, actions and coordination with stakeholders in the catchment to address river health and ecological issues (*Tyson, Panelli & Robertson, 2005*).

“This project has been and will continue to be as much about building up social networks and capacity as it is about positive environmental outcomes” (Robertson, 2005)

The Taieri Trust had four trustees who were landowners, a University of Otago representative and the wider management group (*Tyson, Panelli & Robertson, 2005*). The wider group included more trustees, resource managers, Fish and Game Otago (F&G), Department of Conservation (DOC), Iwi the ORC, Dunedin City Council (DCC) and Central Otago District Council (CODC). A full time salaried project coordinator and a part time assistant were supplied from the Landcare Trust. Financial support came from the Sustainable Farming Fund (SFF), Ministry for the Environment (MfE) and the University of Otago.

Nearly all the management group believed the Taieri Trust was a key motivating influence on ORC and DOC, and actions relating to water quality monitoring, remediation and enforcement of wetland protection. It was noted that the lack of involvement from CODC and DCC, and the slow pace of DOC’s involvement were constraints on the programme. Resourcing from the University of Otago gave the project more credibility and helped ensure efforts were not seen as “Just another off-putting group of environmentalists”. In 2003 the project was awarded one of three ‘Green Ribbon Awards’ from the MfE recognising the programs national leadership role in ICM (*Tyson, Panelli & Robertson, 2005*).

The trustees came from very diverse backgrounds to create a joint vision. Through five years of volunteer input from a dedicated management team, the trust achieved a number of goals including riparian restoration projects, raising awareness of the environment through a children’s book, for schools, videos and media coverage and newsletters to community members and stakeholders (*Robertson, 2005*).

2.4.2 The Upper Taieri Water Resource Management Group

In 2007 The Upper Taieri Water Resource Management Group (UTG) was formed. It was seen as the next move for the integrated catchment model following the completion of the Taieri Trust (G Crutchley *pers com*, 2018). The objectives included:

- research into efficient water use and best use of a water resource,
- management of water quality and quantity
- dealing with the high number of remaining mining licences yet to be renewed,
- to produce a model for community self-management of water resources in a high demand area.

Over 150 water users were involved, many of whom faced the expiry of their current water access permits (deemed permits/mining rights) in 2021 (Landcare Research, 2018). The project also included DOC, F&G, Iwi, local government and researchers. Buy in from stakeholders was much faster than the Taieri Trust with all stakeholders bringing their own objectives to the table (G Crutchley *pers com*, 2018). Once every 2-3 months a public meeting or field day was held involving stakeholders, water users and local and regional authorities. This indicates the development of social capital over time.

The OWP recognised community input and promoted the formation of user groups within catchments (Appendix 5). This policy was adopted to take advantage of local knowledge to ensure local circumstances were considered in maintaining or enhancing natural and human use values. (Otago Regional Council, 2016). This framework was an objective for the UTG that identified schemes/companies as an effective way to manage water for the good of the whole community. (Tyson, Edgar & Robertson, 2011). This led to the formation of user groups, of individual permit holders working together to apply for a single collective consent instead of individual mining permits or resource consents.

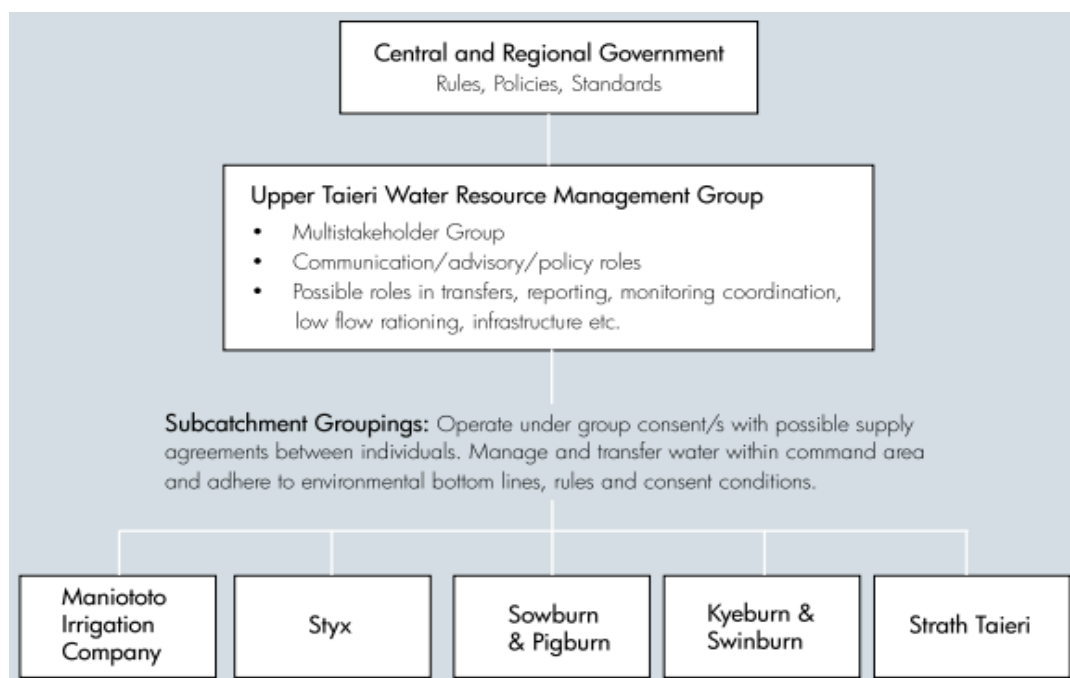


Figure 3 Community self-management model proposed by the Upper Taieri Group (Landcare Research, 2018).

Figure 3 shows the proposed water governance model for the Upper Taieri Catchment established during Phase Two of the project from 2009-2011. This acknowledged the benefits of a group model such as reduced cost of application, economies of scale and controlled water transfers under a collective consent (*Landcare Research, 2018*). If water users apply for resource consents individually there is still competition between users because if one user leaves water in the river above their residual flow someone else will likely utilise it. A single collective consent was also much easier for the ORC to monitor compared to many different individual takes. As a group the water users must work together and share to manage one residual flow. This is discussed more in Section 3.3.

The effects that the project had on farmer beliefs/attitudes and targeted outcomes were measured in two surveys, one in 2007 at the beginning of the project and one in 2010 (*Tyson, Edgar & Robertson, 2011*). They found a significant increase in farmers who thought there were good working relationships between water users and other interested groups/agencies in the Upper Taieri. In 2007 only 50.0% of farmers thought that stakeholders perceived Upper Taieri water users as environmentally responsible; this increased to 80.7% in 2010 (*ibid*). This shows that ICM can help unify the interests of individuals and organisations to create a win-win scenario. The management group also observed that the project had helped the community develop effective leaders.

2.4.3 Collective action in the 2017-18 season

Self-regulation contemplates ethical standards of conduct which can extend beyond the letter of the law and significantly raise standards of behaviour (*Gunningham & Rees, 1997*). This means groups are more likely to act before being directed to by authorities. There is evidence of this in the Upper Taieri Catchment. In the 2017/18 season the Upper Taieri Catchment faced very dry conditions. Kyeburn Catchment Limited (KCL) operated within the conditions of its consent that had not yet been issued (most of this group currently hold deemed permits; this is discussed further in Part III, section 3.3). To maintain ecological flows the Maniototo Irrigation Company (MIC) released an extra 150L/s from storage for much of December and January over and above the consented requirement to maintain dwindling river flows through the Maniototo Plain. Deemed permit holders on the main stem of the Taieri restricted their abstraction to allow these ecological flows from the Loganburn dam to reach Waipiata.

Responsibility for compliance is largely internalised in response to the threat of further regulation, and some groups recognised the need to share with downstream users (*McKeague, pers com, 2018*). Farmers acknowledged that river wellbeing was crucial. Their actions demonstrate change in cultural morality and social norms of the community since the implementation of the RMA in 1991 with water users recognising social and environmental values to the wider community.

“I’d love all rural communities to adopt ownership of the relevant environmental issues such as pests and water like the Maniototo community does!” (Scott McLean, 2018)

2.4.4 Other farmer-managed organisations in the Upper Taieri Catchment

A frequent finding from empirical field research is that when the users of common pool resources organise themselves to devise and enforce some of their own basic rules they tend to manage local resources more sustainably than when rules are externally enforced (*Ostrom, 2000*). This can also be applied to pest control in the Maniototo. See Appendix 3 for the history of Maniototo Pest Management (MPM). MPM is viewed by the ORC as the 'gold standard approach' to pest control in Otago (Appendix 2).

2.5 Top heavy policy

Society technology and land use are all dynamic and the stability of any system depend on the political dynamic s that go with it, politics will always respond to severe pressure (*Martin, pers com 2018*). Currently in New Zealand national and regional policy frameworks have the ability to significantly undermine or empower the functioning of community led responses (*Ostrom, 2009*) & (*Newman & Robertson, 2010*).

Governance in the Upper Taieri Catchment is a delicate balance of limits set by regional authorities creating an incentive for collective actions at community level. Too many rules or blanket regulation from central government will undermine the work done by the local community. These top heavy methods will cause resentment and resistance, especially in a sector with a history and culture of independence (*Gunningham & Sinclair, 1998*). A top down approach will come at a higher cost, and achieve less than the governance system already in place. Finally, this will likely trigger self-interested behaviour, so that opportunities to develop the best local resolutions are lost. As described in Section 1.2 If environmental regulation is seen as the responsibility of regulatory authorities it would likely crowd out public spiritedness which could affect the success of groups like MPM.

2.6 Key points from the effects based approach

- It took time for resource management in New Zealand to evolve under the RMA to recognise social and environmental values.
- Policy based around principles allows a diverse range of communities and environments to solve different issues in different ways.
- Water users recognised the need to address the issues of water quality and quantity resulting from land use changes and the expiring mining licences.
- Farmers are capable of collective action and can put aside their own self-interest for a wider community good.
- In the Taieri Trust, it took time to build trust with some agencies and individuals, but when the UTG was formed buy in was much quicker because of the previous good working relationships. This shows that the level of integration and trust improved over time.

- Face to face communication significantly increased the trust between stakeholders and water users.
- This process identified future leaders through involvement of the UTG with regional authorities and stakeholders.
- The OWP is allowing for communities to solve catchment specific issues utilising a strong level of social capital that can achieve goals well above the required level of compliance.
- However this outcome is dependent on ORCs continued recognition of the value of community management.

3 PART III - CASE STUDIES – COMPARING INTERNATIONAL WATER POLICIES

This section compares two international examples of water policy to the Upper Taieri Catchment and applies learning from the literature review. It also includes a section about efficiency of water use. Finally it describes how the ICM model might develop further in the Upper Taieri catchment.

3.1 Water markets in Australia

A Water Market involves the voluntary trading of an allocation of water and uses market mechanisms to achieve policy goals. Markets vary in complexity around the world but this research focuses on Australia's water markets, in particular the Murray Darling Basin (MDB) where the market is well established. The MDB covers more than 1 000 000 km² or 14% of Australia's land area (Appendix 8). Trading can be broken down into two markets (*Grafton & Horne, 2014*) & (*Wheeler, Bjornlund & Loch, 2014*).

1. Entitlement trading –the permanent trading of an ongoing share of a water resource providing exclusive access to a share of the water resources within a water resource plan area (predominantly in perpetuity) (*Wheeler, Bjornlund & Loch, 2014*).
2. Allocation trading – trading a portion of an entitlement within a season (otherwise known as temporary trading). An allocation is set to an entitlement at the beginning of each season.

As in New Zealand, the Australian commonwealth government promoted the use of water for agricultural production to encourage economic development and the state has subsidised networks of dams and weirs to provide water security. During the 1970's there was concern about the corporatisation of water and land, so the water rights were tied exclusively to a parcel of land (*National Water Commission, 2011*). This often led to inefficiency because more water than necessary was used on a designated area of land. To get access to more water, a farmer would have to buy the land that it was attached to. Despite this, some unofficial allocation trading was allowed during periods of severe drought.

Environmental issues from pressure on water supplies were first identified in the 1970s/80s, such as the major blue-green algal bloom along the length of the Darling River having major economic, social and environmental impacts (*ibid*). The closing of the Murray River mouth in 1981 to 1982 and in 1991, created public awareness of the issue.

In response to these pressures, reforms in 1994 separated water rights from land ownership, allowing more flexible trade. The aim was to promote water trading and its transfer to higher value consumptive uses (*Grafton & Horne, 2014*). These reforms continued both within and between states over the next two decades. Schulte (pers com, 2018) identified these reforms to be a key turning point in the evolution of water markets, away from the administrative allocations by government toward a market orientated approach based on clearly defined and tradeable property

rights. These reforms included arrangements to ensure that trade can occur while protecting the environment and third-party impacts from trade (Aither, 2017). Rules differ slightly between states.

3.1.1 Environmental social and economic Impacts

A key feature of the reforms was the 'Cap-and-trade' (CAP) where state government sets caps on water extraction. This was to maintain and improve existing flow regimes to protect and enhance the riverine environment, and to achieve sustainable consumptive use to meet ecological, commercial and social needs (Murray Darling Basin Authority, 2012). CAPs need to be stringent enough to protect the environment, but also allow for economic gain. However, if a drought is especially severe the Australian Commonwealth Government buys back water access entitlements and can redefine the overall CAP (Burdack, Biewald & Lotze-Campen, 2014). A CAP is a long-term target and is reviewed yearly. If a CAP is exceeded, extraction will be reduced the following year. This means there is very little chance of going over the long-term CAP (Schulte, pers com, 2018). Priority rights still exist between users so higher priority entitlements (higher security entitlements) are more valuable.

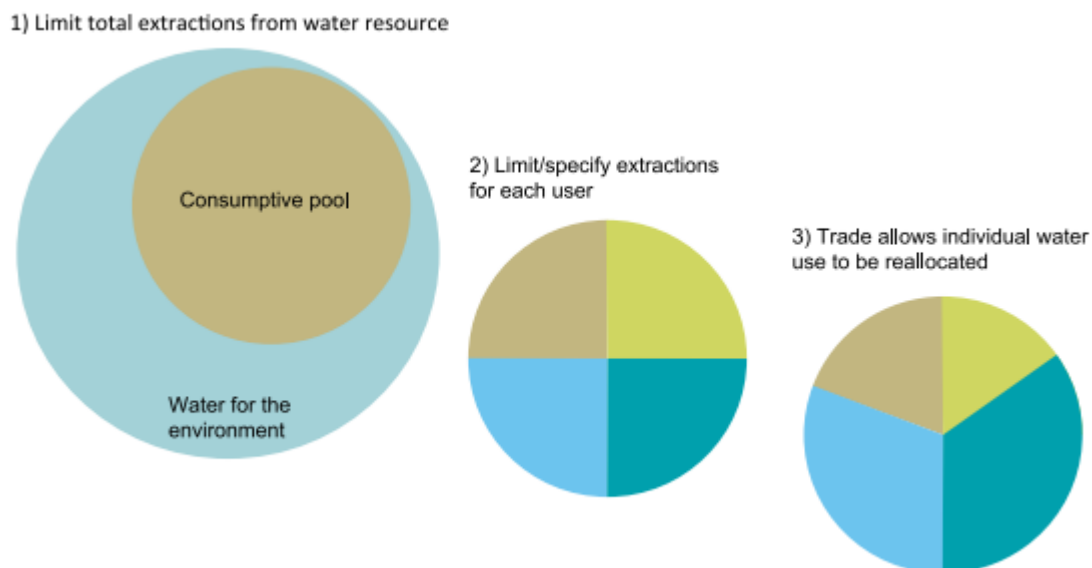


Figure 4 The 'Cap and Trade' approach to establishing water markets (National Water Commission, 2011).

Until the market really developed, some rights were not activated. These were labelled 'sleeper entitlements'. When trade increased these sleeper entitlements were actively traded. This led to an increase of water consumption, especially during droughts when the value of water was very high. Initially this created some problems with CAPs because water use was much higher than expected which led to the government spending millions to purchase water for the environment (Wheeler, Bjornlund & Loch, 2014).

In 2004, one of the reforms resulted in Australian states, territories and the commonwealth agreeing to expand the water market across regional boundaries. This was done to increase trade and eliminate competition between states. Social concerns about water trading are mentioned widely, the most common relates to the transfer of allocation away from a community (Wheeler, Bjornlund & Loch, 2014). However, physical constraints in the system mean there is a limit on how much water can be transferred (Schulte, pers com, 2018).

A high value land use responsible for consuming a lot of the southern MDB water in the last few years is nut farming in South Australia (Appendix 6). This is putting pressure on the infrastructure to meet water demand and indicates that water is being traded from owners upstream. This creates a lack of diversity in the market as water moves to higher value long term uses (*Aither, 2017*). Despite the system constraints, the level of trading indicates the market supports individual wealth creation over community employment. This means that some communities may be affected at the whim of the market without being participants in it (*Hasselman & Stoker, 2017*). Hasselman & Stoker (2017, p511) found that 50% of submissions to the senate select committee of the Murray Darling Basin Authority in the 2015-2016 seasons confirmed this concern.

Victoria is the only state in the MDB that precludes non land-holders and speculators from participating in the market (*Burdack, Biewald & Lotze-Campen, 2014*). Other states allow speculative investment; a risk here is that non-users can benefit from trading when water is at its highest value in times of drought. However, because of the CAP system, licence holders receive very low allocations in times of drought so there is little benefit to selling water and, in all other years the return on investment would be low, hence not a great investment (*Schulte, pers com, 2018*).

Water sharing plans define the rules for sharing within a region, prioritising town supplies, environmental flows and cultural uses (*Aither, 2017*). New South Wales rural councils can apply for extra water for town development (rather than having to buy it on the open market), ultimately reducing the yield and security of entitlements held by irrigators. (*National Water Commission, 2011*). This and spot purchases for the environment by government can lead to a stagnation of water markets.

Hasselman and Stoker (2017, p514), concluded that “the market has discouraged community spirited and altruistic behaviour in respect to water usage. The competitive dynamics created by the market are a source of conflict envy and community breakdown”. This means that the water market crowds out public spiritedness and could make it harder for communities to solve other issues without state or federal intervention.

3.1.2 Is a water market applicable to New Zealand

The characteristics for a successful water market need to be discussed before it is considered for New Zealand. (*adapted from Aither, 2017*).

- **Scarcity of the resource** - meaning there is no more water to be allocated
- **Connectivity** - a large connected system
- **Sufficient Users/Participants** - a greater number of users create more ability to trade
- **Heterogeneous demands** - a range of land uses within a catchment, as different uses are unlikely to have the same pattern of requirement.
- **Increasing Demand** - net increase for demand in water over time
- **Pressure for change** - where there is change in industries in response to external drivers such as overseas markets

The growth of water markets in the southern MDB is at least partly a result of the unique underlying characteristics of the region’s water resources and industry mix (*National Water Commission, 2011*). Because the MDB is such a large interconnected, slow moving system and there are a large range of water uses that can utilise the resource at different times, it is favourable for trading. Schulte (pers

com 2018), identified that ‘in coastal areas of Australia where there are shorter and faster moving systems, trade is virtually non-existent because there are simply not enough buyers and sellers so trading zones are too small’. Limited trade may also be related to the land use in these coastal catchments having a similar water demand pattern, (Aither, 2017), for this reason it was identified that pumping regulations, restricted by environmental flows, have more effect on water use than the market.

Stakeholders in some coastal systems say that that there has been a small increase in allocation trade in recent years, most likely due to transfers from small to medium sized businesses moving out and entitlements consolidating amongst larger users (Aither, 2017). In the Hunter region there has been an entitlement shift to coal mining, limiting allocation access for agriculture (*ibid*). If third parties (or stakeholders) have no ability to intervene in the market, larger users could end up with a significant share and they could create a water shortage in the catchment. Further, there may be other reasons beside speculation for investment in the water market, such as gaining control of the irrigation company or associated business.

Grafton, Horne & Wheeler, (2016, p913) “Water Markets in the MDB when developed within the appropriate institutional framework and coupled with comprehensive water planning, markets have (1) helped improve environmental outcomes (2) Assisted irrigation adaptive responses to climate risk (3) Increased the gross value added of farming (4) Been regulated in ways to meet social goals.” Gross income is not an indication of profit as it does not consider farm expenses. Environmental outcomes and social goals are addressed by regulation from state or federal government. This means that top down regulation has played a large roll in achieving policy goals.

The Taieri Catchment has times of scarcity and large variations in climate between different areas of the catchment. At 5650 km², the Taieri Catchment is the second largest catchment in New Zealand but it is still only just over 1/20th of the size of the MDB. The extreme climate also limits land use in the Upper Taieri, so the current pattern of seasonal water demand is similar between sheep and beef, and some dairy operations. In the short term, a water market with tradable allocations would see some transfer to higher economic value use.

Table 1 Average EBIT (earnings before interest and tax) per hectare from 2013-2016 for differing land uses (Journeaux et. al., 2017).

Land Use	EBIT \$/ha*
Viticulture	11,832
Dairy	2,527
Sheep and Beef	155

* Viticulture, based on Marlborough data, Dairy, Sheep and Beef are based on national averages.

Table 1 shows the difference in income generated, from different land uses that could be appropriate for the Upper Taieri Catchment (numbers may vary for Otago). Pressure for change could see an increase in hardier, high value viticulture or horticulture crops that fit the short growing season, although this would take more time because it would require land use change and development of supporting infrastructure.

3.1.3 Key points from water markets

- Australia's Water Markets are an example of 'the assignment of individual private property'. In the absence of specific regulation they do not provide for environmental and social values.
- However, a series of reforms over the last two decades by authorities were implemented to achieve this.
- While system constraints can stop too much water being transferred away from communities, research suggests that there are negative socio-economic effects on communities that have no involvement in the market.
- In the future, a decrease in diversity in the market may occur because of water transferring to high value long-term uses.
- Clearly defined private property rights in water markets create competitive and self-interested behaviour.

3.2 California water law

California's Central Valley covers about 20,000 square miles and is one of the most productive agricultural regions in the world. More than 250 different crops are grown with an estimated value of \$17 billion per year (*Claudia, Stranlund, & Willis, 2010*). This area has an average rainfall of around 730mm per annum, decreasing to 150 mm/annum in desert areas of the south (*Styles, 2018*). Recently, droughts have been frequent and severe, with the 2014 drought being identified as the worst in 1200 years due to extreme temperatures and reduced precipitation (*Griffin & Anchukaitis, 2014*)

Initially Californian water law was dominated by the old English water law system of riparian rights which entitled a landowner to use a correlative share of the water flowing past his or her property (*State of California, 2018*). In the 1849 gold rush of California, water right law was sent on a different path because water was sometimes required large distances from the source. The culture of mining claims was 'finder's keepers' which also applied to water rights. This led to the appropriative system that exists today, also known as the 'Doctrine of Prior Appropriation'.

All water in California is considered property of the state (*Wade, pers com, 2018*) and water rights are mainly governed by the State Water Resource Control Board (SWRCB). However, an appropriative permit is considered a property right. The role of the SWRCB is to ensure proper water resource allocation and efficient use, for the benefit of present and future generations (*State of California 2018*). The SWRCB has primary authority for ensuring meaningful implementation of the Public Trust Doctrine.

The Public Trust Doctrine requires all water to be reasonably and beneficially used. This includes (but is not limited to), commercial, domestic, dust suppression, fire protection, fish and wildlife culture, flood control, instream flows, industrial, irrigation, mining, power generation, stock water and snowmaking. Public trust uses are sufficiently flexible to encompass changing public needs (*Water Education Foundation, 2018*) and this means that beneficial uses can be changed to reflect the

changing values of society. Three types of water rights are recognised under California Water Law (Kier Associates, 2011).

1. **Riparian Rights-** water is extracted for use on lands directly bordering a stream; they are non-transferable and not subject to prior proof of use. However unused rights can be challenged if they affect downstream right holder's access to water. It cannot be stored, or transferred to a non-riparian land title. Riparian right holders can take as much water as can be beneficially used on that parcel of land. Riparian right holders are required to reasonably share with other riparian right holders. Though they are not governed by the SWRCB, they cannot affect public trust resources.
2. **Appropriative Rights-** water extracted for use on a non-riparian land title. This use requires a permit from the SWRCB, and is subject to a priority system 'first in time, first in right'. Under the priority system they are not required to share but they can take their full entitlement based on priority. Water not put to beneficial use after a period of time can be returned to the public trust doctrine. Appropriative rights post 1914, are junior in priority to pre 1914 appropriative rights.
3. **Pre 1914 Appropriative Rights-** do not require a permit from the SWRCB. However the California Constitution Article 10 Section 2 states that water must be put to beneficial use. Conservation of such water will occur in the interest of people or public welfare (*Justia, 2018*). The owner must be able to prove historic and continuous use dating back to pre-1914. These permits are governed by fewer rules because they are prior to the Water Commission Act 1914.

3.2.1 Water transfers

Water allocation transfers are allowed for appropriative rights, but the sale of complete water rights (or entitlements) is not allowed. Pre 1914 rights can be transferred without notice to the SWRCB, but they are prevented from affecting public trust uses (*State of California, 2018*). This means that transfers can be challenged in court by other water users or third parties. Changes to post 1914 rights must seek public approval through application to the SWRCB. If a "change of point" take affects another user regardless of priority the transfer will not be allowed. The SWRCB must also establish that the transfer does not affect the overall economy from where the water is being transferred.

3.2.2 Water availability

Huge agricultural demand for water is met by a combination of surface water and ground water (*Cody, Folger & Broughey, 2010*). The California Department of Water Resources will notify surface water availability in the late spring based on when, where, and how precipitation occurs (e.g., snow versus rain). In times of water shortage junior water right holders will be the first to miss out on allocation in favour of more senior rights; this is enforced in a court of law. Most of the surface water comes from snow pack stored in the north where rainfall is around 1300 mm.

In the Central Valley, one of the typical consequences of below-average precipitation, reduced snowpack levels and lower reservoir levels is an increase in groundwater pumping to offset reduced surface water supplies (*Cody, Folger & Broughey, 2010*). Central Valley aquifers constitute about 20% of total ground water demand in the US and they are the second most pumped aquifers in the

nation (*ibid*). Pumping of aquifers exceeds recharge, creating a ground water overdraft in Central Valley (*Sugg, 2018*), and this has created increasing pumping costs, and ground subsidence as the water table lowers. Ground subsidence occurs when the ground collapses on empty aquifer space, reducing the capacity of the aquifer.

It is estimated that California will have to abandon about 400 000 ha of irrigated area in California because water will not be available (*Styles, 2018*). Until 2014 ground water takes were unregulated, so water users could take as much as they wanted with no regard for other users (*ibid*). In 2014, the California groundwater act was signed aiming to achieve sustainable groundwater usage by 2040.

3.2.3 Central Valley Project

Much of California's surface water is managed by the Federal Central Valley Project (CVP). It consists of 20 dams and reservoirs, 11 power plants, and 500 miles of major canals, as well as conduits, tunnels, and related facilities. The project manages around 9 million acre feet of water (11 101 million m³), delivering 7 million acre feet (8 634 million m³) for agricultural, urban and wildlife uses (*The Bureau of Reclamation, 2017*). The construction of CVP began in the late 1930s as a response to heavy winter and spring runoff and summer water shortages, also for flood control of the frequently flooded Sacramento-San Joaquin Delta. The project was funded by Federal Government (US Bureau of Reclamation, USBR) because during the depression the state of California couldn't finance the project alone (*Sugg, 2018*).

CVP holds the appropriative right to supply water to 'contractors' with a priority date of 1927. However the law gave them no special powers to overrule older appropriation rights so priority remained with previous right holders (*Cody, Folger & Brown, 2015*). The project involved dams and canals from the Sacramento River Valley and the San Joaquin Valley and head waters. These rivers were already grossly over appropriated by very senior right holders (*Sugg, 2018*). This has resulted in poor security for the CVP contractors. For example, in the last 25 years, CVP contractors have been restricted by 50% or more for 12 of the last 24 years (*Cody, Folger & Brown, 2015*).

The CVP plan entailed damming and diverting practically the entire flow to the San Joaquin River north and south along the Madera and Friant-Kern Canals so that downstream riparian rights were affected (*Sugg, 2018*). Affected downstream users were compensated by the USBR with priority rights from the Sacramento River, supplied with stored water from Sashta Dam as part of the CVP. These were called Exchange Contractors and in the event of severe shortage they can request water deficits be made up from their original source (*ibid*). This means junior CVP contractors with water rights from the San Joaquin River can completely miss out on water.

Another challenge for the USBR was how to transfer stored water to downstream CVP contractors in the Sacramento River; again. Again, USBR negotiated 145 settlement contracts giving them a base supply of water with senior priority. Base supply is the amount of water that can be diverted for free. They are also entitled to purchase some project water over and above the base supply (*Sugg, 2018*). These are known as 'Settlement Contracts' and this significantly reduces security of water to downstream 'junior' CVP contractors.

Table 2 Drought year allocations to CVP water user groups south of the Delta. Percentages (%) of total contracted volumes supplied (adapted from Sugg 2018).

	2012		2013		2014		2015		2016	
	Feb	Jun	Feb	Jun	Feb	Jun	Feb	Jun	Feb	Jun
South of the Delta	-	-	-	-	-	-	-	-	-	-
	May	Aug	May	Aug	May	Aug	May	Aug	May	Aug
Settlement Contractors /Water Rights (%)	92	100	100	100	48	65	75	75	100	100
Friant Diversion (%)	43	50	56	56	0	0	0	0	0	*

Table 1 shows water was allocated from 2012-2016 within the CVP. South of the Delta is the area south of the California delta where the Sacramento and San Joaquin rivers exit central valley to the coast. It shows that Friant Diversion contractors went without water for 2.5 years, while the settlement contractors faced much smaller restrictions.

There was a significant geographical unevenness of impacts during the drought in California (Sugg, 2018). Over half of the fallowed acres in the Central Valley were in the Tulare Basin where the Friant Diversion is located. Fallowing is associated with unemployment and under employment and in 2016 about 75% of the full time and part time agricultural job losses were in the Tulare basin (ibid).

3.2.4 Imperial Valley transfer

Southern California is entitled to a certain amount of water from the Colorado River under interstate laws. A quantity of “4.4 million acre feet and not more than half any excess supply” (Littleworth & Garner, 2007), was allocated using what is known as the ‘Seven Party Agreement’. This involved seven priorities for beneficial uses for Agriculture and Urban uses. Agricultural uses in Imperial Valley were priority number three. It has one of the best water rights in the state of around 2000 mm (Styler, 2018) and the fourth and fifth priority was given to the Metropolitan Water District (MWD) of southern California including the city of Los Angeles (Littleworth & Garner, 2007).

Arizona and Nevada had never utilised their full entitlements to the Colorado River Upstream from California until late in the 20th Century. This meant that California was able to make use of excess supplies. When Arizona enacted its right to take its allocation, it was challenged by California arguing Arizona couldn’t prove historic use, but was rejected in Federal Court (Littleworth & Garner, 2007). Reduction in available excess supplies has also put pressure on metropolitan supplies that are down the priority ladder in California. Imperial Valley is the biggest user of Colorado water in California so its water use was challenged by the Metropolitan district that saw wasteful application methods not to be a ‘reasonable use’.

In early 1989, the Imperial Irrigation District (IID) and the Metropolitan Water District (MWD) of Southern California signed a water conservation agreement. Under this agreement the Metropolitan water district subsidised Agricultural irrigators to become more efficient within their irrigated area. The payment for water transfer was used to finance changes to irrigation infrastructure.

In the MWD water is expensive. Farmers in this area are paying \$2200/ha for water because all water needs to be piped and treated for the city of Los Angeles (LA) (Styler, 2018). LA had the 5th

largest population growth in America in 2016 and 2017 (*US Census Bureau, 2018*). With a rainfall of 150 mm southern California is very reliant on water from the Colorado River.

3.2.5 Considerations for New Zealand

Otago and California have a similar goldmining history; appropriative rights are very similar to mining licences. In 1991 New Zealand started afresh with the RMA phasing out and eventually putting these rights on an even footing with everyone else. The RMA also combined many of the different organisations that were associated with environmental policy. It suggests where NZ could have been if ownership rights to water with deemed permits remained.

In California water is the property of the state but the priority system means that gains in times of water shortage are limited to those with the most senior right. Imperial Valley has higher priority which creates conflict with increasing demands from cities that have a lower priority. These conflicts are settled mainly through the courts with ongoing battles as to what is reasonable and beneficial use. Changing social norms in the Upper Taieri Catchment (Section 2.4.3) indicate a different approach to scarcity.

The water resource in California is also over allocated for the times of the year it is needed most (*Carter, 2018*). During times of shortage when water is the most valuable, profit is restricted to those with the oldest and most senior right. This means wealth for some areas while others bear the costs of the drought. Thus, wealth is unevenly distributed between communities. The next case study is an example of how water sharing has been developed in New Zealand.

3.2.6 Key points from California water law.

- California and New Zealand have a similar history of gold fields, and seasonal water shortages.
- California has kept its historical appropriative rights from a gold mining history that were similar to the deemed permits in Otago.
- A point of difference is that Otago abolished this system when the RMA was implemented in 1991.
- Ownership rights to water in California mean that individuals pursue their own self-interest within the property right.
- This means that in times of scarcity communities where there are no senior priority rights, there are severe negative socio-economic effects
- In Southern California, the water supply for Los Angeles (MWD) has lower priority than irrigation districts such as the IID.
- MWD have and will challenge IID for what is reasonable use of water which will reduce irrigated area for agriculture to support domestic supplies to one of America's fastest growing cities.

3.3 Kyeburn Catchment user group – A collective resource consent

Kyeburn Catchment Limited (KCL) is a user group formed in 2007 to renew their individual water takes with one collective resource consent, as proposed under the OWP (Appendix 4). This is the second biggest group in the Upper Taieri Catchment after MIC, with 15 water users involved. Water takes in the catchment include 24 deemed permits and 6 renewed RMA permits (*Weaver pers com, 2018*), from the Swinburn and the Kyeburn Rivers and tributary creeks (Figure 5). A rain poor climate, high resource demand, and existing priority rights, created a very challenging project for a group of farmers.

In 2007 not many of the higher priority deemed permits had been renewed on the Kye Burn because owners stood to lose some volume of take to residual flows. Residual flows are an environmental flow that must be left behind, and is now a standard resource consent condition. The Kyeburn River is very volatile; flash floods are common, as are periods of extremely low flow.

This project spanning over a decade “reflects a significant change in attitude and approach to the management of water within the catchment from an individual competitive approach to one of collective catchment wide management” (Dicey, 2017)

3.3.1 Timeline for Kyeburn Catchment Limited

The catchment was split into three subsections (Figure 5), the Kye Burn main stem, the tributaries and the Swin Burn (*Mackenzie pers com, 2018*). These groups had to identify historical flow use and how much water was going to be shared. This was an uneasy period for the group because many deemed permit takes held priority. Historic use and climatic extremes are taken into account in consent applications, and they had to prove they were using the water. For sharing to be possible, it was identified that all data on water used needed to be accessed by all members of the group through a telemetry provider. All KCL shareholders now have complete access to all flow volumes and total water used by individual shareholders.

It was agreed that the only way to progress was to relinquish all priority rights within the group. It was a significant decision for some, as this meant their access to water was eventually going to erode and some were sacrificing more than others. Under the OWP, there is no obligation for a water user to share with downstream users as long as they operate above the residual flow stated in their consent. Section 6.4.7 of the OWP outlines “The need to maintain a residual flow at the point of take will be considered with respect to any take of water, in order to provide for the aquatic ecosystem and natural character of the source water body” (*Otago Regional Council, 2016*). Collecting information also meant meeting with effected parties such as F & G Otago, Kai Tahu, and DOC to identify in stream values.

Following priorities being relinquished, and with three to four years reported data, KCL worked with consultants to identify residual flows at each point of take and supported these decisions with science. Some of the most secure water was surrendered for the environment with some sacrificing more than others. This was an incredibly fragile decision because of the importance of irrigation to provide economic value to a farming business and the identified need to provide sufficient flows to meet environmental and cultural needs. The group decided that they would aim to maintain 180 L/s above take 3 at Scott’s Lane. Scott’s Lane is a flow recording site below Take 4 (Figure 5).

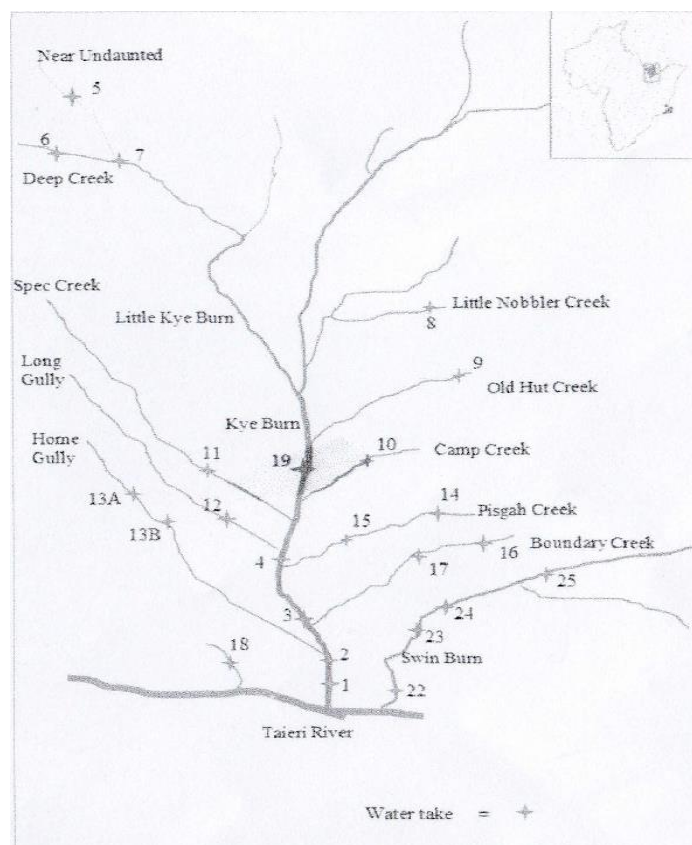


Figure 5 Sketch of the Kye Burn catchment with its tributary creeks, main stem and the Swin Burn (Severinsen, 2017).

In 2017 KCL was granted consent for 180 L/s at Scott’s Lane. This was appealed by F&G Otago which wanted a flow of 250-300 L/s. After months of mediation, a compromise is likely to be reached that KCL will aim for a residual flow of 200 L/s in 5 years, giving its members a chance to adapt to a lower level of security on farm.

3.3.2 Water sharing

The following describes how the flow sharing works on the main stem of the Kye Burn between Takes 1 and 4 (Figure 5) (Mackenzie, pers com, 2018).

Table 3 Takes 1-4 on the Kye Burn mainstem (see figure 3), their individual consented takes and proposed sharing at different flow levels (adopted from Hickey, 2017).

Take	Consented maximum take (L/s)	Flow Rate above Take 4		
		450L/s	300L/s	250 L/s
4*	251	150	70	50
3	112	100	50	40
2	85	0	0	0
1	83	50	30	30
Residual below Take 1		200	200	180

* Take 4 is a water race

- Consented maximum takes are resource consents or deemed permits for individuals or a water race supplying several individuals. Mostly this much water was not utilised because it either wasn't needed in a wetter season or in times of low flow it simply wasn't available.
- The flow rate above Take 4 dictates how much water there is to share (Table 5).
- As the flow drops, Take 4 will reduce intake to allow enough water for takes 3-1 and residual flows, so with this sharing Take 4 is now delivering water to take 1.
- This system also relies on water users on the tributaries sharing and allowing for residual flows
- Originally take 3 held priority, and then Take 4. This meant that when the inflow dropped below 250 L/s takes 1 and 2 were unreliable.
- At flows below 250 L/s at Scott's Lane irrigators will roster. For example, this means take 4 will shut off completely to allow water to reach take 1, or take 1 will shut off completely to allow residual flows provided by Takes 3 and 4 to reach the Taiari confluence.

As described in Section 2.2.1, resource consents are tied to downstream minimum flows, KCL is tied to the Tiroiti minimum flow. Maintaining the Tiroiti minimum flow at 1100 L/S on the Taiari River is done with the same rostering system, and so it dependants which area is receiving the lowest rainfall as to which KCL has to work toward maintaining. It is acknowledged by KCL that when both the Scott's Lane site and Tiroiti are at risk of breaching, there may be no water available for extraction. A link to the flow at Tiroiti means that KCL is also connected to the residual flows in the river at Waipiata and to MIC at the top of the catchment.

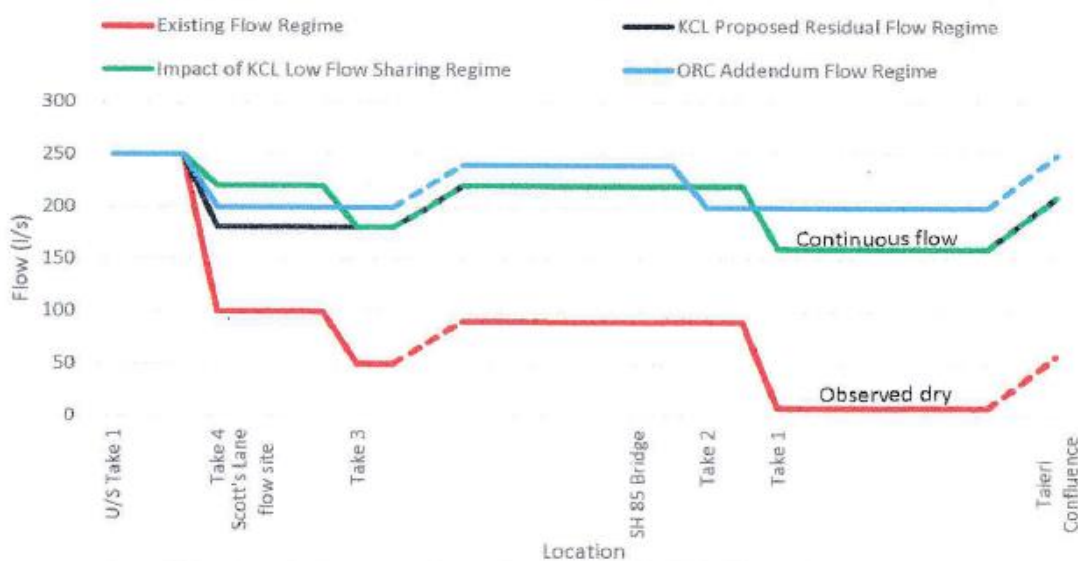


Figure 6 Flow sharing proposed by KCL compared with the ORCs Addendum residual flow proposal for flows of 250 L/s above take 4. Also shown is the existing summer regime, and the absolute bottom line flow regime proposed by KCL. This uses the residual flow of 180 L/s at Scott's Lane (Hickey 2017).

- Figure 5 shows the 'Existing Flow Regime' with deemed permits and some renewed consents. This shows that historically when flows have dropped to 250 L/s the lower Kye Burn was observed dry.

- The ORC Addendum flow Regime was proposed before KCL’s evidence was reported at the hearing. ORC accepted the KCL’s sharing proposal, seeing the severe impact on economic benefits to the community.
- KCL Low flow sharing regime is how KCL aim to share. Take 4 is leaving more water available so take 1 has more secure water but this means that flows in the lower Kye Burn stretch for around 3km may drop to 160 L/s.
- The KCL Residual flow Regime is what they aim to stay above. When Take 3 is off, this water will be available for Take 4 upstream.

3.3.3 Social and environmental gain

In consultation with affected parties, KCL identified existing instream values and problems that were caused by the existing flow regime. KCL employed scientists to identify flow requirements to maintain or enhance instream values. Kye Burn is identified as a high quality spawning area, supporting the area’s trout fisheries, and it is also important for native fish, long fin eels and native non-migratory galaxiids. Issues with the existing flow regime were loss of surface water connection and character below Take 1 that can affect fish passage (Figure 3). The flow sharing regime proposed by KCL was aimed at maintaining or enhancing all the values and maintaining a continuous flow of the Kye Burn connecting to the Taieri River.

Social gains reflect on the balance between economic gain and environmental gain. By enhancing instream values recreational uses are improved including Kai Tahu values associated with the River. Kai Tahu Ki Otago has a long association with the Taieri catchment and it is of great significance (*Kai Tahu Ki Otago, 2005*). KCL is working with DOC and Kai Tahu to protect species such as the non-migratory galaxiids, and long fin eels. With regard to the latter they do not allow commercial eelers across their properties (*Weaver, pers com, 2018*).

3.3.4 Economic gain

The properties in the Kye Burn catchment are large multigenerational family farms. Having enough security of water to irrigate an area of their properties gives them income security in times of drought. The extra income leads to development and corresponding needs for more labour that generates a benefit to the whole community through employment. This also allows farmers to invest in the less productive dryland areas of their properties and such as weed and pest control in the high country.

Table 4 Storage required achieving 95% reliability for existing irrigation infrastructure at Take 4 in the Kye Burn Catchment (*Hickey, pers com 2018*).

Residual flow at Take 4 (l/s)	Surety of supply (%) for pivots based on residual flow	Storage required (m3) to achieve 95% surety for each respective residual flow	Cost(\$) of Storage at \$4/m³ (<i>Aqualink 2015</i>)
160	92.5	485 395	1 941 580
200	90	687 053	2 748 212
250	87.5	963 446	3 853 784
300	82.5	1 263 168	5 052 672

Below 95% security, supply for existing spray irrigation infrastructure becomes unreliable (*Hickey, pers com, 2018*). This means water users have the option of decommissioning some existing infrastructure and reducing the amount of area irrigated, or they invest in storage to improve reliability. Storage would cost around \$4m³ (*Aqualink, 2015*). As the flow requirement at Take 4 (Figure 6) is increased so does the amount of storage required by water users to maintain security for their existing infrastructure. Kye Burn irrigators acknowledge that they will require storage because to maintain Scott's Lane above 200 L/s, Take 4 will be over 180 L/s. A flow of over 200 l/s below take 4 would require an investment of nearly \$3 million across all water users to maintain existing spray infrastructure. As costs increase this means that irrigators need to look for higher value land uses to justify the expense (*ibid*). Cost of water and efficiency is discussed further in Section 3.4

3.3.5 Use it or lose it

This model reduces competition between users, because permit holders behave as a community responsible to one another. Each member can safely leave water in the river for others to use as the courtesy will be reciprocated (*Page, 2017*). As mentioned in Section 2.4.2, the alternative to sharing is individual consents for each point of take. Individual takes create competition for water because if it is not utilised by one individual another will likely take the water, if it exceeds residual flow. As flows drop, this creates a 'use it or lose it' mentality. By sharing the resource water KCL has given the top priority to the environment and achieved equity within the group with each take dropping their extraction equally as flows decrease.

3.3.6 Collective action within Kyeburn Catchment Limited

The success of collective actions can depend heavily on the gap between public and private interests (*Gunningham & Sinclair, 1998*). Removing ownership rights to water gradually changed the norms of irrigators to realise that they were accountable to wider interests. Kyeburn farmers created a user group in response to the deadline for expiry of deemed permits under the RMA. The issue was enhanced by high water allocation and existing priority rights in the catchment. Building trust took time and individuals were more likely to compromise because they could see the benefits of shared use and they had trust in local leaders (the board of directors). They also created their own rules around metering takes and telemetry, creating transparency. Having flow data accessed by all members of the group was identified as a key turning point, creating trust, because members were no longer suspicious that some were taking more water than they said.

The group also had a large number of cooperative members meaning other members of the group were more likely to reciprocate. This supports Ostrom (2000, p140) where one of the seven findings from many public good experiments was that "Those who believe others will cooperate in social dilemmas are more likely to cooperate themselves". Relinquishment of priority rights within the group shows a strong level of trust and compromise. Members chose to share and have good relationships with their neighbours, rather than apply for an individual consent, where many would have had access to more water. Relinquishment of priority rights also shows a significant change in culture that has happened not only over the last 10 years but since gold mining came to the Maniototo in the 1860s. The size of the group was large enough so that they were able to resource themselves and invest in science work and consulting.

3.3.7 Issues

The resource consent for KCL lists a command area which is the irrigated area for the company. KCL can reallocate water within its command area. If a shareholder wants to sell shareholding or reallocate some water within a season they must apply to the board of directors to have the transfer approved. Permanent transfer of allocation requires board approval. The responsibility to see that water goes to efficient and beneficial use rests with five directors of KCL. This means water can be transferred without third party approval, dependant on the good faith of directors of the company. While a majority of directors can put aside their own self-interest for community good this system will work well. A weakness is that this cannot be guaranteed as the directors will change over the 35 year consent period.

Another identified issue is the need to rotate directorships and change leadership so shareholders can all learn how the company operates. All members of the community need to be prepared to step up and share local governance roles. If this doesn't occur, the group could become composed of a certain number of free riders where cooperation levels can fall over time (*Vollan & Ostrom, 2010*).

KCL needs to manage the flow coming from tributary creeks to make sure it can meet the residual flow at Scott's Lane. They know how much water is being taken but not how much is being left behind. KCL aims to employ a contractor to manage these flows, but it still relies on the co-operation of shareholders to watch water takes and respond quickly to changes in flow.

3.3.8 Where the system fails

Incorporating integrated management into the RMA, recognised that siloed considerations of environmental and development matters reduced the efficiency of environmental law (*Brown et al., 2016*). The failure of groups to communicate and compromise means that resource consents can fast track to the Environment Court. Palmer (2015, p20) commented 'hearings take too long, the evidence is too unrestricted, and the time and costs involved are too great'. Consent applications in the Environment Court, add significant time and cost, and create winners and losers. If groups communicate before this point they are more likely to identify shared values and build relationship for the future.

3.3.9 Key points from Kyeburn Catchment Limited

- KCL represents a huge change in culture from the individual competitive priority system to a collective responsibility for whole community good.
- This model reduces competition between users, because permit holders behave as a community responsible to one another. Each member can safely leave water in the river for others to use as the courtesy will be reciprocated (*Page, 2017*).
- The group was large enough to resource itself and expenses were met by farmers with no cost to ORC. Costs would be much higher for the ORC to monitor individual consents.
- This water sharing model is sustainable and can achieve a balance between environmental, social, and economic values through collaboration and trust built over time creating a win-win scenario.
- Modern technology can be used as a tool to create trust in collaborative governance. This may increase short term costs, but save in the long term because of less need for 'boots on the ground' (*Gunningham & Holley, 2016*).

- Cost of renewing and monitoring individual consents is much higher for the ORC. Costs are controlled by shareholders of KCL through ownership and voluntary contribution. This is true reciprocity, because costs and benefits are borne by the Kyeburn community.

“The arc of the moral universe is long, but it bends toward justice.” Martin Luther King

3.4 Efficient use of water and the cost of water

Efficiency is a measurable concept that can be determined using the ratio of useful output to total input (*Investopedia, 2018*)

Equation 1 Calculation of efficiency to achieve best use of water in a community

$$\frac{\text{OUTPUT}}{\text{INPUTS}} = \text{EFFICIENCY/BEST USE}$$

The value of outputs from water use is variable depending on local conditions and priorities, so that the calculation needs to be specific to each application.

As an example, the method used to apply water has negative and positive outputs (Appendix 7). In the Upper Taieri Catchment flood irrigation water can contribute to water quality issues in tributaries to the Taieri (*Ozanne, pers com, 2018*). This is mostly flood irrigation run off containing high levels of *E.coli* entering tributaries to the Taieri River. This is a negative effect, reducing the social dividend through decreased recreational value. Other areas of border dyke irrigation on lower gradient areas that are not near these tributaries have no effect on water quality. This would generate an acceptable overall value because it has no negative environmental effect, while generating income with lower capital costs of infrastructure.

Also, flood irrigation is energy efficient because there are no costs involved with pumping. When MIC was built (Appendix 3) farmers were burdened from the costs of on farm development and facing high operating costs from MWD. Cost had a high local priority; border dyke irrigation was an acceptable option for the majority of farms, because there was no pumping or extra infrastructure costs needed. However this application method involved a lot of wastage with high amounts of water running off to wetlands or ground water.

After about 15 years, with debt at a more manageable level, MIC irrigators began to convert to pipe and spray systems (Appendix 3). MIC has seen a conversion rate from spray to border dyke of about 5% per year between 2000 and 2012. This is driven by the fact that efficient application infrastructure means that more area can be irrigated. This increases financial return as well as social dividend through an increased demand for related goods and services, being a positive output for employment and associated businesses. Positive outputs could include less runoff reaching streams.

A more efficient application method means less water reaching regionally significant wetlands. This could be seen as a negative environmental effect reducing the value of outputs.

Lower water security, as described in Section 3.3.4, increases capital costs through the need to build storage. If capital costs are too high (Table 4) this reduces output through economic value and social benefits for the community (social dividend). If storage required is too expensive, irrigators are less likely to invest in efficient application infrastructure, in favour of flood irrigation. This can produce a lower score for economic effect, and social dividend, and also reduce the score for environmental effect.

Imposed charges, such as ‘taxes’ or ‘resource rentals’ significantly increase capital and ongoing costs, reducing the opportunity to achieve best use. (Appendix 7). Similarly, water markets push water to the higher value consumptive uses which are the most economically efficient but in the absence of community input such transfers can have negative social and environmental impacts, thus affecting the overall efficiency. Table 5, shows that nearly 60% of water used in Australia where water market is used, was applied using flood methods. Flood is the least ‘water efficient’ method of application.

Table 5 Percentages of water users using drip, spray and flood irrigation, comparing California, Australia, New Zealand and Kyeburn Catchment Ltd.

Irrigation Method	Drip (%)	Spray (%)	Flood (%)	Micro-Spray	Source
California	38.4	15.4	43.0		<i>Styes 2018</i>
Australia*	10.8	13.2	58.6	4.4	<i>Commonwealth of Australia (2017)</i>
New Zealand	8.5	83.4	6.1		<i>Curtis 2018</i>
Kyeburn	0	66	34		<i>Hickey 2017</i>

*Data from Australia is from the 2013/14 season.

As described in Section 2.2.1 Minimum flows are set at 5 locations on the Taieri River. These flow levels are science based set following community consultation. This means that a balance is found between requirements for aquatic ecosystem and natural character values, while providing for the sustainable taking of water for use.

3.4.1 Key Points

- Efficiency of use incorporates a range of components that interact. This calculation can be best achieved at community level through consultation and compromise, to find the highest output balancing environmental, economic and social effects.
- Flood irrigation must be considered in broad terms, water application efficiency and economic efficiency are only part of the equation that involves a wide range of interacting components.
- Imposed charges will increase the value of inputs and make water less affordable to lower value uses. These lower value uses may have higher ranking environmental and social effects.
- This is best calculated at a community level where effects and values can be balanced to achieve best use.

3.5 Upper Taieri integrated catchment group

The UTG has been inactive for a number of years while the respective user groups renewed their consents. Gunningham & Sinclair (1998, p17) concluded that “not only is it desirable to use a broad range of policy instruments, but also to match those instruments with particular environmental problems with the parties or party best capable of implementing them”. The end goal for the UTG was to act as an intermediate level of governance between the ORC and User Groups, Irrigation Companies and Individual consent holders. Upper Taieri Farmers have a history of successful collaborative governance which makes them well suited to self-regulate under the Otago Water Plan.

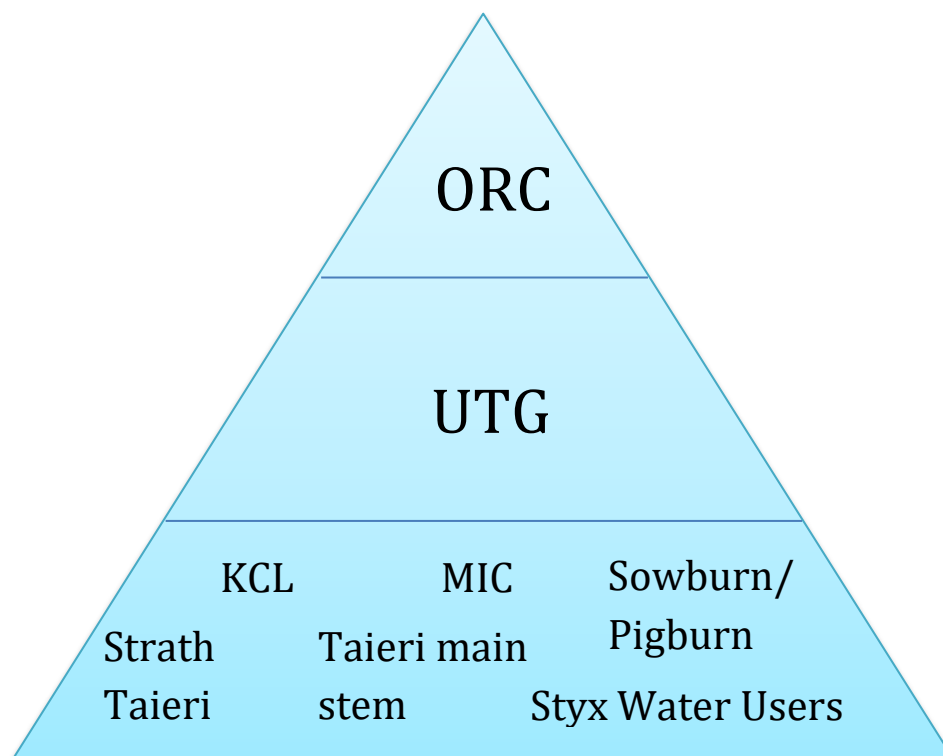


Figure 7 Potential Governance Structure for the Upper Taieri Catchment.

This type of governance can attract some criticism. In 2013, this ICM proposal was challenged at a pre-election campaign held in Dunedin.

“We can’t trust rural communities to manage a water resource because might just be a bunch of dairy farmers wanting to use the river for a drain,” Geoff Simmons, 2013

Self-regulation is often seen as a way for industries to avoid more direct and effective regulation while serving private interests at the expense of the public (Gunningham & Rees, 1997). This assumes tragedy of the commons which can occur if a group becomes dominated by individuals that are driven by self-interest. The Upper Taieri community doesn’t just consist of private interest such as a ‘bunch of dairy farmers’ and the UTG is an open forum including the wider community, stakeholders and regional authorities. Past experience in this catchment has proved this group can

bring together a range of diverse positions and achieve win-win outcomes based on trust and agreement to compromise.

Building transparency into the social structure of the industry sets the stage for a 'theatre of external judgement' (*Gunningham & Rees, 1997*). The UTG will function as the influential interface for user groups, irrigation companies and individual water users in the Upper Taieri Catchment as a larger representative Integrated Catchment group. This creates a larger group of stakeholders such as F&G, DOC, Kai Tahu, local and regional authorities that can influence groups and individuals in the catchment.

3.5.1 Issues to be considered

The success of the UTG will depend on all groups of stakeholders, water users, and regional authorities being prepared to meet face to face and compromise. The Upper Taieri Catchment is a larger ICM group with the ability to govern the whole upper catchment. Larger groups can take longer to build trust, however the change in social norms in the catchment since the RMA was implemented, and previous successes with ICM means that this is a realistic goal.

KCL has five directors, MIC has six and there are also other smaller groups. UTG can help establish trust and confidence from the participating members and wider community by overseeing water allocation and ensuring transparency in decision making

Another issue is the upcoming deadline to meet water quality limits under Plan Change 6A. While water quality at Waipiata is generally above threshold limits (Section 2.3), agricultural land use and irrigation can reduce the quality of tributary creeks. Coordinating work through the UTG gives the opportunity and resources to share ideas around the catchment and allows stakeholders to have input into solutions. By enlarging the set of relevant groups or individuals within the watershed boundary involved in the policy making process, partnerships can fashion innovative policy tools to target problems beyond the scope of existing regulation (*Lubell et al., 2002*). This means a combination of local knowledge and face to face communication with stakeholders will allow diversity of thought to solve catchment specific issues.

3.5.2 Rule enforcement

UTG can also act as part of an escalating response in a pyramid (Figure 3); using government, but also businesses and third parties (*Gunningham & Holley, 2016*). This means that stakeholders like F&G, DOC, Kai Tahu and ORC representatives have the chance to act as surrogate regulators. They have transparency so resource uses that fail to comply with rules can be influenced at the lower levels of the triangle, but if necessary issues can be escalated and referred to the ORC.

Environmental degradation can be accelerated if rules are not enforced. Twenty percent of resource consent holders in New Zealand are found to be non-compliant (*OECD, 2017*). This is because authorities lack the capacity to inspect a high number of individual consents. The UTG reduces the resources needed to monitor individual consents by holding much of the information required.

3.5.3 Key points Upper Taieri Group

- The UTG provides an opportunity for stakeholder groups to work together with water users in a transparent way to create trust and deliver win-win solutions.

- If groups remain in their respective camps and battle through the courts, this comes at great expense, and then there is a winner and a loser.
- This is a cost effective option for the ORC to manage compliance because the UTG has all the necessary data and information.
- Heavily prescriptive government regulation is incompatible with this governance structure, because water users will no longer see the need for collective action or ICM.
- The UTG would be an effective group for calculating best use of a water resource, because of the wide range of values in the group at community level.

4 CONCLUSIONS

Public pressure to improve the state of New Zealand's fresh water resource leads New Zealand to a crossroads for how best to manage the resource. The complexity of environmental systems and the role and character of rural communities needs to be carefully considered before authorities respond. The RMA and its implementation specifically in the Upper Taieri Catchment resulted in a process that empowered different groups across the community to develop a governance and management model for water allocation that exceeds compliance requirements and creates valuable social capital.

It is the role of the regional authorities to enforce limits, but they are ultimately reliant on communities to identify and resolve issues. International experience suggests that top down or overly prescriptive policy can alienate communities, leading to increased monitoring and compliance costs and poor outcomes.

The characteristics of good environmental policy are that they alter behaviour adequately in a way that is appropriate to the needs of communities. The culture of New Zealanders requires a high level of consultation between authorities and communities, so rules or limits are understood and accepted. Rules or limits set by authorities will only be successful if they are understood in the communities where they are implemented. These rules or limits need to be enforced to send the right message and maintain engagement.

Use of water should create public good. While this is a primary consideration during the consenting process it needs ongoing oversight at community level. Individual ownership rights to water in California and Australia create 'Tragedy of the Commons' and when investigated there are indications of social inequity. By contrast, consents granted to groups, results in users working together and members are more likely to compromise for whole of community good. "Those who believe others will compromise are more likely to compromise themselves" (*Ostrom, 2000*). A bottom up group approach can achieve a level of compliance better than levels required by authorities.

Approaches to water allocation based on agreed principles give the opportunity for groups to identify shared values, if they agree with the principle. This enhances the opportunity for collective action. Face to face communication will also significantly increase the likelihood of building trust. If trust is not built between water users, stakeholder groups and regional authorities it increases the likelihood of resource consent applications ending up in the environment court. This adds significant time and cost, destroys social capital and the opportunity to create win-win scenarios is lost.

If efficiency is measured against triple bottom line objectives it defines best use. This should be done at community level where the sum of economic, environmental and social effects is best understood. Imposed charges, such as unfettered markets or 'resource rentals', significantly increase the cost of inputs, excluding opportunities for lower economic return options, even though they may have greater social and environmental value.

Upper Taieri farmers know how to share a water resource, balancing social, economic and environmental values. Otago has the opportunity to develop a world leading governance model in

the Upper Taieri. The UTG model offers an effective way to harness valuable social capital, reduce compliance costs and achieve policy goals. It is reliant on stakeholders and water users being transparent, agreeing to meet face to face and compromise. This structure will not co-exist with prescriptive top down policy.

“Those that fail to learn from history are doomed to repeat it” Winston Churchill

RECOMMENDATIONS

“Our regulators are so focussed on the minutiae of their rules that they miss the bigger picture and fail to recognise how their actions may impact the health and wellbeing of rural communities” (Proudfoot, 2018)

- New Zealanders need to have the conversation about water use. Siloed mentalities and negative reactions to conflict lead to lost opportunities to win-win scenarios.
- Having the conversation involves water users being open and transparent about how they use water, how much water they are using and being able to lead this conversation. The 2018 KPMG Agribusiness Agenda highlighted the importance of telling the story. Unbalanced public opinion around freshwater use cannot be ignored as an annoyance. Water users need to tell the truth.
- Regional authorities need to recognise the value of social capital in communities and support and engage with them to build healthy rural communities. The rules set by regional authorities need to be enforced to send a clear message.
- ICM should be recognised by authorities as an effective governance model that can reduce compliance costs and make policy goals more achievable, reduce time for feedback and response to issues.
- The ORC needs to continue to recognise the value of group allocation and the UTG model, and help bring together groups to create trust and mutual respect. Group allocation has a much better outcome for rural communities, but to succeed, these models need to be supported.
- Politicians in central government need to consider the wider implications of clumsy top down environmental policy in response to public outcry. Social capital has taken years to establish in the Upper Taieri and can be quickly destroyed, likely reducing the effectiveness of other community lead groups like MPM.

“Sound public policy is not a close friend of popular expression of alarm or electoral calls for urgency”. (Graeme Martin, 2018)

LIMITATIONS AND CONSIDERATIONS OF THIS RESEARCH

- The subject of water allocation is very broad. There are many aspects of the topic that time restraints prevented me from exploring.
- Strath Taieri Irrigators have started a project to raise the Loganburn Dam. This is to increase water security, but it will also enhance flows through the catchment in times of water shortage. This was to be the next section of this project but I have simply run out of time!
- Water markets are well established in the southern Murray Darling basin where water is traded over long distances. I would like to do more investigation into the Socio-economic effects on the communities left behind.
- This project has not investigated the likely impact that climate change will have on water availability in the Upper Taieri Catchment. If less water is available in the future this could reduce security of supply.
- I would be interested to investigate the value of 'complimentary' effects. When higher value irrigated areas transfer to higher value land use, what are the negative effects on hill country that is sold as a separate land title.
- Maori Rights to freshwater and the implications for New Zealand have not been discussed in detail. This is a major consideration for freshwater policy in New Zealand.
- Discussions with wider people from the industry have yielded negative comments about the OWP. I would have liked to compare the Otago water plan to other plans in New Zealand to see whether there are other more or less successful plans.
- Since the RMA has been written there have been many amendments and many pages added. It would be useful to investigate the success of these amendments, and whether they have affected the way the RMA was intended to operate. Work is required to investigate where the weaknesses are in the RMA implementation, and whether or not those weaknesses correlate with the findings in this project.
- Imperial Valley conversions to modern drip and spray systems means there is less water available for wetland areas, there is an ongoing debate to whether these wetlands should be preserved. We note similar changes here in the Upper Taieri catchment with less run off changing the nature of wetlands. The effect of spray and drip irrigation on environmental conditions needs to be considered.
- It would be interesting to investigate more overseas approaches to water policy and learn from the mistakes (or not) of other countries.
- Finally, I would really like to investigate the values of different stakeholder groups and water users to identify shared values, I think there are many groups that end up in conflict when they essentially want the same thing.

GLOSSARY

CAP – Cap and Trade

CODC – Central Otago District Council

CPRs – Common Pool Resources

CVP – Central Valley Project

DCC – Dunedin City Council

DOC – Department of Conservation

F&G – Fish and Game

ICM – Integrated Catchment Management

IID – Imperial Irrigation District

KCL – Kyeburn Catchment Limited

MDB – Murray Darling Basin

MfE – Ministry for the Environment

MIC – Maniototo Irrigation Company

MIS – Maniototo Irrigation Scheme

MoW- Ministry of Works and Development

MPM – Maniototo Pest Management

MWD – Metropolitan Water District

NGO – Non-Government Organisations

ORC – Otago Regional Council

OWP – Otago Water Plan

PCO – Participatory Catchment Organisations

RMA – Resource Management Act 1991

RPS – Regional Policy Statement

SCC – State Centralised Control

SFF – Sustainable Farming Fund

SWRCB – State Water Resource Control Board

UTG – Upper Taieri Water Resource Management Group

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APPENDIX

1. Personal communications I would like to thank the following for their time in providing knowledge to this project.

John Carter, A Professional Corporation, Attorney At Law, 1221 State Street, P.O. Box 1945 El Centro, CA. 92244-1945

Geoff Crutchley, Upper Taieri Water Resource Management Group Chair.

Hayden Dunne, “What are the key attributes of successful leadership?” Kelloggs Research Topic.

Matt Hickey, Water Resource Scientist, Otago.

Hamish Mackenzie, Director Kyeburn Catchment Limited.

Graeme Martin, Water & Soil Division of the Ministry of Works – 1969 to 1986, Otago Catchment Board General Manager 1987 to 1989, Nelson-Marlborough Regional Council CEO – 1989 to 1992, Otago Regional Council CEO 1993 to 2012.

Phil Smith, Previous chair of Maniototo Pest Management.

Scott McLean, Director Otago Regional Council; Environmental Monitoring and Operations.

Susie McKeague, McKeague Consultancy Dunedin, Otago; Farm Environmental Consultant.

Rachel Ozanne, Environmental Resource Scientist. Otago Regional Council

Stefanie Schulte, NSW Irrigators’ Council; Policy Manager.

Mike Wade, California Farm Water Coalition; 6133 Freeport Boulevard, FL2, Sacramento, California.

Marian Weaver, Otago Regional Council; Resource Manager, Procedures and Protocols.

Others not directly referenced in this project:

Andrew Curtis, Irrigation New Zealand

Gretchen Robertson, Councillor, Otago Regional Council.

Tony McCormick

2. Maniototo Irrigation Scheme (Adapted from Farley, 2013)

Construction of the Maniototo Irrigation Scheme (MIC) began in 1976 after a right was granted to the Minister of Works and Development by the National Water and Soil Conservation Authority in 1975. It was reported that the scheme would take 10 years to build at a budgeted cost of 6.2 million. This was the last of the large community irrigation schemes constructed by the Ministry of works and Development (MoW). The right allowed a take of up to 8 cubic meters per second from the Loganburn Dam. The water stored in the Loganburn dam gives a continuous supply of water when flows in the Taieri are low. Water is released from the dam into the Loganburn Creek, which supplies the Taieri River. A weir in the Taieri River at Paerau diverts water into a 1.3 km tunnel. From here it supplies a small hydropower scheme before being diverted for irrigation use.

Works on the scheme stopped in 1983 because costs had risen to \$32 million when only 40% of the original proposed area was complete on the west side of the Maniototo Plain. The completed part of the scheme was run by MoW in Alexandra, who was running all the Central Otago Schemes and losing money. MoW had a monopoly on a provision of Operation and Maintenance costs set at \$45/ha. Maniototo Farmers challenged this and tendered to run their own scheme. They won and operating as an Incorporated Society they ran the scheme comfortably at \$18/ha for the next 10 years.

MoW originally estimated that the cost to complete the remaining area of the scheme would be around \$11.5 million. Farmers proceeded to build their own scheme and it was completed at a cost of 1.75 million. Had the MWD completed this at their costings irrigators would have been liable for repaying 30% of the costs to the government, which is much more than it cost them to build it themselves.

It was argued that the cheaper scheme on the East Side would result in lower water use efficiency. But the losses between the high cost scheme and the low cost scheme are similar, the real difference in efficiency relates to the on farm application systems. Between the years 2000 - 2012 conversion to efficient spray system averaged out at about 5% per year (*Crutchley. 2012*).

Maniototo Irrigation Scheme provides an answer to the long debated question of whether the government or the farmers could better manage complex irrigation schemes, it provides an unequivocal answer; the farmers! (Farley 2013)

3. History of Maniototo Pest Management

I grew up hearing stories about plagues of rabbits as both my Grandfathers were professional rabbiters who earned a living by the sale of skins. Their main methods to catch the rabbit was trapping and poisoning and a little shooting. They were usually employed by the run holders and lived on the land in very primitive accommodation this may have been an earth or stone hut. All rabbits were skinned and their skins were put on a wire and hung up to dry. During this time rabbit numbers remained high and it wasn't until the sale of skins were banned, rabbits were DE commercialised and Rabbit boards were set up that there started to be some sort of effective control.

Rabbit boards were set up in most small towns in the Maniototo, these included farmer representation along with agents of the Government, who oversaw the expenditure of substantial government money. These boards covered areas of around 100,000 hectares employing up to 10 rabbiters each. During the rabbit board days the Maniototo boards would put out over 1000 tons of carrot bait a year and most of the more rabbit prone country was on a 5 year poison cycle.

In 1989 local body amalgamation saw these boards disbanded and responsibility for pest management was passed to the Otago Regional Council. The ORC proposed that farmers could choose between services provided by the council to be funded by a "pest rate" or a non-rated "user pays" option. Maniototo Farmers understood that "user pays" was already a proven failure and that the trading entity proposed by the ORC lacked local knowledge and the required incentives to succeed. Instead they opted for a model with all the advantages of the former rabbit boards, but with no external funding. They formed a single farmer owned company (Maniototo Pest Management Company Limited - "MPM") to cover the whole of the Maniototo. After nearly 30 years of operation, rabbit numbers in the Maniototo are lower than at any time in the last 100 years, (with the possible exception of a short period following the arrival of rabbit hemorrhagic disease in 1997) while in other parts of Central Otago they are again approaching plague proportions. From the outset, the charges levied on farmer shareholders were between 30 and 50% lower than the previous rates, and they remain at about that relative level.

MPM operates out of its own depot in Patearoa. The company has two permanent staff who carry most of the operational work. The introduction of RHD has seen a change of tact over the control of rabbits by poison. The company now covers about 28,000 hectares of hill country with helicopter shooting every year along with night shooting the lower country. At this stage rabbit numbers appear to be holding very low, but never under estimate the rabbit.

The company has assumed responsibility for compliance on behalf of all shareholders with the statutory limits on pest numbers prescribed by the Regional Authority. All land owned by shareholders is subject to inspection by the ORC. The ORC may issue enforcement notices on the owners of the land, so that the company may be required to submit a control programme and carry out work when directed, so that an element of "Top Down" regulation applies. In practice, the ORC has little to do in the area. MPM benefits from local knowledge, the incentives of ownership and having a stake in the business, as well as having to meet regional limits. MPM will have some challenges going forward as there is now a new generation of farmers that haven't seen rabbits in plague proportions so in a sense the company could be a victim of its own success.

MPM has been singly focused on the rabbit but now wallabies have been located within the district, this in the future could become the main focus of the company. Staff is also going to be an issue going forward as there are no longer trained personnel in the work force to employ. The job of MPM will be to train up new staff members. MPM has delivered high value for low cost. It has strong community support, and after a difficult relationship with the ORC in the early stages, MPM is now recognised as an ideal model for the purpose.

Phil Smith, Kyeburn Farmer. Previous Chair of Maniototo Pest Management

4. Letter from Scott McLean, Otago Regional Council

From my point of view, community ownership of environmental issues is essential in obtaining the outcomes desired through regulation. Regulation on its own does not work. Compliance activity on its own does not work.

An excellent example of a community owned and driven solution to an environmental issue is Maniototo Pest Management. As is the case of many pests, property boundaries are irrelevant. The best outcomes of pest management and control are always obtained through collaboration and coordination of all affected property owners. This is difficult to achieve without a formal management structure in place.

Taking rabbits as an example, accepted best practice rabbit control stresses the need for all affected land owners / occupiers to work together coordinating control efforts. The Otago Regional Council has attempted on many occasions, to coordinate rabbit control works across multiple properties to maximise the effectiveness of the operations. This always proves to be resource heavy “negotiating” with reluctant landowners and often results in some land owners / occupiers either refusing to take part in a coordinated approach or pulling out at the last minute.

The model of Maniototo Pest Management overcomes this ad-hoc attempt at coordination and streamlines regular control operations in a formal and systematic manner. The net environmental outcome is low pest numbers resulting in general compliance with the relevant rules contained within the Regional Pest Management Plan, over the entire command area.

From my perspective, compliance activity is there to support the efforts of Maniototo Pest Management should they require it. Compliance is not (or should not be) there to drive community action. Communities should want to be empowered to self-manage and know they are supported by regulation when and if required.

The Otago Regional Council is currently reviewing its Regional Pest Management Plan. During discussions with other communities around the region, the question is often posed ‘what’s the best way to manage pests such as rabbits’. I use that opportunity to explain the Maniototo Pest Management model as being the “gold standard” of how communities could and should organise themselves and the benefits of doing so for the community as a whole.

The Maniototo community is proactive in managing its own environmental challenges and this is not limited to pests. Last summer very little rainfall occurred, and river flows were extremely low. The community undertook several voluntary initiatives to ensure the values of the rivers, and the river users, were maximised during the dry period.

This included voluntary water rostering of irrigation takes and extra releases from large irrigation supplies. Neither initiative was required by regulation or consent condition. Compliance activity was there to support them should it have been required however the community worked together with great success.

Scott MacLean

Director Environmental Monitoring & Operations, Otago Regional Council

5. The Otago Water Plan Policies applying to the management of the taking of water (Otago Regional Council, 2016)

6.4.0B

To promote and support shared use and management of water that: (a) Allows water users the flexibility to work together, with their own supply arrangements; or (b) Utilises shared water infrastructure which is fit for its purpose.

Explanation

Shared consents to take and use water provide:

- Benefits for the water users, including making the best use of available water;
- Opportunities for shared investment in, and optimal use of, water transport and storage infrastructure;
- Economies of scale in managing use, maintaining infrastructure and meeting consent and compliance requirements;
- A reduced need for involvement in water rationing by the Council, especially during periods of low flow; and
- Overall potential for greater economic and community prosperity. Individual consent holders may choose to work together, so that they have the flexibility to meet day-to-day requirements from available water.

Such arrangements could range from two individuals, to all water users and other interested parties within an area, working together. Infrastructure is “fit for purpose” if it is working as it was designed to work, with no more than minor wastage of water.

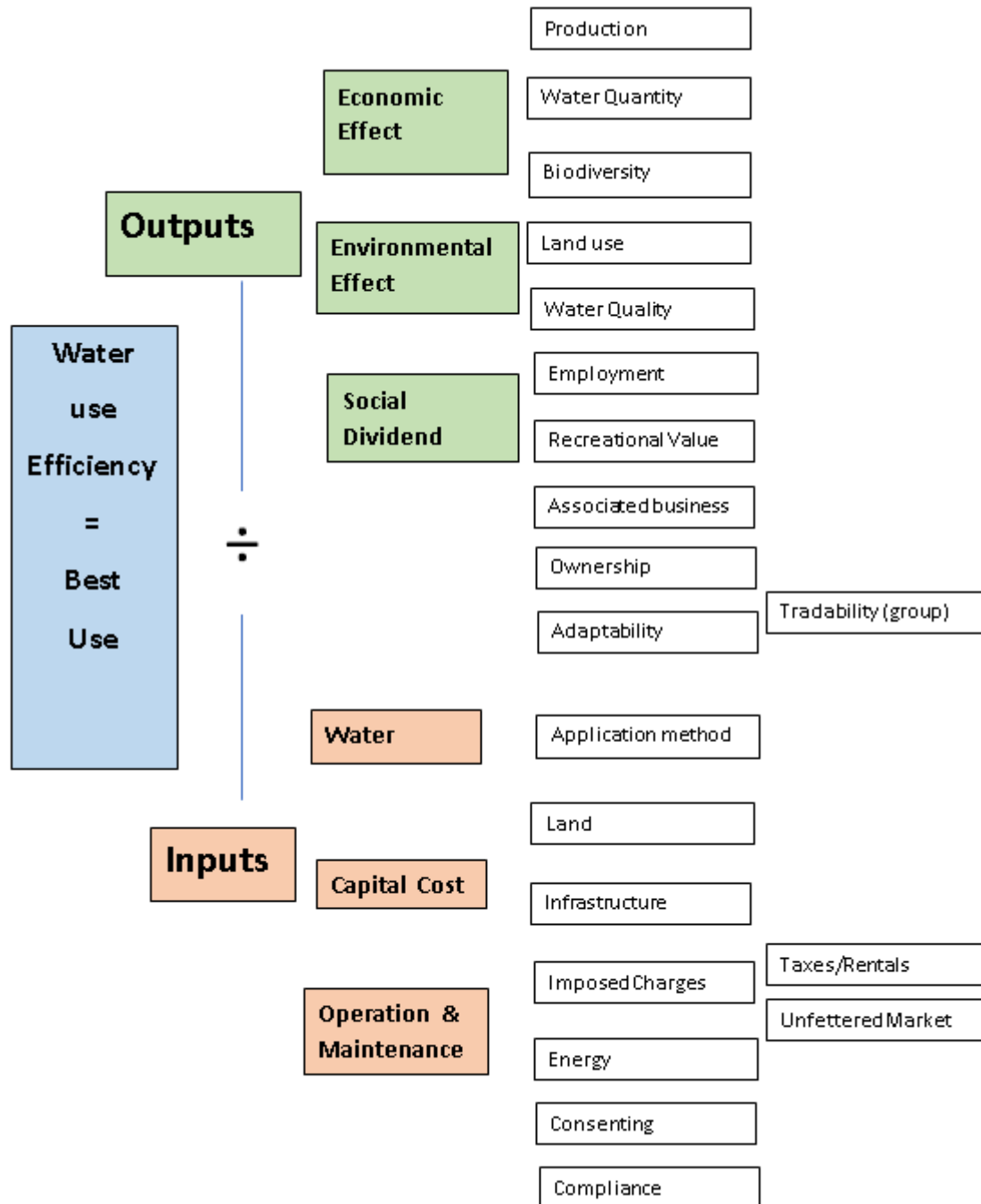
Principal reasons for adopting

This policy is adopted to enable optimum benefit from the use of Otago’s limited water resources and to support the development of infrastructure that will achieve this. This policy enables management of consents for taking and use by groups of water users.

6. *Estimated water cut off price by industry in th Murray Darling Basin in 2013-14 (Aither, 2017)*

Crop type	Cut off price (\$/ML)	Confidence (\$/ML)	Basis
Grapes	1,800	Low. Potential range 1,000 to 3,000.	Analysis of land values. Analysis of farm survey data by Hughes (2011).
Fruits and nuts	3,000	Low. Potential range 2,000 to 5,000.	Analysis of land values.
Rice	165	High. Potential range 150 to 180.	Stakeholder consultations. Analysis of gross margins.
Cotton	250	Medium. Potential range 200 to 300.	Stakeholder consultations. Analysis of gross margins.
Dairy	250	Low. Potential range 150 to 350.	Stakeholder consultations. Analysis of farm survey data by Hughes (2011).
Other	250	Low. Potential range 150 to 350.	Comparison with other activities.

7. *Prototype for Calculating Efficiency of water use (G Crutchley, pers com, 2018)*



Discription

- When water use efficiency is calculated based on all effects it is a measure of “Best use”.
- In simple terms, the greater the value of outputs in proportion to Inputs, the greater is the Water Use Efficiency.
- The coloured boxes show the broad categories describing Inputs and Outputs. To the right are the component values which contribute to these categories. These components have several shared associations and they may be either negative or positive contributors.
- The impact of these components is highly variable depending on specific application. For example, an inefficient application system, such as flood irrigation may yield a better efficiency score where it results in wetland enhancement. Systems using ephemeral streams (unreliable as a source and having no significant instream values) are unlikely to warrant investment, so it is a choice of using the cheap option (flood) or letting the water go to waste. Usually these streams only carry useful water when the main rivers are already near flood.
- These judgements can only be made effectively at a local level.
- Components which contribute to inputs have the effect of reducing opportunity for use by excluding those opportunities which have a lower economic return, even though they may have higher social and environmental values. These opportunities may well have a higher overall score in terms of water use efficiency, but because a higher proportion of their output goes to environmental and social dividend, with little reward for the applicant, the application is not offered for consideration, and the best opportunity is lost.
- Proposals to artificially impose higher costs on irrigation through top down intervention by Central Government may trap many existing uses into this loss-making category, leading to allocation transfer to the cost of the community and the environment.

