Assessing the Consequences of the Lake Taupo Nitrogen Trading Programme in New Zealand, Using a Landscape Approach

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E. Anne Spicer

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This thesis investigates the consequences of implementing a local policy regime that potentially enables a viable agricultural sector to operate within environmental limits. The Lake Taupo Nitrogen Trading Programme is an exemplar cap and trade regime located in New Zealand. It is the only cap and trade programme, to date, in which a limit on non-point source nitrogen discharges is applied at both the watershed and the farm levels. This study uses a landscape approach to assess the effects of this cap and trade implementation in order to achieve a rich understanding of the changes in land-use and farm practices that have occurred, the driving forces involved, and the five landscape paths that have evolved. The study finds that the cap and trade regime is insufficient on its own to achieve a viable agricultural sector in the regulated area. Investigation at different landscape scales, for instance, showed that factors such as the lack of low-nitrogen mitigations and land-uses, the gatekeeping role of the OVERSEER® programme and the perceived effect of nitrogen sales on land values discouraged on-farm innovation and nitrogen trading. These and other drivers have led some landowners to make adjustments that may not have been expected under a cap and trade regime, and some of these potentially make a negative contribution to developing a viable agricultural sector. The latter include: semi-retirement, investment outside of farming, reductions in productive capacity without apparent reinvestment, and relocation of part of the farm outside of the regulated area. Adjustments that may make a positive contribution include: secondary processing on farm, farm amalgamations, and investment in higher value land-uses (dairying, dairy support and carbon forests). Some farmers that have opted for business as usual were reluctant to sell nitrogen because of the potential negative effect on land values and the ability to sell, and so further significant land-use change as a result of trading nitrogen currently appears unlikely. Overall, land-use change that may make a negative contribution to a viable agricultural sector occurred on 42% of the land in the study area while changes that may contribute positively to a viable agricultural sector occurred on 32% of the land. Business as usual is estimated to have occurred on 25% of the study area. As a consequence, it currently appears that the future landscape trajectory for pastoral land in the

Catchment is one of reduced production. Thus, complementary research and technology policies, and the capacity to find new ways of making a living from rural land, are essential additions to a cap and trade regime in order for a viable agricultural sector to operate under environmental limits.

Keywords: Cap and trade, landscape biography, non-point source pollution control, agricultural sustainability, Lake Taupo Nitrogen Trading Programme.

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This thesis is dedicated to my late husband, Leon, who always wanted to do a PhD but unfortunately never did.

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Chapter 1

Introduction

The 2009 background paper to Cabinet[1] was quite explicit. The most pressing problem for New Zealand agriculture, it said, is that the industry is facing water resource limits (Ministry for Environment, no date). Water quality is declining in many areas, it noted, and groundwater, lowland lakes and rivers are vulnerable to the negative effects of mineral and other discharges from farms. It further noted that cleaning-up such pollution is expensive and other sectors of the economy (such as tourism, fishing and aquaculture) are being put at risk or, potentially, are constrained. The decline in water quality has led to mounting political pressure on the government to 'do something' to make waterbodies safer (e.g. Radio New Zealand, 2017) and to warnings that New Zealand is exceeding the capacity of the environment to absorb pollutants (Organisation for Economic Cooperation and Development, 2017). Despite the clarity of understanding of the water pollution problem, however, many commentators are less clear on how to resolve the total problem – that is, how to manage water pollution *within the context of an agricultural economy*.

One strand of the sustainability literature has for some time suggested that business and environmental needs can both be successfully achieved at the same time. It is argued that 'win-win' solutions are not only possible, they are simply a matter of applying the right policy setting. As the Brundtland report concluded (World Commission on Environment and Development, 1987:8):

> *Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.*

This stance has been criticised by many as utopian. An expanding world population and rising standards of living rely on continued business growth. Business growth, however, has been shown to be exploitive of natural resources (Parliamentary Commissioner for the Environment, 2004; Foote, Joy, & Death, 2015). While Brundtland suggests that business growth can be reformed and thus continue to expand, others (such as Jackson (2009) and Victor (2008)) disagree and propose that business growth should be restricted to levels that the environment can accommodate. In order to achieve this, consumers would need to lower their expectations – or refocus their needs towards spiritual and social growth rather than increasing standards of living (particularly in Western countries). To date most consumers have not responded positively to calls for restraint, and demand for many products, including agricultural produce, has continued to climb. Consequently, producers

[1] Cabinet is an executive council of senior government ministers responsible to the New Zealand Parliament.

have continued to intensify and expand their operations in order to meet this demand, but often without regard for the pollution that has resulted. With environmental problems increasing world-wide it often falls to government actions, including regulation, to resolve these sustainability problems.

Sustainability was, therefore, at the heart of the question that led to this study. Is it possible to have both a thriving, business-led agricultural sector as well as a healthy environment? Can public policy bring about such an ideal solution? If so, how can it be achieved? These generic questions, however, become complicated when the setting in which the policy would operate is considered. Could, for instance, a sustainability agenda operate in a political and economic environment that eschews subsidies, endorses small government and promotes competition on the international stage?

New Zealand has been at the forefront of some far-reaching social policy in its short history as a nation, however the adoption, by a left-wing government, of a right-wing neoliberal approach to economic policy in the 1980s (Darwall, 2003) is, in my view, the policy shift that has had the most significant effects of all. In the 1980s, neoliberalism was relatively unknown and untested on the world stage (Darwall, 2003), nonetheless, a wholehearted approach to neoliberalism was adopted in New Zealand and all types of businesses were quite quickly exposed to the full force of international markets. Of note for the agricultural sector was the removal of producer subsidies and the subsequent exposure of the sector to international customer demand and changes in customer preferences. From the 1990s, overseas customer demand for dairy products grew exponentially and farmers and corporates alike rushed to convert land and to join in the production of what many termed “white gold”. Cow numbers around the country soared but it took a while before the agricultural industry and politicians acknowledged that the free market economy was creating problems for the wider community by generating negative environmental externalities (pollution in particular) (Parliamentary Commissioner for the Environment, 2004). It also became clear that the environmental law in place at the time was insufficient to control these externalities (Oram, 2007). Innovative policy regimes, including better regulation, were required.

Unbeknownst to many people outside the scientific community, groundwater was being contaminated with mineral discharges from intensification of agriculture and the environmental threat that was posed by this to the low-lying lakes around the country was significant (Parliamentary Commissioner for the Environment, 2013). However, pollution of groundwater cannot be traced to individual farms and so becomes an agricultural community responsibility[2] which requires action

[2] This is not to suggest that waterbody contamination is always a result of agricultural discharges. There are, for example, situations in New Zealand where urban sewerage disposal has created similar waterway pollution problems.

from farmers who may or may not have been responsible for the pollution problem. This collective responsibility sits in contrast with the market economy which incentivises individual farmers to produce efficiently and at the least cost. It may, therefore, be beneficial for farmers to ignore negative side effects, and so avoid costs involved in preventing the discharge of pollutants from farms.

The Lake Taupo Nitrogen Trading Programme has been widely promoted as an exemplary solution to the problem of agricultural pollution control in a market-led economy, since it is a 'cap and trade' regime that addresses both environmental and economic concerns. Lake Taupo is a collapsed caldera, located in the highlands in the centre of the North Island of New Zealand. Ash resulting from the formation of the caldera fell on lowland, downwind areas and has resulted in free draining, easily erodible soils with poor fertility. Both ground and surface water drain to the lake at the centre of the catchment – Lake Taupo. Although the Lake is currently oligotrophic, it is vulnerable to the land-uses and land-covers within the catchment.

Under cap and trade, the Lake Taupo environment is protected by the cap - i.e. a watershed level limit on pastoral discharges of nitrogen, based on scientific studies. The nitrogen limit is apportioned between farmers in the regulated area, so limits operate at both a farm and a watershed level. Further, central and local government provided a fund to buy out some of the nitrogen allocation to reduce the total nitrogen load going into groundwater and the future risk of excess accumulation of nitrogen in the lake (Lake Taupo) which is at the centre of the watershed. Thus community and individual responsibility for environmental effects appear to have been achieved, while at the same time, a viable agricultural sector is facilitated. Farmers are not required to change their farm operations nor apply farm practices (rules) that they might judge to be inappropriate for their situation. Thus they are apparently able to continue with 'business as usual'. The crowning feature of the Programme is the trading scheme which enabled farmers to have management flexibility. If market forces change in future years, then farmers are free to respond by changing their farm system or land-use. If the new farm practice/land-use discharges a higher rate of nitrogen, then farmers can still implement change providing they purchase sufficient nitrogen from another regulated farmer. It has seemed that this policy regime offers the best of all possible worlds and, even though there were few dairy farms in the Lake Taupo Catchment, the policy regime might apply elsewhere in the country and be important in the achievement of agricultural sustainability. The Lake Taupo Nitrogen Trading Programme is, therefore, potentially an ideal case study of agricultural sustainability in a real world setting. The first research question, therefore, addresses the effects of implementing a cap and trade regime:

'*How are agro-ecological landscapes changing as a consequence of local 'cap and trade' policy and regulation*?'

In planning the investigation of this case of a policy implementation, it soon became apparent that achieving a full understanding was complex. While an implementation could be assessed using a limited number of indicators, it has been shown in the literature (Slee, 2007; Darnhofer, Lindenthal, Bartel-Kratochvil, & Zollitsch, 2010) that this potentially gives a narrow and limited understanding of the case, and risks missing unexpected side effects. This is particularly true if the investigation does not take account of the social context of farmer decision making, the impacts of biophysical elements, the interactions between social and biophysical factors, and the influence of contextual aspects. Similarly, if the investigation is focused on one scale (such as the watershed) rather than taking into account all appropriate spatial scales (e.g. the farm as well as the watershed), important effects might also be missed. Further, time periods are also likely to be of importance since some outcomes of a policy implementation may be path dependent. A broad and inclusive research approach is therefore needed. A landscape approach offers potential to meet this need. It is multidisciplinary, holistic and takes account of spatial and time periods. Further, the notion of change is central. The relationship of policy to landscape change has been well established in the literature. Landscape has one additional advantage and that is that the concept of systems, of dynamic interactions between the social and the biophysical, is integral.

In this study, the landscape approach, and landscape analysis concepts, such as nested systems, driving forces, land-use and land-cover change, and landscape transitions and trajectories, provide the conceptual frame which guides the investigation. A watershed is viewed as a socioecological system with nested sub-systems at the local (community) and farm levels. Driving forces (one of which is the policy regime under study) act on these sub-systems and cause them to change. This change can be measured through landscape, i.e. land-use, land-use system and land-cover, change and it may take different forms at different scales. For example, a farm practice change undertaken at the farm-level (say a reduction in stocking levels) may not be apparent at the watershed level because the land-use (i.e. the stock type) has not changed. As landscapes change over time they transition from one state to another and the path that is inscribed by joining transitions end on end is the landscape path. There can be multiple paths and together they provide an understanding of the overall route that the landscape has followed. If nothing changes, the landscape paths indicate the trajectory that the landscape might follow in the future.

The inclusive strength of landscape as an object of study, however, also creates practical challenges in how to analyse and integrate the different dimensions. One way to do this is through the medium of qualitative, interpretive 'stories' about a landscape over time, i.e. a landscape biography, and that

is the method that has been used in this study. As will be explained in Chapter Three, landscape biographies are accounts of land-use/land-cover change over time for a specific locality. They are integrations of multiple data sources that portray a chosen reality, rather than describing a situation or recounting a story. Landscape biographies are presented for three locations in the study area. Each is focused at a different spatial scale as well as highlighting one aspect of the regulations. The landscape biographies enable the landscape trajectories of the watershed to be established and from these the implications of the regulations for the watershed can be inferred.

This landscape approach, coupled with the landscape biographies, is a novel approach to investigating a policy implementation and consequently the second research question is concerned with whether this method is effective, and hence has promise for other, similar, investigations:

'*How can a landscape approach assist in understanding the consequences of a watershed scale agro-ecological policy*?'

In answering these two questions, the thesis is organised into three groups of chapters. The first group (Chapters Two to Four) reviews the literature. The second group of chapters (Chapters Five to Eight) report the research results and Chapter Nine presents the discussion and conclusions.

More specifically, Chapter Two explains the issue of water quality in New Zealand and its relationship to agriculture, and considers the public policy options for controlling pollution problems arising from pastoral agriculture. In New Zealand and many developed countries, market-based solutions are currently favoured (Tietenberg, 2004; Organisation for Cooperation and Economic Development, 2017), and the approach known as 'cap and trade' is currently receiving much attention. Chapter Three explains how an investigation of a cap and trade regime in New Zealand can be undertaken, using a landscape approach, landscape biographies and landscape transitions and paths, as its methodology and presents a conceptual frame that guides the investigation. Chapter Four concludes this part of the thesis by outlining the research strategy used (a qualitative, case-study approach) and the research methods employed (a semi-structured questionnaire and multiple data sources).

The second part of the study (Chapters Five to Eight) presents the results of the field study. Chapter Five frames the investigation as a case study. The Lake Taupo Catchment is located in the centre of the North Island of New Zealand and it is the site of the implementation of an exemplar cap and trade regime (the Lake Taupo Nitrogen Trading Programme) aimed at controlling nitrogen discharges from pastureland in the Catchment. The Programme is an exemplar case because, unlike other, similar, cap and trade programmes around the world, farm discharges are capped at the level of the farm as well as at the level of the Catchment. Chapters Six to Eight present three landscape biographies of three locations in the Catchment. The landscape biographies are an integration of

multiple sources of information, including interviews with farmers in the Catchment, which follow events as they unfold from the development of pastoral farming to the implementation of the regulations, known as 'Variation 5'[3], which include the Lake Taupo Nitrogen Trading Programme. Each biography is focused on one landscape scale and features the landscape change best illustrated by that scale and that location. The first of the landscape biographies is located in the northern sector, focused at the watershed scale and highlights the land-use changes that have occurred since the early 2000s[4]. The second biography, located in the western sector, focuses on the community level and highlights the land-use system patterns (such as amalgamation and land-use de-intensification) that were apparent at that scale. The last biography is located in the southern sector and is focused at the level of the farm and on farmer goals and motivations.

The final part of the study (Chapter Nine) discusses the results of the study and then draws conclusions in line with the research questions posed at the beginning of the study. The chapter explains the consequences of Variation 5 (up to 2013) for the Taupo study area landscape (i.e. the Catchment, local land-use systems, and farm systems) at the different scales and it outlines the landscape trajectories that are evolving since the implementation of the regulations. The implications of the changes found are considered at each scale and with reference to the landscape trajectories. The chapter then discusses the implications of the study findings for agricultural policy, cap and trade theory and implementation, and the use of a landscape approach to investigate ex-post policy implementations. Areas for further research are listed and explained. The study concludes with an overall assessment of whether cap and trade regulations are the 'silver bullet' that enables a viable agricultural sector within environmental limits in the context of a free market economy. Broadly speaking, the study shows the socially embedded nature of regulations and how their successful implementation is dependent on other policies that operate in tandem with the cap and trade, as well as on the driving forces that are in operation at the time.

[3] Variation 5 to the Waikato Regional Plan regulates discharges of nitrogen from all sources within the Lake Taupo Catchment. This includes both urban and rural sources, and sewerage and farm discharges. See Chapter 5 for an explanation of the aspects of the regulations that pertain to rural land.
[4] The period 2001 to 2005 was the base period for establishing watershed and farm discharge limits.

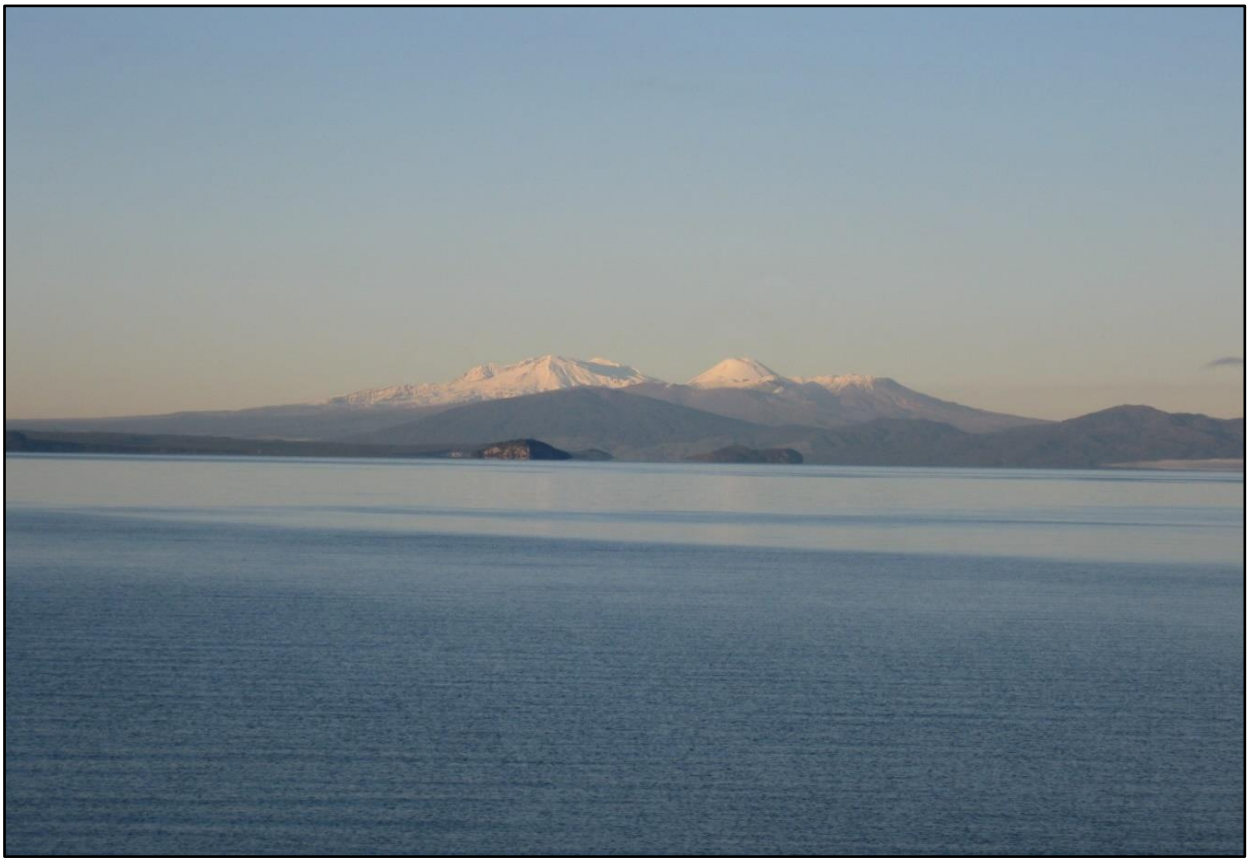

Figure 1: Lake Taupo looking south towards Tongariro National Park.

Chapter 2

Environmental Policy and Cap and Trade

2.1 Introduction

The problem at the core of this study, i.e. ensuring a viable, agricultural sector while taking account of environmental needs, has been Introduced in Chapter One. In this chapter the need for environmental constraints on pastoral farming, and how these can be achieved, is considered in greater depth. Although there are a number of environmental pollutants arising from agriculture, nitrogen is a critical limiting factor for NZ agriculture and has been chosen as the focus of this study. This chapter explores issues arising from excess discharge of nitrogen from pastoral farming in New Zealand. It begins by outlining the development of the NZ agricultural sector, and some of the nitrogen pollution consequences for waterways that have resulted from that development. The current environmental policy framework in New Zealand is then outlined and reference is made to the recently introduced National Policy Statement for Freshwater Management. The chapter then turns to the wider question of how agricultural pollution can be controlled through environmental policy. International studies currently recommend a market-based approach, particularly cap and trade. Examples of ex-post studies of cap and trade for water quality are examined, but the studies are not indicative of the suitability of cap and trade as a policy setting for fully controlling nitrogen discharges because none of the international cases cap discharges at the farm level.

The chapter concludes that traditional methods of policy assessment based upon specific disciplines such as environmental economics are unable to provide the integration of social and biophysical factors that is essential in any study of environmental policy-driven constraints on agricultural production. Environmental policy relating to the management of a complex socio-ecological system (SES) is best appraised using an approach that integrates the social and the biophysical as well as taking account of the interrelationships between the SES and the setting in which it operates. That is, a holistic approach is needed for a study of this type. In addition, traditional approaches rarely take account of issues of scale, which is important because environmental caps are generally set at a watershed level, and then a method needs to be devised to distribute that cap amongst stakeholders at the farm level.

2.2 New Zealand Agricultural Environmental Policy: the Challenge of Nitrate Pollution

This section traces the history of pastoral agriculture in New Zealand and explains how the problem of excess nitrogen in waterways arose. An agenda of local government reform in the 1980s led the

then government to introduce the Resource Management Act (1991) which promotes the sustainable management of NZ's natural resources. In recent years, the government, noting increasing problems with water quality, introduced the National Policy Statement for Freshwater Management (NPS-FM), which includes the aim of controlling rising nitrogen levels. The Act and the NPS-FM are outlined and the way in which they aim to control nitrogen in waterways is explained. The section concludes by exploring the policy options that can be used to control nitrogen pollution and highlights cap and trade as a favoured solution in the literature and by some in government.

2.2.1 New Zealand Government Agricultural Policies since the 1960s

At the end of WW2, the land area in pasture in NZ expanded rapidly in response to rising international demand for wool and meat (MacLeod & Moller, 2006). By the 1970s, however, demand for agricultural produce shifted. A decline in wool prices in 1966, loss of an important market when Britain joined the European Economic Community in 1973 and the 1973 'oil crisis' all combined to put pressure on farm incomes and on the wider economy. From this period, government attempted to shield farmers (and the wider economy) from international pressures. Subsidies to farming and industry were increased and a wage and price freeze was eventually introduced in the early 1980s. The subsidies to the farming sector were wide ranging (Gouin, Jean, & Fairweather, 1994)[5] and by the early 1980s, they had become a large part of the income of many farmers. Gow (2007) believes that up to 90% of the sheep meat price was subsidised but others have suggested that around 40% of sheep and beef farm income came from subsidies (Barnett & Pauling, 2005) which were causing widespread distortions in the industry (Cloke, 1989) and the wider economy (Darwall, 2003).

The Fourth Labour Government, when elected in 1984, faced an economic crisis, and their response was to dismantle the interventionist policies of the previous government. Their neoliberal reforms were far reaching, involving the whole of the economy, and included, over a three-year period, withdrawal of almost all state support for farming (Cloke, 1989). Although many farmers faced severe financial difficulties (Fairweather, 1989), the farming sector was generally supportive of the reforms (Evans, Grimes, Wilkinson, & Teece, 1996). Successive governments have continued this policy of non-intervention and now New Zealand farmers receive the least support of all farmers, except for Vietnam, in the OECD (Organisation for Economic Cooperation and Development, 2016). As a result, agriculture has become increasingly responsive to the demands of consumers (Federated Farmers, 2001), but subject to international market fluctuations and to retail power (Haggerty,

[5] The main categories of subsidies were: the Livestock Incentive scheme (1977) which encouraged farmers to increase stock numbers through either an interest free suspensory loan or deductions from assessable income (Le Heron, 1988), the Land Development Encouragement Loans (1978) which were made available to farmers at low rates for the development of marginal land and for intensification of current pastureland (Gow, 2007) and the Supplementary Minimum Price Scheme (1978) which guaranteed product prices that did not reflect the international market (Cloke, 1989).

Campbell & Morris., 2009). The 1990s saw a further shift in demand for agricultural commodities, with increased international demand for dairy products[6]. As a result, many sheep and beef farms were converted to dairy and the number of dairy cows increased substantially (Parliamentary Commissioner for the Environment (PCE), 2004).

The neoliberal approach to the agricultural sector, based on non-interference in the market and the negotiation of trade agreements, has been continued by central government up to the present day. Many have hailed it a success and indeed agricultural productivity has increased substantially (Rae, Nixon, & Lattimore, 2004) and the New Zealand economy has benefited. Federated Farmers (Sayre, 2003) claimed that the best way to protect the environment was to farm without subsidies. The Parliamentary Commissioner for the Environment (PCE, 2004), however, did not totally agree with this stance. In an in-depth investigation of water quality in New Zealand, the Commissioner concluded that intensive farming (and in particular dairy farming) had led to severe environmental problems in many lowland rivers and lakes and that more water quality problems were likely to follow if things didn't change. Additional compelling evidence was provided by the Parliamentary Commissioner for the Environment in 2013 and 2015 (PCE, 2013; PCE, 2015). Despite this, the Minister for Primary Industries recently announced (Tunstall, 2013) that the government aims to double agricultural exports by 2025. The obvious question that that was left unanswered with this announcement was how this growth could be achieved without further damage to the environment, particularly to waterways. That potential problem was, and is, the responsibility of environmental policy.

2.2.2 New Zealand Government Environmental Policy Development

The Resource Management Act (1991) (NZ Parliamentary Counsel Office, no date) is the central environmental law in New Zealand. It brought together dozens of environmental and planning statutes and regulations[7] under the guiding principle of 'sustainable management' of New Zealand's natural and physical resources. Section 5 of the Act, based on the definition set out in the Brundtland Report (quoted in Chapter One) specifies that natural and physical resources should be managed in a way that enables communities to provide for their social, economic and cultural wellbeing while also meeting the needs of future generations (Memon, 2002). While opponents of the Act argued that this definition is vague and unworkable, decisions by the Environment Court show that the Court views the Act as a conflict resolving statute, i.e. by taking account of both

[6] For example, the Uruguay round of the GATT negotiations, completed in 1993, is calculated to have resulted in a 50% increase in farm milk prices in New Zealand (Zhu, Cox & Chavas, 1999).
[7] According to Memon & Gleeson (1995) the Act supersedes over 50 statutes and regulations, including the (previously pivotal) Town and Country Planning Act (1977) and the Water and Soil Conservation Act (1967).

biophysical and social aspects it allows proper "…*consideration of development in its environmental context*" (Memon, 2002:307).

The Act created a three tier planning system with responsibility for objectives and policies of national significance retained by central government but responsibility for regional resource policy devolved to regional government (Memon & Gleeson, 1995). Thus decisions around water were to be made at a regional level, but guided by central government which would set national policies that ensured uniformity across the country. However, for the first decade little attention was given to the development of national policy statements (Oram, 2007). Unsurprisingly, by 2000 few regional councils had rules governing water quality (Caruso, 2000). Most Councils, Caruso (2000) claims, were (at this time) implementing rules for the control of point source[8] pollution but influenced by the prevailing 'new right' philosophy were relying on voluntary approaches for the management of pollution from non-point sources (such as farming). This led to a critique of the variability in performance of councils (Berke et al., 2006) and some questioned their commitment to enforcement (Jay, 2007).

A 'dirty dairying' campaign, begun in 2001 by the Fish and Game Council[9], reinforced growing public concern about the polluting effects of intensive land-use. Industry responded by collaborating on a set of environmental best practices that their farmer suppliers were encouraged to achieve. The Dairying and Clean Streams Accord was launched in 2003[10] and included goals for farmers such as excluding dairy animals from waterways, compliance with Regional Council consents[11] (e.g. for effluent disposal), managing nutrient inputs to, and outputs from, the farm, and fencing off significant wetlands. The Fish and Game Council checked progress against the industry targets and produced a damming report (Deans & Hackwell, 2008) which suggested that far from improving their environmental performance, significant numbers of farmers were not complying with their resource consents, and that pollution had in fact increased since the Accord was launched. Public condemnation was swift with even the Minister of Agriculture condemning farmers' lack of compliance with consents (Watt, 2008), and the Ministry of Agriculture and Fisheries commissioning an 'independent Understanding' of target achievement (Sanson & Baxter, 2011). The Accord, and

[8] See glossary for explanation of point source and non-point source pollution. In short, the exact source of non-point source pollution cannot be determined whereas the source can be located for point source pollution.
[9] The Fish and Game Council was established in 1990 to represent the interests of anglers and hunters, and provide coordination of the management, enhancement, and maintenance of sports fish and game under Section 26B of the Conservation Act 1987. Retrieved on February 20, 2017 from: http://www.fishandgame.org.nz/.
[10] See the "Sustainable Dairying: Water Accord". Retrieved February 20, 2017 from: https://www.dairynz.co.nz/media/3286407/sustainable-dairying-water-accord-2015.pdf.
[11] Activities defined in regional and district plans as "*controlled activities*" or "*restricted discretionary activities*" or "*discretionary activities*" or "*non-complying activities*" under the Act require a consent from the regulatory body before they can be carried out.

industry self-regulation, lost credibility (Eppel, 2013), and the Resource Management Act was also heavily criticized. On the one hand the Act had often been seen as an impediment for development, but now, it was seen as not even able to safeguard the environment (Eppel, 2013). The Act's inability to cope with adverse, cumulative effects such as deteriorating water quality was becoming clear (Foote, Joy, & Death, 2015). A briefing paper to the incoming Minister for the Environment (Ministry for the Environment (MfE), 2008) noted that devolving decision-making to the regional and local level had led to variability in resource management across the country.

The Minister for the Environment, in 2009, established the Land and Water Forum[12] - a collaborative endeavour charged with developing guidelines on how Regional Councils should set standards for fresh water that took account of the influence of land-uses. One of the Forum's recommendations was that a national framework be established which includes limits, determined at the local scale, on the levels of pollutants allowed in Lakes, and as discharges off land[13]. The government agreed, and using the provisions of the RMA, introduced a National Policy Statement (NPS) for Freshwater in 2011, and an updated version in 2014. In addition to minimum standards, the NPS-FM (Ministry for the Environment, 2014a) specifically requires councils to take account of pollutants arising from farming and to implement plans at an appropriate scale (a watershed for example).

Farmers are now under pressure from both the government and the public (see Hughey, Kerr, & Cullen, 2013) to improve their environmental performance. Regional Councils are likewise under pressure to demonstrate that they are acting in the interests of the environment. Haggety et al. (2009) aptly refer to the 'mixed legacy' of neoliberal reform which has, on the one hand, led to greater involvement of consumers in the agricultural sector but, on the other hand, has contributed to farmers following a path of increased production through higher stocking rates and increased fertiliser application in order to maintain incomes as food has become cheaper (Canning, Weersink, & Kelly, 2016).

2.2.3 Agricultural Pollution and the Effect of Excess Nitrogen

Water bodies, particularly lakes, are vulnerable to excess nutrients. High concentrations of nitrogen (N) and phosphorus (P), if they occur together, can result in blooms of phytoplankton which are both unsightly, can give off musty odours and, sometimes, are toxic (Paul et al., 2012). In New Zealand, significant amounts of P occurring in some water bodies have resulted from leaching of volcanic rock

[12] See Land and Water Forum web site for more information on the Forum. Retrieved February 20, 2017 from: http://www.landandwater.org.nz/Site/About_Us/default.aspx.
[13] The Forum is currently monitoring progress on all of its recommendations and labels this recommendation as "*underway*". Retrieved February 20, 2017 from http://www.landandwater.org.nz/Site/Progress.aspx.

(Hamilton, 2005), and since this cannot be controlled, attention is generally concentrated on control of nitrogen discharged from agricultural land.

Water quality in New Zealand has deteriorated in recent years, particularly in the lowland lakes and rivers (PCE, 2004). It is not a coincidence that this deterioration has increased with the rise in farming intensification[14] since studies have shown that agriculture is a major contributor to the pollution of waterbodies (PCE, 2013).

Nitrogen moves, with water, to receiving water bodies. It can be discharged directly into water by livestock or from piped waste (known as point source pollution). It can travel overland through surface run-off, or travel through soil into the groundwater (known as diffuse or non-point source pollution) (Howard-Williams, Davies-Colley, Rutherford, & Wilcock, 2010). In agriculture, fertiliser and animal urine are major sources of nitrogen. It is held in the soil and utilised by pasture (Waikato Regional Council, 2008) but excess nitrogen is washed, generally by rain events, through the soil into the groundwater and from there it moves to rivers, streams or lakes. If the ultimate receiving body is a lake, then an accumulation of N (and P from surface run-off) can quickly occur. In 2010, 32% of NZ lakes[15] had sufficient levels of nutrients to be termed 'eutrophic', while 43% had very low levels of nutrients (Howard-Williams, Davies-Colley, Rutherford, & Wilcock, 2010). Currently, however, the number of eutrophic, or close to eutrophic, lakes is calculated at 45% (Hamilton, Collier & Howard-Williams, 2016).

Commentators and academics have often framed current water quality problems as the direct responsibility of the modern dairy industry (e.g. Foote, Joy, & Death, 2015). Studies of groundwater, however, have shown that nitrogen pollution of waterways is much older than the recent rise of dairying (Morgenstern et al., 2015; Abell, Özkundakci, Hamilton & Miller, 2011; MacLeod & Moller, 2006). Framing water quality as a dairy farming issue implies that only this sector contributes to water quality issues. However, studies have shown that all primary production, including land clearance for forestry (Hamilton, 2005), has contributed to pollution of surface and/or groundwater.

Di & Cameron (2002) found that land-uses leach nitrogen differentially. In their study, established forests were found to leach the least nitrogen, followed by cut pasture, then grazed pasture or arable cropping, followed by ploughing of pasture. The largest contributor per hectare is market gardening. However, given the total amount of land devoted to each land-use, most of the nitrogen currently

[14] The Parliamentary Commissioner for the Environment (Watters, Rowan, & Williams, 2004:4) explains intensification as "…*the process of lifting profitability through attaining higher levels of productivity*" and goes on to explain that important drivers of intensification are increased animal numbers, use of nitrogenous fertilisers and irrigation.

[15] The authors calculate that NZ has 3820 lakes of 1 ha or more in size. Eutrophic refers to the capability of the lake to grow phytoplankton if light and temperature conditions allow

discharged to waterbodies has originated (roughly equally) from dairy farming and sheep and beef farming. Dairy farming, in general, has the highest N pollution footprint but sheep and beef (utilising 66% of New Zealand's agricultural and forestry land (Morris, 2013), it is also a significant contributor. On a per hectare basis, however, dairy farming contributes the most (Howard-Williams, Davies-Colley, Rutherford, & Wilcock, 2010).

Pollution caused by primary production is problematic because agriculture is central to the economy. New Zealand's 70,000 farms (PCE, 2004) directly and indirectly contribute eight percent of New Zealand's GDP, and around half of New Zealand's total export earnings (The Treasury NZ, no date). However, Parfitt, Schipper, Baisden & Elliot (2006) suggest that if the agricultural sector expands in the future as it has in the past, at the rate of 3% per year, by 2050 dairy farms could be leaching 88 kg N/ha/yr, sheep 18 kg/ha/yr, and beef 35 kg N/ha/yr. By way of comparison, nitrogen leaching from dairy land is currently estimated to average 28 kgN/ha/yr while the average across all agricultural land averages 8 kg/ha/yr (Foote, Joy, & Death, 2015)[16]. At the levels predicted by Parfitt et al. (2006), lakes in New Zealand are at high risk of algal blooms that would affect water supplies, recreational and food gathering uses, and biodiversity (Hamilton, Collier & Howard-Williams, 2016) as well as New Zealand's largest earner of foreign income i.e. tourism[17].

Because of lag times in groundwater, the effects of past land-use change have yet to be experienced in full measure. This heritage pollution will be in addition to discharges from current land-uses, and waterways that receive groundwater with both short and long lag times could, therefore, be at risk of excessively high levels of pollutants.

In summary, NZ agricultural policy since WW2 has led to increased agricultural production through increased stocking rates and fertiliser application. While New Zealand has gained economically from this trend, its water bodies, unfortunately, have deteriorated. As the PCE (2013:7) commented, New Zealand now faces a "…*classic economy versus environment dilemma*". This dilemma may be resolved, in part, by the implementation of the NPS-FM because it requires regional councils to determine objectives/goals for each water body in their area, an appropriate water quality limit, and a means to attain that goal/s by 2025[18].

[16]In 2013 the median NDAs in the Taupo Catchment were 27 KgN/ha for dairy and 12KgN/ha for sheep and beef (See Appendix E).

[17] Tourism is New Zealand's largest export industry in terms of foreign exchange earnings. It directly employs 7.5 per cent of the New Zealand workforce and in 2016 contributed 5.6% of GDP (Statistics NZ, 2016)

[18] The National Policy Statement for Freshwater Management (see Ministry for the Environment, 2014a) requires Regional Councils to have a Regional Plan in place by 2025 which defines water quality limits and the means by which they will be achieved. To define the limit, regional councils will need to identify:

- the current state of water quality
- the quantity of water available and how it fluctuates seasonally and over time (as concentrations of contaminants will be influenced by the quantity of water present)

2.2.4 Policy options for controlling nitrogen pollution

There are four categories of policies aimed at controlling pollution. First is education – where authorities provide information about pollution, its causes and effects, in the expectation that farmers will adopt less polluting practices as a result. Second is the voluntary approach and the Clean Streams Accord, developed by the dairy sector in New Zealand, is an example of this. The Land and Water Forum (2010) concluded that educational and voluntary approaches would be insufficient to control the pollution of New Zealand waterways. Third, there is the prescriptive approach (commonly called 'command and control') where farm inputs or, less commonly, outputs are specified (Freeman & Kolstad, 2007). This is the most common approach to controlling nutrient pollution in developed countries (Organisation for Economic Cooperation and Development, 2012). Fourth, there are so called market-based approaches. The focus of this study is on the latter two – that is a combination of regulation and trade.

The NPS-FM is a significant change in environmental management philosophy in New Zealand because it has moved management of water quality from performance based (as in the RMA) to limits based. Thus discharge limits on nitrogen (and other pollutants) will now begin to be applied to farms throughout the country and regional councils must determine appropriate policy settings for achieving their water quality goals. Doole (2013) studied the financial and land-use change impacts of implementing the NPS-FM in the Upper Waikato catchment. He found that the cost to the catchment of maintaining or improving water quality standards across the catchment are significant and that some farms could become financially unviable and that the income of the Catchment could be severely affected. Clearly a policy setting is needed that will deliver the environmental limits required but also minimise the cost involved in doing so, and will resolve a current limitation of the RMA – that is its inability to deal with diffuse pollutants and their cumulative effects

Although regulation is a policy setting that is commonly used for diffuse pollutant control, it has been heavily criticized for being excessively costly (Tietenberg 2006, Doole, Marsh, & Ramilan, 2013); for locking in outdated technology (Jaffe, Newell, & Stavins, 2005); lessening innovation (Requate, 2005); for fostering resistance amongst farmers (Barnes, Willock, Toma, & Hall, 2011); and for being heavily

- the attribute(s) and objective(s) that the setting of a limit is intended to manage
- inputs and outputs (freshwater accounting). In the case of water quality, that includes identifying the sources of relevant contaminants (eg, sediment, nitrogen, phosphorus)
- the limit for each relevant contaminant, taking into account any possible interactions between contaminants and possible lag effects
- the timeframes over which the limit can be achieved, and targets that may be required to reach the limit
- the scale at which the limit is to be applied (eg, to the input into a lake itself, the streams feeding into the lake, or by managing nutrient inputs to the land in the catchment). Some limits may not be allocable at anything smaller than a catchment scale.

reliant on appropriate levels of monitoring and enforcement (MacDonald, Connor, & Morrison, 2004). It is better, many environmental economists argue, to enrol the power of the marketplace, and combine regulation with market instruments (MBI), in the pursuit of pollution reduction (Stavins, 2003), particularly in New Zealand (Organisation for Economic Cooperation and Development, 2017). In the 2008 briefing to the incoming Minister for the Environment (MfE, 2008), the government department responsible for the RMA, advised:

> *Generally speaking, putting a price on resources that reflects the cost to society of their use increases overall wellbeing. Use of 'public' resources like water and the atmosphere (as a sink for pollutants) has been under priced in the past. Users who do not face the costs of their impacts on others or the environment lack an economic incentive to change their behaviour.*

The approach using market-based instruments is based on the premise that producers do not bear the full 'cost' of production when polluted waste is released into a communally owned environment (such as air or water). The cost of remediating such polluted 'commons' becomes a cost to society, and environmental economists argue that the polluters should be charged for these 'externalities' through pollution taxes, or tradeable permits (i.e. the 'polluter pays' approach). Studies undertaken in New Zealand to look at ways of implementing limits on farm discharges (Kerr, McDonald & Rutherford, 2012; Anastasiadis, Nauleau, Kerr, Cox, & Rutherford, 2011; Daigneault et al., 2012; Daigneault, Greenhalgh, & Samarasinghe, 2012; Daigneault, Samarasinghe, & Lilburne, 2013; Denne, 2005; Doole et al., 2013; MacDonald, Connor & Morrison, 2004; Parsons, Doole & Romera, 2015) tend to favour cap and trade over taxes, and market-based instruments over command and control systems such as a set of good management practices[19]. In the following section some of the arguments are considered.

2.3 Cap and Trade as a Proposed Policy Solution

The previous section has outlined the context within which a cap and trade implementation would operate in New Zealand. In this section, more detail is provided about cap and trade programmes and how they might achieve both an environmental target and be farm-business friendly. Experience with programmes that are currently operating around the world is also outlined but since there is no international experience of caps on discharges from farms, section 2.3 reviews other relevant dimensions of cap and trade implementation.

The section concludes by considering possible approaches to investigating policy implementations of cap and trade in agriculture. By its nature, cap and trade in agriculture operates at multiple scales, in

[19] For example: reducing the use of nitrogen fertilisers (Parfitt, Schipper, Baisden & Elliot, 2006), reducing stocking rates (Monaghan et al., 2007), stand-off pads or similar for cattle (Monaghan et al., 2007), and changing to a lower leaching land-use (Hamilton, 2005).

particular at both the watershed and farm levels, and so effects of the policy must be expected to occur at these levels but potentially they may also occur at intermediate (e.g. community) levels. Further, interactions are likely between social and biophysical factors and these may change over time. Consequently, the approach taken to investigating the consequences of a cap and trade example in agriculture must be capable of accommodating different spatial scales and temporal periods as well as combining social and biophysical data.

2.3.1 Cap and trade – principles and international examples

Cap and trade is generally characterised as a combination policy (Stephenson & Shabman, 2011) in that it includes both market incentives and command and control type regulations and rules. The cap is rule based in that it limits the aggregate amount of pollutant that can be discharged. It is generally defined first at a watershed level and then apportioned to the regulated polluters at the farm level. Underneath that aggregate level, agents are able to trade their allocated allowances in a market specifically created for this purpose. The role of the cap is to ensure that environmental goals are achieved at the watershed level and the role of the trading facility is to provide flexibility in farm management and therefore achieve the best economic outcome. Trading could be viewed, under the NPS-FM, as a means by which farmers can respond to product price signals and so remain competitive in international markets.

Principle reasons for the preference for cap and trade policy option are the improved certainty of achieving an environmental goal under cap and trade (in comparison with a tax regime[20]) and the economic benefits that are considered to result from cap and trade in comparison with command and control. As Shortle (2012) explains, the economic benefits are believed to occur at two levels. First, the individual, under cap and trade, is incentivised to reduce their level of pollution by implementing the cheapest and best reduction technologies, and the surplus allowances created then become available for sale to another regulated individual to change or expand their business, or for a new entrant. Thus overall economic efficiency is increased since pollution allowances flow to their highest use, unlike under a command and control regime (Tietenberg, 2003). Second, the overall (societal) costs of achieving a target are likely to be less. Administrative costs that occur with command and control systems, for example, are reduced or avoided by shifting the burden (cost) of identifying pollution control strategies (and remaining current with technology changes) from the regulatory authority to the polluter (Tietenberg, 2006) – in this case, the farmer.

[20] If a tax is set at the right level, then cap and trade and tax policies will theoretically provide the same level of pollution reduction. However, if the tax is set too low then the environmental target is unlikely to be reached because polluters will choose to pay the tax rather than implement reduction technologies. Since tax levels are set before policy implementation, and the cost of reducing pollution for individual operations is not known by the regulators, achieving the environmental limit is uncertain. See Wittneben (2009) for a counter argument.

Thus a cap and trade policy setting potentially combines the best of all worlds. In theory it can deliver an environmental goal (through the implementation of a 'regulatory' cap) while using market mechanisms to incentivise action at the individual level, as well as reduce the societal cost of change. Other claimed benefits of cap and trade include increased innovation[21] and technology uptake, and flexibility of (farm) management since businesses operating under a cap can choose to operate the farm system and technologies of their choice, rather than have to conform to best practices chosen on their behalf by regulators (Tietenberg & Johnstone, 2004). Monaghan et al. (2007) report that farmers in the Taupo Catchment in New Zealand identified management flexibility as their main requirement of an environmental policy.

Fisher-Vanden & Olmstead (2013) estimate that there are 21 active and pilot, water-related, cap and trade programmes world-wide[22]. Of these, 16 involve non-point source pollutants. Three cap and trade programmes are located outside of the United States and only one (in Canada) involves diffuse pollution. This, however, might be an underestimate since Greenhalgh & Selman (2012) counted 33 active water quality trading programmes worldwide. Part of the reason for the discrepancy may be related to different definitions of cap and trade. Many of the so-called trading schemes in the US are in fact offset programmes, where a point source polluter can invest in approved projects rather than trade pollution allowances (Fisher-Vanden & Olmstead, 2013; Shabman, Stephenson & Shobe, 2002). These off set schemes, while involving nonpoint source pollution from farms, were not set up to regulate emissions from agriculture – but rather agriculture has been included to enable point source polluters to more cheaply compensate for their own emissions (Shortle, 2013; Greenhalgh & Selman,

[21] Porter & Van der Linde (1995) argue that pollutants released to the environment represent a waste of inputs (resources) that could be utilised by the firm rather than be discarded (commonly referred to as the 'Porter Hypothesis'). This hypothesis argues that environmental policies encourage firms to reassess their processes and work out ways to reduce their waste streams. The pay-off for the firm is that their input costs are reduced because less of that input is wasted and this might cover (or more than cover) the full cost of the technology/process upgrade. This is based on the notion that firms are currently making sub-optimal choices and are not profit maximisers (Ambec, Cohen, Elgie, & Lanoie, 2013; Jaffe et al., 2005). Policies such as cap and trade are particularly favoured by Porter & van der Linde because firms are able to choose processes and technologies appropriate for their own situation, rather than have to conform to a standard. Cap and trade, therefore, could theoretically induce valuable innovation. There is empirical support for this argument (e.g. Ambec, et al., 2013) but these studies have been undertaken in the manufacturing sector. Studies in primary production are few but two studies undertaken in dairy and viticulture show no support for the Porter hypothesis (Ferjani, 2011; Muscio, Nardone, & Stasi, 2015). These studies, however, involve policy settings that are not market-based instruments and so may not be relevant to this study. Amongst leading market-based instrument researchers, support for the Porter Hypothesis (i.e. dynamic incentives in cap and trade) is mixed. Shortle (2012) for example, supports the view that cap and trade encourages dynamic incentives but Tietenberg & Johnstone (2004) report mixed results. Kemp & Pontoglio (2011) claim that there is more evidence of regulations encouraging *radical* innovation than there is of market-based instruments of promoting such change.

[22] This may be an underestimate. For example, it excludes the Lake Taupo Nitrogen Trading Program

2012). Thus firms can approach farmers and negotiate with them to voluntarily reduce their discharges by implementing approved best practices. The 'credits' created, calculated by the scheme's trading ratio formula, can then be used by the firm to offset their own pollution levels. Since both the firm and the farm will be discharging into the same waterbody, no overall change in pollution levels results (Stephenson & Shabman, 2011) but the firm has been able to continue, or even expand, its operation.

A smaller number of schemes in the US use a market mechanism to trade pollution 'allowances' (Shabman, Stephenson & Shobe, 2002). In such cases the problem of measuring diffuse pollutants is resolved by trading ratios which specify the 'value' of agricultural mitigations and thus the rate at which they can be exchanged with point source allowances. In these cases, however, agricultural discharges remain uncapped (Shortle, 2012). Schemes implemented elsewhere in the world have the same shortcoming – agricultural pollution is uncapped and control is limited to the implementation of best practice rules. One of the drawbacks of these point-non-point trading systems is the risk that environmental goals will not be met (Greenhalgh & Selman, 2012).

2.3.2 Identifying success in a cap and trade regime

The primary objective of an agricultural water quality cap and trade regime is to achieve an acceptable level of pollutant discharge from agricultural land, at least cost. In ex-post reviews, however, the environmental success of such programmes is seldom evaluated (Greenhalgh & Selman, 2012). As Shortle (2012:42) explains:

> *These [water quality] programs do not limit agricultural nonpoint pollution. Instead they allow point sources to use pollution reductions produced voluntarily by agricultural nonpoint sources as a technology for point source regulatory compliance.*

As many researchers point out (e.g. Shortle, 2012), diffuse pollution cannot be directly measured and so discharges from farms can only be approximated. This has led to caps that are applied at a watershed level but not at a farm level. Consequently, farmer involvement is voluntary[23] and the achievement of reductions of a nominated pollutant uncertain. This lack of environmental certainty makes point-non-point source trading, such as is carried out in the US, Australia and Canada and described above, untenable in New Zealand since the NPS-FM requires water quality to be maintained or improved, and diffuse pollution from agriculture is held to be the largest negative

[23] In the US cap and trade water quality programmes are not the only regulations that affect farm practices. Some states have regulations that cover specific nutrient discharges from agricultural lands (King & Kuch, 2003). Farmer involvement in these programmes may not be voluntary.

contributor to water quality in New Zealand (PCE, 2004). Thus a successful cap and trade, for NPS-FM, will be one that regulates discharges at both the watershed and the farm level.

For agriculture to be fully included within a cap and trade programme farmers need to accept limiting their farm discharges. Colby (2000) found, in the schemes that she reviewed, that acceptance was often not automatic and that some schemes had become 'stuck' with the competing interests of resource users, policy makers and affected communities unresolved. One way of achieving acceptance is through the initial allocation of discharge allowances and for this reason cap and trade has been described as politically appealing (Hahn & Stavins, 2011). Many schemes use grand-parenting as an initial allocation method because it allows business as usual, but some researchers have argued that this allocation method risks suboptimal outcomes and increased overall costs (Tietenberg, 2006; Goulder & Parry, 2008). Hahn & Stavins, however, argue that trading that takes place after the initial allocation will lead to a 'proper' (efficient) distribution of allowances providing that holders act in a financially rational fashion. If insufficient trading occurs, these authors conclude, the final allocation of allowances will reflect the initial allocation and may be suboptimal. This is an important aspect of cap and trade because it points to the need for high trading volumes to take place in order for one of the prime benefits of this policy setting (i.e. minimising the overall cost of change) to be gained. For reasons such as these trading volumes has become an important indicator of project success in the environmental economics literature (King & Kuch, 2003; Shortle, 2012; Greenhalgh & Selman, 2012). As Shortle (2012:41) explains, problems with many current implementations are not the result of trading but of "…*inactive trading failing to achieve potential cost-savings*".

Many authors explain low trading volumes in terms of high transaction costs[24] (Tietenberg, 2006), poor market design and other institutional factors (Randall & Taylor, 2000; Shabman, Stephenson & Shobe, 2002; King & Kuch, 2003; Morgan &Wolverton, 2005; Stephenson & Shabman, 2011; Greenhalgh & Selman, 2012; Borghesi, 2014), the cap being set too high (and therefore not binding) and thus not forcing farmers to reassess their farming practices (Duhon, Young, & Kerr, 2011), lack of acceptance of a cap (Colby, 2000; Greenhalgh & Selman, 2012), and human behaviours such as aversion to loss or discounting of the future (Hahn & Stavins, 2011) or lack of trust (Breetz, Fisher-Vanden, Jacobs, & Schary, 2005) or fear of greater regulatory scrutiny (Ribaudo & Gottlieb, 2011). Recent studies in the field of behavioural economics, however, suggests that these types of explanations for low trading volumes are biased toward a narrow view of human decision making. According to Gowdy (2008:633):

[24] Defined as the cost of making one trade rather than not trading at all (Tietenberg, 2006:70).

> *Experimental results from behavioral economics, evolutionary game theory and neuroscience have firmly established that human choice is a social, not self-regarding, phenomenon.*

In other words, it is essential to understand the social context around trading in order to understand the trading volumes that have taken place. For example, Gowdy (2008) explains, behaviours such as loss aversion, habituation, altruism, and hyperbolic discounting of the future, are not anomalies to be 'fixed' but rather are normal human behaviour and a result of the 'social embeddedness' of actions. This term, made prominent by Mark Granovetter in the mid-1980s, encapsulates the notion that behaviour is constrained by social relations to such a degree that the two cannot be separated (Granovetter, 1985). In other words, farmers are not necessarily solely focused on profit maximisation. Granovetter does not reject the notion of economic rationality and profit maximisation but rather, in his view, agents have both "…*simultaneous economic and non-economic motives*" (Granovetter, 2005:38). This was confirmed by Sinner, Fenemor & Anastasiadis (2012) when, in one of the few cap and trade related studies to involve farmers directly, they undertook a trading simulation exercise with farmers from the Lake Taupo Catchment, New Zealand. They found that personal values, in this case social ties, were important in trading decision making. For example, at times in the trading exercise more profitable trades were declined because the allowances available for trading had already been promised to another farmer.

Literature outside of the cap and trade field points to other factors that may be of relevance in a discussion of low levels of trading by farmers. Principle amongst these, as the Sinner, Fenemor & Anastasiadis (2012) study suggests, is the literature around farmer motivations and the social nature of decision making. For example, Fairweather & Keating (1994) found three different approaches to farm management in their study of farmer management styles but profitability was not the central, defining goal for any of their categories. Rather, the authors suggest (p. 197) profitability was seen as a means to obtaining ends that were not primarily economic – such as being the best, finding a balance between on and off farm pursuits, and living close to nature. When Gomez-Limon, Riesgo & Arriaza (2004) tested their model of farm systems they too found that farmers had a range of objectives in addition to profit maximisation, including minimising the use of working capital and reduction of risk. Further, a study undertaken by Pedersen, Nielsen, Christensen, & Hasler (2012) found that farming goals affected purchasing behaviour more than market signals do. They investigated farmer reactions to a pesticide tax in Denmark and found that for a significant proportion of farmers the price of pesticides was of far less importance than achieving farm goals, such as maximising yield. This further confirms that the way farmers respond to cap and trade is socially embedded.

Other literature, in rural sociology, suggests that not only are farmers socially embedded but their farms are also part of wider relationships. Fairweather & Hunt (2011) found that farmers see their farms as a network of interacting social and biophysical factors with themselves at the centre. Thus farms can be viewed as systems, and, in the conceptualisation put forward by Darnhofer, Fairweather, & Moller (2010) these systems interact with exogenous factors at different scales (such as markets) and in addition, are constantly changing over time. Thus outcomes of farmer decision making may be distributed across both time and space. So the effects of decisions taken at one point in time may not become apparent until some later time or at a different spatial scale[25]. Thus cap and trade investigations to date may not give a full understanding of those implementations because they have (a) not taken account of contextual factors, particularly the social context within which decisions have been made and (b) the outcomes of decisions may be dislocated by time and space.

2.3.3 A new approach to understanding cap and trade

The section above shows that the international experience with cap and trade for non-point pollution control, to date, is not encouraging in terms of meeting environmental goals nor in terms of enabling farmers to operate a viable farm. Four possible reasons for this have been identified as a result of the preceding literature review.

1. Most cap and trade programmes do not place limits on the main source of non-point pollution i.e. agriculture. To date almost all rely on voluntary involvement from farmers whereas the literature (e.g. Land and Water Forum, 2010) suggests that this is insufficient for attaining an environmental goal. To fully understand the potential for cap and trade for agricultural pollution control, investigations on implementations that set limits at both the watershed and the farm level need to be undertaken.

2. The second possible reason is that researchers to date have focused their attention on a narrow set of issues that are commonly raised in the literature, such as institutional deterrents to trading. Literature outside of cap and trade suggests that there are other important factors that have an important bearing on the functioning of a cap and trade regime have been overlooked by using this approach. Appreciating that farmers are socially embedded, for example, means that farmers are understood to be located in a broad social and cultural context, which has regional, national and international components. Thus farmer responses to a cap and trade implementation cannot be understood without consideration of the context and, it is suggested, this aspect has been lacking in studies to date.

[25] This is explained in more detail in the section entitled 'Landscape as a socioecological system', Section 3.2.1.

3. The methods used in water quality investigations to date have been in the nature of evaluations, primarily concerned with attainment of the programme goal and using selected indicators (see, for example, Thurston, Smith, Genskow, Prokopy, & Hargrove, (2012)). In cap and trade, the textbook goal is to achieve the environmental goal at least cost to society (Tietenberg, 2003). Ex-post studies have concentrated on whether this goal has been achieved[26] and if not, why not. However, focusing on goal attainment has been shown to restrict findings about unexpected effects (Scriven, 1967) and to encourage tunnel vision (Coryn, Noakes, Westine, & Schröter, 2011). In this study, a watershed is viewed as a system with nested sub-systems at the local and farm levels and one of the properties of systems is that outcomes are unpredictable (Berkes, Codling & Folke, 2003). Thus an investigation of all effects and outcomes, intended and unintended, is required in order to fully understand a cap and trade programme and its suitability for the control of non-point pollution.

4. Uncovering side effects requires an approach that is inclusive of areas where such effects might potentially be perceptible. Farmers are the core decision maker and their decisions are made in the context of their farm system but the outcome of multiple decisions at the farm level may not be apparent until the researcher focuses on the local (community) or watershed level (Parrott & Meyer 2012). Thus an investigation of the outcomes of a cap and trade regime must take account of issues of spatial scale and time periods. Studies of cap and trade, to date, have not taken account of this.

The international experience, therefore, may not be a good indicator of the suitability of a cap and trade regime for fulfilling the needs of the NPS-FM. This question (of the suitability of cap and trade) would be more appropriately answered by an investigation of an implementation that sets limits at both the farm and watershed levels and uses a holistic (Rindfuss, Walsh, Mishra, Fox & Dolcemascolo, 2004), systems-based approach to the investigation. There is some support in the literature for this view. Shortle (2012:43) calls for more research on trading where the agricultural sources are fully capped and Marsh (2014) and OECD (Organisation for Economic Cooperation and Development, 2012) suggest that more behavioural studies are needed to understand farmer trading responses. Marsh, Tucker, & Doole (2014) suggest that gains from trading may be less than theory would suggest, and AgFirst (2010) found that farmers in the Waikato (New Zealand) were concerned about the introduction of a cap and in need of more information on the on-farm effects of such policy settings.

[26] see Tietenberg & Johnstone (2004) for an outline of how they recommend that an ex-post study of a cap and trade regime be undertaken

It is apparent that a conventional single discipline approach to understanding cap and trade is insufficient (Slee, 2007; Darnhofer, Lindenthal, Bartel-Kratochvil, & Zollitsch, 2010). Sustainability and resilience approaches are cross or multi-disciplinary but unfortunately at this stage there are limited tools available to study integrated social and environmental systems (Ness, Urbel-Piirsalu, Anderberg, & Olsson, 2007; Walker & Salt, 2012) and few "…*agreed upon criteria*" for economic and social contributors (Berkes & Folke, 1998:20). Some researchers (e.g. Irwin, 2001) have therefore encouraged their peers to search outside of the usual disciplines to find new and potentially more appropriate approaches to integrate the social and ecological. Niles & Lubell (2012:55) suggest policy researchers turn to "…*disciplinary interfaces*" to find the theories and methods appropriate for the understanding of complex environmental problems.

Landscape is one such body of knowledge that is located at the interface of several disciplines and potentially offers an approach to understanding a cap and trade programme. In landscape analysis, human and biophysical components are connected across scales of time and space (Parrott & Meyer, 2012), the concept of systems is integral (Matthews & Selman, 2006), and the notion of change is central (Wood & Handley, 2001; Antrop, 2000). Further, the relationship of policy to landscape change has been well established in the literature (Hersperger & Burgi, 2009; Klijn, 2004). For example, Van Vliet, de Groot, Rietveld, & Verburg (2015) in a review of 218 case studies of landscape change in Europe, showed that institutional factors (which included policy measures) are one of the most important factors contributing to change. In the following chapter I therefore turn to the potential suitability of landscape and its metric (land-use) as a conceptual framework, for investigating the consequences of a cap and trade policy.

Chapter 3

Landscape Systems and Methodology

3.1 Introduction

Landscape is a concept and perspective that is located at the nexus of the social and the biophysical as well as taking account of both time, and spatial scale. This chapter explains how a 'landscape' approach can be applied to investigating the suitability of cap and trade for implementing the NPS-FM. Issues of metrics, landscape paths, trajectories, and system dynamics are covered before a conceptual frame is devised and described.

3.2 Landscape as a framework of analysis

To many people landscape is a view, or a picture – that is, it is visual. But if one stops to think about how it got to be the way that it looks, then it is apparent that there are multiple ways of reading a landscape (Meinig,1979). One landscape reading might focus on just the natural processes that formed the landscape over a long period of time, but humans have overlaid these natural processes by cultivating the land and introducing non-endemic species, and structures. Thus landscapes reflect both natural and human impacts (Piorr, 2003), since they are the result of the interactions between the two. In fact, one of Meinig's ten versions of one landscape is as an assemblage of "…*surficial clues of underlying processes*" (Meinig, 1979:3). This is particularly apt in this study because it draws attention to the processes, materials, entities, flows and interactions that are operating together, at a particular time, in a specific place. The processes might be human in origin (farm management practices for example), the materials might be biophysical (such as soil) or of human origin (such as plantation trees) but because of the interactions between them changes in one area will result in, often unpredictable, changes elsewhere. Thus landscape can be understood as a system of interacting parts, but it is also a holistic system in that the parts working together can achieve a different outcome than the individual parts do working alone (Antrop, 2000:18). It is the interface of society and nature (Plieninger et al., 2015), at a particular place and time or, in the words of the European Landscape Convention (Council of Europe, 2000):

> *Landscape means an area as perceived by people, whose character is the result of the action and interaction of natural and/or human factors*

The particular strength of a landscape perspective, as defined above, is that it considers humans – both as individual agents and as communities - as integral elements of landscapes, whereas other models tend to see humans as impartial observers, external drivers of ecosystems, or mere beneficiaries of ecosystem services (Matthews & Selman 2006). Inclusion of both the social and

natural in this way means that landscape is multidisciplinary and provides a meeting point for different theories, concepts and analytical tools (Plieninger et al., 2015). This integration of methodologies has led Matthews & Selman (2006:200) to suggest that landscape provides an ideal framework for "…*scientific analysis, data capture and policy delivery*" – and so, by extension, it also provides a framework suitable for the understanding of a policy intervention.

3.2.1 Landscape as a socio-ecological system

The work of Fairweather & Hunt (2011) demonstrates that a farming system is a complex interweaving of natural, economic, and social factors. Hence farms and the landscapes they constitute cannot be understood using single indicators that are fixed in time. Rather they need to be understood as dynamic, whole units, i.e. as a socio-ecological system (SES) that undergoes constant change along a landscape path (Matthews & Selman, 2006). An SES is generally defined as coupled social and ecological systems where any delineations between the two are artificial and arbitrary (Berkes et al., 2003). But SESs are also nested within other SESs so changes at one level may result in an outcome that is only apparent in another SES, located at a different spatial scale (Berkes et al., 2003). For example, the results of multiple small changes in farm-level systems may result in change that is only apparent at a different spatial scale (such as the community or watershed) (Darnhoffer et al., 2010). Further, although systems generally undergo only gradual change, their route - i.e. their landscape path – can be disrupted, as Darnhofer, Fairweather, & Moller (2010:187) explain, by *"…shorter, episodic disturbances"* that may cause change sufficient to *"…reconfigure"* the system. Change in farm systems and the landscapes of which they are a part is therefore unavoidable, can be gradual or episodic, and is both unpredictable in its effects and the location of those effects. Change is also dependent on past history (Parrott & Meyer, 2012) and the options that are either opened up or restricted, so change has a temporal aspect in addition to the spatial one.

Walker & Salt (2012:17) suggest that ignoring the cross-scale effects of change is one of the most common reasons for failures in resource management. No system can be understood (or managed), they argue, without also understanding the SESs with which it is interacting. For example, Gray (1999) studied land degradation in Burkina Faso in Africa and found that conclusions about whether land degradation is a problem or not differed depending on the scale of analysis. At the farm scale, soil samples showed that there had been little change in soil quality. At the regional level, however, decreases of forested land, increases of cultivated land, and land that appeared to be degraded caused analysts to conclude that land degradation had increased. Further study, however, showed that farm practices had changed resulting in changes to land-covers but not in degradation of soil. Thus, Gray (1999) concludes, analysis at multiple scales is essential. Further, Selman & Knight (2005)

note that aggregation across scales may change perceptions of land-use. For example, an urbanisation trend may not be apparent at the farm level but becomes obvious at the local scale. Similarly, patterns of intensive pastoral farming, woodlot plantings or biodiversity corridors may all require a coarser scale than that of the farm (i.e. the local scale) to become apparent and Lambin, Geist & Lepers (2003:227) explain this aggregation effect as follows:

> *Land-use change is a spatial property observed at the scale of a landscape. It is the sum of many small, local-scale changes in land allocation that reinforce or cancel each other. These changes are the product of multiple decisions resulting from interactions between diverse agents, who act under certain conditions, anticipate future outcomes of their decisions, and adapt their behaviors to changes in external (e.g., the market) and internal (e.g., their aspirations) conditions.*

Thus the outputs of farm SESs are aggregated and cumulated into patterns of land-use at the local (and larger) scales. Conventionally, at the regional and national levels, land-uses are aggregated and cumulated into economically-orientated industry categories such as sheep and beef, dairying or forestry (for example see Kerr & Olssen, 2012). This categorisation, however, masks important changes that have taken place in rural economies in New Zealand. Not only has there been diversification away from the primary pastoral industries into land-uses such as viticulture and tourism, but there have also been changes in the knowledge base used to produce products from some rural land (Campbell et al., 2009). These changes have included: integration of technology for product tracking, regional branding, and biological farming (Lewis et al., 2013). Thus traditional categorisations of sectoral land-use at regional or national levels are no longer sufficient to describe economies at these scales and some prefer to use the term 'Biological economies' (Campbell et al., 2009) to describe categories of value creation from rural land. In New Zealand such biological economies have resulted from: localised climate and limestone/clay soils (resulting in the Waipara wine landscape in Canterbury), from heritage landscape, and recreational amenity values (contributing to the tourism industry in the Central Otago region (Perkins, Mackay,, & Espiner, 2015) and from soil conservation (resulting in exotic forest plantations in the East Coast of the North Island).

Thus a regulated watershed can be understood to be a socio-ecological system, that expresses one or more types of biological economy, with sub-systems located in a nested fashion at local and farm scales. As noted above, the path that each SES follows, as it undergoes change along a time-line, is termed a landscape path, and the implications of such paths for the study of a cap and trade regime are important and need to be considered in more detail.

3.2.2 Landscape paths and watershed trajectory

An important feature of landscape research is the notion of temporal change – of SESs that are transitioning from one state to another (Lambin & Meyfroidt, 2010), and so are transforming themselves along a pathway of connected changes (Martens & Rotmans, 2005). Transitions reflect changes in the SES that are sufficiently significant to alter the outputs of the SES. They are not deterministic, since they are only a reflection of actual events, but once joined end on end into a landscape path they contribute to an understanding of the direction the landscape has followed. Further, landscape paths, integrating different scales, contribute to a projection, i.e. an estimate, of the future trajectory of the landscape at the watershed level. Thus connected transitions (landscape paths) can have many shapes. Wilson (2007) describes six theoretical patterns, ranging from a straight line progression (of increasing change over time) to a model where stable phases of incremental change are interrupted by an abrupt change which disrupts the landscape path.

The disruptive model of transition is commonly referred to in landscape ecology where ecological systems are said to undergo periodic catastrophic change which can result in the ecological system following a different landscape path (possibly a radically different path) after a disruptive change (Gunderson & Holling, 2002). If discontinuous change, followed by progressive and gradual change, were to be repeated a number of times then the path could be described as 'episodic'. Lambin, Geist & Lepers (2003), for example, describe how, in Indonesia, vast accidental forest fires periodically occur as a result of drought induced by El Nino conditions. These periodic fires result in a land-use change path of episodes of abrupt destruction followed by forest regrowth and then further destruction after the next El Nino event. Intuitively, policy interventions could result in disruptive change, so a landscape path punctuated by a series of policy interventions could tend towards an episodic path, and there is some evidence that policy interventions may act in this way. For example, Wilson (2007) suggests that disruptive change can occur with a change in farmland ownership, particularly when such change is forced upon landowners (e.g. through the introduction of regulations) rather than resulting from voluntary action.

Van Vliet, de Groot, Rietveld, & Verburg (2015) categorised landscape changes in Europe into three generic landscape paths. One (intensification/de-intensification) arose from market influences. A second (diversification) arose from societal change, and the third (land abandonment) resulted from political change in Eastern Europe. Thus while policy was seen as an important driving force in all three landscape paths, it was not deterministic, and it did not result in episodic change. One the other hand, Jepsen et al. (2015) found that land management paths in 28 European countries have been affected by national level political/institutional factors (including policy) and by farm-level technology uptake (such as the introduction of mineral fertiliser and tractors). Similarly, Primadahl &

Swaffield (2010), comparing six in-depth case studies across OECD countries found that policy on incentives and subsidies can slow change in some agricultural landscapes but in others it may accelerate change. Schneeberger, Bürgi, Hersperger & Ewald (2007), found that public policies are important contributors to landscape paths and further that they cause episodic change and in a study of rates of change in landscapes in the Swiss Alps from the 1880s, found that agricultural landscapes changed very rapidly after the introduction of subsidies for agricultural intensification in the 1960s. The rate at which landscape elements such as trees, hedgerows and streams were altered or removed was so abrupt that the introduction of the CAP agricultural policy could be called a disruptive change. It was evident in this study, however, that there were drivers, additional to the policy change, which also contributed to the change in the landscape. This is not surprising given the integrated nature of landscape, so the next section considers how a landscape approach includes these change influencers.

3.2.3 Land-use, land-cover and landscape change drivers

Landscape change is often expressed as a change in land-use or land-cover. While land-cover is generally used to describe natural and introduced elements in the landscape (such as native and exotic trees) (Briassoulis, 2000), land-use refers to the purpose for which the land is used (Briassoulis, 2000). In rural areas land-uses are primarily production orientated (e.g. farming or forestry) but the term land-use is also used to describe amenity uses (such as recreational or visual reserves) and natural areas (e.g. nature conservation) (Selman, 1988).

Landscape change at a local level is driven in a direct sense by changing practices within the socio-ecological system (as discussed above) but can also result from pressures that are located outside of the local system. These latter influencers are generally referred to as exogenous driving forces (Burgi, Hersperger, & Schneeberger, 2004), and the study of exogenous drivers has a long tradition in landscape management (Wood & Handley, 2001). Hersperger & Burgi (2009) identify five types of driving forces: political, economic, cultural, technological, and natural/spatial. Similarly, Van Vliet, de Groot, Rietveld, & Verburg (2015) found, in a review of 218 case studies, the most important exogenous forces were institutional drivers (including agricultural policies, land consolidation, ownership security) and economic drivers (e.g. international agricultural markets, off farm employment and urbanisation). The most important influencer of specific land-use change, however, was found to be the behaviour of managers such as farmers, which included factors such as motivation for farming, farmer attitudes, age, household income and farm size. However, researchers are not in agreement about the overall significance of local agents such as farmers and land managers. Van Vliet, de Groot, Rietveld, & Verburg. (2015) and Klijn (2004) suggest that they are driving forces in their own right who process other driving forces and initiate action. On the

other hand, Verburg (2014), suggests that farmers/agents and other driving forces are integrated to such a degree that they cannot be individually distinguished. Hersperger, Gennaio, Verburg & Burgi (2010) suggest that both positions are correct but for different situations. None of these authors, however, have specifically referred to issues of scale. It may be that at a regional and landscape scale, farm-based agency cannot be disentangled from other endogenous driving forces of the SES at that level. At the farm scale, however, as Fairweather & Hunt (2011) point out, farmer decision making mediates all components of the farm system, so decision making is therefore distinguishable from the other components. It is central to the functioning of the SES, and acts as a conduit through which other factors are channelled.

Exogenous driving forces have also been found to interact with each other in multiple ways. Geist & Lambin (2004), for example, concluded from their review of 132 cases studies of desertification that it was a combination of climate, economics, institutions, national policies, population growth and global factors that drove landscape changes such as cropland expansion, overgrazing and infrastructure expansion. Similarly, Keys & McConnell (2005), in reviewing 108 case-studies of agricultural intensification in the tropics, found that demographic, market and institutional forces together resulted in the adoption of new field crops, tree planting and the development of horticulture. In addition, they found that government and/or NGO agricultural policy was important in just over half of all cases. Van Vliet, de Groot, Rietveld, & Verburg (2015), however, found that in very few of the 218 cases that they reviewed was one driving force, acting alone, responsible for landscape change. Geist & Lambin (2002) reviewed 152 case studies of land-use change relating to tropical deforestation. They found that change was driven by factors external to the SES (i.e. economic factors, national policies) that operated on factors within the landscape-level SES (i.e. agricultural expansion, wood extraction, and infrastructure extension). They also found that specific change such as deforestation was linked to different combinations of the driving forces in different locations. Policy was considered to be a relevant driver in 105 of the 152 cases. Most recently, Plieninger et al. (2016) reviewed 144 case studies of landscape change in Europe with the aim of determining the driving forces involved. They also found that landscape change was related to distinct combinations of forces (including political, institutional, cultural and natural/spatial). So these studies indicate that factors located outside of the SES under study can have a significant effect on outcomes, including policy implementations. This suggests that the study of a policy implementation must be open to exogenous influencers that exist beyond the boundary of the study.

The studies outlined above also show that landscape change drivers do not act alone. Rather the interrelationship of drivers implies that they are a collective - a 'field' of forces. Thus cause and effect for an individual driving force (such as a policy intervention) is difficult to prove (Eiter & Potthoff, 2007) and, if it is assumed, could lead to erroneous conclusions. For example, as Lambin et

al. (2001) explain, poverty is often identified as a driving force of landscape change but the influencer of change is more likely to be global market forces interacting with cultural and location factors.

Exogenous driving forces, therefore, act collectively and cumulatively on the SES, and while the influence of a single act of policy implementation cannot be completely untangled from the influences of other such forces acting on it, as Schneeberger et al. (2007) demonstrated, a major change in policy regime can have a significant effect on a landscape path and, as Primdahl & Swaffield (2010) argue, can affect the rate of change. Thus endogenous driving forces result in change, measured as land-use or land-cover change, and visible through the landscape path. At the farm level, as Van Vliet, de Groot, Rietveld, & Verburg (2015) show, these forces are channelled through farm decision making but at other levels, the literature suggests, no such mediating factors are involved.

3.2.4 Studying landscapes as objects, through landscape biography

Landscapes and humans co-evolve (Matthews & Selman, 2006) and thus as society changes so will the landscape (Klepeis & Turner, 2001). Landscape changes can therefore be examined as a way of understanding the effects of societal changes that have occurred. Societal changes might include political, policy, economic or social norm changes but a landscape approach assumes that these changes will result in discernible changes to the landscape, although the time period and the spatial scale in which the changes can be discerned are unknown. This implies that a variety of spatial and time scales are required in a study of this nature.

Landscapes also act as a boundary object within which social and biophysical data can be merged (Opdam et al., 2013). Thus a farmer's knowledge of their farm can be combined with scientific knowledge of nutrient pollution, alternative land-uses, market pressures and other knowledge without loss of comprehension. In this way, landscape provides a platform for all knowledges that pertain to land management and since it is understood by all participants, it can provide a means to negotiate understandings between diverse groups and knowledges. It is thus a place of negotiation for different concepts, tools and knowledges (Plieninger et al., 2015).

However, the inclusive strength of landscape as an object of study also creates practical challenges in how to analyse and integrate the different dimensions. Some researchers suggest that the best way to bring social and biophysical aspects together is through the medium of interpretive 'stories' about a landscape through time (e.g. Lapka & Cudlinova, 2003) and landscape biography is one such approach. To Van London (2006:1) landscape biographies are "…*a narrative of transformation of meaning through time*" and for this reason Lambin, Geist & Lepers (2003:230) argue that narrative (and thus landscape biography) is a powerful investigative tool.

> *The narrative perspective seeks depth of understanding through historical detail and interpretation. It tells a land-use/cover change story for a specific locality. Historical analyses of landscape grasp all the complexity of events … It avoids the simplifications and erroneous interpretations that could result from studies focused only on the present and immediate past, outside the context of longer histories of human/environment interactions.*

Thus landscape biographies are a means of unpacking the complex interactions of a socio-ecological system and the drivers that are interacting with the system, taking these elements and synthesising them into stories of landscape. As a biography they create an account of the 'life' of a landscape, amalgamated from the interwoven stories of different features, networks, communities and individuals associated with the land. The ability of this approach to handle contextual complexity, identify unpredictable events (Verburg, 2014), and enable in-depth explorations (Lambin, Geist & Lepers, 2003) makes it useful for a variety of studies, including investigating the consequences of a policy implementation. Further, the emphasis on landscape through time automatically includes notions of path dependencies which are important for understanding current landscapes (Marcucci, 2000; Roymans, Gerritsen, Van der Heijden, Bosma, & Kolen, 2009). As Pickles & Unwin (2004:11) explain, transitions can be thought of as using the resources resulting from the "…*legacies of the past*" to change to a "…*construction of whatever is new*" and such transitions are aptly captured by the biographical approach.

Lambin, Geist & Lepers (2003) argue that landscape narrative (i.e. biography) avoids the type of simplistic explanation that can arise from quantitative methods, or from qualitative methods that do not take account of the effects of history on the present. Landscape biographies assist in unpacking opaque entities, such as socio-ecological systems, clarifying transitions and uncovering drivers of system outcomes (Young et al., 2006). This approach has been used in landscape studies (Antrop & Rogge, 2006), but has more frequently been used in related fields such as environmental law (e.g. Myint, 2003), geography (e.g. Revels, 2014), and archaeology (e.g. Roymans, Gerritsen, Van der Heijden, Bosma, & Kolen, 2009). Further examples include Wilson (2007), who used a narrative and transition framework to question the reality of current discourse around post-protectionist agriculture and Conte (1999), who studied changes in forests in Tanzania and by using a biography approach was able to show that episodic transitions in forest structure were occurring as a result of governance and policy factors. Similarly, Riley & Harvey (2007) used a 'collective oral history' approach to explore the processes of agricultural and landscape change in the UK. This approach enabled them to (p. 410), "…*unpick and unlayer complex histories of landscape change, with events, practices and processes provided with a deeper temporal framework and more nuanced cultural context*". Roymans, Gerritsen, Van der Heijden, Bosma, & Kolen (2009) have also found the biographical approach to be effective. They undertook an extensive study of the construction of a Dutch landscape from pre-history to the present day and found that the biographical approach

enabled 'innovative' story lines and revealed critical times of transformation. Lapka & Cudlinova (2003:323) have used landscape biographies to explore the shared meanings of landscape in Eastern Europe and to enable scientists and policy makers involved with tourism policy to understand policy effects. While this study is ongoing the authors have already found that (p. 323) "…*landscapes and people form a partnership to reveal a story of changing communities, changing land use and changing landscapes*". The biographical approach with its emphasis on change over time, therefore, has been used by researchers in several disciplines. Their comments on its use suggest that it is particularly helpful in developing a shared understanding of complex situations, identifying episodic events and driving forces of change, and in following change as it evolves over time.

3.3 The landscape approach as a conceptual framework

In this section, landscape concepts are synthesised in to order to answer the research questions. Thus the elements of landscape discussed above are drawn together into a conceptual framework for the study.

Berkes & Folke (1998:15) describe a conceptual framework as a means to "…*think about phenomena, [and] to order material*" to assist in "…*revealing patterns*". Thus they are a way of organising and analysing data (Schon & Rein, 1994) that is underpinned by an overarching set of ideas, organised into a framework (Cumming, 2014), and thus provide a direction for the interpretation of data. Of particular importance in this study, a conceptual frame provides a means to integrate decision makers' attitudes and actions with information drawn from other sources (Swaffield, 1998).

A landscape approach provides a useful conceptual framework for a policy implementation assessment because it is a holistic concept which takes account of spatial and temporal factors. At the core of this approach are landscape biographies and the narratives of change that they express. Landscape biography, produced by combining accounts of farmers and others associated with the implementation, will enable the outcomes of the implementation to be told as a story, within their historical, social and biophysical context. The story takes the form of transitions i.e. transformations that the landscape has undertaken from the chosen beginning point (e.g. conversion of indigenous vegetation to pasture) to the present day and will assist in identifying land-use changes, particularly land-use system changes, and the drivers of that change.

Spatial scale effects within the regulated watershed are accounted for through the nested socio-ecological system approach. Landscape stories, collected at the farm scale are aggregated and cumulated to provide landscape biographies at the local (intermediate) scale and then to the regulated watershed level. It is anticipated that different perspectives will be facilitated when biographies are combined with each other and with data from other appropriate sources. Thus land-

use at the farm scale may involve different explanations and drivers from land-use at the local or watershed scale.

The framework will be expressed at three levels, each using different metrics.

Landscape Unit of Analysis (Scale)	Significance in analysis of cap and trade	Metric
Watershed	Total regulated area	Rural land production category
Local	Group of land managers	Land tenure; land-use system
Farm	Decision making unit	Farm practices, specific land-uses /land-covers

Table 1: Showing the scales and metrics used in the study framework.

Outcomes of SES processes at the regional or watershed scale are categorised in terms of the amount of land devoted to a production sector or industry, for example sheep and beef production or dairy support. At this watershed level, the landscape biographies are aggregated and analysed to show the transformations that have occurred across time and thus the overall landscape trajectories.

At the local scale the expression of a socio-ecological system is the groups of land-uses/land-covers/land tenures that have subtle effects on rural production. Van Vliet, de Groot, Rietveld, & Verburg (2015) uses the term 'manifestations' to describe outcomes at this scale, rather than the more usual land-use and land-cover, because at this level important patterns (land-use systems) become apparent. Of particular note are intensification or extensification of pastoral land-uses. Such land-use systems are important in this study because of their potential for differing contributions to economic and farm viability. The emphasis, at this local scale then, is on the amount of area in related land-uses or land-covers where the relationship is established through the perceived contribution to business continuance.

At the farm scale, the expression of the socio-ecological system are farm practices – that is the patterns of activity in a particular place by which farmers manage their farms for multiple goals e.g. animal husbandry at different stocking rates.

The diagram below shows the components of the conceptual frame used for this thesis and how they relate to each other. It is drawn from the work of Darnhofer, Fairweather, & Moller (2010) and mirrors their conception of an agricultural system as nested socio-ecological scales at different spatial scales. In this study the chosen scales are farm, local and watershed and at each spatial scale there is a temporal aspect (as indicated by the transitions) as well. As the diagram shows, each spatial scale is linked to the one above and below. In addition, there are links between the farm

scale and the overall watershed level. The socio-ecological systems are acted on by driving forces that lie outside of the systems and have effects at each of the spatial scales.

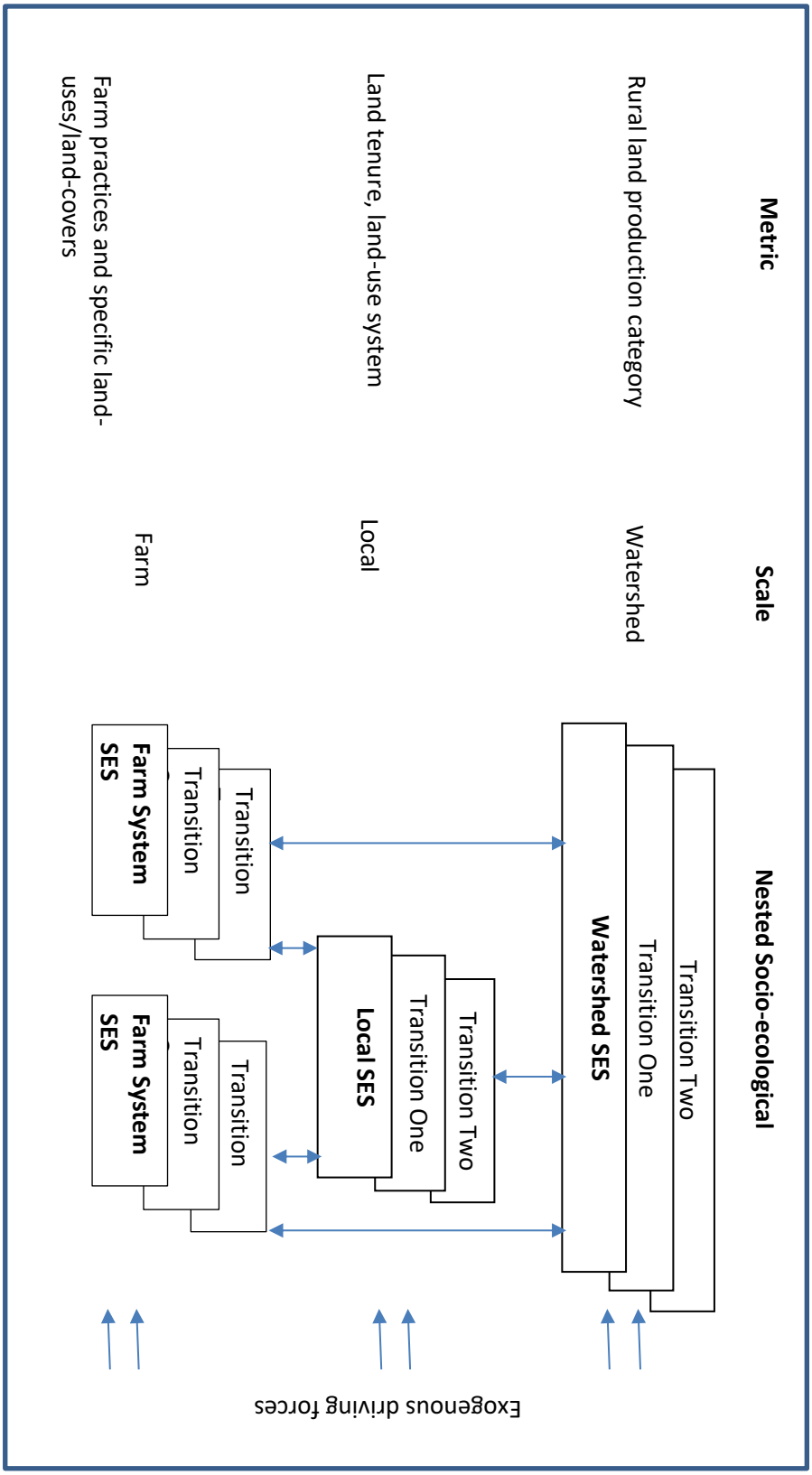

Figure 2: Conceptual frame: Integration of key elements in the investigation of a cap and trade regime.

An interpretative story of the landscape, a landscape biography, can be produced for each spatial scale. At the farm scale, stories relate to farm practices and land-use changes taking place on a farm over time. At higher spatial scales, different socioecological system configurations are brought into view (across time), and thus landscape biographies at these levels point to changing patterns of land-use, local-level configurations and values and to changes in the distinctive ways in which communities and businesses make a living from the land.

By cutting across the spatially-based landscape biographies and by focusing on the element of time, the path that the landscape has followed can be traced. The diagram below describes the concept of landscape trajectories and shows how they are composed of transitions joined end to end and interrupted by events. In this example, system production levels initially rise, despite the interruption of the first event, but after the second event production levels reduce and subsequently fall. Events are not necessarily causal because a number of driving forces may be involved, as would be explained in the textual description of the path. Thus landscape path diagrams can be misleading and are not used as part of the results of the study. The diagram below is included as a visual illustration of landscape pathways transitioning from one state to another and given structure by reference to relevant events, not as a definitive account of a particular SES.

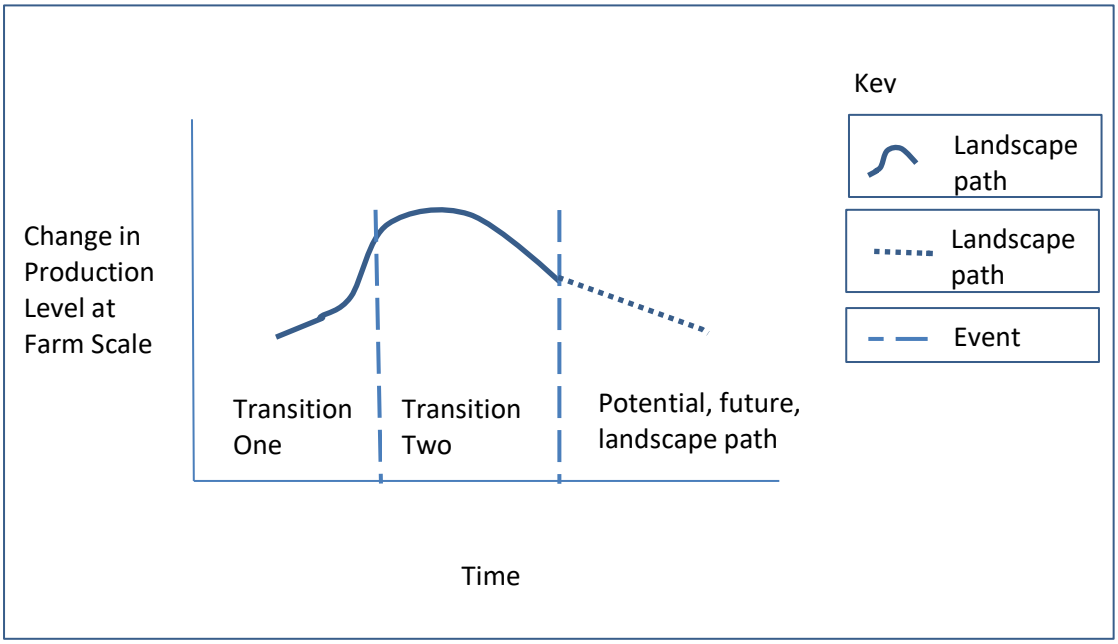

Figure 3: Conceptual model of a landscape path at the farm scale showing transition changes resulting from event interruptions, and potential future landscape path
(Source: adapted from Wilson (2007))

3.3.1 Applying the conceptual frame to the study of a cap and trade regime

In this study, farm scale practices and system dynamics are viewed as the result of the history of the farm, of driving forces acting on the farm system, and of farmer decision making. Thus exogenous driving forces may result in changes in the farm practices that farmers choose to implement. For example, international market prices are a driving force that, in conjunction with other drivers such as the availability of finance, might result in a change in land-use from sheep and beef production to dairy support[27]. Many changes are likely to be mediated by intermediate scale, i.e. local scale, factors. For instance, as Mariola (2012) noted in relation to trading schemes, community relationships may directly effect on-farm choices, and, further, types of ownership of farms may result in change to local communities. Some land-use changes, however, are likely to result from a direct link between the farm at the local-level, and watershed-level, factors. In the case of cap and trade, a cap may operate at the watershed level and be applied by apportioning the cap amongst the farms in the watershed. In this instance the intermediate (local) scale is bypassed but the effects may become most apparent at that level. The relationship operates in both directions because it assumes policy modifications may be made in response to on-the-ground issues.

When individual, farm scale, changes in practice cumulate to the local scale, patterns of land-use change become apparent. For example, a change in husbandry and stocking numbers at a farm level (to fewer sheep for example), when viewed at the local level, may contribute to a land-use system change, i.e. a less intensive use of the land and potentially a reduced income from farming. However, the same change viewed at the watershed level is not visible because the way that income is earned from rural land (sheep farming) has not changed.

Landscape biographies can be applied to any spatial scale. In this thesis, one landscape biography is presented for each of the three chosen spatial scales. Thus there is a biography which concentrates on the watershed scale, a second one that gives attention to the local scale, and last, one focused on the farm scale. Each biography is the story of the socio-ecological system/s as they appear to be operating over time, and at the chosen spatial scale, under a cap and trade system, and each is focused on upon a different embedded case within the watershed[28]. As will be shown in the second part of this thesis, different factors come into focus as the emphasis shifts from one scale to another. This will be an important contribution to answering the research question which focuses on the assistance of a landscape approach to understanding the consequences of cap and trade.

[27] Dairy support includes both heifer grazing and the grazing of non-lactating cows, often over the winter months, on a drystock (e.g. sheep and beef) farm.
[28] See Chapter Five for an explanation of the embedded cases.

3.4 Summary and conclusions

Cap and trade, according to the literature reviewed in Chapter Two, is an appropriate policy setting for achieving both the environmental goals of the National Policy Statement for Freshwater Management while at the same time providing for the needs of farmers. However, there is no experience internationally with implementations where caps are applied at the farm scale. This study sets out to investigate the consequences of a cap and trade regime where such limits have been applied.

This chapter has developed the concepts that will be employed in the investigation. A landscape approach has been chosen since it enables watersheds to be viewed as dynamic, nested socio-ecological systems which are influenced by exogenous driving forces – of which regulations are one. The complexity of this multi-disciplinary approach is accommodated through use of landscape biographies i.e. interpretive stories of the landscape, which portray the path that the landscape has followed pre- and post- the implementation of cap and trade regulations. The landscape biography approach has been used, for example, as a frame for validating policy (Matthews & Selman, 2006) but as far as can be ascertained, the landscape biography approach outlined in this chapter has seldom been used in a case-study of a policy implementation. Consequently, it is a relatively novel approach to investigating a policy implementation.

The next chapter details the methods that will be used to put the landscape approach into effect.

Chapter 4

Research Strategy and Methods

4.1 Introduction

The previous chapter concluded that the international literature to date may not be a good indicator of the suitability of a cap and trade implementation for fulfilling the needs of the NPS-FM. An investigation of a suitable case of cap and trade policy implementation (one that sets limits at both the farm and watershed levels) using a holistic (Rindfuss, Walsh, Mishra, Fox & Dolcemascolo, 2004), systems-based approach to the investigation offers an alternative approach. Ideally, such an investigation should produce results that have some degree of generalizability. Flyvbjerg (2006) suggests that by using a case-study approach and by careful choice of the case to be studied, generalisations can be drawn. He argues that an in-depth study of an exemplar case, such as a theoretically-ideal implementation of a policy setting, is likely to reveal more information than other research methods. Thus studying the best example of a cap and trade implementation allows a generalisation of the type: if environmental requirements and farming needs cannot be achieved simultaneously in this exemplar case, then it is unlikely that cap and trade is a suitable policy setting for implementing the NPS-FM.

This line of argument determines much about the methods used in this study. This chapter first considers the strategy used to answer the research questions and then explains the research methods that have been employed to achieve the outlined strategy.

4.2 Research Strategy

An in-depth study of an exemplar case requires the use of an appropriate approach from amongst the range of options available in social science research. This section makes the case for the use of an interpretative approach to the study of a cap and trade regime. It then considers the issues in choosing the case to be studied. Finally, it describes in the methods used to obtain and analyse the data.

4.2.1 An interpretive approach

In this study, farms, communities and watersheds are viewed as nested socioecological systems. Thus they are complex systems with both biophysical and social components. Data relating to this complex world is likely to be multifaceted. Thus there is a case for using an interpretive strategy to understand the consequences of a cap and trade implementation. An interpretive strategy is one where observation and experience of the world is 'made sense of' by the researcher using a reflexive

process (Deming & Swaffield, 2011) to distil the significance and sense of collected material. Interpretation is an active process in which meaning (information) is constructed from data, and, as Deming & Swaffield explain (2011:152), this is achieved through the researcher moving "…*reflexively between the observed data and the theoretical concepts*" that underlie the study. The conceptual framework outlined in Chapter Three, based on a review of the literature, provides the theoretical basis for the interpretation task. While it is acknowledged that in this approach the interpretation of data can never be completely impartial (Denscombe, 2010), it is incumbent on the researcher to reduce the level of subjectivity as much as possible. To this end, in addition to using the conceptual frame as an interpretation medium, and reflection on the meaning and context of gathered material, sector experts were used informally to challenge the validity of the developing narrative.

One of the strengths of using an interpretive approach is that it is compatible with the landscape biography method, which, as explained in Chapter Three, is particularly relevant to investigating cap and trade applied to land management. In both of these approaches, the active involvement of the researcher is fundamental to making sense of social relations, and in the construction of a coherent account of the issue being studied (Deming and Swaffield, 2011). In addition, the landscape biography method uses data from many disciplines and sources and thus an interpretive process is essential for integrating the divergent material. This integration process is discussed in more detail later in this chapter.

4.2.2 Research Design: The Lake Taupo case study

In addition to contributing to the choice of research strategy, the complexity involved in a study of socioecological systems indicated that a case study approach was appropriate for the research design.

A study of a socio-ecological system requires an understanding of the interactions between social and biophysical factors operating within the system. But this knowledge is mediated by spatially and temporally dependent factors and interactions with the world outside the boundary of the SES, i.e. the context within which the SES is operating. As Flyvberg (2006) explains, it is the understanding of this real life situation and how it deviates from the 'normal' or 'expected' situation that builds expert knowledge. Thus, for a policy regime, an in-depth case study assists in broadening the understanding of its operation in the real world and of the situations for which it is the ideal choice.

Hammersley & Gomm (2000) suggest that case studies are particularly suitable for smaller numbers of respondents, and Blaikie (2010) suggests that case studies may have sub-cases within the overall case. Sub-cases may be differentiated on the basis of location, farm system type, and cultural identification etc., and enable in-depth investigations of like groupings. The case study approach,

with sub-cases, is therefore a suitable design for the study of socioecological systems, and consequently is the method used in this study. Case studies are most often criticized for being too place and time specific and therefore the results of case-studies are not generalizable (Blaikie, 2010). In this case the aim is to increase expert knowledge rather than to determine rules regarding implementation (Flyvbjerg, 2006) and an exemplar case has been chosen which will increase the understanding of which types of situations are suitable for the implementation of a cap and trade policy setting to control water quality.

The selected case of the Lake Taupo Catchment, in the centre of the North Island of New Zealand is the only cap and trade, known to the research community[29], where agricultural pollution is controlled at the farm level, and thus is an exemplar of a policy setting aimed at the control of nitrogen in waterways. Shortle (2013, 64) describes the Taupo implementation as "…*exceptional*" in that "…*it is designed as a true cap-and-trade program*" and meets the performance criteria that he considers essential for a water quality programme, including an aggregate environmental cap imposed in a defined area, non-point discharges of nitrogen from regulated farms being calculated and monitored, and a facility for trading allowances between agents being set up (Shortle, 2012:30). Other cap and trade water quality programmes do not place limits on (non-point) discharges from agriculture and neither do they calculate or monitor discharge changes. Instead, they limit discharges to point sources only, and/or allow point source polluters to off-set their discharges by implementing input/output rules on (contracted) farms (see Chapter Two).

Thus the Lake Taupo Nitrogen Trading Programme is unique amongst cap and trade programmes aimed at controlling non-point source agricultural discharges, and appropriate for study as an exemplar case in cap and trade theory. While the best policy instrument for a particular situation, as Stavins (2003) points out, will depend on the environmental problem and the social, political and economic context, this does not negate the usefulness of case-studies of a single exemplar case in informing policy.

Early in the interviewing process it became clear that the experiences and responses of farmers varied, particularly by location, within the Catchment. This finding confirmed the proposed research design of multiple sub-cases, with each case located in a specific part of the Catchment. The sub-Catchment cases that were identified from initial farmer and key informant interviews are described below and map locations are shown at the start of each result chapter (Chapters Six, Seven and Eight).

[29] See Greenhalgh & Selman (2012) for a list of programs world-wide that are operating, are under development or are now inactive

The north of the Catchment is characterised by small to medium-sized farms, a mixture of land-uses (dairy support and sheep/beef), and significant subdivision of rural land into lifestyle blocks. The west of the Catchment is remote from townships and there are limited numbers of lifestyle blocks. Farms here range from small to large and most run sheep and beef with some plantation forest. In the south, farms are large or very large and predominantly sheep and beef although there is some plantation forest land. In the eastern sector forestry is the predominant land-use but it is also the location of the largest pastoral farm, a state-run prison farm. This latter, eastern, sector was not included in this study because plantation forest is not included in the cap and trade regulations and the prison farm is not a commercial enterprise. The owners of forested land are permitted to continue with their current land-use but they are not able to trade nitrogen. Thus with in the case study of the Taupo Catchment, three sub-Catchment case studies were distinguished, located in the northern, western and southern sectors.

4.2.3 Use of quantitative and qualitative methods

A combination of quantitative and qualitative methods was chosen because of their ability to provide rich descriptions of the experiences of farmers and others associated with the implementation. Taken together, they provided depth and explanatory power to the landscape biographies particularly since they allowed the participants to interact with the interviewer "…*in their own language on their own terms*" (Kirk & Miller, 1986:9). Interaction with the interviewer is considered to be essential in this study since the stories of interviewees must by well understood and ambiguities avoided where possible in order to build landscape biographies during the analysis phase.

Morse, Barrett, Mayan, Olson, & Spiers (2002) argue that rigour in qualitative studies should be established by the researcher adopting a number of verification strategies (such as iterative evaluation of data during data collection). In contrast, Sandelowski (1993) suggests that trustworthiness should be established by the reader themselves on the basis of the information provided by the researcher about the processes followed, claiming that rigour in qualitative studies is an attribute of an individual study and not something that can be established in a blanket fashion for all studies. Further, it is an attribute of the *report* of the study, since this is likely to be the only material on which the reader can judge the study (Sandelowski & Barroso, 2002). In this study a combination of these two approaches was adopted. In line with the views of Sandelowski, full details of sampling methods and data analysis are included so that the reader may judge the rigour and repeatability of the study. In addition, extensive use of quotations from interviews is used in the results sections to justify the conclusions that are drawn. In line with the views of Morse, Barrett, Mayan, Olson, & Spiers (2002) trustworthiness of the study was established through purposeful

sampling (see section 4.3) and triangulation of data. Triangulation is described as 'crucially' important in qualitative studies (Lincoln & Guba, 1985:283) to mitigate against bias that could arise from reliance on an individual source. An example of this is Busck (2002) who studied the relationship between farmers' values and their landscape practices, and used data gathered from farmer interviews, aerial photography and from maps. In this thesis, qualitative and quantitative information is gathered from a variety of sources including farmers, sector experts, media reports, and numeric data from the consents to farm as well as from the nitrogen trades that have been undertaken.

Given that the analysis of interviews and development of landscape biographies is an interpretive process, another researcher may not develop exactly the same biography out of the base material. Van Londen (2006) for example, in a study of heritage management in the Netherlands, draws attention to how the same base material could be used to produce a story of academic value, or alternatively, a story of tourist value, depending on which elements are highlighted. Trahar (2008) suggests that when developing stories (such as landscape biographies) the mediating factors involved should be made explicit so that the audience can read the resulting narrative with these 'lenses' in mind. Prime amongst the mediating factors is the reason for the interest in the topic and a summary of the analytic attention given to different elements of a story as it was being assembled. The decision about what to include and the process followed is explained in the Data analysis section below, with reference to the topic of interest explained in Chapter One.

4.3 Research Methods

In this section data sources are described and their contribution to the study explained.

4.3.1 The questionnaire

In line with the aim of studying a socio-ecological system in context, a semi-structured questionnaire method was chosen. This is a less formal approach than question and answer questionnaires and allowed farmers and key informants the opportunity to explain their experience in their own words as well as to choose which contextual factors to include. Semi-structured questionnaire surveys are a method commonly employed in landscape research when landowner characteristics and motives need to be understood (for example see Kristensen, Busck, van der Sluis & Gaube, 2016). An unstructured questionnaire may have also achieved this end but the emphasis in this study is on landscape transitions so it was important that all farmers reported on their experiences of the same transition periods, so some structuring of the questionnaire was required.

A copy of the questionnaires, one for farmers and a separate one for key informants (both approved by the Lincoln University Human Ethics Committee) can be found in Appendix A.

The **farmer questionnaire** was centred on the transition from pre- to post-regulations. Thus the first section of the questionnaire was concerned with the story of the farm and the relationship the interviewee had with the land. The second part dealt with the ten-year period when the regulations were being developed and was followed by a question concerning the farmer's aims for the farm. Last, the expected future for pastoral farming in the Catchment was addressed. There was no specific section on post implementation of the regulations because they were finalised in 2011 (but backdated to 2005) and interviews were conducted shortly afterwards in 2013.

Within each section of the questionnaire was a series of prompts. These were largely drawn from the literature, as described below:

1. Geist & Lambin (2004) in a meta-study of case studies of desertification found that a combination of driving forces was involved. Similarly, Keys & McConnell (2005) found in a meta-study of cases that a combination of forces led to agricultural intensification in the tropics. Combinations of forces, therefore, were likely to be at play in this study. Specific mention of the regulations, therefore, was made to prompt interviewees to distinguish the effects of the regulations from other driving forces, if possible. This was done in two ways. First, the four sections of the questionnaire mark transitions that revolve around the regulations and second, attention was specifically drawn to the regulations and interviewees were asked to distinguish the effects of them from other effects (such as weather).

2. Dairy farm socio-ecological systems are essentially very similar to sheep and beef systems, (Fairweather, Hunt, Rosin, & Campbell, 2008), although dairy farmers place more importance on external factors such as marketing and customers. Fairweather & Hunt (2011) concluded that at the core of sheep and beef farming are production (quality and quantity), the farmer as decision maker, and farmer satisfaction, and so these were primary prompts in this study. Important secondary influences for both farm types included weather, family needs, financial factors, farm environmental health and soil fertility/health and these also influenced the choice of prompts.

3. The aims of the farmer are an important component of their decision making. Fairweather & Keating (1994) concluded that farmers can be categorised by their management styles – that is a combination of their business goals and their chosen way of life - which led to the insertion of a question regarding the farmer's plans for their farm. Prompts were also included about farmer aims and the longer term future of the farm.

   Van Vliet, de Groot, Rietveld, & Verburg (2015) in a meta-study of case studies of landscape change found farmer characteristics were an important mediating factor in the relationship

between driving forces and landscape change. Prime amongst the descriptors of farmer characteristics were farmer motivation, attitude to farm production and the environment, and farm succession. Thus, the authors concluded, different motivations explained why farmers made different land management decisions, despite facing similar conditions. Characteristics such as age and education were found to be of less importance in explaining such differences. While this study was published after the interviews were completed, it confirms the stance taken in the questionnaire of understanding the business goals and way of life of the farmer rather than assessing age, education and similar, commonly-used indicators.

In addition, it was originally intended that a request be made for a copy of the farm Nutrient Management Plan, but because interviews were held in farmer homes, no copying facilities were available and so this question was discontinued. Apart from this no other changes were made to the questionnaire itself, although changes occurred in understanding and emphasis.

The questionnaire for the **key informants** mirrored that of the farmer questionnaire but took a more strategic view. Thus key informants were asked about the story of the Catchment as a whole rather than of a specific piece of land.

About half of the key informant interviews took place before the farmer interviews. Consequently, a deeper understanding of the regulations was gained before talking to the farmers. While the knowledge gained from these experts was not formally used to shape the farmer interviews it will have influenced those that followed. For example, it was key informants that pointed out that the collapse of land prices in the Catchment was, in part, the result of oversupply of lifestyle blocks and the flow on effects of the global financial crisis. The fact that farmers were unable to continue to subdivide their properties as an exit strategy from farming was thus shown to be unrelated to the implementation of the regulations. The timing of the implementation of the regulations suggested a causal link but, in the event, this timing was coincidental. As a result of this information more careful attention was paid to comments by farmers in subsequent interviews about effects on land prices, subdivision ability, and on planned land sales.

4.3.2 Primary data sources

The main source of data in this study was the farmers operating a farm in the Lake Taupo Catchment and the target respondent on-farm was a person(s) who has the authority to speak on behalf of the farm/production unit. In the main this was the owner of the land, particularly in the case of owner/operators. On other farms, however, different ownership models apply (e.g., multiple ownership) and in these cases the target respondent was the farm manager, a trustee (if the farm is

held in a Trust) or similar. The aim was to interview one (or more) decision maker(s). The farmer interviews contributed to building landscape biographies and these biographies, in turn, were used to develop landscape trajectories for the Catchment.

A second important data source was key informants. Interviews were conducted with experts who were professionally associated with the cap and trade implementation in the Taupo Catchment. Most of these respondents were resident in the Catchment but others lived in towns or cities in the region. The information from these interviews was used to provide context and explanation for the farmer interviews as well as an objective view of the regulations that might counter potential bias from farmer interviews.

The selection of both categories of interviewees is discussed in sections 4.3.4 and 4.3.5 below.

4.3.3 Secondary data sources

In addition to the interviews with farmers and key informants, a number of secondary data sources were used to guide respondent choice, provide explanation, and to provide numeric data. These included: -

Waikato Regional Council consent data. The consent data provided by the Waikato Regional Council as a spreadsheet and has been central to this study since it is the source of the nitrogen trading and land-use change tables. The Council have requested that individuals not be identified as a result of reproduction of this data and consequently only a summarised version of the data supplied by them is included with this thesis. A listing of consents is reproduced in Appendix B. Consent data reproduced in the appendix includes: consent number, area of farm, band of nitrogen discharge allowance and sector that the farm was located in.

Lake Taupo Protection Trust. A spreadsheet, provided by the Trust, listed their trading activity up to 2012. It specified the farm practice changes that have/will be undertaken by contracted sellers of nitrogen in order to comply with the lowered level of nitrogen discharged from their farm[30].

Taupo District Council consent data. The Taupo District Council is responsible for approving consents for the subdivision of rural land within the district. They provided a list of consents issued for the development of rural land between 2000 and 2013 and these are listed in Appendix C. The consents constitute an approval by the Council to proceed with the consented activity and do not

[30] Similar information on farm changes arising from private sales of nitrogen was not available. Information about private sales included in this study comes from interviewed farmers.

mean that the proposed development took place. The intentions of the consent applicants, therefore, are unknown.

Media reports. The development and implementation of the Lake Taupo cap and trade regulations was contentious and frequently featured in the media. A search was made of local newspaper cuttings and sector journals and newsletters for articles, and one farmer lent their extensive scrapbook record of media articles.

Other records. The secretary of Taupo Lake Care assisted with supplying records of farmer meetings, the Waikato Regional Council Hearing and the Environment Court Appeal. A judge for the Environment Court Appeal made copies of the public documents submitted to the Court available. These documents included a comprehensive and detailed report by the Ngāti Tuwharetoa Agricultural Group on the history of pasture development, the current situation of the Trusts and Incorporations belonging to this Group along with their aims for their farms.

4.3.4 Selection of farmer interviewees

The aim of selection of farmer interviewees was to ensure sufficient diversity so that the main types of land manager response to the regulations were identified. First a list of potential interviewees was created, based largely on recommendations from key informants. Interviewees were chosen from the list with the aim of achieving both a sufficient sample and maximum variation (Patton, 1980). Thus a purposive (Guest, Bunce, & Johnson, 2006) or quota (Blaikie, 2010) sampling method was used.

Guest, Bunce & Johnson (2006), in a review of the literature concerning sample size in qualitative studies, found that most ethnographic studies used a sample size of between 30 and 60 interviewees. In their own study, these authors looked at the effect each successive interview had on the number and importance of the thematic codes discerned during analysis. They found that, in a relatively homogeneous population, 92% of the important code categories had been identified after 12 interviews and thus, as Mason (2010) and O'Reilly & Parker (2012) advise, more data does not necessarily lead to more information. Morse, Barrett, Mayan, Olson, & Spiers (2002) conclude, therefore, that depth of data and full coverage is more important that numbers of interviews. These aspects are realised when saturation has been achieved (Deming & Swaffield, 2011; Sandelowski, 2008) i.e. when similar information is elicited from farmer interviewees located in the same area and operating similar farming systems, or from key informants providing unvaried information.

Federated Farmers (a farmer lobby group) were contacted and asked if any of their members would be interested in being interviewed, and an article about the study was included in the Lake Taupo Care (a lobby group for Taupo farmers) newsletter. This list of potential interviewees was

supplemented by adding the names of farmers selected from the consent data provided by the Waikato Regional Council (WRC), the local government body responsible for the implementation of the cap and trade regulations (see Chapter Five). The WRC spreadsheet did not supply contact details of farmers so a search of public information[31] was undertaken to find these. The contact details of many of the farmers could not be found through public information sources and therefore no further effort was made to find or to contact them. In addition, interviewees, (both farmers and key informants) were asked to recommend farmers to be interviewed, as per the 'snowball' technique (Deming & Swaffield, 2011).

The Waikato Regional Council calculated that there were 116 farms operating in this area in 2012[32]. There were 83[33] consents to operate a farm in the Catchment in October 2013 from the data provided by the Waikato Regional Council. Interviews were conducted with 26 farmers between May and October 2013, covering 27 consented properties in the north, south and western sectors. The table below shows how these interviews were distributed across the Catchment.

Northern Sector		Southern Sector		Western Sector		Eastern Sector		Total	
Consd	Intvd	Consd	Intvd	Consd	Intvd	Consd	Intvd	Consd	Intvd
46	13	16	7	11	7	10	0	83	27
	28%		**44%**		**64%**		**N/A**		**32%**

Table 2: Distribution of interviewed properties across sub-Catchment cases, compared with all farms with consent to farm in October 2013
(Source: Waikato Regional Council consent data). (Key: 'Consd' refers to farmers with consent to farm and 'Intvd' is the number that were interviewed).

Overall 32% of consented properties were included in the interview sample. As the table above shows, the highest proportion of properties where the landowner was interviewed are located in the western sector and thus this sector is comparatively overrepresented in the study. Although there are consented properties in the eastern sector, these have been excluded from the study. Most farmland in the eastern sector belongs to a prison farm, and most of the land area is forested (and therefore a permitted land-use). Consequently, this sector was considered to be unrepresentative of the effects of the cap and trade regulations.

Two key factors influenced farmer interviewee selection – geographical spread, and type of farmer. In addition to selecting interviewees who could enable the construction of a range of landscape biographies (one for each sub-Catchment case) a further aim was to explore the range of ways in

[31] Search included the White Pages (a listing of land-line telephone numbers), the internet and the Company's Office register
[32] Jon Palmer, Waikato Regional Council, personal communication
[33] In the spreadsheet provided in Oct 2013, there are 81 consents but one consent had been surrendered and two farms had formed a partnership and were operating under one consent. These have been counted as separate consented properties. See Appendix B for a list of consents

which landscapes have transitioned. Consequently, emphasis has also been placed on coverage of the different types of farming operations in the Catchment. The consent data, provided by the Waikato Regional Council, enabled the farm types in the three sub-Catchment cases to be determined and interviewees to be chosen for their contribution to *information* saturation. The table below shows the distribution of these interviews across farm size and stock type and show that coverage, and replication within each category, were achieved. The exception to this is the small-farm-size category but since they are less likely to be commercial operations (i.e. the farm size is too small for a stand-alone pastoral farm operation) less effort was made to fully sample this category.

Farm size/ Land-use	>100 ha	101-500 ha	501-1000 ha	>1001 ha	Total
Sheep Beef	7 (43%)	12 (42%)	4 (25%)	9 (44%)	32 (48%)
Trees	1 (0%)	3 (33%)	1 (100%)	2 (50%)	7 (11%)
Cattle[34]	4 (0%)	15 (40%)	4 (75%)	2 (100%)	25 (41%)
Subdivision	2 (0%)	2 (0%)			5 (0%)
Other	4 (0%)	1 (0%)			4 (0%)
Total	18 (17%)	33 (36%)	9 (55%)	13 (54%)	73 (100%)

Table 3: Number of consented properties and percentage where owner was interviewed, by stock type and farm size
(Source: Waikato Regional Council) (Excluding eastern sector)

In Appendix D is a list of all farmer interviewees and a summary is provided below.

Interview number	Interviewee location	Occupation
1	Western Bays	Farmer
2	Southern sector	Farmer
3	Southern sector	Trustee
4	Southern sector	Trustee
5	Northern sector	Farmers (husband and wife)
6	Western Bays	Farmer
7	Western Bays	Farmers (husband and wife)
8	Northern sector	Farmer
9	Northern sector	Farmer
10	Western Bays	Farmer (husband and wife)
11	Northern sector	Farmer
12	Northern sector	Farmer
13	Western Bays	Farmer
14	Northern sector	Farmer
15	Western Bays	Farmer (husband and wife)
16	Northern sector	Farmer

[34] This category includes dairy grazing, milking cows and 100% beef

17	Northern sector	Farmer
18	Northern sector	General manager/farmer
19	Northern sector	Farmer
20	Southern sector	Farm manager and Trustee
21	Southern sector	Trustee
22	Southern sector	Trustee
23	Southern sector	Farm managers (husband and wife)
24	Northern sector	Corporation farm environment manager
25	Western Bays	Investment manager
26	Northern sector	Farm manager

Table 4: Farmer interviewees and location of interviewee

Morse, Barrett, Mayan, Olson, & Spiers (2002) suggest that a sample must not only cover people who have a knowledge of the subject but must also include negative cases. Negative cases in this study are of two types: farms that have not gained consent to farm and thus are required to operate at a very extensive level, and farms that have consent to operate commercially but have not traded in nitrogen discharge allowances.

The total population of farmers that chose not to apply for consent to farm is unknown but the data provided by the Waikato Regional Council shows that around 170 farms/farmlets applied to the Council for consideration for a consent (i.e. they were benchmarked as will be explained in Chapter Five) and around 90 of these appear to have not pursued their application. For some this was because they chose to farm at a very low level and therefore did not need a consent to continue farming (see explanation in Chapter Five). If Duhon, Young, & Kerr (2011:6) are correct, there will be around 1000 land titles[35] in the Catchment operating at this very extensive level, and three interviews with such farmers (in addition to the 25 mentioned above) were undertaken.

The survey aimed to interview traders as well as non-traders of nitrogen. The table below shows the trading undertaken by interviewees.

Trading status	All consented properties	Properties where owner was interviewed	% Interviewed
Sold nitrogen to LTPT	17	9	53%
Sold nitrogen privately	9	4	44%
Purchased nitrogen	3	2	67%
No Trading	44	12	28%
Total	73	27	37%

Table 5: Consented properties that have traded nitrogen by 2013 and showing the number interviewed. (Excluding the eastern sector)
(Source: Waikato Regional Council)

[35] Land titles do not necessarily equate to farms since several titles might be included in one farm.

The table above shows that in the Catchment, 26 properties located in the north, west and southern sectors have sold nitrogen[36] and that farmers that have traded nitrogen are better represented than those who have not traded. However, in both cases, the interviewing indicated that saturation was being achieved.

4.3.5 Key informant selection

Key informant interviews also used a purposive sampling strategy. Interviewees were selected from the recommendations of previous interviewees and also through a direct approach. The aim here was to achieve (1) input from as wide a range as possible of professional categories and non-farmers that have had input into the regulations (Morse, Barrett, Mayan, Olson, & Spiers, 2002) and (2) to achieve information saturation (Deming & Swaffield, 2011). Thus sampling continued until all non-farmer work designation categories were covered and it was possible to anticipate the replies that respondents gave. After each interview had taken place a judgement was made about the contribution of that interview to achieving information saturation. Central to this judgement was achieving a strategic view of the regulations and an understanding of how experts saw the implementation operating. Have the regulations been successful (or not) in combining farming needs with environmental requirements? Since the key informant interviews were used to explain and support the farmer interviews, there was no requirement for statistical representation.

Interviewees were asked to recommend other experts that could contribute to the study. In addition, approaches were made to local businesses and community groups[37] requesting an interview with people that had knowledge of, or involvement with, the regulations. Within the first few interviews the same contacts were suggested by multiple sources and thus there is reason to believe that most people that were key to the development of the programme have been interviewed. Some of the suggested respondents were not interviewed either because, when approached, they did not wish to take part in the study or because it was judged that their contribution to the regulations had been covered by another interviewee. In order to broaden the range of expertise consulted, representatives of sectors not directly involved in the regulations were approached by the author. Thus interviews with a banker, with a local businessman and with district council staff were undertaken.

Thirty-one key informants were interviewed across a wide range of occupations as shown in the table below. Some of the interviewees had been involved with the Taupo implementation from its

[36] Duhon, McDonald, & Kerr (2015) calculate that there are 29 trades to June 2012 including the eastern sector. Ten of these are private trades and 19 are with the Lake Taupo Protection Trust.
[37] Organisations approached were: Royal Forest and Bird Protection Society, Lake Taupo Care, Lake Taupo Bike Challenge, Enterprise Great Lake Taupo and Lakes and Waterways Action Group.

inception and others were more recently involved. The table in Appendix E lists the interviewees and information about the contribution of each interviewee to the regulations. A summary of this information is included in the table below.

Interviewee number	Organisation	Interviewee Location
1	Waikato Regional Council	Taupo
2	Waikato Regional Council	Hamilton
3	Lake Taupo Protection Trust/Mayor	Taupo
4	Lake Taupo Protection Trust	Hamilton
5	Lake Taupo Protection Trust	Hamilton
6	Lake Taupo Protection Trust	Cambridge
7	Taupo District Council	Tauranga
8	Taupo District Council	Taupo
9	Taupo District Council	Taupo
10	Banking	Taupo
11	Accountant	Taupo district
12	Farm consultant	Taumarunui
13	Farm consultant	Hamilton
14	Farm consultant	Hamilton
15	Farm consultant	Taupo
16	Federated Farmers	Taumarunui
17	Taupo Lake Care	Taupo district
18	Beef and Lamb NZ	Hamilton
19	Real Estate	Taupo
20	Real Estate	Taupo
21	Real Estate	Taupo
22	Valuer	Taupo
23	Valuer	Hamilton
24	Restauranter/District Councillor	Taupo
25	Social scientist	Hamilton
26	Water scientist	Taupo
27	Lakes and Waterways Group	Taupo
28	Lakes and Waterways Group	Taupo
29	Lakes and Waterways Group	Taupo
30	Waikato Regional Council Councillor	Taupo
31	Conservation Board	Taupo

Table 6: Key informant interviewees and location of interview

4.3.6 Interview sequence, timing and process

About half of the key informant interviews were conducted in advance of the farmer interviews, in April and May 2013, and so enabled an understanding of the Taupo implementation and its history to be gained before talking to the farmers. This was a successful strategy and resulted in better quality interviewing of farmers since knowledge of the finer points of the scheme and its implementation were obtained and able to be utilised from the outset of the farmer interviews. The remaining key informants and all of the farmers were concurrently interviewed between May and October 2013.

Both farmers and key informants were telephoned and invited to be part of the study. It was made clear to these potential contributors that they were under no obligation to be involved in the study and that they were welcome to refuse. Five farmers did refuse at this stage and several did not reply to phone messages. One key informant, likewise, refused to take part. Each potential respondent was asked for their email address and an outline of the study and a consent form (both approved by the Lincoln University Human Ethics Committee) were emailed to them for their consideration. Approximately a week later the respondent was phoned and asked if they were still interested in taking part in the study. No-one refused at this stage and all made an appointment for an interview to be held at the location of their choice. In almost all cases, the interview was held at the farmer's home or at the key informant's place of work. The remainder were held in a public space chosen by the interviewee or in an office loaned by the Institute of Geological and Nuclear Sciences in Taupo.

Interviews were face to face and lasted between one and two hours. All interviewees (both farmers and key informants) signed a consent form (Appendix A.3) at the start of the interview (which gave permission for the interview to be recorded and also guaranteed anonymity for the interviewee) and an outline of the study was then presented. In five cases both husband and wife were interviewed and in one instance both the farm manager and a Trustee were present. This generated discussion between the partners which proved particularly insightful.

Interviews followed the outline and prompts shown in the questionnaire in Appendix A but they were conducted in the form of a conversation with the overall structure dictated by the four main questions. Interviewees were asked to tell the story of their land, and their relationship to it as they transitioned to a nitrogen limited farming operation. Farmers were encouraged to volunteer the factors that were of most importance to them regarding working within the regulations. At the end of the interview, the interviewee was thanked and farmer interviewees were presented with a bottle of wine, a gift of food or a business card holder as a token of gratitude for their time.

In 2014 the recorded interviews were transcribed and a transcript was returned to all farmers, and key informants if they requested it, so that the accuracy of the transcript could be checked. One key informant and two farmers requested changes to their transcripts.

4.3.7 Data analysis

Three landscape biographies were developed, one for each of the sub-Catchment cases, by combining information from the transcripts of farmer and key informant interviews, and data from other sources. Meinig (1979) points out that the same landscape can be viewed by different people in different ways and he gives ten such examples. In the same way, the stories told by the farmers and the key informants can be combined in numerous ways to give different landscape stories

depending on the themes that the researcher chooses to emphasise or ignore. Each alternative story is potentially valid, depending on the aim of the researcher, as van Londen (2006:9) points out:

> *In the choice of representation lies the message or analysis the author wishes to express. Others may want to portray a different aspect of the same landscape and thereby producing, of course, different views of that landscape.*

Landscape biographies, therefore, "…*portray*" a chosen reality rather than describing it (van Londen, 2006:9) and reflect mediating influences such as cultural context and the researcher's own story (Trahar, 2008). A researcher using this method, therefore, must be explicit about their perspective and the means by which they filtered the stories of the interviewees. The landscape-based, conceptual frame (described in Chapter Three) formed the backbone of this study and, along with the research questions (see Chapter One), was used to guide the development of the biographies.

In this study the farmer interviews were first analysed for categories of response to the regulations using a thematic analysis approach (Braun & Clarke, 2006). This was a broad brush analysis, using a spreadsheet, which was not directly utilised in the final biographies but which served to alert the researcher to the range and types of farmer responses. Several iterations of the analysis were undertaken before it was deemed that the significance of farmer choices had been fully understood. The question at the heart of this analysis was "What has this farmer done to ensure they have a viable farming operation by the end of this transition period?" Each iteration took a slightly more strategic (higher spatial level) view and moved response types from categories of farm-level transition response to categories of Catchment-level (regional) responses. The question here was "How can this response be interpreted if it was applied at the Catchment level?" For example, what appeared in the first iteration (at the farm level) to be a case of change in stock type, at the second iteration (at the local level) was found to be part of a de-intensification pattern, and at the Catchment level this farm practice change was reframed into a partial exit from the pastoral farming industry, since the ownership entity had sold down the productivity of the farm and invested the capital raised outside of the farming sector. Farmer responses were, therefore, not limited to land-use or land-cover changes but rather the researcher sought to understand all types of change including ownership, farm practices, farm amalgamations and subdivisions, structural changes and other factors that were considered relevant to the question of enabling farmers to operate a viable farm. Some of these changes may be a direct result of the regulations but others may the result of external market forces and the like.

Once this initial analysis was completed, the task of building landscape biographies was begun. Each farmer interview was assigned to a sub-Catchment case by virtue of their location (west, south or north of the Catchment). The key informant interviews and other data contributed to all of the

biographies. These interviews were read (and reread many times over) as well as being loaded into QSR NVivo 10 where they were queried using keyword searches.

The biography method assumes path dependence (Roymans, Gerritsen, Van der Heijden, Bosma, & Kolen, 2009; Lambin, Geist & Lepers, 2003) so each of the landscape biographies begins by tracing the history of pasture development in the sub-Catchment area up until the time that the regulations were first mooted. The second transition covers the ten-year period of the development and implementation of the regulations. The last part of each biography looks at the consequence of the regulations that is best exemplified by the history and character of that area, and the spatial level of the case. Thus the first biography describes changes at the Catchment level, using the metrics of land-use and land-cover for each rural production category. The second biography is at the local level and describes changes that are apparent at that level i.e. land-use system patterns such as de-intensification. The last biography is at the farm level and focuses on farm practices and specific land-uses. This is not intended to imply that the changes described in each case are happening in only the featured area – simply that this area is an exemplar for the factor that is highlighted.

Cutting across the landscape biographies are the landscape paths that describe the transitions for each case and at the Catchment-level. These describe the consequences of the regulations i.e. the paths that farmers have taken in order to achieve their needs in an exemplary cap and trade regime. Given the complexities of socio-ecological systems, there are many potential paths. Stafford-Smith & Reynolds (2002), however, suggest that, in reality, there are a limited number of possible paths because many are functionally equivalent. This was found to be the case in this study where only five significant landscape paths were discerned (see Chapter Nine).

4.4 Problems encountered

It was intended that interviews be evenly spread across the sub-Catchment cases. In the event, interviews were difficult to obtain in the south of the Catchment. Three Māori trusts refused interviews and telephone contact was not able to be established with others. Thus the landscape biography (Chapter Eight) that uses interviews from farmers located in the south is reliant on a group of interviewees located in the same part of the sub-Catchment and several of whom sit on the Boards of each other's Trusts. The interviews, therefore, were supplemented with information from the presentation of the Ngai Tuwharetoa Agricultural Group presentation to the Environment Court in 2008. In addition, the Lake Taupo Protection Trust provided information about nitrogen trading that had occurred with these Trusts and the Trusts featured in several media reports. It cannot be inferred, however, that the farming intentions of the southern sector Trusts have been fully understood, particularly those that have not traded nitrogen.

Further interviews were also intended in the north of the Catchment but unfortunately the beginning of the calving season in September/October meant that farmers were unable to spare the time for an interview. While the interview period was chosen to avoid peak work periods on sheep and beef farms it was not understood until after interviewing began that many of the farms in the north of the Catchment had changed to dairy support farms. The smaller number of interviews is not considered to be detrimental to the northern sector biography because, as will be shown, the regulations are not the principal driver in the move to dairy support and lifestyle blocks that is happening in this part of the Catchment.

4.5 Summary and conclusions

An in-depth qualitative case-study approach was used in this study with three location-based embedded cases and semi-structured interviews with farmers and key informants. Case-studies are often criticised on the grounds that their results cannot be generalised. In this study, an exemplar case, the Lake Taupo Nitrogen Trading Programme, has been chosen because it points to how farmers might act in a situation where nitrogen discharge levels are capped at the farm level. This approach avoids the problem of singling out the effects of the regulations from all other driving forces and establishing a causal link in order to generalise. As has been discussed in Chapter Three, driving forces are interacting and thus difficult to disentangle but in an exemplary case the generalisation applies to the combination of driving forces, of which regulations are one.

The issue of causality is also addressed in the structuring of the questionnaire, with three of the four questions organised around the transitions that occurred/will occur with the implementation of the cap and trade: pre-regulations, regulation development and implementation, and the future of farming in the Catchment. The attention of farmers was specifically drawn to the regulations and its effect on their farm systems and so they made the causal link themselves. The prompts that supported these questions allowed farmers to answer in an unstructured way. That is, the study uses an investigative approach with the farmer interviews grounded in the experiences, attitudes and actions of farmers and revolving around every-day farm practices, but organised around the transition from pre- to post-regulation. The biographies are the collective wisdom of the contributing farmers but interviews with key informants and data from secondary sources was used to challenge the developing narrative and, at times, provided an alternative perspective.

For the farmer interviews, a purposive sampling strategy was used and it is concluded that information saturation was achieved, except in the case of Māori Trusts and Incorporations in the south of the Catchment. Here difficulties in obtaining interviews led to data supplementation from secondary sources, such as submissions to the Hearings in 2006.

The data analysis initially took the form of a thematic analysis that identified categories of farmer response at three spatial scales as described in the study's conceptual frame: farm, local and watershed. Three landscape biographies were developed, grounded in the study's conceptual framework, and focused on a consequence of the regulations that is appropriate to the chosen scale (i.e. watershed, local, or farm level).

This study uses a qualitative approach and although a full range of farmer responses may not have been identified in the south, the study methods ensured that the responses identified are valid, the analysis repeatable, and the results pertinent beyond the Lake Taupo implementation.

An outline of the Taupo implementation, its initiation and an outline of the regulations that have been put in place, is presented in the following chapter.

Chapter 5

The Case study: Lake Taupo Catchment

5.1 Introduction

The second part of this thesis (Chapters Five to Eight) presents the results of the field study. The current chapter (Five) introduces the case study area and provides information about the social and biophysical resources that are present in the Catchment, which is necessary for understanding the subsequent chapters. Chapters Six, Seven and Eight present the landscape biographies that have been developed for the three sub-Catchment cases as well as a summary of the landscape consequences arising from the case.

The Lake Taupo Catchment is a unique landscape. Its proximity to the mountains of central New Zealand has directly affected its social and economic history as well as the development of farming in the area. Thus this chapter begins by describing the Catchment with particular emphasis on the history of pastoral land development and the land-covers and land-uses that were in existence at the time that the Lake Taupo Trading Programme was first signalled in 2000.

In the second part of this chapter the evolution of the cap and trade regulations is presented, including the public policy drivers, and the factors that shaped the response of farmers to the implementation of the regulations. The chapter concludes with an outline of the Variation 5 regulations and the amount of trading that has taken place.

5.2 Catchment description

The terrain and location of the Catchment has had a significant influence on the both the physical and social landscapes, with consequences for the Lake itself, for farming practices, and for local communities.

5.2.1 Catchment Location and physical landscape

Lake Taupo Catchment is situated in the middle of the North Island of New Zealand. At the centre of the Catchment is the largest fresh-water lake in New Zealand, Lake Taupo. It covers 616 square kilometres and has a mean depth of 95m. In the south west of the Catchment is the smaller (13 square kilometres) Lake Rotoaira. In total, the Catchment covers 3487 square kilometres (including the Lake). The Lake and the surrounding countryside was formed by volcanic activity over many thousands of years so that today the main features of the area are the volcanic mountains to the south (Mt Ruapehu (at 2797 m), Mt Ngaruahoe, and Mt Tongariro), the mountain range to the south-

west (the Hauhungaroa Range rising to an altitude of 900-100m) and two large river systems (the Waikato and Tongariro Rivers). Most of the Catchment is at 350m above sea level or more (Timperley, 1983a) and so the area is often referred to as the Central Plateau.

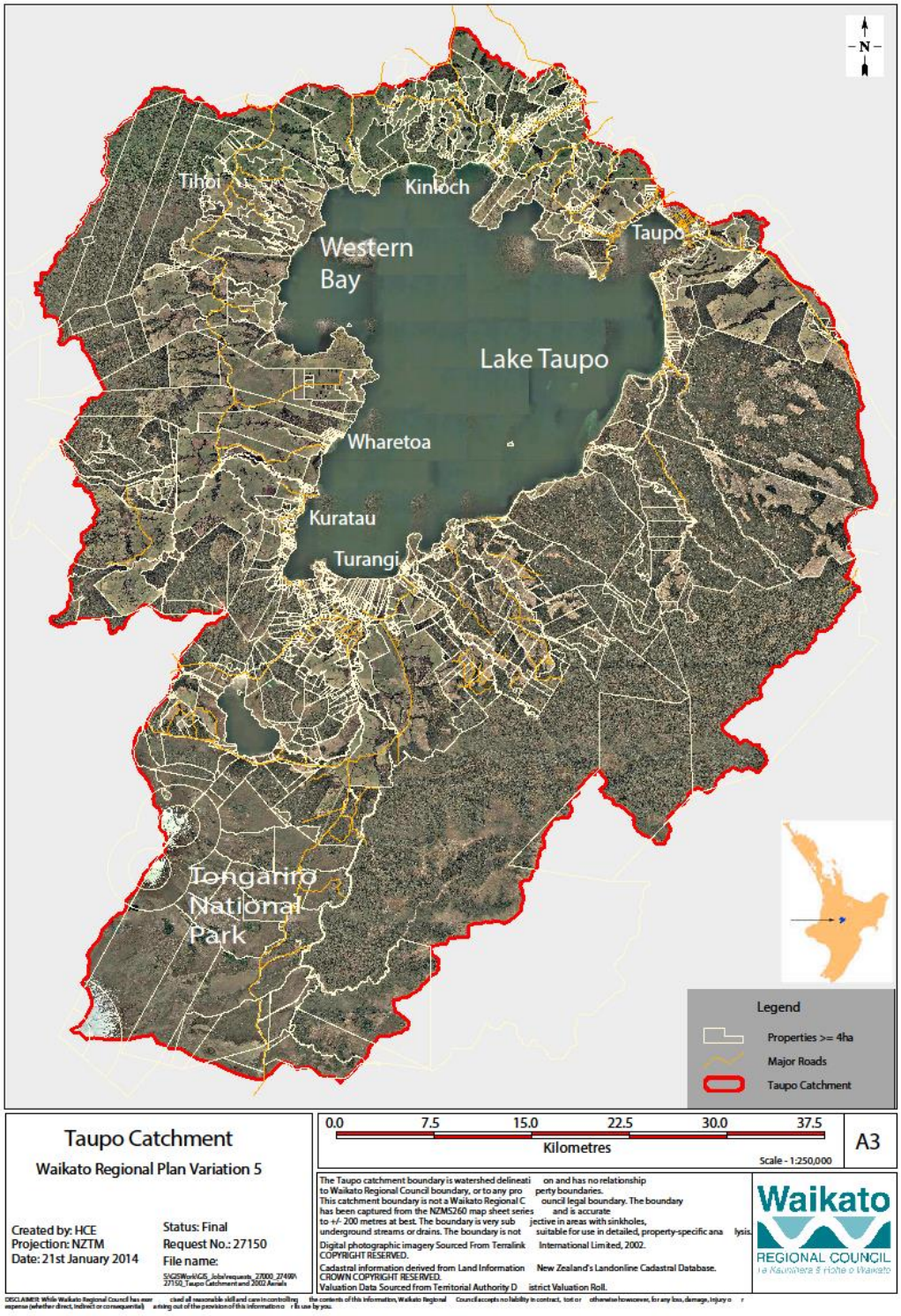

Figure 4: Map of Lake Taupo Catchment in 2002, showing its main features, property boundaries and its location in the North Island of New Zealand
(Source: Adapted from Waikato Regional Council. Reproduced with permission).

The Lake itself is in good health and is oligotrophic. Phytoplankton (algae) growth in the Lake is limited and the quality of the water in the Lake is excellent with water clarity being high (Vant & Huser, 2000). It has low levels of dissolved nitrogen but higher levels of naturally occurring phosphorus of volcanic origin (Petch, Young, Thorrold & Vant, 2003). Because of the phosphorus levels, the Lake would be vulnerable to algal blooms if nitrogen levels were to increase (Petch, Young, Thorrold & Vant., 2003). Most of the nitrogen currently found in the lake enters from the surrounding rivers and streams, and is a direct reflection of land uses in the catchment over an extensive period (Petch, Young, Thorrold & Vant, 2003). Thorp (2006) states that the average lag-time between farm run off and ground water entering the Lake is 35 years but other researchers have suggested that lag time could be up to 80 years (Vant & Smith, 2002). Thus there is nitrogen already in the groundwater, currently moving to the Lake, which cannot now be mitigated. The only change that can be made now is to reduce the amount of nitrogen entering the groundwater in the future so that the problem of nitrogen build-up in the Lake is minimised and the threat to Lake health lowered.

The last volcanic eruption in the Catchment took place around 130 AD (Leathwick & Mitchell, 1992) and resulted in deep deposits of pumice in most low lying areas in the Catchment. Pumice is very free draining, with a loose structure and is low in nutrients. The soils that have developed from it are low in fertility, erosion prone and have low water holding capacity (Journeaux, 1997). Paradoxically, pumice from the volcanic eruptions did not settle on steeper slopes and so they have more fertile and better moisture-retaining soils (Gordon, 1971).

The topography for the area is hilly to rolling and so large areas of the Catchment are able to be worked by tractor despite the roughly 40 streams that dissect the farmland as they flow from the mountains into the Lake (Ministry of Agriculture and Fisheries, 1997).

The climate is related to the high altitude, with long cool winters, high rainfall near the mountains and significant differences between night and day temperatures (Timperley, 1983b). The Catchment's location, in the centre of the North Island, means that it is further from the prevailing westerly winds. Although the area is shielded in the south and west by mountain ranges and the westerly wind is less prevalent than elsewhere in the North Island, average rainfall is still relatively high, at around 1020 mm (Hoogendoorn et al., 2011). Farmland on the Plateau, however, is often regarded as marginal because of hot, drying, summer winds, and soils that are resistant to re-wetting once they have dried out (Hume & Chapman, 1993). Rainfall data for the Taupo shows that the period 2006 to 2010 was a particularly dry period with an average of 91 days each year in soil moisture deficit. The 1990s, on the other hand, was a period of high moisture levels and therefore good for pasture growth.

Period	Median number of days of soil moisture deficit (days per year)	Median rainfall (mm per year)
1980s	Not recorded	Not recorded
1990-1995	41	1061
1996-2000	77	891
2001-2005	60	925
2006-2010	91	899
2011-2013	57	938

Table 7: Rainfall and soil moisture levels at Taupo Airport
(Source: NIWA)

The figures in the table above, however, mask the variability that is an inherent feature of the climate on the plateau. Many farmer interviewees commented that in the period from 2001 to 2005[38] there were drought years but also one year in which the weather was exceptionally good (in 2004). Drought is a significant limit on pasture growth and therefore on farming in the area since irrigation is not common.

From a farming perspective pumice land is attractive because it is free draining and pasture is not trampled into the ground in wet weather, but it is also relatively infertile, and the climate in the Catchment can be extreme. Overall, farming in the area is not easy, as one recent arrival in the Catchment explained:

> *So, as I've said to people, compared with Southland, this is very poor country. An economic unit in Southland is 400 acres. Up in this country its 750 acres to sustain a family.*

The hard physical conditions of the Catchment have made it less desirable than other parts of the country for Māori and European settlers, and the establishment of an economic base was therefore delayed until after the Second World War.

5.2.2 Catchment Social Landscape

The Plateau has been settled, although sparsely, for a long time. Population growth was restrained by the after effects of volcanic eruptions, which limited food supplies for Māori (Drake, 1983) and, for Europeans settlers, caused pastoral animals to not thrive because of soil nutrient deficiencies. This section outlines the human occupation by both Māori and European and shows how the establishment of an economic base was dependent on tourism and government projects.

[38] This period is crucial to the cap and trade regulations in the Catchment because it is the period on which baseline nitrogen discharge levels for each farm were set as explained later in this chapter.

Tangata Whenua[39] The land around Lake Taupo was settled by Ngāti Tuwharetoa in the late 15th century (Hamilton & Wilkins, 2005). Compared with living on the coast, this inland area is thought to have been a difficult place to live with little food, poor soils and a cold climate. Consequently, settlements were never large and by the mid-1800s the population of the district was estimated at between 2000 and 5000 (Williams & Walton, 2003). Settlements were dispersed around the Lake edge or on the bush margin with communal gardens and hunting being the major methods of food provision. After the arrival of European immigrants, around the 1850s, Tuwharetoa developed commercial enterprises. In particular, they operated dairy farms and a butter factory located at Waihi (at the southern end of the Lake) while other family groups logged and milled indigenous timber from their lands (Ngāti Tuwharetoa Agricultural Group, 2006).

Māori land has multiple owners and in the Taupo Catchment is often managed as an Ahu Whenua Trust or an Incorporation under the Te Tuna Whenua Māori Act 1993, with the owners as beneficiaries. The Act states that sales of Trust or Incorporation land must have the approval of 75 percent of the owners as well as the approval of the Māori Land Court (Community Law, no date). Given that the owners of such land are now dispersed worldwide, this effectively means that land cannot be sold.

For Māori, land is a source of identity and is integral to their well-being (Rotarangi, 2011). They do not 'own' land in the European sense but consider themselves to be guardians of it with an obligation to pass it on to the next generation (Durie, 1998). This obligation does not mean that the land cannot be used, developed or changed but rather that the resource that is passed on is enhanced by the efforts of the current guardians (Durie, 1998).

European settlers began to arrive in the area by the 1850s but even up until the Second World War Lake Taupo and its environs did not have a significant established economic base, despite its renowned trout fishing industry and the butter factory and indigenous forest logging mentioned above. It seemed to some that Taupo would remain a backwater indefinitely (Drake, 1983). From the 1950s, however, this began to change. New roads in the area increased tourist numbers, a government scheme was underway to convert scrubland into pasture (as described later in this chapter), and the Tongariro Hydro-power Scheme was being built. By 1981 the borough of Taupo had a permanent population of 13,600 compared with just 750 in 1946 (Drake, 1983).

Land Ownership. The largest landowner in the catchment is the Crown. Most Crown land is held in reserves or is managed by the Department of Conservation but, in 2000, Landcorp[40] was managing

[39] The literal translation is 'People of the Land' and the term refers to the original inhabitants of the land.
[40] Landcorp is a government State Owned Enterprise and is the successor to the Department of Lands and Survey. Its core business is pastoral farming.

substantial pastoral land on behalf of the Crown. The second largest landowner is Ngāti Tuwharetoa, as shown in the table below.

Land-use	Tuwharetoa Land (ha)	Crown Ownership (ha)	Private Ownership (ha)	Total
Undeveloped	50840	103660	0	154500
Planted forests	35500	4300	24700	64500
Sheep and beef	23800	14800	12100	50700
Dairy	778	0	1022	1800
Urban	0	0	3500	3500
Total	**110918 (40%)**	**122760 (45%)**	**41322 (15%)**	**275000**

Table 8: Land Ownership in the Lake Taupo Catchment in 2005
(Source: based on Young, 2007)

The table above shows that in 2005, 40% of the land in the catchment (110918 ha) was owned by Tuwharetoa, the Crown owned 45%, and 15% was in European title. Of the latter, close to 30% is in sheep and beef farms and nearly 60% is in plantation forestry. For land held in Tuwharetoa multiple ownership (Māori-titled land), 21% is in sheep and beef and 32% in plantation forestry but nearly half (46%) is either undeveloped or is in indigenous forest/scrub reserves. Thus, only a relatively small amount of this Catchment is in pastoral farming as Figure 8 in section 5.3.3 below illustrates.

The regional economy. The Catchment is remote from large population centres and from processing plants, sea ports and international airports. As will be shown (see section 5.4.1) this remoteness limited the expansion of dairying in the Catchment at a time when other districts in New Zealand profited from the dairy boom of the late 1990s and 2000s. Its location has not, however, hampered the tourist industry. Since the early 1900s, Taupo has been a destination for tourists and particularly for fishermen. Trout were released into the Lake in 1895 (Burstall, 1983) and have made the Lake a renowned fishery. Other tourist facilities include the hot springs, outdoor activities such as mountain biking and hiking in the nearby mountains. Tourism contributes $400m to regional GDP (Taupo District Council, no date a) but visitor nights fell from 2005 to 2011, by around 13% (Economic Solutions Ltd, 2012).

The Lake is, therefore, central to the economy of the region and a high level of water quality is crucial. The Mayor of Taupo explained:

> *From our perspective Lake Taupo is a unique resource nationally and internationally because it's not just a source of water for drinking (which is the issue for a lot of the other water arguments), it's a tourism issue, it's a power generation issue, it's a whole raft of things. It's a fishing issue - it's one of the world's few wildlife fisheries so yes it's an economic attraction from the tourism perspective. When you're talking about waterways that are becoming polluted, that is about water quality pure and simple. Ours was about water quality but plus plus plus.*

Overall in 2012, tourism contributed 12% to the regional GDP and primary production (forestry and farming) contributed 11%. In 2013, tourism was the largest employer with 2000 fulltime equivalents (Taupo District Council, no date a). The fastest growth in this period, however, was in the farming sector and this was due to the increased number, and production levels, of dairy farms in the wider region (Economic Solutions Ltd, 2012).

5.3 Land-covers and land-uses

The economy of the rural area in the Catchment is based on pastoral farming and forestry, and in this section, the development of these land-covers and uses is described. In addition to farming and forestry, considerable areas in the Catchment are held in reserves, with the aim of protecting the land and the Lake. Their development history is also explained.

5.3.1 Pasture land

Before the last eruption around 130 AD, a significant portion of the Catchment was in broadleaf and conifer forest but much of this was burnt or smothered in the pumice showers that occurred at that time (Wilmshurst & McGlone, 1996). Where pumice accumulated, only tussock and fern subsequently grew because of the low soil fertility. Except for Māori gardens close to the Lake shore (largely in the South), and some burning of tussock and fern in order to trap birds, the Catchment vegetation remained largely unchanged from plant colonisation after the last eruption until the 20th Century. European immigrant farmers were deterred by the failure of animals to thrive in this area as well as by a plague of rabbits and wild horses and poor access to the Coast (which was needed for the transport of produce) (Department of Lands and Survey, 1975). It was not until the government was eager to settle veterans of the Second World War that conversion of the tussock lands to pasture was given serious consideration and government support. While Māori had been keen to develop their land all through the 1900s they had faced many hurdles (Rotarangi, 2011). In particular, they were unable to raise capital for development since financial lenders would not accept multiple ownership land as collateral (Waitangi Tribunal, 2008). The government's eventual response was to instruct the Māori Affairs Department to develop Māori-titled land on behalf of the owners and to subsequently farm the property until the development debts were paid off. In the event, this system was only partially successful since the input of owners was spurned, farms were not returned in a timely fashion and some farms were eventually returned (in the 1980s) with development debt still outstanding (Waitangi Tribunal, 2008; Ngāti Tuwharetoa Agricultural Group, 2006).

A second avenue of land development in the Catchment involved the planned settlement of Crown land under the Land Act 1948, primarily by war veterans. From the 1950s through to the 1980s the

Department of Lands and Survey, on behalf of the Lands Settlement Board, crushed and burnt the fern and scrub land-covers in order to develop pasture land. They then farmed the land in order to recoup the development costs and subsequently subdivided it and sold one man units as European titled farms. The farmers that bought these properties were selected by ballot and were therefore known as 'ballot farmers'. Preference in these ballots went to returned servicemen and Lands and Survey employees that were to be made redundant by the property subdivision, but anyone that could show they had the required assets and skills could apply (Department of Lands and Survey, 1984). These requirements included the following: the applicant had completed an appropriate training course, had sufficient capital and a promise of seasonal finance, could produce a reference from a farmer and one from their current employer, and they owned a vehicle with a satisfactory mechanical report. By the 1970s many of those applying for balloted farms in the Catchment were from this latter, civilian, category. The ballot farmers, interviewees said, formed a tight social network. The community was centred on the local Marotiri School (which opened in 1961), and involved school calf club days, working bees and fund raising and there were also tennis matches, a rugby team, garden club, and numerous social activities.

Figure 5: Crushing scrub on the Waihaha Development Block in 1956
(Source: Landcorp Farming Limited. Reproduced with permission)

Figure 6: A recently developed farm, in 1954. Otaupuhi Farm, Waihaha Development Block
(Source: Landcorp Farming Limited. Reproduced with permission)

The success of the ballot farms in the Taupo District was variable. Some farmers built up successful businesses and reported being 'happy' to be farming in the area despite the problems of climate, grass growth and infestations of grass grub (Brown, 1980). Other settled farmers were not so fortunate. Sixty dairy units located from Kinloch to Tihoi, plagued by ragwort and also uneconomic, were repurchased by the Crown and turned into sheep and beef farms (Ministry of Agriculture and Fisheries, 1997). Other struggling farmers were assisted with purchasing extra land, were resettled, or their debts were reduced (Gordon, 1971). According to one farm advisory officer, it took "…*skill and determination*" coupled with "…*advanced technology*" to make "…*efficient and economical progress*" in pumice land farming (Gordon, 1971:12). A further problem arising from farming pumice land became apparent in the early 1970s. Severe erosion was causing concern and was shown to be worst under pasture on valley floors and steep slopes (Selby, 1972). In response, the Waikato Valley Authority (later the Waikato Regional Council) set up the Lake Taupo Catchment Control Scheme which ensured that, from 1976, vulnerable farmland was retired and some stream margins planted (Vant & Huser, 2000).

It has been estimated (Young, 2007) that only 16,000 ha had been converted into farmland in 1955 but by 1973 this had risen to 47,000 ha due largely to government initiatives. The amount of pasture land rose only slowly after that and in 1990 was estimated to be 48,375 ha (see table below). The Land Settlement Scheme was halted in the early 1980s and land that had not been sold at that point

remained under the management of the Department of Lands and Survey (later Landcorp). In the Taupo Catchment this amounted to around 8-10,000 ha spread over ten properties (Yerex, 2009; NZ Parliament, 2006).

While the government has had an enormous influence on land development in the Catchment, some pastoral properties, both Māori and European titled, were privately developed. Examples of these are the Puketapu Incorporation in the south and the Crisp Family farm that bordered the current Catchment boundary in the north. In both of these cases the original indigenous forest (which had escaped destruction in the Taupo eruption of 130AD) was logged, the timber milled locally, and the profit used to develop pasture land.

On farm land use	1955[41] (ha)	1973[42] (ha)	1990[43] (ha)	Early 2000s[44] (ha)	2013[45]
Developed pasture land	16,000	47,000	48,375	49, 695	42,975
Total farmland	n/a	n/a	70,797	78,747	78,747

Table 9: Pastureland development since 1955 in the Lake Taupo Catchment
(Source: various, see footnotes)

As the table above shows, most pasture development took place before 1973 although subdivision and settlement by ballot farmers may not have occurred until later in that decade. The difference between developed pastureland and total farmland is made up of underdeveloped pastureland, reserves, wetlands and plantation forestry. This latter land-use became more important in the 1990s. An analysis undertaken by Thorrold & Ledgard (2001) showed that stock numbers fell by 13% from 1990 to 2000 as a result of an increase in on-farm woodlots.

5.3.2 Plantation foresty

Timber milling has been an important industry in the Catchment since the turn of the 20th century. Indigenous timber, particularly in the west and south west of the Catchment, was milled by the Taupo Totara Timber Company – a private company set up by Hitiri Te Paerata and a Mr Atkinson which they hoped would provide jobs for Māori in the south and western part of the Catchment (Cudby, 2001). The indigenous forest milling industry thrived sufficiently for a school to be started in 1941 at Tihoi to service the families of mill workers. In 1978, the Minister of Forests called a halt to all logging in indigenous forests and so the mills and the school closed.

[41] Young, 2007
[42] Young, 2007
[43] Thorrold. & Ledgard, 2001
[44] Waikato Regional Council
[45] Waikato Regional Council

A map of land-use in 1954 (Campbell, 1979) does not show any significant plantation forestry within the Catchment but various forestry companies have shown an interest, over the years, in developing plantations in this area primarily because it lies close to extensive plantations in Kaingaroa Forest and to several processing facilities. NZ Forest Products, for example, owned the land from which the Whangamata Sheep Station was developed (above Kinloch) and are reported (by interviewees) to have approached land owners in the 1990s about selling their farms for conversion to plantation forest.

The eastern side of the Lake is now predominantly plantation forestry and mostly owned by the Lake Taupo Forest Trust. The Trust is a collective that represents the owners of the 58 separate Māori land titles on which the forest has been planted (Rotarangi, 2011). It was formed in 1968 and negotiated a forest lease with the Crown whereby the Crown would plant and manage exotic forests on 32,771 ha of its land for a period of 70 years. The agreement stipulates that production forestry is secondary to (a) the prevention of erosion in order to protect waterways, (b) the protection of wildlife and fish habitat and (c) the protection of sacred sites. In 1999 the lease was renegotiated and the lease term reduced to one rotation. As each section of forest is harvested control is handed back and so by 2020 the owners will have full control of the resource i.e. both the land and the forest growing on it. Rotarangi (2011) conducted interviews with the owners of the land and concluded that there is unlikely to be any immediate change in land use since interviewees were "…*united in the view that they supported the existence of planted forests on their ancestral lands*" (Rotorangi, 2011:193).

5.3.3 Land-covers and land-uses at the time of development of the regulations

The major land-cover in the Catchment in the early 2000s, is forest, as shown in the table below.

Land-cover	Area[46] (ha) (early 2000s)	Area (%) (early 2000s)	Area[47] (2007)
Pine forest	65,800	Incl. below	64,500
Indigenous forest, scrublands and mountain	154,500	80% (Pine and indigenous)	154,500
Urban	1,950	0.7%	Not known
Pasture land	52,250	19%	52,500
Total Catchment Area	274,600	100%	271,500

Table 10: Land-covers in the early 2000s in Lake Taupo Catchment.
(Source: adapted from Hamilton & Wilkins (2005) and Young (2007))

[46] Hamilton & Wilkins (2005)
[47] Young (2007)

Figure 7: Sheep and beef farm in the Catchment in 2013.

The majority of the plantation forestry is located on the eastern and southern sides of the Lake and the indigenous forest, in general, lies along the catchment boundary or forms a fringe around the Lake edge. Pastoral land, therefore, is situated away from the Lake edge and in an arc from the southwest of the Lake around to just east of Taupo. Many interviewees commented that they found it difficult to understand how such a small area of pastureland could be responsible for the potential water quality problems that they were being told, in 2000, were likely to occur.

Most of the pastureland in 2000 was in sheep and beef farms. Only 1,400 ha was in dairy (McDermott Fairgray, 2001), carrying 5% of the stock units in the Catchment (Thorrold & Ledgard, 2001).

Sheep grew well in this region, - for example the country's top sheep sire breeding unit (Waihora Station) was located here. Some farmers experimented with deer and the area was also home to the largest deer farm in the country (Lands and Survey Department's Motere Farms).

Estimates of the number of farms in the catchment vary widely between studies because of different data sources. Finlayson & Thorrold (2001) have used a survey, undertaken in 2000, of the farmers that belonged to Taupo Lake Care[48]. They estimate that this survey covered 90% of all pastoral land

[48] Taupo Lake Care are an incorporated society whose aim is to represent the views of pastoral farmers that are members of the society and have land in the Catchment.

and they have scaled their figures accordingly. This survey indicates a total of 104 farms of greater than 15 ha of pasture and a total of 46,026 ha of land.

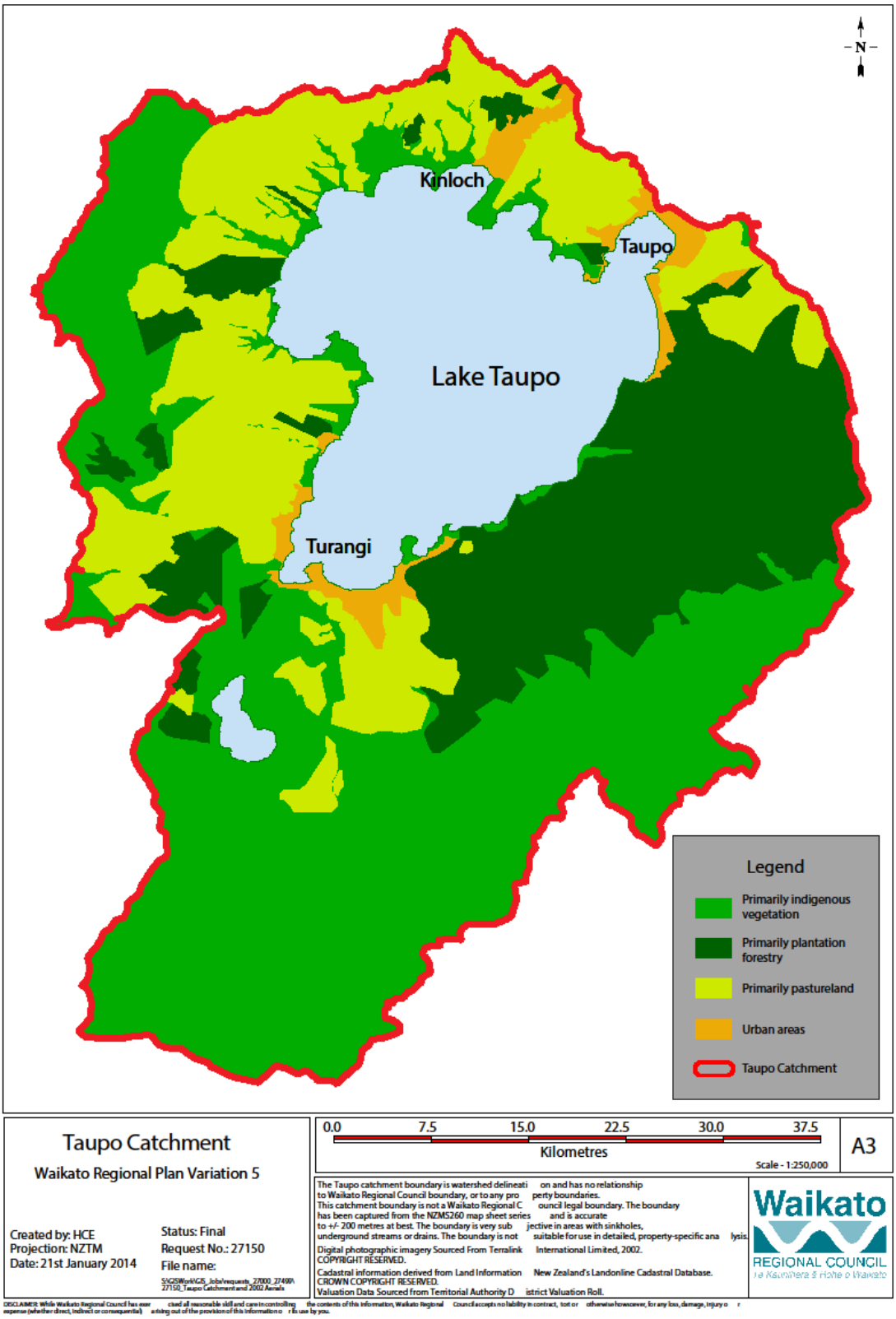

Figure 8: Map indicating land-covers in the Catchment in 2002
(Source: Adapted from Waikato Regional Council. Reproduced with permission)

This total is less than the farmland calculated for the catchment in 2000 shown in the table of pastureland development above. It is likely therefore that there are a considerable number of farms and lifestyle blocks that are smaller than 15 ha in the catchment. This is confirmed by Young (2007) who states that, in the early 2000s, there were 900-1200 blocks of less than 20ha (5% of pasture land)[49]. In 2007, an interviewed senior resource officer at the Waikato Regional Council confirmed there were 116 farms for which baseline nitrogen discharge levels were calculated. Not all of these were commercial operations but this figure, along with the Taupo Lake Care study, indicates that the number of commercial farms in the Catchment is a little over 100.

The largest farms are the Māori-titled farms (ranging from 38 to 4547 ha) located mostly in the south and this is also where the largest forest reserves are located.

5.3.4 Forestry vs Agricultural land-use

On several occasions the question of converting scrubland in the Catchment into production forest, rather than developing it for pastoral agriculture, was debated. In 1966, Ward, Parkes, Grainger & Fenton undertook an economic analysis of the merits of plantation forestry in the government owned Maraetai land development block in the Taupo Catchment compared with developing the land for agriculture. The authors found that the return for agriculture, after 30 years, was higher than that of forestry (present net worth of £706,000 as against £652,000 for forestry and an internal rate of return of 7% for agriculture vs 6% for forestry). The authors cautioned, however, that this calculation did not take into account the extra 'social' costs incurred such as roading and housing. If these costs were taken into account, then the position was reversed with agriculture falling far behind forestry (present net worth of £233,000 vs £419,000 for forestry). The authors concluded:

> *The final conclusion … therefore turns upon whether social costs should be included as a charge against development. If it is agreed that houses for the farm families settled on the block would have to be found elsewhere in the country if the land went to forestry, and that the through roads have a social value in opening up the country over and above their value for agricultural production, then social costs should not be charged against agricultural development. In this case development would appear to be slightly more profitable for agriculture than for forestry*.

A year later, Jackson (1967:3) added to the development debate when he suggested that forestry would be a better option because of the risk that agriculture posed to the health of the Lake.

> *If land-development there must be in the Taupo basin, in the name of progress, let it be towards forms of resource management that do not involve practices so detrimental to the primary objectives in preserving Lake*

[49] Young (2007) also states that there were 100 blocks between 20 and 100 ha (8% of pasture land); and 92 to 100 blocks greater than 20 ha (87% of pasture land) in the early 2000s.

> *Taupo. Among these forms of management forestry stands pre-eminent in retarding normal trends towards eutrophication. There need be no pollution whatsoever from this form of land-use. On this point alone, the local and national authorities must regard forestry very favourably for any further development. Moreover, as the Maraetai Study has recently shown, residents of the district would secure just as much economic benefit from forestry as from farming.*

The argument, however, appears to have been won on political grounds, as explained below by an interviewee who was on the Land Settlement Board:

> *What they call the 'Rehab Scheme' (the rehabilitation for returned soldiers from the Second World War) was a raging success, because the crown was much more generous and much more realistic in the settlement process [than it had been after the First World War]. The country was still short of money and the land developers were still regarded as heroes, you know? And the biggest lobby group, the most powerful lobby group in New Zealand was the Returned Servicemen's' Association. So they put huge pressure on for "all our sons and grandsons" and everything to have the same benefits that they had had….So yes, they went ahead with civilian settlement in the Taupo area, - that's the Western Bays.*

Thus pasture, ballot farmers and government intervention became intimately bound up with European-titled land in the Catchment.

5.3.5 Establishment of reserves and Catchment management

In 1965 Taupo County Council took a proposal to the government that land adjacent to the Lake be retired and put into reserves in order to lessen run-off from farming (Jackson, 1967). The report was the joint effort of the Tuwharetoa Māori Trust Board and the Taupo and Taumarunui District Councils, and was aimed at protecting the Lake partly because of its recreational use. As a result of this initiative a plantation forest was initiated in the south west of the Catchment in 1969 (and eventually evolved into the Lake Taupo Forest Trust) (Yerex, 2009), land was voluntarily retired and significant areas of farmland were purchased by the Crown through the Lake Shore Reserves Scheme (Ministry of Agriculture and Fisheries, 1997). Although the project was, according to the Taupo District Council, never fully implemented, a total of 18,601 ha was put into reserve throughout both Taupo and Taumarunui Counties (Taupo District Council, no date a). Other areas were voluntarily retired and these were largely on Māori-owned and Crown land (Yerex, 2009).

The Lake Taupo Catchment Control Scheme was initiated in the mid-1970s by the Waikato Valley Authority in order to halt, and to prevent additional, erosion on pastureland. It was phased down in 1989 as a result of local government reform. Up to 1989, the Scheme had cost $11m and had been responsible for 860 km of conservation fencing, 4,360 ha retired from grazing and 1370 ha of land planted in conservation plantings (Ministry of Agriculture and Fisheries, 1997).

Figure 9: Plantings undertaken to control erosion and protect waterways.

5.4 Local agri-environmental policy - Variation 5

In 2000, the rural community was informed by the WRC of the need to limit the amount of nitrogen that could be discharged from farmland. That introduction to the forthcoming regulations was abrupt and, many farmer interviewees commented, insensitively handled. The Council may have felt that urgent action was required but farmers were not even aware that there was a problem to be solved let alone that their conservative farming practices were a contributor. As one ballot farmer interviewee explained:

> *This whole Taupo catchment is so underdeveloped. If someone was looking in here from afar and said there was a leaching problem [with nitrogen] going into the Lake, so [to fix it] we'll forest out 80% of the catchment and we'll fence off all of the water ways, and we'll put a buffer zone right around the Lake filled with bush or trees, we'd win environmental awards! But that was the state of what this [Catchment] was before the regulations started.*

In this section a brief history of the 11-year development of the regulations is outlined, with an emphasis on choosing a cap and trade policy. Unlike many other cap and trade implementations, there was no intermediate position of a rule based (command and control) policy in the Catchment. Farm discharges went from being unregulated to being capped at the farm level. Details of the policy that was eventually confirmed by the Environment Court, in 2011, are outlined and indicative

transactions and administration costs of the scheme are given. The section concludes with a summary of the trading that has occurred since the regulations were introduced.

5.4.1 Drivers of policy change

There were five key drivers of change that led to Variation 5. They were: the high regard in which the Lake was held by both rural and urban citizens, the growing concern for the health of the Lake that was being expressed by the scientific community, the agreement from one dairy company to pick up milk in the area, the threat to the tourism industry from potential algal blooms and the conviction of the Waikato Regional Council that the RMA gave them the legal mandate to regulate land-uses.

Citizen Concern. Actions to protect the Lake were not confined to developing reserves around the Lake and its tributaries or to rural areas. In 1997, farmers and townspeople together formed a lobby group whose focus included the health of the Lake. The Lakes and Waterways Action Group (now a Trust) was set up with the aim of advocating for the environment. The secretary of the Trust explained in an interview that they regularly submit on local and regional policy, were involved in the development of the 2020 Taupo-nui-a-Tia plan (see below), and also in lobbying for the introduction of a policy to control nitrogen discharges from pastureland. The Group has about 100 members.

The largest 'citizen' undertaking has been the development and implementation of a plan specifically aimed at protecting the Lake. In 1998 a community survey, undertaken by the Taupo District Council, identified 14 important values about the Lake. The Tuwharetoa Māori Trust Board, the Waikato Regional Council and the Taupo District Council then began to work together to produce a plan (the 2020 Taupo-nui-a-Tia Action Plan (Taupo District Council, no date b) on how these values could be guaranteed. The chosen values are: clear water, diverse plants and animals in lakes and rivers, foreshore reserves, geological features, good trout fishing, high quality inflowing water, outstanding scenery, recreational opportunities, safe drinking water, safe swimming, weed-free Lake, wilderness areas, commercial opportunities and cultural values. A survey undertaken in 1999 (Stewart, Johnston, Rosen & Boyce, 2000) provided further proof that citizen feeling about the Lake is strong. A mail back, questionnaire survey (with a 50% response rate) confirmed that clean and clear water was the most highly valued feature of the Lake, and that weed and slime occurrences were not acceptable. Respondents were of the opinion that environmental protection was more important than economic development, but they did not see reason for a conflict between these two.

Thus there was strong support in both the rural and urban community for actions that would protect the Lake. It was this mandate from the public that led to the introduction of a plan to protect the

water quality of the Lake. As a Regional Councillor patiently explained when questioned repeatedly about the drivers for the introduction of the regulations:

> *The thing I'm struggling to get across to you a little bit is that the community cared deeply about the Lake, farmers included … It's quiet because it's happening and no one makes much fuss about it now. But it was very clear at the time I stood for election that the Lake must be protected. "How" is the difficult bit. I wouldn't say it was conservation led, it was the general people that live in the town and they love their lake.*

Thus there was strong community support for the notion that the Lake needed to be protected.

Scientific Advice. The science community was also concerned about the health of the Lake from an early date. An ex-Councillor on the National Research Advisory Council observed:

> *Concern was increasing about the potential for Lake Taupo to go sour, and the pressure went on and on, and I was involved in putting the pressure on. And DSIR set up a fresh water laboratory in Taupo, it would have been in the late 70's, I suppose, yes. They recruited an Englishman by the name of Eddie White, and he set up a very robust monitoring system - of testing the water and observing it.*

With the establishment of the Department of Scientific and Industrial Research Laboratory in Taupo, scientific studies of the Lake began in earnest (Elliot & Sorrell, 2002), and scientists began to routinely study the nutrient status of the Lake (e.g. White & Downes, 1977; White et al., 1980; Schouten, 1983). Howard-Williams, Gibbs, Viner, James, Schwarz (1994) reviewed studies undertaken about Lake Taupo to 1994 and found there to be 130 published reports and 'numerous' unpublished ones. After analysing these studies the authors concluded that although phytoplankton levels had not changed since the 1950s, there had, since the 1980s, been marked increases in the amount of nitrates in the surface waters of the Lake. Nitrates in the inflowing streams were later shown to have increased between 50 and 300% since the 1970s (Petch, Young, Thorrold & Vant, 2003).

WRC appear to have taken note of these studies since Elliot & Sorrell (2002) remark that WRC suspected that the raised nitrogen levels might be a delayed response to the development of pastureland before 1975. Studies in Taupo, and elsewhere around New Zealand, had begun to investigate the relationship between water quality and land-use (Cooper & Thomsen, 1988; Williamson, Smith, & Cooper, 1996; McColl, 1982; Wilcock, 1986; McColl & Hughes, 1981). The conclusions were all the same: water quality is affected by pastoral farming, dairy farming is the largest contributor and waterways are being put at risk of eutrophication. As explained by Edgar (1999; 381)

> *Water quality protection at Lake Taupo, and the introduction of dairy farming, are neither compatible nor sustainable in the long term. In essence, water quality protection and the intensification of land-use development in the Taupo catchment are mutually exclusive.*

Picking up Milk from the Catchment. The warnings about water quality from the scientific community coincided with a rush of land-use conversions to dairying by sheep and beef farmers located just outside of the Taupo catchment boundary in the Whakamaru/Tihoi area. Farmers were finding the economics of dairy farming compelling. The author of a Ministry of Agriculture and Fisheries report (1997: Section 8) calculates that the cash farm surplus for a sheep and beef farm in the Taupo area in 1996/7 was $180/ha but for a dairy farm it was $935/ha. Even when higher capital costs and debt servicing were taken into account, dairy farms returned seven times the disposable profit of sheep and beef. Unsurprisingly, the number of conversions in the district increased dramatically in the late 1990s (Journeaux, 1997). It was estimated that 250 km^2 within the Catchment would be suitable for conversion from sheep and beef to dairying (Ministry of Agriculture and Fisheries, 1997) and, it was calculated, this amount of dairying could result in a 20-60% increase in nitrogen levels in the Lake (Vant & Huser, 2000).

The largest dairy company in New Zealand, NZ Dairy Group[50], up until this point, had refused to pick up milk in the Taupo Catchment because it was too distant from processing plants. Consequently, farmers in the Catchment could not convert to dairy. In the 1990s, however, NZ Dairy had a change of heart and when approached by farmers from the Catchment agreed that they could convert. In the event NZ Dairy withdrew that agreement but another milk company (the Kiwi Co-operative Dairy Company) stepped in and agreed to take on farmers in the area as suppliers. The stage was now set for wide-spread conversions to dairying in the Lake catchment.

The Threat to Tourism. Tourism and water recreation is a big contributor to the Taupo economy. So if increases in nitrogen pollution resulted in algal blooms in the Lake, it was argued, this would threaten the economic welfare of the district (Journeaux, 1997). WRC commissioned a report on the level of risk involved and a cost/benefit analysis was prepared (Waikato Regional Council, 2004). This indicated that the cost of regulating nitrogen discharges was in the order of $116m (mostly to farmers) but the benefit (mostly to tourism) was $39m. There was, however, some criticism of this cost/benefit analysis – mostly on the grounds that it reflected one period in time (using figures from the 1990s) and that the contribution of different sectors has since changed. The then Chair of the Economic Development Agency, Enterprise Great Lake Taupo explains these changes below:

> *2005 was the peak of the tourism market and every year – year on year – tourism numbers are coming down. So we are 10% down now on the peak –*

[50] In 2001 they became Fonterra New Zealand.

> *so that is the contraction of that sector in the last 8 years. Whereas all of the other sectors have been growing. Dairy is racing ahead. Geothermal is racing ahead. Forestry is rebounding since the early 2000s. So these [1990's] figures are not the picture that I would expect to see today.*

In the 1990s, however, the perceived risk to tourism, coupled with the mandate from the citizens of Taupo (in the 2020 Taupo-nui-a-Tui project) to protect the water quality of the Lake, the scientific evidence that nitrogen was building up in the Lake (and the inflowing streams) (Thorrold et al., 2001) and the threat of increased nitrogen reaching the Lake because of mass conversions to dairy farming (Vant & Huser, 2000; Vant & Smith, 2002) all served to convince WRC that limits on nitrogen discharges were urgently needed. Coincidentally, in 2001 and 2003, there were blooms of cyanobacteria (blue green algae which can fix their own nitrogen) in the Lake (Hamilton & Wilkins, 2005) and extensive weed growth in shallow water at Kinloch and in Taupo itself (ex-Chair, Lake Taupo Protection Trust, pers comm.).

Resource Management Act. In the late 1990s the Waikato Regional Council decided that it had to act. Trends in land-use change were indicating that there was a risk to the Lake from farmers increasing production, potentially from forest owners who were investigating conversion of forests to pasture and from the continued sub-division of rural land for residential purposes without reticulated sewerage (Thorrold & Betteridge, 2006). Regional Councils administer the Resource Management Act (1991) and section 30[51] of the Act directs them to control the use of land "…*for the purpose of the maintenance and enhancement of the quality of water in water bodies*". As a WRC manager explained:

> *Section 30 makes it quite clear that we have the ability to control the use of land for water. That is incredibly powerful and quite unusual in terms of jurisdiction around the world for resources management. In America private property rights predominate and there is no way that you can control the use of land. You can control the outputs from the land but by controlling the <u>use</u> of the land you can start controlling the expectations of landowners in terms of offsite emissions. So it is very powerful....*

The Waikato Regional Council felt compelled to act, and believed that Section 30 of the Resource Management Act (1991)[52] gave them a legal mandate to do so. Under the Act, Councils are required

[51] Section 30: Functions of regional councils under this Act (NZ Parliamentary Counsel Office, no date).

[52] Extract from Section 30: Functions of regional councils under this Act: (NZ Parliamentary Counsel Office, no date).

(1) Every regional council shall have the following functions for the purpose of giving effect to this Act in its region:

(c) the control of the use of land for the purpose of—

(i) soil conservation:

(ii)the maintenance and enhancement of the quality of water in water bodies and coastal water:

(iii)the maintenance of the quantity of water in water bodies and coastal water:

(iiia)the maintenance and enhancement of ecosystems in water bodies and coastal water:

to produce a Regional Plan and the rules in these plans are given effect by issuing consents. Activities that are allowed as of right, are termed 'permitted activities' and do not require a consent[53]. Activities that are allowed, but subject to specific conditions, are termed 'controlled activities'. Various other consent categories allow the Council different degrees of ability to approve or deny the right to undertake an activity.

Given the strong community support described in this section, the introduction of the regulations should have been relatively quick, but in fact it was an 11-year process to develop and implement them and it was not until 2011 that the Environment Court ruled that farming in the Catchment would become a controlled activity under the Act (Environment Court, 2011).

5.4.2 Farmer responses

According to Clark & Lambert (2002), at the turn of the 21st century farmers in the Taupo district were more optimistic about their future than they had been for some time. Life had been tough. The abrupt removal of farm subsidies in the mid-1980s, coincided with a period of low international commodity prices (Willis, 1991), and the resultant sharp drop in land values reduced equity and added to farmer difficulties (Willis, 1991) - But by the early 2000s, it looked like things were about to get better. Real net farm income had recovered to pre-1985 levels (Gouin, 2006:55), farms were recovering after the severe 1997 drought, the dollar was low and farmland prices were appreciating (Clark & Lambert, 2002). Added to this was a feeling of satisfaction about the care that the farmers were taking of the land and of the Lake with the extensive reserve and land retirement that had been undertaken in the previous decade. Many of the European-titled farmers, who were all balloted onto their farms at around the similar time, were heading towards retirement and looking to sell, or hand on, their properties to the next generation of farmers. Māori-titled farms, too, had faced difficulties and were hoping for better times. Many of these farms had plans to development their underutilised land and these plans were part way through being implemented.

[53] See: 3.10.5.2 Permitted Activity Rule –Non-Farming Activities (Waikato Regional Council, no date a).

Figure 10: Underdeveloped Māori-titled pasture land.

The recognition that the Lake was under threat and that a policy to limit pollution was needed cut across these plans. First, the imposition of a nitrogen cap would mean that the plans would be halted partway through and could not come to fruition. But there was another, more serious, issue for the Māori owners of this land. As guardians of their land (kaitiaki), to imply that they have not done a very good job of being stewards (because the groundwater is polluted), was offensive[54]. Dr Edmeades, summarising the discussion at a field day in Taupo, instructs Councils as follows (Beef and Lamb, 2012: 25):

> *Regional Councils, in terms of how you approach farmers, it's just not a matter of listening – it is more than that – it's a matter of understanding farming and farmers.*

There were also mixed views amongst interviewees on the extent to which the Council understood farming in the Taupo case. Most agreed that WRC "…*started out with a very 'Lake centric' view of the world*" (Yerex, 2009:16) but some felt that the Council did engage with farmers once a consultation process got underway. This quote is from one of the farmer representatives:

> *[Farmer representatives were] meeting about every six weeks with Environment Waikato [i.e. WRC], AgResearch and other outfits working through things and at times, we've agreed to disagree but we wouldn't let that drag us under. We wouldn't agree on some things but we'd keep on going – which is really good. We'd built up a really good relationship which*

[54] This is discussed further in Chapter Eight

> *is why it annoys us that people say Environment Waikato didn't actually consult.*

On the other hand, some farmers considered that the Council only made minor changes to the original plan, despite three years of consultation.

> *I have likened them [the Council] and their legislation to a freight train. They had their tracks set. Farmers set up barriers and the like and at these points WRC said "Let's have a discussion" and they hopped off and called a meeting but even while they were talking the train was still moving on its set course. They used to say "let's hop on this freight train and travel together" – but they knew where the train was going and that the course would not be deviated. The outcome had been set back in 2000.*

The farmers had banded together to form a group to represent their interests (Taupo Lake Care Incorporated Society (TLC)) shortly after the regulations were first mooted. This ex-Chair of TLC explains their aims:

> *Right from the start Taupo Lake Care was about maintaining long term viability and flexibility of farming while protecting the Lake, and that basically didn't change.*

It claimed to represent almost all of the owners of working farms in the Catchment (Yerex, 2009) but, while owners/managers/trustees of Māori-titled land were initially also part of this group, they eventually broke away to form their own group, the Ngāti Tuwharetoa Agricultural Group, which made its own submissions to the Waikato Regional Council Hearing in 2006. Before this occurred, however, it was TLC representatives that consulted with the Council. In addition to this, TLC started a newsletter, reported on the consultation process to meetings of farmers, commissioned scientific and economic research, made submissions, and employed legal representation for the Environment Court proceedings.

5.4.3 Policy development

Considerable work was undertaken to arrive at an appropriate policy setting and then to design a cap and trade scheme appropriate for the Taupo Catchment. There was extensive consultation with the general public (Organisation for Economic Cooperation and Development 2015; Petch, Young, Thorrold & Vant, 2003), assessment of methods of implementation (MacDonald, Connor, & Morrison, 2004); assessment of likely outcomes for farmers and foresters (Nimmo-Bell, 2002) and argument before the Environment Court (Yerex, 2009), before the final design of the scheme was arrived at. A list of important events during the 11-year development period can be found in the table below.

2000	In May a letter and information sheet is sent to interest groups Article appears in the Waikato Times (i.e. the city where the Waikato Regional Council is located)
	In July farmers set up the Taupo Lake Care group (TLC)
	In October the Waikato Regional Council produces a report about options for management (Waikato Regional Council, 2000) and holds meetings for the public
2001	Waikato Regional Council decide that the goal of their Lake Taupo policy will be to maintain Lake Taupo water quality at the same level as 2001 and conclude that a 20% reduction in nitrogen discharged into the Lake will be required to achieve this[55]
	TLC, WRC, scientists from AgResearch and others meet for 35 meetings over the next three years
	TLC commission research on the effect of nitrogen limits on farming and request confirmation of nitrogen inflows into the Lake
	AgResearch begin research on potential new farm systems and mitigations for nitrogen leaching
2003	In July, central government commits to financially supporting land-use change in the Catchment to achieve 20% reduction in nitrogen loads to the Lake
2004	In August the draft Variation 5 is released. Submissions on this close in March 2005
	Ngāti Tuwharetoa request a review of the choice of a 20% reduction in nitrogen discharged from land
2005	In July the Proposed Variation 5 is notified. Submissions close in September
	First Landcorp property sold (Mangamawhitiwhiti (647 ha))
2006	In May the Waikato Regional Council Hearings begin
	Central government approves a fund of $81m to reduce nitrogen input to the Lake by 20% from 2001 levels
2007	In March the Waikato Regional Council Hearings findings is released – the Variation 5 Proposal is adopted, largely unchanged. The decision can be appealed and TLC decides that it will do so. Foresters also decide to appeal.
	Waikato Regional Council begins benchmarking farms
	Lake Taupo Protection Trust[56] was set up and began buying nitrogen discharge allowances
2008	In May the Environment Court began hearing the Appeal
	A Beef and Lamb monitor farms started in the Catchment with the aim of finding a way to farm within a cap
2011	Environment Court judgement released and Variation 5 became operative i.e. agriculture was confirmed as a controlled activity in the Taupo Catchment under the Resource Management Act 1991.
	Benchmarking largely completed
2013	Processing of applications for consent to farm completed by Waikato Regional Council
	Lake Taupo Protection Trust advised that they have one last contract to complete when it is finalised then the 20% reduction target will have been achieved.

Table 11: Timeline of events relating to the development of the cap and trade regulations
(Source: Yerex, 2009; Taupo Lake Care Inc.; various media reports)

[55] Young & Kaine (2010)
[56] See Section 5.4.4 for an explanation of the Trust

While science had been crucial in identifying that there was a problem that needed to be solved, and what the source of that problem was[57], little work had been undertaken in the farm management area on how the problem could be solved. This presumably was realised soon after the announcement of the Taupo project and contributed to the sudden increase in research on possibilities for managing nitrogen leaching (e.g. Green & Clothier, 2002; Betteridge et al., 2007; Cameron, Di, Moir, Roberts, 2007; Hamilton, 2005; Hoogendoorn et al., 2011; Ledgard, Thorrold, Petch, & Young, 2001; Ledgard et al., 2007; Lilienthal, Brauer, Betteridge, & Schnug, 2007; Thorrold & Ledgard, 2001; Thorrold et al., 2001) but despite these initiatives and the implementation of a policy to control nitrogen, science has not, to date, been able to assist with the means to resolve the issue. Dr Edmeades, tasked with summarising the presentations at the final meeting of the Beef and Lamb Monitor Programme in 2012, made the following comments (Beef + Lamb, 2012: 24, 25):

> *We have got this clash, environment versus farming, and underpinning that clash is the science. One of the important things I heard [today] was the question of uncertainty, lots of uncertainty….*
>
> *I guess in terms of the tools that the farmers currently have I was disappointed with this section of today. I've heard all of these things going back 10 years and I was expecting and hoping to hear some really new initiatives from the scientists… but I did not hear that today and it disappointed me.*

The lack of mitigation options available for farmers, and the role of science in this matter, has been an ongoing issue in the Taupo implementation and will be addressed in Chapter Seven.

5.4.4 Policy design

As part of the RMA Section 32[58] analysis needed to justify the proposed regulations, WRC commissioned a report on the cost to farmers of restricting nitrogen discharges from farms in the Catchment. Findlayson & Thorrold (2001), who undertook the report, concluded that intensification of land use is a profitable option for farmers in this Catchment so regulatory control (rather than a voluntary approach) would be necessary to stop increased nitrogen leaching. They acknowledged, however, that such controls would result in substantial costs for farmers and could lead to reduced

[57] See Section 5.4.1

[58] Section 32 of the Resource Management Act requires (Ministry for the Environment, 2014b):

- new proposals must be examined for their appropriateness in achieving the purpose of the RMA
- the benefits and costs, and risks of new policies and rules on the community, the economy and the environment need to be clearly identified and assessed
- the analysis must be documented, so stakeholders and decision-makers can understand the rationale for policy choices.

The Resource Management Amendment Act 2013 introduced new requirements under s32. These new requirements do not change the purpose of s32. They do however encourage quantification of costs and benefits, emphasise the need to assess economic costs and benefits, and generally require a more robust, more clearly articulated analysis that is proportionate to the type of proposal.

farm viability. In 2002, TLC commissioned a report on the effects of three methods of achieving a 20% reduction in nitrogen discharges on farming in the Catchment. The three options were a cap, a 10% reduction by all farmers or a 20% reduction by all. The report made it clear that farmers would face losses no matter which implementation method was used but that a cap would result in the least cost to farmers i.e. $96m for cap and trade compared with $175m for the 20% reduction on each farm[59] (Nimmo-Bell, 2002). The major contributor to these losses, the authors concluded, was the inability of farmers to change to more intensive land-uses. Clearly a cap was the least unpalatable option for farmers.

The policy solution put to the government in 2003 was a restriction on nitrogen discharges, supported by land-use changes on government owned land in the Catchment (Yerex, 2009). In the event, the government decided not to use the government (Landcorp) farms for this purpose and instead agreed to contribute to a fund to assist with land-use change in the Catchment. This decision put the onus back onto the landowners in the Catchment to make appropriate land-use changes on privately owned land in order to reduce the nitrogen load to the Lake. Should WRC now opt for a command and control policy? The farmers argued that this would limit their ability to manage their land and earn an income. But there was support from the TLC consultation team (and by extension from the farmers of the Catchment) for a cap and trade system since it provided the flexibility that a command and control system could not. Cap and trade allowed tailored solutions to be devised for individual farms by the farmers themselves. As one farmer told WRC (Yerex, 2009: 20):

> *We accept there is an issue, but don't tell us how to farm, tell us what you want to achieve and we'll figure out how to farm to achieve it.*

Nevertheless, a cap was seen by farmers as a reduction of property rights (Federated Farmers, 2008). Others, however, considered that the introduction of a trading scheme effectively privatised a public resource (Royal Forest and Bird Protection Society, 2006).

An important addition to the cap and trade regime was the introduction of the Lake Taupo Protection Trust[60]. The Trust, eventually operative in February 2007, was to administer an $81.5 million fund provided by central and local government and was charged with developing a programme of work to reduce the amount of manageable nitrogen leaching into the Lake by 20 per cent.

[59] These values do not include the expected (but unquantified) loss in land values.
[60] The Trust reports to the Government (Ministry for the Environment, Ngati Tuwharetoa, the Taupo District Council, and Waikato Regional Council. Retrieved February 20, 2017 from: http://www.laketaupoprotectiontrust.org.nz/page/5-Home.

In July 2005 the Waikato Regional Council, as required under the RMA, issued (i.e. notified) the proposed regulations and advised that submissions for and against the proposed variation to the Regional Plan needed to be received by September of that year. In choosing to implement a cap and trade system as a key feature of Variation 5, the Waikato Regional Council aimed to maintain the Lake water quality at 2001 levels, whilst minimising costs, and mitigating social and cultural effects (Waikato Regional Council, no date a). Social and cultural effects were to be mitigated by grand-parenting the cap[61] and so allowing farmers to continue with current farm systems and by trading, which allows flexibility in land-use management. A 20% reduction in Catchment nitrogen output was to be achieved through nitrogen purchases funded by local and central government and administered by the Lake Taupo Protection Trust.

The Council held Hearings about the proposed Variation in 2006, at which members of the public could talk to the Council in support of their submission, and released their decision in 2007. The regulations were to remain largely as set out in the proposal. Appeals to the Environment Court were heard in 2008 and the Court released its final judgement, in favour of Variation 5, in 2011. There was considerable argument, both in and out of the Hearings and the Court, about the details of the Variation (e.g. whether to grandparent discharge allowances, which years to choose for benchmarking and whether to include forestry in the scheme), but the overall policy direction remained true to the 2005 proposal. TLC, however, was successful in arguing that the years on which the nitrogen allowance calculation would be made should be changed because of unusual weather events, as this ex-committee member explains:

> *The biggest achievement of TLC was to get [nitrogen allowances based on] the best year (2001 to 2005) rather than the average [of those years]. There were some drought years in there that would have made the average very low. TLC also bought us time (I thought it would all be done and dusted by 2001 or 2) and we farmers needed this time to understand it all. We got the best outcome that we could.*

The Waikato Regional Council was pleased with the Court decision because the Variation, as confirmed by the Court, delivered three aspects that the Council considered crucial: a limit on nitrogen discharges from farming operations, the ability in law to enforce that limit and a publicly funded mechanism for reducing the overall amount of nitrogen entering the groundwater from farming sources. A key manager from WRC explains below (Yerex, 2009: 19):

> *Without a cap we can't be assured that, under a monitoring regime, farmers are adhering to a benchmark. The policy needed all three components –*

[61] Daigneault, Greenhalgh, & Samarasinghe (2017) show that grand-parenting is less socially disruptive than most other initial allocation approaches.

> *being: the cap, a robust regulatory regime to enforce the cap, and the public money to assist the precedent setting change.*

It is not the intention of this thesis to revisit all aspects of the process of developing Variation 5 since this has been well covered in other documents (particularly Yerex, 2009), however it should be noted that it was a bruising exercise for all concerned and the effects of that experience had not entirely faded when interviewing took place in 2013. Several interviewed farmers said that they were angry in the early 2000s and did not hesitate to let the Council know what they thought (often quite forcefully (Petch, Young, Thorrold & Vant, 2003)). As the years continued to pass without a decision, the uncertainty caused difficulties for some, as one farmer explained:

> *They [farmers wishing to exit] felt forced out [but] no-one would buy their farms and that was because the nitrogen rules hadn't been established. It really drove a lot of them to the point of depression.*

Some farmers, however, worked through their anger and managed to turn the situation to their advantage, as this director of a Māori incorporation explains:

> *We got a sense that it [the regulations] wasn't going to go away and we decided to front foot on it. … I guess that's how we dealt with the nitrogen capping. After we stopped having a tantrum and we thought hard about it, we decided to make some money out of it - and we did.*

The Waikato Regional Council appears to agree that the process could have been improved. In a water quality improvement scheme that they are implementing outside of the Taupo Catchment they are talking to farmers from the outset, as a key manager of the process explains below.

> *[The new project] is about restoring the Waikato River and perhaps too about doing things that we didn't do right in Taupo - such as pre-warning farmers, helping them years in advance of regulations.*

By 2011, the Variation 5 legal framework was complete. The Council had undertaken some work in advance of the Court decision, such as beginning to calculate the discharge allowance for each farm and the Lake Taupo Protection Trust had been set up and the trading of nitrogen could now begin. Around the country the regulations were being recognised as "…*ground-breaking and pioneering*" (Resource Management Law Association of New Zealand, 2011:2) and the WRC received an award in recognition of this from the Resource Management Law Association of New Zealand. It was hoped that they heralded a new era in water quality management in New Zealand.

5.4.5 Variation 5 regulations

The Variation became officially operative in 2011 (Barnes & Young, 2013) but rule 3.10.5.3 specifies that consented activity status applied from July 2007 (Waikato Regional Council, no date a). Aspects

of the Variation are outlined below. This is not a full description of the regulations, which are available on the Waikato Regional Council website (see Waikato Regional Council, no date a).

Regulation aims. The aims of the Regulations are to:

a) Maintain water quality in the Lake at 2001 levels

b) Manage land based activities so that water quality can be restored to 2001 levels. This was achieved by placing a limit on the total amount of nitrogen that can be discharged from the Catchment into the Lake[62] and then apportioning this total amongst farmers with consent to operate above permitted use level.

c) Manage wastewater discharge close to the Lake shore

d) Minimise the economic costs of managing land use activities to achieve the restoration of 2001 water quality levels and to mitigate the social and cultural effects of managing land use activities.

In order to restore water quality to 2001 levels, the WRC calculated that a 20% reduction in nitrogen discharged from manageable sources (primarily farms) would be required. As explained above, this reduction was to be achieved through the Lake Taupo Protection Trust purchasing land and/or nitrogen discharge allowances from farmers who have consent to farm in the Catchment and have voluntarily agreed to sell allowances to the Trust.

Permitted activities. If a landowner uses less than 75 KgN/ha and grazes fewer than a specified number of animals[63] then they are likely to be a permitted use under these regulations and therefore do not require a consent to continue their operation. Similarly, plantation forestry and most lifestyle block activities are also permitted uses. An interviewee with a lifestyle block described the type of farming operation that results from operating at this level

> *[A discharge rate of] eight [kgN/ha] is an incredibly low stocking rate. It's below grass management - way down. I've got 12 acres. I can only run 15 sheep and 2 horses. That's why I [have to] make hay.*

Farmers that expect to operate at a level that will cause more than eight kgN/ha/yr to be discharged, i.e. commercial farmers as opposed to lifestyle block owners, are required to apply for a consent.

[62] The cap was set at a level that took account of current discharge levels as well as the historic load that is in transit to the Lake and currently is stored in the groundwater (Vant & Palmer, 2013).
[63]The stock limits for permitted activity status are listed in Table 3.10.5.1 of the regulations (Waikato Regional Council, no date a). The limits are, per 10 ha land area: Dairy cows 5.5, Beef cattle 8, Calf 33, Horse 8, Sheep 77, Deer 33, Goat 100, Alpaca or Llama 33, Pig (free range) 25.

Benchmarking. The first step in applying for a consent was to have the property benchmarked. The benchmarking exercise established the share of the Catchment total discharge amount that would be allocated to an individual consent holder – commonly called their Nitrogen Discharge Allowance (NDA). It was calculated using OVERSEER®[64], a computer based model of nutrient flows within an individual farm system. The amount of nitrogen that could be discharged by a consent holder was grand-parented - i.e. benchmarking was based on historic farm production levels and farmers were able to choose one year (from 2001 to 2005) on which the calculation would be based. For ease of expression, benchmarking in this study is assumed to have based on the 2001 year for all properties in the Catchment.

Consent conditions. Since they were non-notifiable (and therefore were not publicly reported) Variation 5 consents were automatically granted providing farmers complied with the WRC requirements which included the following[65]:

- Keeping records of nitrogen related farm activities (for audit purposes)
- Have negotiated a Nitrogen Discharge Allowance (NDA) with the Council
- Provided a Nitrogen Management Plan to show how the NDA will be adhered to

Consents were granted for a 25-year period and all will expire on the 31st July 2036[66].

N trading market. A key feature is the trading market for nitrogen allowances. To be eligible to trade, a farm had to have been benchmarked, have received a Nitrogen Discharge Allowance and have obtained a consent to farm from the Waikato Regional Council.

The Waikato Regional Council set up a trading web site but this is little used. Interviewees reported that they heard 'through the grape-vine' when someone (other than the Lake Taupo Protection Trust) was looking for nitrogen to purchase or sell and so most private sales were the result of personal approaches. When parties agreed to trade, they were both required to apply for a variation to their consent and to provide new Nitrogen Management Plans that showed how the farming operations intended to meet their new Nitrogen Discharge Allowances.

The numbers of trades that have been undertaken is listed in the following section.

[64] See http://overseer.org.nz/ Retrieved February 20, 2017.
[65] A fuller set of requirements is listed on the WRC website. See https://www.waikatoregion.govt.nz/Community/Your-community/For-Farmers/Taupo/Nitrogen-management-in-the-Lake-Taupo-catchment/. Retrieved February 20, 2017.
[66] Policy 3 (Waikato Regional Council, no date a).

Monitoring and enforcement. Audits are carried out yearly. For higher risk farms[67] (e.g. those that have sold nitrogen or are operating close to their NDA) Waikato Regional Council reserve the right to audit more frequently and for low risk farms, they may choose to audit less frequently. Audits are generally arranged with the owner but Council intends for some random audits to be carried out.

Farmers must retain and be able to produce the following records to show that they are operating in accordance with their Nitrogen Management Plan[68]:-

1. Annual accounts for the 2013-2014 financial year detailing the opening and closing balance of on-farm stock
2. A monthly stock reconciliation for all stock types and classes, including weaned stock
3. All invoices pertaining to the sale and purchase of livestock
4. All grazing invoices, contracts, and/or cartage invoices if your operation is contract grazing based
5. All invoices pertaining to the purchase and application of nitrogenous fertiliser
6. All information regarding the import of stock feed supplements
7. All information regarding the growing and feeding of crops – including area, crop type sowing and feeding dates, and fertiliser applied specifically for the crop
8. Confirmation of milk solids produced from milk company

For the purposes of auditing a farm is defined as the total farm enterprise. Thus for farms that cross the Catchment boundary, records must include operations that took place on land outside of the boundary as well as on land inside the Catchment. The OVERSEER® programme is used to calculate, from the records provided, the discharge level that applies to land inside the Catchment[69].

[67] In 2011 Council developed a ranking of farms and estimated that there were 60 farms that would be audited yearly and a further 20 that would be audited every three years (Vant and Palmer, 2013).
[68] From Waikato Regional Council, personal communication. This is an excerpt from the letter sent to farmers when monitoring information is requested.
[69] For a farm that crosses the Catchment boundary, there is an advantage in locating specific nitrogen intensive operations, such as on-land effluent disposal and crops that require nitrogen fertilisation outside of the boundary since OVERSEER® will separate these out. There is no advantage, however, in locating animals on land outside of the boundary since OVERSEER® assumes that animals graze the whole farm enterprise. For animals to be excluded from the nitrogen discharge calculation, the farmer would need to provide evidence that the animals had left the area included in the legal description of the farm enterprise (R. Edwards, Waikato Regional Council, personal communication).

Review. There is to be a review of the scheme in 2018 and the Council has reserved the right to alter the total amount of manageable nitrogen that can be discharged from land (the Catchment limit) into the Lake. If this happens then it follows that individual farm allocations will be altered accordingly, unless government funding is forthcoming to buy out the reduction in allowable Catchment discharge levels.

5.5 Consents and trades transacted

In this section the number of consents issued, the costs involved and the amount of trading that has occurred by 2013 are listed.

5.5.1 Consents issued

Data supplied by Waikato Regional Council of benchmarked farms and lifestyle blocks shows that, in 2013, there were a total of 391 benchmarked land titles and 83 consented farms (see Appendix B), as shown in the table below.

Category	Land Titles	Farms and lifestyle blocks
Benchmarked	391	116
Benchmarked and consented	218	83

Table 12: Benchmarked and Consented Land in the Taupo Catchment by 2013
(Source: Waikato Regional Council)

Of the 83 consented properties, 63 (76%) are over 100 ha. As indicated earlier in this Chapter, estimates of the total number of farms in the Catchment vary. Duhon, Young, & Kerr (2011) and Hania (2008) suggest that there are between 92 and 100 farms greater than 100 ha in size i.e. 'commercial' farms within the Catchment. Findlayson &Thorrold (2001) found 90 properties in their survey that had more than 15 ha of pasture and had grazing stock. These figures suggest that there were a significant number of farmers and lifestyle block owners (perhaps 30) that have decided to operate their properties at the permitted activity level or, perhaps, have amalgamated with other farms.

5.5.2 Nitrogen Trading

The sales of nitrogen that have occurred are listed in the table below. Most trades have involved the Lake Taupo Protection Trust. Of the private trades that have occurred, only one significant purchaser was involved.

	Total Consented Properties (%))	Trades with Lake Taupo Protection Trust	Private Trades
Sold NDA	31 (37%)	22	9
Purchased NDA	3 (4%)	n/a	3
No Trading	49 (59%)	n/a	n/a
Total	83	22	12

Table 13: Trades undertaken to Oct 2013
(Source: Waikato Regional Council)

Kerr, Greenhalgh, & Simmons (2015) find that there were 32 trades up until the end of 2012. Further, Kerr, Greenhalgh, & Simmons (2015) report that one trade only (for a small amount i.e. 164 KgN) took place in 2014. These same authors conclude that transaction costs, as outlined in the following section, are sufficiently low so as to not act as a deterrent to trading of nitrogen.

The total amount of nitrogen sold to private purchasers and to the Lake Taupo Trust is listed in the table below. The table also shows the sector of the Catchment from which nitrogen has been sold.

	Northern Sector	Western Sector	Southern Sector	Eastern Sector	**Total KgN (%)**
Private Sales	15,086	1,240			**16,326 (10%)**
Sales to Trust	23,064	37,514	70,811	20,772	**152,161[70] (90%)**
Total	**38,150 (23%)**	**38,754 (23%)**	**70,811 (42%)**	**20,772 (12%)**	**168,487**

Table 14: Nitrogen sales (KgN) by sector and purchaser to 2013
(Source: Waikato Regional Council and Lake Taupo Protection Trust)

As the table above shows most of the nitrogen sold has originated from the southern sector and these sellers traded exclusively with the Lake Taupo Protection Trust. The nitrogen that was privately traded came from the north and west of the Catchment and amounted to nearly 10% of all nitrogen traded.

Further issues around trading will be raised and explored in the following chapters.

5.5.3 Transaction costs to farmers

Transaction costs are often claimed to be a major deterrent to trading in cap and trade implementations (Greenhalgh & Selman, 2012). Transaction cost information was not specifically collected as part of the interviews but information volunteered by farmers or provided by the

[70] There is a slight discrepancy between figures provided by the Lake Taupo Protection Trust and the Waikato Regional Council. The Trust advised that at the time of interviews 151,066 KgN had been purchased. The data base provided by the Waikato Regional Council showed a total of 152,161 KgN had been sold to the Trust. This latter figure excludes one "*technical*" trade (of 93 KgN) and a within property transfer (of 520 KgN).

Waikato Regional Council has been used in this section. It is not expected that this is a full listing of the costs involved.

Mettepenningen, Verspecht, & Van Huylenbroeck, (2009) suggest three categories of transaction cost: search, negotiation, and monitoring and control costs. Search costs are estimated to be very low in this case because they are limited to the cost of the time involved in 'putting the word out' amongst a limited number of potential traders many of whom resided in the Catchment. Most purchases were made by one farmer who explained their approach as below.

> *I am not in the market for nitrogen at the moment but if I put it out there that I am interested then I would get people coming to us because we pay and we pay upfront.*

Negotiation and monitoring costs to farmers have been estimated and are listed in Appendix H. These costs are considered to be low (Duhon, McDonald, & Kerr, 2015).

Those farmers that raised the issue of transactions costs reported that the total cost for a consent ranged from $1500 (with a land-use change involved) to $3000 (with a nitrogen trade involved). As shown in the table in Appendix H, to sell, lease or purchase nitrogen between two consented farmers, each farmer would pay $500 for a change to their consent plus between one and four hours of Council staff time to produce an amended nitrogen management plan[71]. Duhon, McDonald, & Kerr (2015) reported that a nitrogen trade with the Lake Taupo Protection Trust cost around $4000 to $11,000 depending on the number of changes required to the Trust's standard legal agreement.

An estimate of the direct, on-going, costs to the farmer of a 100 ha property with a straightforward nitrogen management plan is around $800 (i.e. an annual consent holder's fee plus an annual audit fee of say $500).

Information about the time required to maintain farm records was not collected. It was apparent, however, that this administrative load was a deterrent to new entrant farmers looking to purchase within the Catchment. A real estate agent with 35 years' experience in the Catchment explained that farmers see the work involved in compliance as burdensome.

> *Currently it takes about 2 years to sell a farm in this catchment. Before 2000 it took about 90 days. The reason for the difference is compliance and the old bogy of compliance costs as well – limitations [on farm practices] and then compliance costs. It is not what you can't do it is what you have to prove that you are doing all the time. It is the cost and the hassle.*

[71] Megan Coup, Resource Officer, Waikato Regional Council, personal communication.

Overall, transaction costs compare well with estimates from overseas studies where there are often large time inputs involved e.g. in permit negotiation, searching for trading partners and site inspections. One study, looking at a point-non-point trading scheme in the US found that the cost for one (large) trade was $US105,000 (Fang, Easter, & Brezonik, 2005) which is far larger than the charges listed above. A 'hassle' cost, however, is not included in the Taupo estimated costs and, if the quoted real estate agent is correct, this cost may be large for New Zealand farmers.

5.6 Conclusions

The tension that this thesis addresses is the policy outcome of trying to achieve the water quality goals set out in the National Policy Statement for Freshwater Management that also allows farmers to operate a viable business. Is cap and trade the means to resolving the challenge set forth by the Parliamentary Commissioner for the Environment when she commented that New Zealand now faces a "…*classic economy versus environment dilemma*" (PCE, 2013:7)?

The cap and trade scheme that was implemented in the Lake Taupo Catchment in New Zealand presented an ideal opportunity to explore the kinds of questions that the Parliamentary Commissioner for the Environment raised. The Taupo implementation is the only cap and trade implementation where discharges of nitrogen from agricultural land have been controlled and thus the achievement of environmental goals are able to be quantified and attained (assuming that the underlying science is correct). An examination of the Catchment showed there to be several other advantages to using this as a case for study. First, the Catchment was found to be culturally diverse, second there were a range of ownership structures from one-person farm units to multiple ownership of land and last, there were a range of land covers, land-uses and farm systems. While the predominant land-use was sheep and beef farming, dairy farming was also undertaken there with more land suitable for conversion. Thus the potential for land-use change to a theoretically more profitable use existed in the Catchment and the trading arm of Variation 5 potentially can facilitate this type of land-use change. Thus, Variation 5 could be the ideal policy implemented in an ideal setting, making Lake Taupo Catchment the place where environmental and farming goals are both met, thus resolving the Parliamentary Commissioner for the Environment's dilemma alluded to above.

As shown in Chapter Two, other cap and trade programmes have had problems with an inability to determine whether environmental goals are met, high transaction costs, low trading volumes, and lack of trust between farmers on the one hand, and point source polluters and administrators on the other hand. The examination of the cap and trade regulations that have been put in place in the Taupo Catchment showed that some of these have been resolved in Variation 5. First, a nitrogen discharge limit has been placed on the Catchment and then apportioned to each farm, and the WRC

has plans in place to monitor compliance. Achieving the environmental goal is thus assured, providing the underlying science is correct. Transaction costs in this case have been found to be low in comparison with other cap and trade implementations. In part this is because search costs are much lower and Council administrative costs are low. Trading volumes, however, are acknowledged to be low (Duhon, Young, & Kerr, 2011). Up to October 2013, 31 sales of nitrogen and three purchases had been undertaken, most with the (local and central government funded) Lake Taupo Protection Trust. Of the farmer to farmer trades, almost all involved a single purchaser. Last, public acceptance of the regulations during their development period was mixed. There is a long history of care for the Lake in this Catchment which has resulted in a high proportion of the Catchment being in forest and on-farm reserves. Many farmers, however, were opposed to the introduction of a cap, although they saw benefits in the management flexibility that trading enables. Support amongst other stakeholder groups has been demonstrated through the implementation of the 2020 Taupo-nui-a-tui Plan, and the backing of citizen groups such as the Lakes and Waterways Action Group.

There are two other factors, concerning the regulations, which are important. First, discharge allowances were grand-parented, and second, local and central government established an $81m fund (vested in The Lake Taupo Protection Trust) to assist with the reduction of the nitrogen load entering the Lake. Both of these factors resulted in 'business as usual' for the 83 landowners that (by October 2013) had obtained consent to farm, since they were able to choose which year out of five specified years they wished their farm to be benchmarked on. Further, reductions in Catchment nitrogen loads were voluntary, funded by government and enacted through the trading arm of the regulations.

The location, too, has unusual characteristics. The investigation of the biophysical influences on farming showed that the Catchment is subject to dry summers and cold winters. In addition, the soils were shown to be very free draining, of low fertility and easily erodible. Both of these factors have presented challenges for grass growth and for farming in the Catchment and have a bearing on the choices that are open to farmers in a regulated environment.

This examination of the Lake Taupo Catchment and the Variation 5 regulations forms a background to the landscape biographies that have been developed, one for each sector, that are presented in the following chapters. Thus the thesis now turns to the investigation, in situ, of the consequences of the Lake Taupo Nitrogen Trading Programme.

Chapter 6: Sub-Catchment case one: Landscape and land-use change in the northern sector

6.1 Introduction

The landscape biography set out in this chapter seeks to understand the land-use changes that have occurred in the northern sector since the regulations were first signalled in 2000. In general, there are two types of land-use change: change that is in response to market signals and would have occurred whether the regulations were enacted or not, and change that occurs as a direct result of the implementation of the V5 regulations (perhaps mediated by market demand). This landscape biography sets out to understand both the amount of change that has occurred and also whether the change appears to be market-led or as result of Variation 5. A full understanding of land-use change requires a recognition of the situation of those that have not changed land-use and so this chapter also explores the experiences of those that chose to continue with an unchanged farm system under the regulations.

The biography focuses on the northern sector of the Catchment because this area is closest to Taupo city and to an area of rural land (outside of the Catchment) that has undergone significant market-led land-use change in recent years. Thus this area is subject to exogenous pressures in addition to the implementation of the regulations. While the focus of this chapter is land-use change in the northern sector, such changes have obviously also occurred elsewhere in the Catchment and so comparisons are made with changes in the south and west.

The biography first traces the history of land ownership and land-use change before the Variation 5 regulations were first signalled. It moves from Māori settlement, through land clearance by European settlers and the Department of Lands and Survey to the recent rise of dairy in the district just outside of the Catchment boundary.

The case then turns to the period from when the regulations were first publicly discussed until 2013. Land ownership and land-use changes at this time centred on the sale of substantial landholdings by Landcorp (the revamped Department of Lands and Survey) and continued pressure from dairy conversions in the area outside of the Catchment boundary. Other changes include subdivision of rural land, conversion to dairy support and conversion to trees. This latter change occurred as a result of trading in nitrogen and so commenced after the Catchment wide nitrogen trading facility was set up and trades by the Lake Taupo Protection Trust and by private traders began.

The landscape changes that have occurred are summarised and the chapter concludes with a description of the transitions that have occurred as part of the landscape path of this northern sector, and the landscape consequences that have been identified from this case.

6.2 Sub-Catchment case description

The northern sector study area is situated at the top of the Taupo Catchment. It stretches from the west of Taupo, around the northern edge of the Lake, to State Highway 32 in the east. In the centre of the sector, on the Lake edge, is Kinloch township, which is popular with fishermen and holiday makers. By 2002, most of the land in this area was in private ownership but over 3000 ha inside the Catchment boundary was still owned by Landcorp. One small commercial forest (Marotiri Forest) and two large pastoral stations in this sector were owned by Māori Trusts/Incorporations.

The contour of this area is undulating to strongly rolling, with steeper contoured land in the Kinloch area (Landcare Research NZ Ltd, 2017a) and so this latter area is considered to be less suitable for intensification (such as dairying) than land in the north-west, west and south of the Catchment (Nimmo-Bell, 2002;10). Soils in the area are predominantly pumice soils and so, like most such soils, are low in fertility, free-draining and erosion prone. Rainfall data is not specifically collected for this area but is assumed to be similar to that of Taupo. In general, the climate in this sector is considered suitable for a wide range of primary production purposes (Landcare Research NZ Ltd, 2017b) although summer dry and slow grass growth in winter can be limiting factors.

Archaeological surveys have revealed some pre-historic Māori settlements on the shores of Lake Taupo in this sector (Williams & Walton, 2003) but it is unlikely that there were ever as many as on the eastern and southern portions of the Lake (Drake, 1983). The number of occupied sites is thought to have increased in the mid/late 19th century but numbers then reduced under the pressure of European occupation and the sale of Māori-owned land to the Crown (Hamer, 2010).

Ngāti Tuwharetoa were reportedly opposed to selling their land but were open to leasing it to settlers (Rotorangi, 2011). Consequently, by 1900, settlers were leasing large areas to the north of the Lake. Other areas of the Catchment were considered too marginal for farming and too inaccessible by the settlers so few farms were developed outside of this northern region. The farms were not successful, however, because of a wasting disease (known as Bush Sickness) that afflicted stock grazing on pumice land pastures. Although this problem was solved in the 1930s (with the addition of cobalt fertiliser) it was not until around 1950 when rye grass and clover were introduced that farm development on pumice soil became economically feasible (Gordon, 1971).

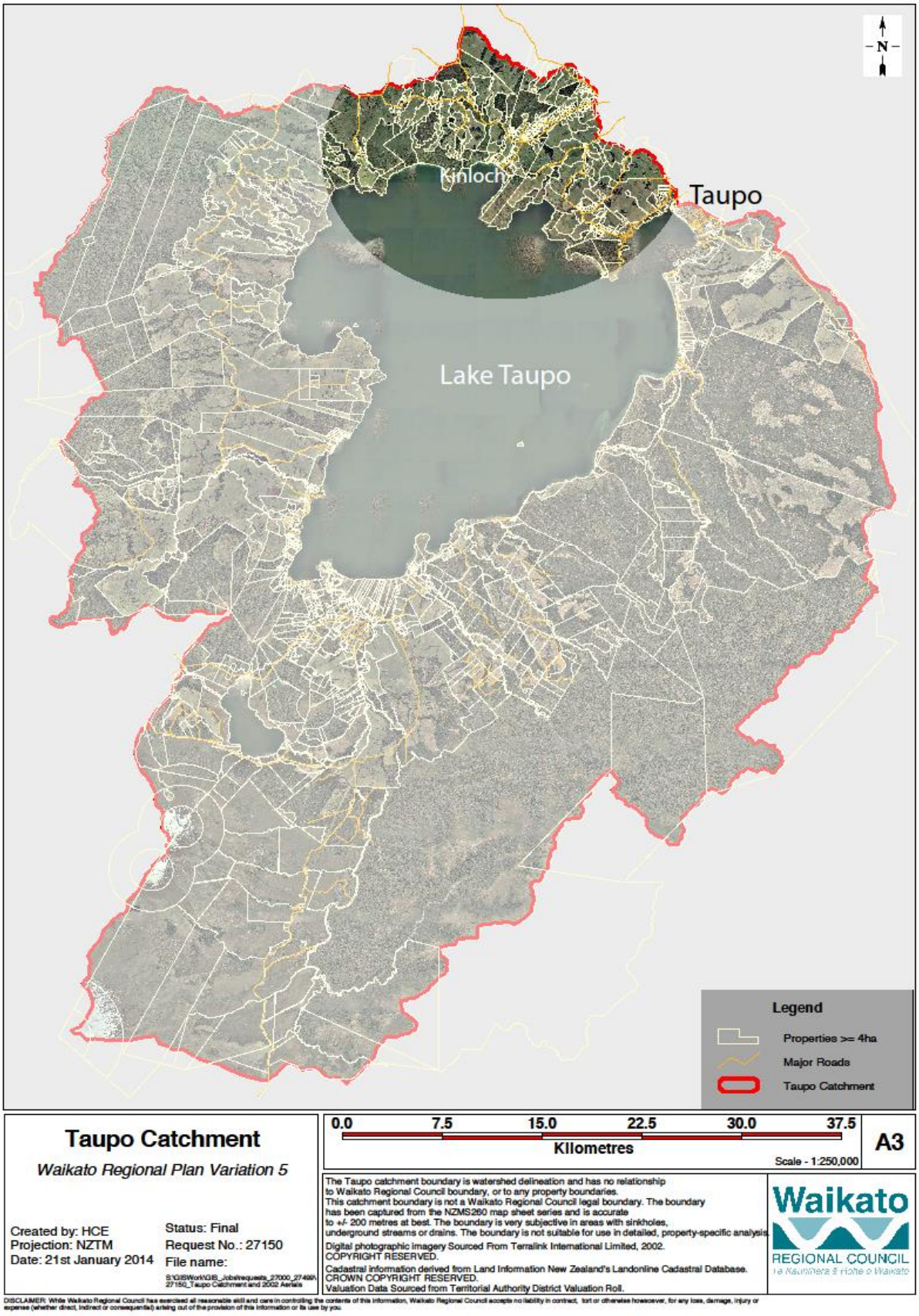

Figure 11: Map showing the location of the northern sector and property titles in 2002
(Source: Waikato Regional Council. Reproduced with permission)

One settler family, the Crisp family, purchased native forest on the northern boundary of the Catchment in an area that had been sheltered from pumice showers. The soil, therefore, was unusually fertile. The family logged the land, developed pasture and eventually sold farm blocks to sheep and beef farmers. Ben Lomond and Whangamata Stations were similarly purchased and developed by the European owners in this same area. The latter, located in the valley between Acacia and Marotiri Lands and Survey Department Development Blocks, was purchased by then Prime Minister Sir Keith Holyoake and his partner, Ian Gibbs. Together they established a sheep and beef station and, in 1959, Sir Keith subdivided off the township of Kinloch and developed it into a tourist destination (Hamer, 2010).

The remaining land in the sector was government or Māori owned and all of it was developed by the Department of Lands and Survey into sheep and beef farms. In the case of the Māori-titled land, the Department farmed the land itself and used the income to repay the farm development costs. According to one of the Land Settlement Officers (now a Landcorp manager) working in this area at the time, this land was handed back to its Māori owners, debt free, in the 1980s. The government-owned land was developed into pasture and divided into farms that were sold to ballot farmers[72]. These were some of the first farms in the Catchment to be balloted.

6.3 Recent history

The first ballot farmers in the Catchment were settled in this area, in the 1960s and the last ballot sales took place in 1983 (Dept Lands and Survey, 1983). At this point, and up until the 2000s, the Department (soon to become Landcorp NZ) still owned substantial land in the northern sector: Otutira (1353 ha), Waihora (1391 ha), Kakaho (1040 ha) and Wairakei (763 ha) stations. Waihora Station was the location of the Waihora Breeding Scheme which was a large sire breeding operation for Angus cattle and Romney sheep from late 1969s till 2008 (Dept. Lands and Survey, 1986). The remaining Department farms were operated as sheep and beef farms, but, according to a Landcorp manager, their productivity was low. In the late 1990s, a local real estate agent, who has sold farms in the area since 1979, approached the government on behalf of a client with a view to purchasing the Landcorp farms:

> *Mr Chesterman (Minister for Landcorp Farms at the time) commented to me that he would love to be able to sell the farms because they were not making any money and they were a liability - but Cabinet had earmarked them for Treaty [of Waitangi] settlements.*

[72] See Chapter Five, Section 5.3.1 for an explanation of ballot farms

Low productivity was a problem for many sheep and beef farms in the 1980s with low wool and sheep meat returns. One Landcorp farm manager recalled that prime lamb fetched as low as $10[73] a Kg in the mid-1980s and added that "…*you can't make money on those sorts of prices*". This situation was compounded by the sudden removal of farm subsidies in 1985 (Gouin, 2006), a sharp increase in farm input prices (see below), falling sheep product prices (Kerr & Olsen, 2012) and a rise in interest rates. One interviewed farmer reported that his mortgage interest rate rose to 33% at this time and that his income dropped by 50%. These financial stresses, coupled with a harsh drought in 1997, made farming difficult, as one farmer located in the Catchment at the time explained.

> *All the sheep and beef farmers at that time, in the late 1980s to early 1990s, were going broke – particularly those on small blocks of 2-300 ha … At this time we had 600 beef with a few sheep (quite intensive bull rearing) and 300 ha (leased) also in sheep and beef … We were expanding quickly but sheep and beef was not making any money. At that time, it was common for sheep and beef farmers to be carrying over $1m in debt.*

Lamb, nationally as well as in this area, is a significant contributor to sheep and beef farm income (Gouin, 2006) and, as the graph below shows, the late 1990s was a period of low lamb prices and high farm input costs.

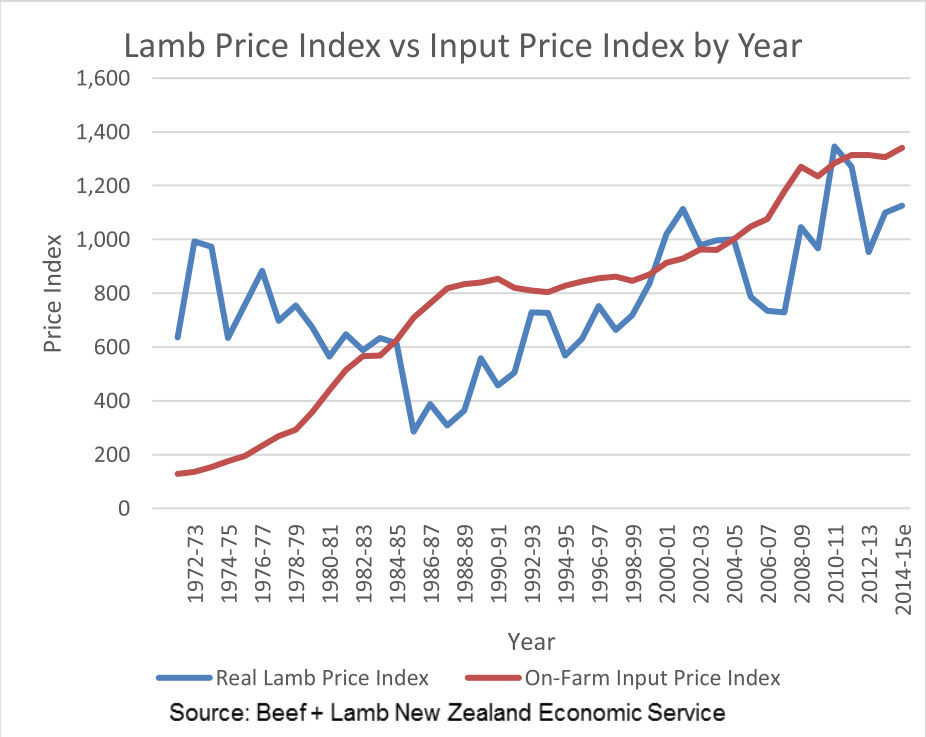

Figure 12: Lamb price index vs farm inputs index
(Source: Beef + Lamb NZ Economic Service)

[73] This equates to $25.35 at the end of 2013 when this interview took place.

Up to 40% of the income of sheep and beef farmers came from subsidies (Smith & Montgomery, 2004). But with their withdrawal in 1986, high interest rates[74] low lamb prices and a slump in the value of wool (McDermott, Saunders, Zellman, Hope, & Fisher, 2008), farm incomes were stretched. As the graph above shows, lamb (the main income earner) was insufficient to cover even farm costs most years after 1986. Other income sources, or large reductions in farm outgoings, were therefore needed to enable the farm to stay in business. A real estate agent, working in the Catchment at the time, recalls the following:

> *When subsidies came off in the 1980s the result was poorer farms and less fertiliser being put on in the Catchment - it got quite run down. The farmers were largely still ballot farmers at that stage. There was a general feeling of despair. I remember selling a farm in 1990 – a 500 acre [200 ha] farm - and the farmer commented that for the price he got he would be lucky to get a section in town. And that happened to a few farmers – they had to move because they had no income and were under pressure from the bank.*

Nationwide, the amount of land in sheep and beef, however, did not change substantially until the mid-1990s (Kerr & Olssen, 2012). Farmers were, it appears, committed to continuing with sheep and beef and managed the profitability reduction by reducing domestic spending and farm costs such as fertiliser (Fairweather, 1989; Smith & Montgomery, 2004). They also began to look for new ways to increase farm incomes (Wilson, 1994). The Taupo Catchment was no exception. While some interviewed farmers in the northern part of the Catchment reported opting for off-farm income, others turned to productivity improvements, increasing the size of the farm or finding alternative land-uses.

The same real estate agent as quoted above reported that farmers throughout the country were struggling in the late 1980s but that the ballot farmers (such as those in the northern sector) found it particularly tough because their farms were now too small to be economic:

> *When subsidies came off in the mid-1980s the result was poorer farms and less fertiliser being put on in the Catchment - it [the Catchment] got quite run down … They were 3000 stock unit farms and they needed 4000 to 4500 to be economic - many farmers were trying to sell.*

For some of the ballot farmers the situation was so dire that, according to one of its farm managers, Landcorp took farms back, repaid deposits and then resold the land – sometimes as 40 ha lifestyle farmlets. Alternatively, the government adjusted the mortgage of some ballot farmers. The ballot

[74] According to Smith & Montgomery (2004; 109) macro-economic conditions increased the burden on farm incomes. According to these authors, the dollar rose in 1985 (after the government floated the exchange rate) and this made exporting difficult for farmers. In addition, interest rates were high with mortgage rates reaching as high as 29%.

farmer quoted below began leasing his ballot farm from the Department of Lands and Survey in 1982 i.e. just before subsidies were removed.

> *The Lange government was in full flight then, so they decided to discount our mortgage … We had a debt originally, something like $350,000, plus the fact that it was leasehold land. So basically they threw the freehold in for nothing … I remember our debt was whacked back to $196,000 … We were still struggling with stocking. We had about 3000-4000 stock units by then with the extra land (and you needed that), - and doing it on my own. But we slowly ground away.*

There were three additional solutions to the problem of low farm incomes and all of these were pursued by at least some farmers in the northern sector. They were (1) subdivide and sell part (or all) of their farm for lifestyle blocks, (2) farm more beef and fewer sheep (Gouin, 2006), or (3) convert from sheep and beef to dairy support.

A change of land-use through subdivision was a popular solution to low farm incomes. The Taupo District Council, up until 2002[75], were tolerant of rural subdivision with one of the Council planners reporting that rural landowners were able to subdivide down to one or two ha sized blocks. Interviewed farmers described how they, and their neighbours, carved pieces of land off the backs of their farms for sale, or they sold whole farms to developers for division into small lots, in order to pay off debt. Both the Council planner and a real estate agent that specialises in sales of lifestyle blocks claim that the lifestyle block purchasers are primarily locals (commuters, retired farmers, farm labourers and forestry workers) rather than (absentee) holiday home owners or primary producers that only require a small land area (such as horticulturalists). There is, however, a steady demand for small blocks on which to run horses because of the proximity to the National Equestrian Centre. Thus the rural land to the east of Taupo has been largely urbanised. The lenient Council policy has led to pockets of intensely subdivided land, particularly in the area close to Taupo, with farmlets and a small number of original ballot farms[76].

A second approach was to change stock ratios by reducing the number of sheep on farm and increasing the number of beef cattle. This land-use change is considered in more detail in Chapter Seven, which investigates land-use system changes. A third approach was to change to a different and more intensive type of pastoral land-use. Just north of the Catchment boundary, particularly around Reporoa, sheep and beef farmers began to convert to dairy farming. Up until the 1990s dairy farming had not been considered viable in the area because of the lack of water. The Department of

[75] In 2002 regulations were introduced which mandated a minimum sized block of 4 ha and in 2006 this was changed to 10 ha.

[76] In 2013, the median farm size in the northern area amongst European-titled, consented farms was 114 ha. This compares with a median of 202 ha for consented European-titled farms in the west and a median of 315 ha for the same type of farm in the south of the Catchment.

Lands and Survey had developed some dairy farms as ballot farms in the district in the 1960s but these farmers had suffered with drought, grass grub and small farm sizes and many had exited the industry. The manager of a Landcorp farm watched the rise of dairy in the 1990s in the wider district in amazement:

> *So we were shaking our heads because we couldn't even fatten lambs in the area because of the hard winters and dry summers. And we thought well if we can't even fatten lambs here, how on earth are they going to milk cows? But the water was all there – just underground.*

The owners of these newly created dairy farms to the north began to look for places to send their cows over winter, in order to spell the pastures on their farms. The Taupo Catchment was close by and the sheep and beef farmers there were more than willing, as this sheep and beef farmer explained:

> *For a sheep and beef farmer all your income comes in about three months from February to May and so the regular income from dairy grazing was amazing – just about everybody changed. [Names of three farmers] didn't change and that's all that I can think of round here.*

The difference in income was potentially substantial. One farmer, still dairy grazing in 2013, recalls the following comparison:

> *Six or seven years ago some of the AgFirst[77] sheep and cattle monitor farms were returning $1150/ha gross. I was returning $1650/ha gross doing dairy grazing. So that is the difference – 50%!*

Although this income difference encouraged farmers to convert to dairy support, others believed that milking dairy cows was a preferable solution to low sheep and beef incomes. They began to pressure the dairy companies into allowing them to follow the lead of farmers just outside of the Catchment and convert to a dairy platform. In the late 1990s, farmers were told by one dairy company that milk from this area would be collected by them, and two ballot farms in this northern part of the Catchment immediately converted. As one farmer explained, the swing to dairying in the wider district was a generational land-use change that resulted from the ballot farmers all retiring at about the same time. The new entrants, with hefty mortgages to repay, could see that dairying was more profitable than sheep and beef. This same interviewee added that the Catchment would have been "…*stage two*" of this generational change if the regulations had not intervened. It was at this point, however, that the Waikato Regional Council became sufficiently concerned about the future health of Lake Taupo that it did intervene and the Variation 5 regulations began their long gestation.

[77] An agricultural consulting firm.

6.4 Development of the regulations

The regulations were developed, and eventually confirmed by the Environment Court, over an 11-year period (2000 to 2011). This section describes farmer experiences during this period through the eyes of the farmers. Most were located in the northern sector but where appropriate the experiences of farmers in other sectors have been included.

According to Clark & Lambert (2002), at the turn of the 21st century farmers in the Taupo district were more optimistic than they had been for some time. Life had been tough as a result of the abrupt removal of farm subsidies in the mid-1980s, which coincided with a period of low international commodity prices (Willis, 1991). The resultant sharp drop in land values reduced equity and added to farmer difficulties (Willis, 1991) - but sheep farm incomes had risen again (Gouin, 2006) and the outlook was looking positive. Added to this was a feeling of satisfaction about the care that the farmers were taking of the land and of the Lake with the extensive reserve and land retirement that had been undertaken in the previous decade (see Chapter Five). Many of the European-titled farmers who were all balloted onto their farms at around the similar time were heading towards retirement and looking to sell, or hand on, their properties to the next generation of farmers, unaware of the storm that was about to overtake them.

Farmers reported that they became aware of the intention to implement Variation 5 through the media. One farmer recalled that just three weeks after he bought his 'dream' farm he read about the proposed regulations, and how they would prevent the implementation of his plans for his farm, in an article in the Waikato Times. After this article appeared the Waikato Regional Council began to inform, and consult, through a series of public meetings held in Taupo and around the Catchment. Farmers were reported to have been on the defence. This quote from a concerned citizen who later became a Regional Councillor:

> *I went to the first meeting that the Regional Council held (in the Bowling Club) and it was a bit fiery. Everyone there was given four choices; return it [the Lake] to pristine; improve it; the same as it is now; or let it go. And some there in the farming community wanted to let it go. That just doesn't fit anywhere in my moral fibre and I just sat there stunned that people would think like that.*

Many farmers had seen themselves as good stewards of the land, doing the best that they could in difficult financial and climatic circumstances, and felt that they were being unfairly singled out. These negative reactions were perhaps further fuelled by media coverage and unwise remarks by Council staff. There were several comments from interviewees similar to the one below, made by a sheep and beef farmer, neighbour of the farmer mentioned:

> *[Name of dairy farmer] was out by his letterbox getting his mail one day, and some idiot from Waikato Regional Council, drove down the road and sort of got out of his car and puffed up his chest, and said 'Oh, are you one of those dairy farmers down here?', and [Name] doesn't exaggerate, and the WRC man says 'We're going to close you down, because this lake is full of nitrogen, and algae bloom and whatnot, and it's all come from you jokers'.*

Certainly the interviewed farmers said that they were angry and did not hesitate to let the Council know what they thought (often quite forcefully (Petch, Young, Thorrold & Vant, 2003)) but they also felt that there was no room here for negotiation.

> *If there is one thing the Council should learn from this it is that it needs to engage in meaningful dialogue, meaningful relationships and build long-term relationships within any rohe[78] that it is dealing with … If they came to us and said "Look we have the scientific data and it can't be disputed – can we work together?", it would have been in our best interests to have done that. But sometimes it seems easier just to impose the rules.*

The owners of Māori-titled farms felt particularly undermined. Many of these farms had plans to develop their underutilised land and these plans were part way through being implemented. The imposition of a nitrogen cap would mean that that those plans could not come to fruition. But there was another, more fundamental, issue for the Māori owners. As guardians of their land (kaitiaki[79]), the Māori owners had always taken into account the effect of current land-uses on the well-being of future generations. As a director of one of the Incorporations in the south of the catchment explains:

> *As Māori, we've always looked after our rohe, and we always will, and we're not fly-by-nighters. That land will never be sold; it will never be sold. It will always be passed on to the next generation. We have always worked sustainably knowing that...*

Thus regulations would cut across both development plans and the belief system of the Māori landowners in the Catchment.

The farmers banded together to form a lobby group (Taupo Lake Care (TLC)) and it was this group that began regular consultation meetings with the Council, reported back to meetings of farmers, started a newsletter, commissioned some further research, made submissions and employed legal representation for the Environment Court proceedings. TLC claimed to represent almost all of the owners of commercial farms in the Catchment (Yerex, 2009). While owners/managers/trustees of Māori-titled land were initially also part of this group, they eventually broke away to form their own

[78] The territory of an iwi or hapu. Retrieved February 20, 2017 from: http://www.nzhistory.net.nz/culture/Māori-language-week/100-Māori-words
[79] Kaitiakitanga is explained and further explored in Chapter Eight

group, the Ngāti Tuwharetoa Agricultural Group, which made its own submissions on the proposed Variation 5.

Once Taupo Lake Care was set up, the Regional Council began to engage directly with the farmers that would be affected by the regulations. This, however, took time. As explained by one of the members of the TLC negotiating committee communication between the two organisations was difficult. On the one hand farmers had "…*different levels of understanding*" and concerns that the Council had not considered. On the other hand, the people that TLC dealt with in Council and in government constantly changed.

> *We talked to - it was either 3 or 4 Ministers of the Environment and I think it was 3 Ministers of Agriculture. We've gone through 3 or 4 local body councils in the time we were involved with the thing. Each time we established a certain rapport with them and then they would go. The biggest problem with anything, is this lack of continuity - with people leaving.*

Consultation with Ngāti Tuwharetoa was inadequate and largely excluded those associated with the farms, because the Council consulted with the Iwi Authority rather than with the Trustees of the Stations that were going to be directly affected by the regulations. According to this Trustee:

> *Within any iwi you have to make the right connections to get to the right people … if your reach is not good in the first place because you haven't got the relationships, and you haven't got a respectful way of relating with the people anyway, then you're not going to get the right feedback from the right people anyway. And does that stuff us up? Yes it does.*

The situation for the owners of farmlets was also uncertain. They felt, one owner reported, that the Council was concentrating only on the larger farms and that farmlet owners were left in a vacuum, which at the time of interviewing farmers in the Catchment (in 2013) had not been fully resolved.

> *Being a small farm holder, I guess we were at the very end of their pile - second class citizens - bottom of the food chain in terms of our ideas, and the value of our inputs.*

Farmers had already retired extensive tracts of land around the Lake edge, along gullies and on erosion prone slopes, and considered themselves to be good stewards of the land. In addition to their already reduced farm size, they argued, the proposed scheme interfered with their ability to earn an income and amounted to a reduction of property rights (Federated Farmers, 2008) although this view was not universal amongst farmers (Rural News Group, 2012). Environmental groups, such as Forest and Bird, argued that the proposed policy did not go far enough and that the introduction of a trading scheme would effectively privatise a public resource (Royal Forest and Bird Protection Society, 2006).

An unfortunate side effect of this protracted consultation was the uncertainty that it engendered, particularly since it coincided with the Global Financial Crisis. As a result, some farmers chose to pre-empt the regulations and to make changes early on.

6.5 Land-use and tenure change in the north in anticipation of the regulations

Farmers were worried about how they could operate under the proposed regulations and so they sought ways of getting out of the Catchment before the regulations took effect. In the north this was particularly evident by the number of farmers that sold to property developers. What took many farmers in the Catchment by surprise, however, was that Landcorp also chose to exit.

One of the options that the Council was considering was that all farmers in the Catchment would be required to reduce their nitrogen discharge levels by 20%. This, the farmers claimed, would put them out of business (Nimmo-Bell, 2002) and thus it was natural that farms became difficult to sell – although many, interviewed farmers claimed, wanted to do so. The sheep and beef farmer quoted below did sell his farm (to a farmer already resident in the Catchment), quite soon after the Council announced its intention to regulate:

> *I was probably the first to exit the catchment. The reason that I left was because I wasn't sleeping - my whole livelihood was at stake because I had high debt levels and an income that was insufficient. Dairy had been going to save us. But as soon as there was a whisper of Variation 5, the NZ Dairy Group backed away and wouldn't allow us to convert.*

While farm sale volumes in the whole Catchment fell during this period of uncertainty, land values increased. The consultation period for the regulations coincided with renewed interest in rural subdivision and this was particularly relevant for the northern sector since it was close to Taupo. In the early 2000s, developers, apparently predicting a boom in tourism, purchased properties with Lake views for subdivision, farm parks, and tourist facilities such as hotels. An analysis of consents granted by the Taupo District Council showed 12 large developments were approved for the northern sector of the Catchment between 2000 and 2013[80]. Silvester & White (2006:70) estimated that 729 ha of farmland was earmarked to be converted to urban and rural residential in the period 2001 to 2005. Waikato Regional Council consent data shows a total of only 270 ha was actually converted to subdivision between 2001/05 (benchmarking[81]) and consent approval (2011/2013). But this demand from developers, coupled with dairy land price rises in the wider district, were

[80] A listing of all consents can be found in Appendix C.
[81] Benchmarking is explained in Chapter Five. In summary, farmers were required to choose one year (2001 to 2005) on which their Nitrogen Discharge Allowance calculation would be based

factors that helped to push up the price of rural land, particularly if it had Lake views. As one real estate agent explained:

> *The world went mad between 2000 and 2008 – everything was going to double in value by the next year – and it did almost. No-one could see an end in sight.*

The Global Financial Crisis in 2007/8, however, quickly cooled demand for lifestyle blocks and tourist ventures and an oversupply (and mortgagee sales) followed. A Waikato Regional Councillor, and Health Board member, summed up the situation as follows:

> *About 3 years ago, the Health Board did a survey looking at the hospital that we were building and [found that] there's about 20 years' worth of sections in the Taupo area (up to about 10 acre blocks) already subdivided. Two farm parks have gone belly up, untold subdivisions have all gone belly up, - massive ones, things on ridge lines. It was bizarre - it was crazy rhetoric driven by crazy developers and we tried as a community to say "Where's the population coming from"?*

Figure 13: A rural subdivision subject to mortgagee sale in 2013

As the consultation period wore on, it became apparent to farmers that the regulations would definitely be implemented and that they would have to decide how to operate their farm under a regime of restricted nitrogen discharge. Expectations of a fall in land values under the proposed regulations coupled with worries over the Global Financial Crisis, the age of the remaining ballot farmers, and continued uncertainty about the form that the regulations would take, were all taking

their toll. In the midst of this difficult period, Landcorp decided to exit from the Catchment, a move that further demoralised the farmers (Yerex, 2009) and resulted in significant land-use change in the northern sector.

Many farmers had hoped that Landcorp (a government owned, major landholder in the Catchment) would play a leading role in reducing nitrogen discharges in the Catchment. It was pointed out, for instance, that planting all Landcorp property would have contributed significantly to the required 20% reduction in total nitrogen discharged[82]. Landcorp itself used a similar argument to justify its involvement in converting forest to dairying just north of the Catchment. The Ministry for the Environment reported to Parliament in 2004 that the increase in greenhouse gases that will result from this dairy conversion would be offset by planting up land in the Taupo Catchment (Ministry for the Environment, 2004:5):

> *Some of us are concerned that this [conversion] represents significant land-use change debits as well as increased methane and nitrous oxide emissions and more nitrogen flowing into waterways. The ministry told us, however, that Landcorp owns a substantial amount of land in pastoral farming in the Taupo catchment. The ministry is in discussions with Landcorp, and is working with Environment Waikato and Ngāti Tuwharetoa, to consider the viability of moving some of that land into forestry or into other forms of protection.*

Landcorp had drawn up a Memorandum of Understanding to this effect (Rennie, 2008) but, according to the CEO Chris Kelly, "…*dithering*" on the part of local government meant that the process of setting up a mechanism to purchase nitrogen was proceeding too slowly (Rennie, 2008:4). Landcorp, it seems, had alternative plans for this land – it was aiming to use it to "…*reposition*" itself, not offset dairy conversion outside of the catchment, as this Landcorp manager explains:

> *If you look at Otutira, the return is much less but the value of the property is high … We wanted to cash in that value and buy land elsewhere.*

It is also possible that an expected decline in land values was contributing to the decision about whether to exit or not. A valuer who has contributed to four studies on the likely effects of the regulations on land values said, in our interview, that he had concluded that there would be around a 25% reduction in land values as a result of the implementation of the regulations. These conclusions were relayed to farmers in meetings in the Catchment and were also published as part of investigations into likely effects of the regulations (See Finlayson & Thorrold, 2001).

[82] Silvester & White (2006) estimate that planting all land owned by Landcorp would have reduced the nitrogen load to the Lake by 48 tonnes N/yr. This equates to a 73% reduction in N discharge from the Landcorp properties from their 2006 estimated discharge levels.

This caused much concern amongst farmers. Many interviewees said that sheep and beef farming was a poorly paying industry (e.g. "…*it's only just pays the grocery bills*"). Consequently, farmers counted on capital gain from the land to provide an avenue for wealth generation ("…*by taking the land and moving it to the next regime - carve off the dairy land from a sheep and beef farm*") or for the money to retire ("…*like buying a house in town – there is an expectation that it [land] will go up in value and that that value will fund your retirement"*). One farmer saw their core business as land trading, that they were a "…*farmer of real estate*", and that "…*the animals are just the means to that end*". Studies have supported these points of view. Eves & Painter (2008) for instance, found that farmland in NZ increased in value by 28% each year between 2000 and 2005. For sheep and beef this rise in land value was unrelated to profitability, with return on capital falling below 1% in 2004/05 (Journeaux, 2015). Capital value, then, was an important component of farming, particularly sheep and beef farming as it has always been and continues to be in New Zealand.

In a statement to Parliament in 2005, Chris Kelly claimed that Landcorp was supporting the proposed regulations by moving its operation out of the Catchment (NZ Parliament, 2006):

> *Landcorp has continued to exit its 10,000 hectares of land at Taupo during 2004/05 … The sale of its properties in the Taupo catchment is also an initiative by the company to support the anti-nitrate leaching programme. As the company buys only when it sells, the recent purchase of the King Country properties [outside of the Catchment] are at least in part a response to the sale of Landcorp's Taupo holdings.*

So it appears that the exit of Landcorp[83] from the Catchment was driven, at least in part, by the forthcoming regulations. But Landcorp was not the only farming operation that was keen to exit the Catchment at this time. One sheep and beef farmer, reflecting on their own decision to stay, perhaps echoes the factors that led other farmers to decide to leave:

> *A few years ago I would like to have moved off this property because of the effects that the N regulations were having – the uncertainty, our neighbours gone, the risk to capital value. I would like to be with more people … [And now] the cash income from the farm is not improving sufficiently to make me feel that this is a worthwhile thing to put time and energy into … The LTPT were paying reasonable prices so maybe we should have sold at the same time and then we would have had some certainty.*

[83] Waihora (2305 ha sold in 2009 with 1240 ha inside the Catchment), and Otutira (1358 ha sold in 2007/8). were located in the northern sector. The latter property was sold to Boat Harbour Trust (Smith, 2009), an entrepreneurial company, and the former (initially) to the Hikuwai Hapu Land Trust (Taylor,2007). Sales in other parts of the Catchment took place around the same time i.e. Mangamawhitiwhiti (647 ha sold in 2005), Motere (1449 ha sold in 2008) and Otaipuhi (1333 ha sold in 2008). The first four properties were sold to the Hikuwai Hapu Land Trust (the land dealing arm of Tuwharetoa) and then on-sold to private owners.

Benchmarking and consent data (supplied by WRC) suggests that 10 farmers in the northern area sold and exited the Catchment from the early 2000s to 2013.

6.6 Land-use change resulting from nitrogen trading in the northern sector

As explained in Chapter Five, two key aspects of the Variation 5 regulations were the establishment of the nitrogen trading facility and the Lake Taupo Protection Trust (LTPT). The Trust was charged with the task of removing 20% of the manageable nitrogen load into the Lake using the trading mechanism to do so. It purchased nitrogen from farms using capital vested in it by the government, and placed covenants on land titles to ensure that the contracted nitrogen was permanently removed from the Catchment. Few farmers in the north traded with the Trust but almost all of the private trades that were transacted involved sellers from the northern sector and all three purchasers of nitrogen were also located in this area.

Variation 5 allows for trading between farmers providing they hold a consent to farm. As Duhon, McDonald, & Kerr (2015) point out, the Trust will withdraw from the market once its objective has been achieved and so transactions between private farmers are better indicators of market driven land-use change. Thus private trades indicate that nitrogen allowances have been (p. 26) "…*reallocated to [their] most highly valued uses*" and income levels to the Catchment have potentially increased. Table 13, in Section 5.5.2, shows that three private purchases of nitrogen have been undertaken in the Catchment to 2013. The only significant purchaser converted (extensive) sheep and beef farms to a dairy platform (a more intensive land-use). One of the other two purchasers used the small number of allowances that they purchased for a sheep and beef operation (in the north) and the third purchaser used their purchase on a dairy support unit (in the north). One possible reason for low numbers of private trades is that there are insufficient differences in farm systems, and therefore in nitrogen discharges, to make trading worthwhile. Cap and trade assumes that the cost of implementing land-use change is not evenly spread amongst farmers and thus it would be worthwhile for those farmers for whom the cost is low to make a land-use change, and to sell the excess nitrogen allowances for a profit. The table below gives an estimation of the differences in utilisation of nitrogen at the time of benchmarking. Nitrogen utilisation varies because of management practices and biophysical factors such as soil type (Ledgard & Luo, 2008). If the nitrogen surplus is high then, in theory, there will be easy and cheap technologies or practices available that farmers can implement to reduce their nitrogen surplus, and their nitrogen discharge, and thus have spare allowances available to trade.

Farm System	Median N Surplus per benchmarked farm (KgN/ha/yr) (n=114)	Range N Surplus for benchmarked farms (KgN/ha/yr)	N Surplus NZ average[84] (KgN/ha/yr)
Sheep/beef (low or moderate stocking rates)	67	17 - 135	9 for low intensity 34 for med intensity
Sheep/beef (high stocking rates & stock finishing[85])	77	35 - 149	72
Deer (including sheep/beef/deer)	69	31 - 118	94
Dairy	126	97 - 187	100

Table 15: Nitrogen surpluses in benchmarked properties in the Catchment compared with New Zealand, by farm system[86]
(Source: Waikato Regional Council)

The table above shows that nitrogen surplus values vary both between farm types but also within farm types. For example, the literature suggests that a sheep and beef farm operating at medium intensity will have a nitrogen surplus of 34KgN/ha/yr. Data supplied by the Waikato Regional Council shows that some sheep and beef farms in the Catchment have nitrogen surplus levels much higher than this. This suggests that these farmers could reduce their discharge levels without affecting their overall business. Smeaton, Cox, Kerr, & Dynes (2011) confirm that variations in discharges are present on sheep and beef farms throughout New Zealand and so the surpluses pointed to above are not necessarily a feature of the Taupo area. Mitigations used elsewhere in the country, therefore, could be applicable in Taupo.

Variation in discharge levels is thought to promote trading (Shortle, 2012) since farmers can introduce more nitrogen efficient farm practices, reduce their nitrogen discharge/surplus and cash in the unused discharge allowances. For this to work there has to be variation between discharge levels between farmers, as has been demonstrated exists in the Taupo Catchment. Thus it can be concluded that lack of variation in discharge levels is unlikely to be a factor contributing to low levels of trading. Another reason given in the literature for low trading levels is the newness of the trading scheme. Colby (2000) suggests that it takes time for farmers to become comfortable with this radically different approach. Over time, then, more land-use

[84] From: Ledgard, Steel, Roberts & Journeaux (2000).
[85] Finishing refers to stock that are at a sufficient weight to be sent directly to the meat processors. Finishing requires good pasture so if only lower quality pasture is available (e.g. in high country and on unirrigated, low rainfall farms) stock may be on-sold to another farmer to 'finish'.
[86] Marginal abatement rates for the farmers in the Catchment are unknown but the calculated nitrogen surplus for each farm at the time of benchmarking, is known from data provided by the Waikato Regional Council. Nitrogen surplus is calculated by the OVERSEER® programme by summing the nitrogen inputs and subtracting nitrogen removed from the farm in products (Ledgard, Steel, Roberts & Journeaux, 2000) and this value is used as a proxy for abatement rates in this table.

change could result from nitrogen sales, and the process might be speeded by new entrants to the Catchment. Two of the twelve nitrogen trades from the northern sector of the Catchment involved land-owners that were new to the Catchment and significant land-use change resulted from these sales. As a Group Manager from Waikato Regional Council commented:

> *New entrants to the catchment hold a different world view about how they use their land - and we have to think now about how we view the use of land. The Minister of the Environment helicoptered into one of the lead farmer's places and we were in his wool shed with a bunch of farmers (20-30). The Minister said "So have you thought about how you can use your land differently?" There was a long silence and then the lead farmer said "But Minister – we are farmers". And that is the essence of the question – who are you and why you are here? The farmers were very clear that they were farmers – not landowners that had a range of different choices.*

The new entrants that were interviewed have, indeed, brought some new farm systems into the Catchment. One, located in the northern sector, has converted a sheep and beef farm to carbon farming (using nitrogen and carbon trading), another has established a large dairy platform (through trading) and a third has converted a farm forestry block back to sheep and beef (without trading). Elsewhere in the Catchment a new entrant farmer has converted sheep and beef to an eco-label beef farm (without trading) and another has introduced deer onto a sheep and beef farm (including nitrogen and carbon trading). Whether more farmers will choose to move to the Catchment is an open question. Expert interviewees, such as the Taupo valuer quoted below, suggested that the sale of the large Landcorp blocks was a crucial draw card for these new entrants:

> *New [farmers]? Very, very few. Most of the new ones would be {Names] who bought Landcorp blocks … the odd developer, - and they've gone belly-up. So really, very, very few apart from guys that have bought a farmlet or small lifestyle block under 100 ha …*

Interviewees involved in the real estate industry suggested that the lack of interest in purchasing in the Catchment is unlikely to change in the near future. While potential buyers are constantly attracted by the relative cheapness of the land, they are deterred by the regulations. This comment is from a real estate agent with 35 years' experience in the industry:

> *[It's because of] the old bogy of compliance costs – limitations and then compliance costs. It is not what you can't do, it is what you have to prove that you are doing all the time. It is the cost and the hassle … Currently [2013] it takes about two years to sell a farm in this Catchment. Before 2000 it took about 90 days.*

Nitrogen trading, therefore, brought few private trades despite the range of nitrogen surplus values found and thus a theoretical incentive to trade. New entrants brought much land-use change but

some question the number of new entrants that will be attracted to the Catchment in future now that there are no more Landcorp (i.e. large) farms for sale.

6.7 Land-use change in the northern sector since benchmarking

Nitrogen trading (both private and with the LTPT) resulted in land-use changes, but trading is not the sole driver of land-use change in the Catchment. The table below shows land-use change that has occurred in the northern sector between benchmarking in 2001-2005 and 2013. It is apparent that most of the change that has occurred is associated with nitrogen trading but that the exception to this is the change to dairy support. As the table demonstrates, 16% of the northern sector land-use changed to dairy support but only 2% was associated with a nitrogen trade. It appears, then, that this is a market-led change and has drivers other than nitrogen trading. Where trading is involved to a considerable extent, most land-use change involved conversion to dairy platform or to plantation forest. This is in contrast to the study area as a whole (see Appendix F) where conversion to dairy platform is shown to be a small land-use change in comparison with conversion to plantation forest and woodlots.

In the northern sector the amount of area that has not changed land-use amounts to 45% of the consented area but in the total study area it amounts to 76% of the consented land area (see Appendix F). Counter intuitively, about 4% of this 'no change' category is associated with a nitrogen trade in the northern sector (44% in the whole study area). This aspect is considered further in the following sections.

Land-Use Change for Consented Pastoral Land – Northern Sector	Consented Pastoral Area. Hectares	Consented Pastoral Area %	Nitrogen trade involved (ha)	Nitrogen trade (%)
No Land-Use Change	5,558	45	468	4
To Mixed Farming (farm is a mixture of pasture and trees in woodlots)	300	2	300	2
To Forestry (all of farm converted)	1,720	14	1,720	14
To Dairy Farming	2,003	16	2,003	16
To Dairy Support	1,997	16	231	2
To Sheep and Beef (SB)	557	4	261	2
To Subdivision	175	1	157	1
Total	12,420[87]	99	5,140	41

Table 16: Land-use changes from benchmarking to 2013 in the northern sector
(Source: Waikato Regional Council and Lake Taupo Protection Trust)

[87] The 'other' category has been omitted from this table and therefore the total column does not fully add up. Most change in the other category involves small properties changing to horses and amounts to 111 ha or 1% of the northern sector area.

Two main types of land-use changes are apparent from the table above. The first land-use change involves some intensification in the form of the conversion of sheep and beef land to dairy and/or to dairy support. The second includes land that has been converted to low nitrogen land-uses, such as plantation forests or a mixture of woodlot and pasture.

Figure 14: Mixed land-use of planted woodlots and pasture

6.7.1 Land-use changes involving trees

As a result of selling nitrogen, farms were contracted to reduce the nitrogen discharge of their farms by an equivalent amount. Plantations of trees have a very low nitrogen discharge rate of 3kgN/ha (Waikato Regional Council, no date a). So conversion to trees provides the maximum amount of surplus nitrogen for sale. Conversion of pasture to forest was, therefore, a common response by owners that sold nitrogen the Lake Taupo Protection Trust[88]. Often these conversions were areas of trees (from which animals were excluded) that were isolated from other plantings i.e. they are woodlots and they form part of a mixed land-use (pasture and trees). Others were larger scale commercial plantations.

In the northern part of the Catchment, one of the first new entrants was an entrepreneur who purchased three parcels of land directly from Landcorp[89], sold nitrogen allowances to the Lake Taupo Protection Trust, and converted 930 ha of tractor-able farmland (Rennie, 2009) to a eucalypt plantation. It was hoped that this example would encourage other farmers in the Catchment to do the same (Chapman, 2009), although some expressed the opinion that they would prefer steeper,

[88] One small conversion from sheep and beef to trees was undertaken as a result of a private trade.
[89] Land purchased was: Managamawhitiwhiti, 647 ha, purchased in 2005/6 and then on-sold, Otutira 230 ha in2006/07 and Otutira 1128 ha in 2007/08.

less productive pastureland to be the focus for conversion. In the event, some landowners elsewhere in the Catchment did choose this option and, in the west of the Catchment, whole farms were converted from sheep and beef to forestry. The manager of this forestry conversion saw the benefits of the trading scheme as follows:

> *From our perspective the nitrogen trading thing was very interesting – it is very friendly to forestry use – it enabled us to buy the property at a realistic price for forestry. We have sold N (mostly to the Trust) … subdivided off a farmlet of 56 ha … and sold off the 3 farm houses. So all these things went to offset the price of the land and make it realistic for forestry.*

One drawback to forests as a productive land-use investment, besides the difference in land values[90], is the lack of cash flow during the growth of the forest[91]. Thus there is little incentive to convert unless these differences in value can be offset in some way. The sale of nitrogen alone was not sufficient[92] to compensate for this difference and other sources of income were required.

Figure 15: Land-use change from sheep and beef to plantation forest

[90] Journeaux (2015:21) states that the average land value for sheep and beef farms nationally in 2013/14 is $8182/ha and forestry land averaged $2486/ha net of trees. A real estate agent with 35 years' experience in the Catchment confirmed that pastoral land values in the Catchment are similar at $8-10,000/ha in 2013.
[91] Forests do not return an income until harvest time but planting and tending costs are paid upfront
[92] For example, if a farmer on a 250 ha farm with an NDA of 15 (median value for pastoral NDA in the western sector in 2013) sold 12 KgN/ha (i.e. 3 Kg/ha remained to enable a plantation forest to be established) at the going rate in the mid-2000s of $300 to $400Kg (Duhon et al., 2011; 16) then the transaction would raise $900,000 to $1.2m plus land sold at forest land value ($621,500). Assuming a pasture land value of $8000/ha, the nitrogen trade coupled with sale of land at forest land value would be less than the 'ballpark' saleable value of the land as a sheep and beef farm i.e. $1.82m compared with around $2m for the sheep/beef farm.

The forestry investment company that converted sheep and beef farms in the western sector reported that they bridged this gap, in addition to nitrogen sales, by subdividing off and selling lifestyle blocks and a farmlet. Subdivision, however, is not always possible, particularly in remote locations. In a fortuitous piece of timing a national power company sought landowners willing to sell carbon allowances from their newly established blocks of trees. Carbon allowances are tradeable permits that operate within the New Zealand Emissions Trading Scheme, which was introduced in 2008. The Scheme covers the energy, industry and waste sectors (but not agriculture) and businesses within these sectors can offset their carbon emissions by purchasing carbon allowances from 'carbon sinks' such as producers in the forestry sector.

Several forest plantation and woodlot landowners in the Catchment signed up with the energy company that was seeking allowances for purchase[93] and one large conversion in the northern sector, involving planting a fast growing eucalypt species, was established on an ex-Landcorp farm. The owner of a third conversion, located in the western sector, reported that they had "*…been lucky and caught a business wave*" because these contracts were drawn up at a time of high carbon prices. The net result, the CEO of the Lake Taupo Protection Trust reported, was that landowners:

> *[planted] some of the worst parts of their land (which is common sense), and had a carbon deal with Mighty River Power and so they were getting a higher income off that land than they were getting with sheep and beef.*

The price of carbon, however, fell[94] dramatically between 2010 and 2013 and the only company offering carbon contracts withdrew from the market, reportedly because of the market volatility. The quote below is from a farmer who entered into discussion with this company.

> *We just missed out. We were going to put all of our farm into trees, we were, with [Name of company] on a carbon thing. But they would not agree that if the carbon price changed they would wear it. They agreed for {Name], and [Name] further down the Lake, but they would not agree with us. So it never happened. And it did change - it went from $25 down to $2.*

This land use change option, therefore, ceased early in the regulation transition phase, but not before one large farm in the northern sector had been converted from sheep and beef to a eucalyptus carbon farm. If carbon prices improve it may again become a viable land-use change option, but in the northern sector the farm sizes are small and potentially not viable for forestry conversion even with a carbon contract. Rennie (2009) suggests that such conversion could be

[93] For example, a Māori-titled Station in the south sold carbon credits to Mighty River Power (Mighty River Power, 2010)

[94] New Zealand carbon units (NZU) traded just above $20 in 2010 and below $2 in 2013 (Leining, 2015)

suitable for the large Māori-titled farms in the south, but without carbon contracts, conversion of pastureland to forestry appears less financially attractive for landowners.

6.7.2 Land-use change: conversion to dairy

In 2008/09 Landcorp sold a property located in the northern sector[95] to the Hikuwai Hapu Land Trust, who then on-sold it. The land was purchased by a dairy farmer who owns several dairy farms elsewhere in the country. This farmer also purchased other, smaller, blocks in the northern sector and these were amalgamated with the ex-Landcorp farm. From these sheep and beef farms, and with the purchase of nitrogen allowances, the new owner developed a total of nine dairy platforms and one run-off block[96]. The General Manager summed up the attractions of moving their operation from the nearby Rotorua district to the northern sector of the Catchment as follows:

> *Yes it was a risky move by the directors but if you look at it past a year or two to see where you are heading … we managed to buy land cheaply we've converted it to a land use which is the best land use for that land and we get a return on our investment - knowing that we can live on that for 25 years[97] doing what we are doing … So we knew we were going to the only place in the country [Taupo] where there was actually certainty in what you can do and for a period of time,*

For this farm the Variation 5 regulations offer business certainty for the medium term and trading also enables them to operate the farm system of their choice (providing they can find willing sellers of nitrogen). In addition, continuity of management across all of their farms is also important. The General Manager explains:

> *So the fertiliser programme that I have on these farms in the Catchment is also the fertiliser programme that I have on farms outside the Catchment. What it means is the NDA I'm running in the Catchment is what I am also running outside of the Catchment.*

Thus the regulations are sufficiently flexible to enable this farm to operate the farm system that is convenient and profitable for their nationwide operation. This farm needed the trading system in order to achieve this management flexibility but in one case, in the southern sector, the same goal was achieved without trading nitrogen. In the early 2000s, the owners of a large station had converted 400 ha of better quality land (carrying sheep and beef) to dairy. The owners were

[95] The property sold was Waihora Station (2305 ha), most of which is located within the Catchment. Neighbouring property, located outside of the Catchment, and also ex-Landcorp land, was sold to the same purchaser.

[96] According to the General Manager, all of the milking sheds, and 30% of the farmland are situated outside of the catchment boundary. As explained in Chapter Five, the whole farm enterprise (including land outside the Catchment boundary) is audited at the time of farm monitoring. Thus locating the milking sheds outside of the Catchment is for public perception purposes and does not reduce the total nitrogen discharge rate of the farm.

[97] All resource consents expire in July 2036 (Barnes & Young, 2013:17)

sufficiently encouraged by the results of this conversion to extend the dairy farm after the regulations came into force. This change was enabled by reducing sheep and beef stocking rates on the remainder of the farm by an amount equivalent to the extra milking cows. Thus the NDA level for the farm remains the same despite the conversion of some of the land to a more intensive land-use. The limitations of the climate, however, make further (future) readjustments difficult, and a Trustee of this station suggests that the owners may have to look outside of the Catchment if they choose to expand their dairy operation further.

There are other large farms in the south of the catchment that could potentially follow this same pattern of internally reorganising their NDA and using their best land for intensive uses such as dairy farming. However, the Trustee quoted above warns that a reasonably high level of NDA is required.

> *We are finding that it is easy to maintain a financially viable farm under the N cap … [But] If our NDA was reduced, you would have a fight on your hands! I think that we are at the lowest that we could manage [and still stay profitable] now.*

Despite there being land that is suitable for conversion from sheep and beef to dairy in the Catchment[98], particularly in the northern sector, only six dairy farms had been established by 2002. Further, only one new dairy farm (albeit a large one) was created after 2002, and one, also in the northern sector, was in the process of closing down in 2013, having sold out the nitrogen allowances to the Lake Taupo Protection Trust. While the potential for conversion exists and it appears dairy farming is profitable, it is apparent that few farms have chosen to do so since the regulations were first signalled.

6.7.3 Land-use change: conversion to dairy support

It is common practice for dairy farmers to rest their pastures by grazing their herd (and/or raising replacement animals) off-site, particularly over winter, and this creates a need for 'dairy support' farms. Five to seven such operations were in existence at the time that the regulations were introduced (according to a dairy grazer interviewee) but more conversions have occurred since that time. One of these original dairy grazers, who has owned his farm since 1997, explained the attraction of dairy support as follows:

> *I wanted to do dairy grazing because that was the highest return and it means that I don't need to own any animals. I don't do beef because it is an unreliable market. I love sheep and beef - but it is dead.*

[98] It was estimated in 2002 that there are a minimum of 9000 ha suitable for dairying in the Catchment (Nimmo-Bell, 2002: 35).

Consent data shows that ten predominantly sheep and beef farms have converted to dairy support since benchmarking was undertaken (see Appendix F). Most of these are dairy farmers from outside of the Catchment who have purchased or leased property, particularly in the northern sector of the Catchment, and manage the farm as part of a multi-location dairy farm. Thus the prevailing model in the Catchment of owner occupied ballot farms and Māori-titled land has changed to one where the owner may or may not live in the Catchment, but the main farm is located outside of the Catchment.

One interviewee in the northern sector, for example, with three dairy farms located outside of the Catchment, has purchased and leased properties totalling nearly 1000 ha within the Catchment, as run-off units. The NDA levels of some of the leased land, however, were too low for dairy grazing and this farmer, rather than buying nitrogen allowances, has leased two tonnes of nitrogen from the owners of Māori-titled blocks for a period of five years.

The change to dairy support has been a market-led change rather than a regulation response, according to the farmer quoted below, who has been dairy grazing in the Catchment since 1997:

> *These conversions to dairy grazing happened at just about the same time as the regulations were coming in. The [dairy] converters converted and then they realised the limitations of the Central Plateau – it doesn't grow grass in winter - so they had to get the animals off. So they looked around for properties that they could do this on.*

Many of these conversions occurred to the immediate north of the Catchment and with sheep and beef farmers located nearby and keen to find alternative income streams, dairy support was an obvious land-use choice, as this real estate agent explains:

> *Farms [in the north] were selling as adjuncts to established farms - service and support units for farms elsewhere for dairy or for beef.*

The irony of this change to dairy support is that, although it does not appear to benefit the Lake, it has occurred under the umbrella of the regulations. As a farmer interviewee pointed out:

> *There are now more female Friesian stock urinating in the Catchment than there ever were before these regulations came into force - and they are there permanently.*

Without the regulations, however, this land-use change may have been more extensive, and so it can be argued that this change, driven by proximity to dairy farms outside of the Catchment and cheap land within the Catchment, has been a controlled change that has not endangered the Lake. Thus market-led change has occurred under the regulations i.e. land-use change that is in-line with market trends has occurred without the input of trading. If, as one interviewee suggested (see Section 6.3), dairy support returns are higher than sheep and beef, then this market-led change has resulted in moving land to a higher land-use without the need to trade nitrogen.

6.7.4 Business as usual

Farmers in the Catchment were worried that Variation 5 would put them out of business. The Court, however, had allowed two important features (Environment Court, 2011). First, the amount of nitrogen discharge allowance to be allocated to a farm was to be grand-parented. That is, it would be based on historic levels and calculated for each farm. (One rejected alternative was to apply an average value across all farms in the Catchment). Thus farms could carry on operating as they had done in the benchmarking years. Second, as previously mentioned, farmers could choose one year (between 2001 and 2005) on which their nitrogen limit was to be based. This period included drought years (with lowered farm production) but, according to interviewees, it also included at least one year when the climate was very favourable and production was particularly high. Thus business as usual appears to be a realistic choice under the Variation 5 regulations. This section reports on concerns expressed by farmers throughout the Catchment about the effect of the regulations, before focusing on the reasons why farmers in the north have chosen not to change land-use.

Having thought the regulations "…*would just go away*" farmers apparently had become accepting of Variation 5, but grand-parenting had not eased their worries about the future of their farm systems under a cap, as this farmer in the western sector explains:

> *Say sheep prices crashed - we would have nowhere to go. We can't run all cattle [e.g. beef] and make the same amount of money that we do now and we can't milk cows (and some of this land here is suitable) … We are locked into farming a fair proportion of sheep because of our NDA.*

As part of the Beef + Lamb New Zealand Farm Monitor Programme, this farm was used for a desk-based analysis of a dairy support system and this demonstrated the difficulties that these smaller sheep and beef farms face in changing land-use. The study found that this farm could not produce sufficient feed for a dairy support operation and that supplementary feed would have to be brought in – but to do this would require the owner to purchase extra NDA. It is the inability of the farm to adjust to market demands (such as the demand for dairy support) which appears to be at the heart of this farmer's concerns, particularly as it is a small/medium sized farm with little ability to retire less productive areas and concentrate NDA on highly productive land. For other farmers, changes in life circumstances lead to similar problems. As this ballot farmer (located in the southern sector) pointed out, farm systems need to be able to change for social as well as market reasons:

> *[Name] is 52, he's got stuffed knees and osteoarthritis in his toes. He doesn't want to dag sheep any more - doesn't want to run drenching things - but this is a small one-man unit … He would dearly love to go to dairy grazers but we can't do that, - we haven't got enough NDA to go straight [100%] dairy grazers – we need sheep.*

Farmers elsewhere in the Catchment, who chose to continue to farm under the regulations, voiced similar concerns that farms are now locked into the situation that they were in during the benchmarking years, are worried that markets will move and that they will not be able to respond appropriately, and further, are hoping that science will eventually provide a solution. A farmer, located in the northern sector, when asked how he planned to operate long term under a cap, suggested that science was the only solution:

> *[I'll do it] by – well – hopefully there's going to be some more science coming through with mitigation options….*

Without such science-based solutions, farmers suggested that increases in production levels over time would be unavoidable. This however, requires a sufficiently high level of NDA or the ability to purchase more. A manager on one of the Māori-titled blocks in the southern sector hazarded a guess at the level of NDA required for a (large) sheep and beef farm to be commercially viable long term:

> *An NDA of 22 would see me through the next, say, 20 years. An NDA of 18 will last the next 10 to 15 years but with an NDA of 13-15 the farmer is in trouble already and their land will be in trees within 5 years.*

By way of comparison, the median NDA for pastoral land in the Catchment in 2013 was 12 with a range from 8 to 29. Thus without the input of science, farmers are predicting that, long-term, farms may become less viable. Should this occur it might be expected that less viable farmers would sell NDA and perhaps exit the Catchment. Interviewees, however, including one that had purchased nitrogen themselves, claimed that they would never sell nitrogen. This farmer, located in the northern sector, summed up the views of many:

> *Look cap and trade is a wonderful thing but I would never sell nitrogen because what you are doing is selling the productive ability of your land.*

Thus NDA is considered to be integral to the productivity of the farm – an asset that would affect land values. A local real estate agent, with 35 years of experience in selling land in the district, agreed and further suggested that land with a low NDA could be unsaleable.

> *That 40 ha [in the northern sector] that is proving hard to sell – it adjoins [Name's] farm and although he could use the land he won't buy it – it is of no use to him because it has no NDAs.*

Thus some farmers saw themselves as having few options. They wanted to stay farming, they would not sell nitrogen because of the potential effects on capital value and they were convinced that, despite the grand parenting of allocations, caps on production would make their farm unprofitable long term. The farmer quoted below, with a medium sized farm in the northern sector of the Catchment, saw no future for farming under a cap and had decided to sell.

> *One of the reasons I am looking to sell is because I think the long term future here is not good. I have enough NDA to do anything that I want but even so costs increase over time[99] and, with a cap stopping me increasing production, in the long run I won't be able to recoup those cost increases. Eventually it will wipe me out.*

In 2013, all farms in the Catchment were operating under their allocated caps[100], most because of weather conditions. A drought in 2008 was followed by severe drought in 2013 and NIWA reported that soil moisture that year was in extreme deficit (McMicheal, 2013). Many farmers had opted to reduce stocking rates because of the lack of feed. When rainfall resumes in the future, however, these farmers cannot increase stock numbers (beyond the number that their NDA allows) in order to make up for lost income. Under the regulations, flexibility of management is limited to nitrogen trading. The farmer quoted below (located in the western sector) owned a medium sized sheep and beef farm and is doubtful about their future:

> *Sheep and beef is what I want to do – but within that there are not many choices … [So] we carry on as we are – but that is it – we can only ever carry on as we are.*

Thus sheep and beef farmers, particularly those with small farms and/or low NDAs and who haven't changed land-use, view their future with concern.

Of note in Table 16, is the amount of land that has not changed land-use but is associated with a nitrogen trade. This same anomaly occurs in the whole study area (see Appendix F) and, since it has not been explained by the land-use changes found in this northern case, is further addressed in the following case (Chapter Seven) where the focus moves to the local (community) level.

6.8 Chapter summary and conclusions

This section summarises the landscape biography of the northern sector, with an emphasis on the transitions that have occurred and the driving forces of changes that have transpired within each transition. At the end of the section, the consequences arising for the sector are outlined.

The first transition began in the northern sector with the development of farmland by European settlers in the early 1900s but it was not until the Bush Sickness disease was cured in the 1930s, and the government ballot farm system was instigated in the Catchment after World War Two that farming in the area began to expand. The ballot farmers who purchased were often heavily indebted

[99] On-farm inflation has been problematic in recent years. Sheep and beef farm input costs have increased by 32 percent over the ten-year period 2004-2014, which is 7% more than the increase in the consumer price index over the same period (Beef + Lamb NZ, 2015).

[100] Waikato Regional Council Senior Resource Officer, personal communication. An estimated 70% were under cap because of weather conditions and the remainder because they had sold nitrogen.

and many were negatively affected by the removal of subsidies in the 1980s. Since this sector is close to Taupo, urbanisation of rural land through farm subdivision was seen by many farmers as a solution to their financial difficulties. Thus the development history of the sector led to small farm sizes, and limited options for land-use change. One potentially profitable land-use which came into prominence in the 1990s and is suitable for smaller farms, was dairy farming. When one dairy company finally agreed to pick up milk from the Catchment, two sheep and beef farms in this sector quickly converted. The Waikato Regional Council, fearing an avalanche of conversions and increased discharge of nitrogen into Lake Taupo, announced that limits of some sort would be placed on farming in the sector. This was a turning point in land-use in the Catchment and thus a disruptive event that ushered in a new transition period.

At the outset of the second transition, most farmers in this sector were farming sheep and beef on small, possibly uneconomic, units. Major drivers of land-use change in the Catchment at that time were international market prices for primary produce, the potential for dairy conversion, and the demand for lifestyle properties, particularly near the Lake and/or Taupo township.

The development of the regulations was a drawn-out affair. The uncertainty that was engendered, an anticipated fall in land values because of the impending regulations, and a reduction in the market for lifestyle subdivisions, led many farmers, including the government owned Landcorp, to exit from the Catchment or from farming. It also, reportedly, dissuaded many potential new entrants from purchasing in the Catchment. After the regulations were finally notified in 2005, the (local and central) government-funded Lake Taupo Protection Trust began its task of buying up sufficient nitrogen allowances to reduce the amount of manageable nitrogen entering the Lake by 20%, with the first purchases occurring in 2009. Trades of nitrogen allowances also occurred between farmers with consent to farm in the Catchment but, up to 2013, only three farmers had purchased nitrogen allowances and nine had sold. Land-use change resulting from both types of trades included conversion to plantation forest or woodlot (including carbon forest), conversion to dairy platform and subdivision. In addition, some land was converted from sheep and beef to dairy support and one farm expanded its dairy farm, without any sale of nitrogen allowances. Thus cap and trade has both facilitated land-use change (trees/dairy farming/subdivision) and not impeded market-led change (increased dairy support, the expansion of one dairy farm and the negative influence of the Global Financial Crisis on subdivision).

The reason for the low level of trading volumes between private individuals is not immediately apparent. Given the demand for dairy products, the existence of land that is suitable for this land-use and the poor performance of sheep and beef, why have more conversions not been undertaken? Further, given the difference in nitrogen surpluses between farmers of the same farm type in the

Catchment, why haven't some of these farmers cashed in their surplus allowances? For answers to these questions the biography turns to the farmers that have not changed land-use. Some of these farmers suggested that the grand-parenting of nitrogen allocations has not allayed fears that, long-term, farming under a production cap is not possible without some (future) help from science, particularly if the NDA level of the farm is low. Thus, the strongest arguments against selling nitrogen were that it lowers the productive capacity of land (and thus the ability to counter farm input cost inflation) and, second, it is likely to negatively affect the value and saleability of a farm.

Important drivers of land-use change that influenced the decision to trade included the contracts that were on offer for carbon trading and the sale of attractively-priced, economic units, i.e. the large Landcorp blocks. Neither of these drivers currently apply. Forestry, without the added inducement of carbon credits, appears not to be an attractive financial option and there are no longer farms of the size of the Landcorp blocks available for sale. Farms in the northern sector are small and so possibly better suited to sub-division. In 2013, however, there was little demand for lifestyle properties and an oversupply of this type of property. Thus, one of the few land-use options for this sector, a real estate agent advised, is as run-off units for farms located outside of the Catchment. Given the number of dairy conversions just outside of the Catchment, and the potential increase in income, more such conversions might have been expected.

Benchmarked NDAs were set on a year of high production. The cap, therefore, may not to be acting as a driver for land-use change for farmers, despite there being variation in nitrogen surpluses between farms and the presence of new entrants (potentially with a different world view) in the Catchment. In addition, farmers report that nitrogen is an asset that they are reluctant to sell because of potential effects on land values and this may be one reason why so many farmers have not changed land-use.

To understand the decision to continue with business as usual in the face of strong pressures to change land-use (such as low incomes from sheep and beef, rising demand for (and properties that are suitable for) dairy support, and the opportunity to trade nitrogen) investigation at a scale below that of the Catchment level is required. To this end, the following chapter focuses on the local, or community, spatial scale in the western sector of the Catchment, and the land-use systems that have evolved since the development of pastureland, up to 2013.

Chapter 7: Sub-Catchment case two: Landscape and land-use system changes in the western sector

7.1 Introduction

The introduction of nitrogen discharge limits (the cap) has inserted a new element into the relationship between farmers, land-uses, farming practices and the environment. In the last chapter, land-use changes in the north of the Catchment were investigated and revealed, when viewed at the Catchment scale, that 76% of consented land in the study area appears not to have changed land-use since the regulations were introduced[101]. However, Van Vliet, de Groot, Rietveld, & Verburg (2015) have pointed out that some land-use change only becomes apparent when the scale of focus is changed. Thus, this sub-Catchment case moves the focus of analysis from land-use viewed at a Catchment level (as in Chapter Six) to land-use systems viewed at the community level, to establish whether more subtle land-use changes have occurred.

The western sector of the Catchment has been chosen as the focus area for this case because when the regulations were first signalled in 2000, the predominant land-use was sheep and beef (and deer) and, despite there being many new entrants to this area, sheep and beef remained the dominant land-use in 2013. This case is centred on farms operating commercially at the time the regulations were introduced. The landscape biography traces the historical development of the area and the effects of the introduction of Variation 5. The biography then considers on-farm changes made by both original farmers and new entrants. Having chosen to move to this area it is expected that new entrants will have found innovative land-uses or mitigations that enable them to operate in a capped situation. The effects of changes in land-uses occurring on farms will lead to changes in land-use patterns visible at the local landscape scale. Thus innovative land-use change may lead to patterns of land-use intensification.

7.2 Sub-Catchment case description

The western sector is situated between the Hauhungaroa mountain range and the Lake. To the south are the large Māori-titled blocks which will be the subject of Case study three in Chapter Eight and to the northeast is the area that was the subject of Chapter Six.

[101] See Chapter Six, Section 6.7 and Appendix F

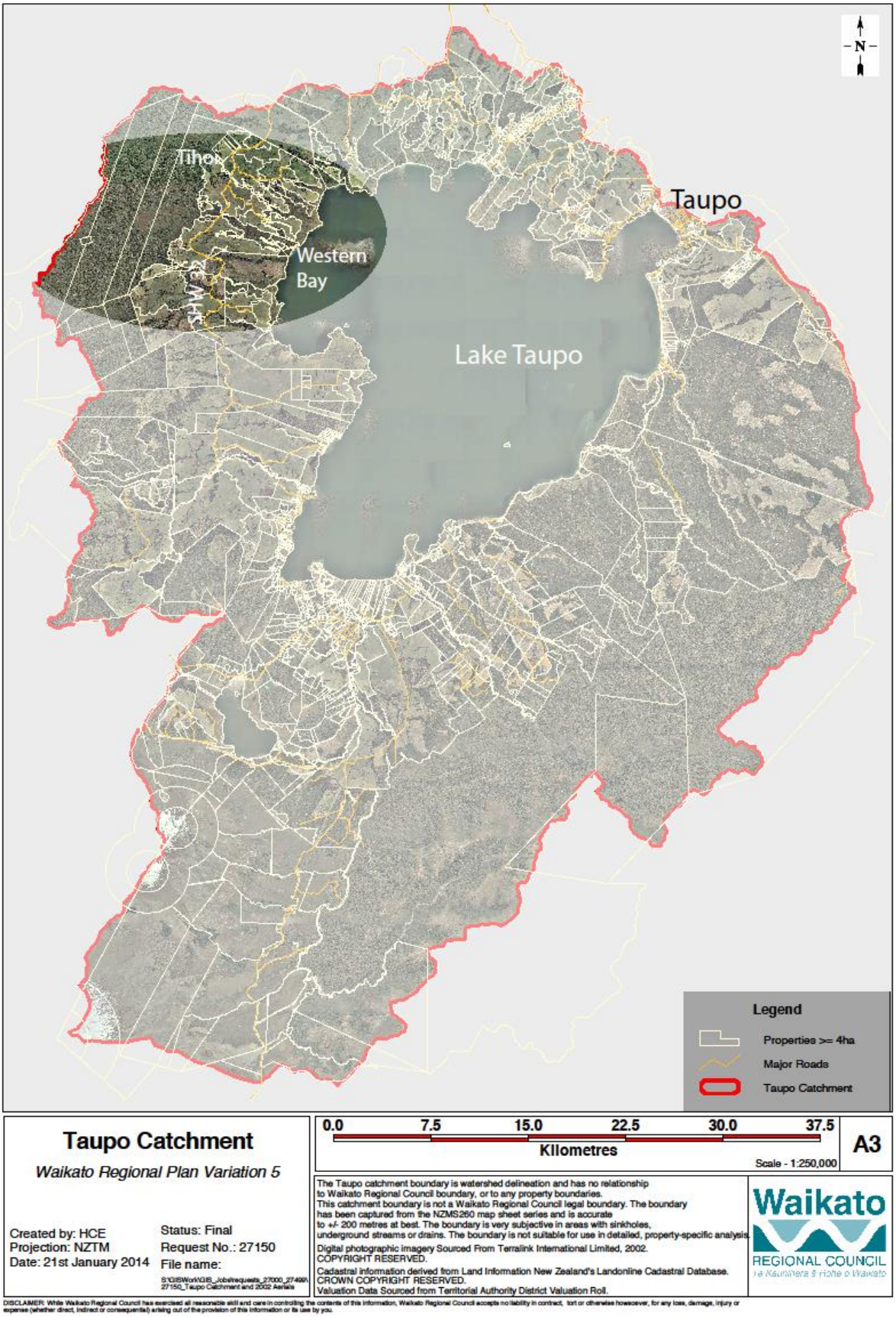

Figure 16: Map showing the location and main features of the western sector in 2002
(Source: Adapted from Waikato Regional Council, Reproduced with permission)

The western sector is commonly known as the 'Western Bays,' after the large natural harbour of that name in the western quarter of the Lake. The land is largely flat to undulating, suitable for pastoral farming or forestry but with little land that is suitable for arable farming (Landcare Research NZ Ltd, 2017b). Climate records are not kept for this specific area and thus it is assumed that the area has rainfall that is similar to that of Taupo. That is, rainfall is assumed to be around 950mm per year and the area subject to summer drought.

State Highway 32 runs through the length of this sector. It is a secondary highway which provides an alternative route around Lake Taupo when travelling north/south. Because it has few views of, or access to, the Lake it is an area that is seldom visited by tourists. There are no major towns or settlements in the western sector although there is one tavern (the Tihoi Tavern) that provides a focus and meeting point for activities such as the Young Farmers' Group. The Tihoi School once provided a primary level education for farm and forestry families in the area but was amalgamated with the Maroitiri School, located to the north of the Lake just outside of the Catchment boundary, when the forestry sawmill closed in 1979. There are no other schools in this area. The western sector, therefore, is remote and sparsely populated. Most pastoral land is sheep and beef (and deer) and there are lifestyle blocks on some of the secondary roads that lead to the Lake.

7.3 Recent history

Over time, farmers in the Catchment have adapted their farming practices to the realities of farming in the remote and challenging area. They developed low intensity farm systems that took account of long winters with low grass growth, summer droughts and free draining, low fertility soils. They protected the Lake with reserves and, in addition, they built strong local communities of interest and of farm support. Thus an equilibrium was established between biophysical factors, land-use and society – a socio-ecological system (SES) that has been relatively stable.

In the West this SES was linked to the historical development of the land as ballot blocks, which were all established at about the same time and all to the same standard, by the Department of Lands and Survey. Land was converted from the native tussock vegetation to pasture on two Department of Lands and Survey development blocks (Waikino and Waihaha) by the 1970s. The area was considered less fertile than land located closer to Taupo and thus it was one of the last areas to be developed, subdivided and balloted. In addition, a block of Māori-titled land to the south was converted to pasture, on behalf of the owners, by the Department of Māori Affairs.

The Waikino development block was broken into three farms and they were balloted in the early 1980s. A portion of the Waihaha development block was similarly sold off in the 1980s but most of it remained in government ownership, having been transferred from the Department of Lands and

Survey to Landcorp[102]. Thus by the end of the 1980s, after ballot farm subdivision had ceased, land ownership in this sector was a mixture of two large, government-owned farms, two large Māori-titled farms and around 20 European-titled ballot farms.

The ballot farm 'package' that was delivered to new entrant farmers included both a fully functioning farm and a readymade community. That is, as well as the developed pasture, fenced paddocks, and on-farm infrastructure (such as woolsheds and houses), the Department also built schools and settled several farms in the same location at the same time. Thus they created groups of fulltime farming families of a similar age, experience and, possibly, indebtedness. These groups were often situated in remote locations, cut off from other communities and local townships. There was a community of this type in the western sector of the Taupo district, as this ballot farmer recalls:

> *When I first came here the Tihoi Trading Post [*now the Tihoi Tavern*] sold everything from a toothpick to a saddle and if they didn't have it they would get it for you within a couple of days. That was fantastic because the roads were really rough here. [The most direct road to Taupo] was all loose metal and the water would run down the wheel tracks and gouge them out.*

This community provided its own social life (BBQs, tennis, dinners, darts at the pub, clubs such as the garden club and the Red Cross) and a peer group for farmers. One member of this community, still farming in the area, explains:

> *We would share tools, borrow drench if we ran out and help each other at peak times like crutching. Just knowing that you had neighbours that you could call on in times of need was very comforting but also those neighbours were a big part of our social life. We did lots of things with them - cups of tea, barbeques, talking over the fence, helping out with children. So with some of them we spoke every day and others we might see once a month - but they were all regular contacts.*

The local school, Marotiri Primary School (located just out of the Catchment area), was an important social hub. Many people in the district, even if they did not have children at the school, attended the social events, calf club days and working bees. As their children aged and attended high schools in Taupo township, however, the focus of social activities for some of the parents changed. Despite this, some relationships appear to have remained intact.

> *I still play tennis for the same tennis club and we play all around the district. But my wife does not belong to the Red Cross or to the garden club because we no longer have to rely on them for social contact.*

Despite the strong and supportive community network, farming life was not easy. The ballot farmers were heavily mortgaged and struggled to both farm the infertile pumice land as well as reduce their

[102] Landcorp became a State-owned Enterprise on 1 April 1987, under the State Owned Enterprises Act 1986.

debt levels. This was complicated by the level of farming skill of the ballot farmers, which is reported by interviewees to have varied significantly. Although all potential ballot farmers had to prove that they had five years' experience of farming full-time (Department of Lands and Survey, 1981), in the event, skill levels were not always appropriate for the situation and in some cases it appears that no amount of skill was going to make the farm succeed. A ballot farmer, located just outside of this sector, explains their situation in those early years:

> *So we arrived here in '82. We had basically a 600-acre farm - a dry stock farm - carrying 3000 stock units with debt at about 93% … For the year, we were down to 2000 stock units, and horribly in trouble basically. The farmers just weren't up to it. They settled us on a deficit budget to start with, so it was on deficit work. I think we had, if I remember rightly, - we budgeted for a gross those days of $77,000, and we were settled on a $13,000 deficit budget. So it was never going to work.*

Despite these challenges, some farmers retiring, new entrants integrating into the community and the difficult financial periods faced by farmers because of drought and/or changes to international product prices, the overall subsystem appeared to be relatively stable right up to the time that the regulations were first signalled. While the removal of subsidies in the mid-1980s was difficult for all sheep and beef farmers in the country (Gouin, 2006) it was particularly hard for farmers in the Taupo Catchment, many of whom had only recently been settled onto their ballot farms and therefore carried high debt levels. Farmers met this challenge by improving productivity. Fewer sheep with higher carcase weights, more beef cattle and favourable weather conditions (in the 1990s) all helped to keep farms somewhat solvent. The notion that this outwardly stable, low intensity system was endangering the Lake came as a bombshell to the farmers, particularly in the western sector which was, by 2000, the largest group of remaining ballot farmers. Many of these ballot farmers were close to retirement, and with the development of the regulations proving to be a drawn out affair, uncertainty about the future negatively affected land sales on the open market, as well as impacting the community and the well-being of farmers. In addition, the weather in the early 2000s was inconsistent (varying from very favourable to drought), and the economics of sheep and beef farming were continuing to decline. As tensions increased during the consultation period, the community began to fragment.

In the following sections, farm size, efforts to improve productivity, innovation attempts, community responses and mitigation options are all discussed.

7.3.1 Farm Size

The size of a ballot farm was established by the Department of Lands and Survey as a 'one-man' farm. That is, it could be operated by the owner with assistance from contractors (such as shearers)

at peak periods. A real estate agent with 35 years' experience in the Catchment suggested that many of the ballot farmers in the district were struggling financially during the 1990s because their small farm size meant that they had become uneconomic.

> *They were 3000 stock unit farms and they needed 4-4500 to be economic. Many farmers were trying to sell [during the 1990s].*

The same pressure, i.e. to increase stock numbers, was still operating in 2013. Two interviewed farmers claimed that, in 2013, 5-6000 stock units were required for an economic unit because "…*the margins are just so low*". They calculated that this equates roughly to a farm of 750 at eight stock units per ha[103]. But a Beef + Lamb NZ Environment Extension Manager claims that farms smaller than 5-6000 stock units can be economic providing the farmer is using all available technology. She suggests that a minimum of 400 ha is needed for a sheep and beef farm in 2013.

> *So farms greater than 400 ha, that have electronic ear tags, that weigh their animals and act on that information (by feeding appropriately and drafting well at sale time) are likely to be profitable.*

Ballot farms in the western sector in the early 2000s, by comparison, varied between 220 and 300 ha[104]. This suggests that amalgamation of farms in the northern and western sectors would be one way to counter falling profitability. In the Taupo area, however, amalgamations did not occur very often, possibly "…*because they [farmers] didn't have the money to do it*" as one ballot farmer suggested. Further, this same interviewee claimed, in the 1990s bank lending policies were the cause:

> *If you said to the bank that you were a good sheep and beef farmer and wanted to buy the neighbour's place they would think that you were nuts even if the amount that you were borrowing was the same [as the amount needed to convert to a dairy farm]. The cashflow is in dairy farming and they could see that. It is probably still the same now.*

Around the time that the issue of regulating nitrogen leaching was first raised, then, farms were largely the same size as when they were when first subdivided and sold by the Department of Lands and Survey. By the 2000s, these farms might be described as small and some as uneconomic, under sheep and beef. But, as the owner of a large European-titled farm in this sector observed (in 2013), for sheep farming to have a bright future these farms "…*need size*". Some farmers, particularly new

[103] North Island hill country sheep and beef farms carried between 8 and 13 stock units per ha in 2014. Sheep and Beef farm survey, (Beef + Lamb NZ, no date)

[104] In 2013, in the north, the average farm size was 114 ha close to Taupo and 235 ha to the west of the northern sector. In the south, however, Māori-titled farms averaged 3354 ha and European-titled farms averaged 315 ha.

entrants, turned their attention to land-use change in an attempt to make small units profitable and the farm amalgamations that resulted will be discussed in more detail later in the chapter.

7.3.2 Productivity

Originally, farms in the Catchment were settled as sheep and beef farms and typically they carried 10 stock units per ha (in the early 1980s) (Department of Lands and Survey, 1986)[105]. By the time of benchmarking (in the early 2000s), however, the median stocking level for farms in the Catchment was 14.6 stock units per ha[106].

The subsidy schemes of the 1980s had incentivised farmers to bring marginal land into pasture and to increase stock numbers, often to the point of overstocking[107]. Once subsidies were removed, production per ewe was increased. The use of technologies such as sheep pregnancy scanning and genetically improved rams (Amer, 2014) nationwide resulted in substantial gains in lambing percentages and improvements in pasture species and management led to an increase in carcass weights (McDermott, Saunders, Zellman, Hope, & Fisher, 2008). In the Catchment, interviewees reported lamb carcass weights increased from 15 to 18Kg during the 1990s and early 2000s. Thus, although the total number of sheep declined significantly in New Zealand, the total tonnage of lamb meat exported has increased since the 1990s (McDermott, Saunders, Zellman, Hope, & Fisher, 2008) because of increased production per animal (Morris & Kenyon, 2014). Lambing rates too improved and were reported by interviewed farmers to have increased from around 80 – 90% in the 1980s to 140 – 160% in 2012. These improvements, farmers reported, were the result of "…*increasing the quality of the grasses*".

A ballot farmer, who moved onto his farm in the western sector in 1981 with a debt level of 90% [of the sale price], reported that he intensified his operation by increasing lambing from 90% to 122%, and changing the percentage of cattle from 20% to 35% of stock. These improvements were achieved by increasing the number of paddocks on his 260 ha farm from 13 to 120 which, in turn, helped to improve feed management - according to interviewees, an important prerequisite for increasing lambing rates. With appropriate feed lambs can be fattened more quickly, higher carcass weights be achieved and lambs sent off the property earlier to meet the higher paying pre-Christmas market:

[105] The Otutira farm, located in this area and run by the Department of Lands and Survey (later Landcorp) ran 8.5 stock units per ha. (Department of Lands and Survey, 1986:46),
[106] From data provided by Waikato Regional Council
[107] As a result, many farms showed poor levels of productivity and the schemes were often referred to as 'skinny sheep' policies (van Reenen, 2012).

> *Traditionally the highest earning sheep meat will go out in October and November. From there the market works its way down to March/April when sheep meat is at its lowest price because that is when everyone is selling. That is a normal cycle.*

Although interviewed farmers talked about the productivity improvements that they had made, they also pointed out that the amount of feed available is often limited, since the Taupo Catchment has relatively low soil fertility, harsh winters and can be subject to dry summer weather. One ballot farmer explains the interaction between productivity improvements and biological limits as follows:

> *This property only grows a certain amount of grass, unless you're prepared to constantly put in new grasses (and there's a huge cost associated with that) … Sheep and beef returns have not encouraged us to really push our production performance. That extra push has a cost associated with it. For instance bringing in feed - the returns just aren't there to justify that.*

The crucial role of climate in the development of this sector was emphasised by a Landcorp farm manager who pointed to the 1990s as being a climatically favourable period.

> *[In the 1990s] the summers were wetter and so there was a lot more grass growth. If you keep on getting rain on this pumice country it keeps on growing grass – so long as the temperature is OK. And also the winters didn't seem to be so harsh. During those years even we started to fatten lambs.*

While rainfall records are not available for the Taupo area back into the 1980s, data from the National Institute of Water and Atmospheric Research (NIWA)[108] shows that in the 1990s there was only one very dry year (i.e. 1997 when there were more than 90 moisture deficit days). Lamb prices steadily increased over this period (see Section 6.3) and, coupled with improved pasture growth and thus higher carcass weights, sheep and beef farm incomes also improved. Unfortunately, weather patterns changed again. In the 2000s, NIWA data shows that there were six dry years (2000, 2005, 2008, 2009, 2010, 2013). In the period 2000 to 2013, these unfavourable growing conditions have contributed to a lowering of stocking rates in the Catchment (see Appendix G) - a reduction that is unrelated to the introduction of the regulations, but by coincidence happened at the same time.

Thus, despite the gains in productivity outlined above, sheep and beef farm returns, nationally, have continued to be low. For example, the internal rate of return[109] for dairy (excluding land values) averaged 5.7% in the period 2001 to 2008, but the IRR for sheep and beef farmers declined from 6.9% to 1.1% over the same period (Evison, 2008). Return on investment for sheep and beef was

[108] Data sourced from: http://cliflo.niwa.co.nz/ Retrieved May 10, 2015.
[109] The internal rate of return (IRR) is the rate at which an investment breaks even (present value of costs equal present value of incomes). It points to the desirability of an investment with the higher the IRR the more desirable the project, providing that this project returns more than the cost of capital.

3.3% (Evison, 2008) compared with 6.07% for ten-year government bonds[110] over the same period. Productivity improvements, therefore, have not proved to be a long term solution to low sheep and beef farm incomes.

7.3.3 Attempts at innovation

Alternatives to the traditional sheep and beef system were also tried in the Catchment, but there were few successes. One of the first deer farms in the country was located on the Landcorp farm in the western sector and deer have remained a significant stock type in the Catchment ever since, particularly on the Māori-titled farms in the south. But they have not been a popular choice of stock type overall. One ballot farmer, who farmed deer in the past, said that the industry "…*has gone through some shocking economic highs and lows*" and consequently were less suited to small farms because of the capital requirements for deer fencing and the impact of volatile prices on farm income.

A small number of farmers had beef operations in the Catchment in 2002. One such farmer, located in the western sector, reported that beef is a difficult market because of its "…*unreliability*". Another found that changing from sheep and beef farming to beef (in the late 1990s) did not solve his financial problems, and led to him eventually selling his farm.

> *The reason that I left was because I wasn't sleeping - my whole livelihood was at stake because I had high debt levels and an income that was insufficient.*

Other pasture-based innovations included an ostrich farm, set up in the 1990s in the western sector, which went bankrupt, and a goat milking operation in the northern part of the Catchment that has recently ceased.

Horticulture too was attempted in the Catchment. There have been small blueberry operations established but, according to a couple who grew blueberries for a time near Kinloch (in the northern sector) it is very labour intensive and, it did not return sufficient income to encourage them to continue. A trial patch on one of the Māori-titled blocks is currently being assessed for scalability. A block of saffron, established in the western sector, sold well in the Auckland market but was discontinued after eight years because of the difficulties of growing it in pumice soils. Last, a farmer, in the southern sector, began to grow potatoes in the 1990s, but it appears that no other horticultural enterprises have been established in the Catchment.

[110] Calculated from: http://www.rbnz.govt.nz/statistics/tables/b2/ Retrieved December 5, 2015.

Farmers have been planting trees for erosion control under the mantle of the Waikato Valley Authority, and a few farmers have tried farm forestry (i.e. animals grazing under trees) as an innovation in land-use. A 300ha block of eucalypt trees just outside of the western sector was established as a farm forestry operation in the 1990s. Recently, however, it was converted back into pasture by a new owner, after the previous owner was bankrupted. Other attempts at farm forestry in the Catchment have reportedly not been successful either. One interviewee, who had recently harvested their ten-acre woodlot, for example, reported that "…*there is no money in putting in small blocks of trees – as we found out*" because of high harvesting costs. Similarly, a new entrant to the Catchment, who bought a farm forestry block that was being harvested, said that he "…*wouldn't replant trees, because we couldn't plant a big enough area*" for it to be financially viable.

Forestry companies and syndicates, on the other hand, have recognised the potential of this area for plantation forestry. A ballot farmer in the western sector remembers when the interest from such companies in purchasing land in this area was high.

> *Carter Holt Harvey were looking at this area and had a plan to plant a lot of the farm land down Western Bays 'cause there wasn't any dairy here [and so land prices were lower].*

Such interest has led to the establishment, over the years, of several small plantations in the Catchment, including in the western sector, but even so plantation forestry has remained a minor land-use (other than to the east of the Lake and thus not the subject of this study).

Many farmers, therefore, saw changing from sheep and beef to dairying as the only realistic change in land-use system to become more financially viable. The farmer quoted below was farming in this sector in the 1990s.

> *Just north of the Catchment, they were small Lands and Survey ballot blocks and they all had to convert [to dairy] or get out because of the economics of sheep and beef. And that is what would have happened up the Western Bay as the ballot farmers sold out, or retired and leased their land out.*

The lack of alternatives to sheep and beef farming made converting to dairy or dairy support an attractive solution to the low returns that sheep and beef farmers were experiencing. It was a solution particularly suited to smaller farms because it is an intensive land-use. This brought the role of cattle in land-use systems in the Catchment to the fore.

Cattle have played a significant role in the Catchment because they provide substantial benefits to a dry stock farm system. First, cattle assist in building up a carbon layer in the soil (Hao, Chang, Travis & Zhang, 2003). This is important in pumice soils because they generally have low levels of organic

matter and the soil. Carbon, in turn, encourages pasture growth. A former sheep and beef ballot farmer, now a dairy farmer, explains:

> *The soil needs time to build up - years of fertiliser and animal return and building up the humus layer. You can see that [hummus layer] now. When we cultivated paddocks in earlier days it was very easy to reveal poor pumice knobs. Now it's a lot harder to actually find a bit of pumice – the soil is definitely building up.*

Second, cattle eat grass species that sheep are not partial to (particularly 'brown top'[111]). This stops undesirable species such as 'brown top' dominating the grass sward, and maintains pasture that will enable sheep and lambs to grow quickly (Morris and Kenyan, 2014). A Landcorp manager described how cattle can support sheep farming, as follows:

> *Sheep are 'grass maggots' – they kill grass by the way that they graze. Cattle are much better. So you have a much better chance of getting rye grass that stays there [with cattle] … The sheep will eat out all of the rye grass and everything else and the last thing that they will eat is the brown top.*

There is a third benefit to cattle and this is in relation to their complementarity with sheep (Morris, 2013). The proportions of sheep and cattle in the stock mix can be relatively easily altered to suit short term objectives. These might include changing market conditions ("…*see a gap and go for it*" as an interviewee described this), controlling the spring flush (e.g. by buying in surplus animals from other farmers) or because in times of drought they don't chew pasture too low and "…*it recovers more quickly in following years*" (a Trustee explained).

Without cattle, then, soils are slower to build an organic layer, poor quality pasture species are more likely to dominate the sward and short-term market opportunities are harder to take advantage of. These three factors, therefore, encouraged the retention of cattle on sheep and beef farms in this western sector as well as elsewhere in the Catchment. A survey of stock levels and types in the Catchment, undertaken by TLC in 2000, found that 48% of all stock units in the Catchment were sheep, compared with 6% for deer[112], 5% for dairy cows, 27% for female cattle and 13% for male cattle[113] (Thorrold & Ledgard, 2001). However, while sheep remained the dominant farm animal at the beginning of the cap and trade implementation, cattle were significant.

[111] A pasture species that has low productivity (Suckling, 1960)
[112] Deer are low nitrogen emitters (Hoogendoorn et al., 2011)
[113] The latter two categories include both beef animals and dairy support.

7.3.4 Collective responses to the proposed regulations

After the regulations were first signalled in 2000, the farmers quite quickly formed a lobby group, called Lake Taupo Care (TLC)[114]. A sub-group of TLC began a (nearly) two-year consultation process with the Waikato Regional Council (then known as Environment Waikato). There are conflicting reports from farmers on this consultation. On the one hand there are accounts, such as the following from a farmer member of the consultation group, that indicate that the talks led to gaining an understanding of each other's point of view and of genuine negotiation.

> *[Lake Taupo Care] had a consultation team that was involved for – I think it was around 37 meetings or something like that – meeting about every six weeks with Environment Waikato, AgResearch and other outfits - working through things. At times, we've agreed to disagree but we wouldn't let that drag us under … We'd built up a really good relationship - which is why it annoys us that people say Environment Waikato didn't actually consult.*

On the other hand, some interviewees felt that that the Council did not fully listen to the farmers. In particular, these farmers expressed doubts such as the following: there may have been methods other than regulation to tackle the problem, that there was reason to doubt the science[115], that the contribution of pine pollen to the nitrogen problem was minimised, and that their fears for the future of farming in the Catchment weren't being given sufficient consideration by the Council. Interviewees were frank about their reactions to the signalled regulations:

> *I was a very very angry person seven - ten years ago when the regulations were being worked out. The Waikato Regional Council [WRC] visited me and I got stuck into them – the girl left because she was sick of hearing from farmers like me about what the regulations were going to do to them. They were just doing a job - but they had been brain washed by their WRC masters and then they were coming out and talking to people like me and finding out that it was going to send us broke.*

Central to the issue of financial viability under the cap was the issue of how to apportion the required reduction in manageable nitrogen amongst the farmers. The quote below is from one of the farmer group that regularly met with the Regional Council:

> *What we argued for - successfully - through that consultation process was that there is a huge cost to the cap. The cost of the cap, that's a big cost to us already. If you ask us to individually reduce 20% as well then we're going to hit the wall and go bankrupt. And we proved that with quite a bit of financial modelling - and so that's when the Regional Council, along with the District Council, went to Central Government and said "We need some help".*

[114] See Chapter Five for more detail about this group

[115] A review of the underlying science was eventually commissioned by the Ministry for the Environment and Waikato Regional Council. The study found the science to be sound. See Hamilton & Wilkins (2005).

The eventual result was the establishment of the Lake Taupo Protection Trust with the funds to purchase and retire 20% of the manageable nitrogen load. Although this relieved pressure on short-term profitability it did not resolve the long-term profitability problem outlined previously. The negotiation, however, had bought much needed time for farmers to understand the issues, and the science, and decide whether they had a future in the Catchment or, if they could find a buyer, whether they should sell.

For many amongst the farming community, the net effect of this drawn out process was uncertainty and stress and one of the most unfortunate aspects was the toll that it took on the community. Fear of the future appears to have negatively affected relationships between neighbours and communities as this farm manager, a long-time resident in the Catchment, explains:

> *The regulations have fragmented the whole community now – no-one gets on with [name of farmer] for instance. It is a shame. We talk a lot at the pub about all the issues of the day and NDAs came up all the time … There is a lot of hostility around when people see what the outcomes have been.*

One possible reason for this fractious situation was that policy had outstripped science. Although it was science that had drawn attention to the potential for harm to the Lake, it had few answers for the farmers about how to minimise nitrogen discharge from farms. This knowledge gap was quickly recognised, and efforts were made to remedy it.

7.3.5 Options for improved nitrogen sensitive practices

In a study carried out on a Landcorp farm in the western sector, AgResearch compared the amount of nitrogen that leached from paddocks that were grazed by deer, sheep and cattle. This study (Hoogendoorn et al., 2011) established that Taupo was no different from other farming areas in that leaching from pastoral farming was occurring and that leaching under cattle was higher than that under sheep and was least under deer[116]. Thus it was clear that, although present-day farmers were not responsible for current levels of nitrogen in the groundwater[117], pastoral farming was contributing to the nitrogen problem, and would be a risk to groundwater in the future, particularly if animal numbers in the Catchment were not capped. It also suggested that an obvious way to reduce nitrogen discharges from farms would be to reduce the number of cattle. However, as pointed out previously, cattle play an important role in sheep and beef farming in income and pasture management complementarity.

[116] losses averaged 37,26 and 25 kg N/ha/year respectively (Hoogendoorn et al., 2011).
[117] Groundwater age is estimated to be up to 80 years old (Vant & Smith, 2002). Thus, current levels of nitrogen in the groundwater are the result of practices that were undertaken around 50 years ago.

Funds were obtained from the Sustainable Farming Fund (SFF)[118] to undertake a research study located on a Māori-titled land in the southern sector[119]. The study did not result in any clear directions for farmers but did suggest that improving stock performance (e.g. by continuing to improve lambing percentages and carcass weights) "*…emerges as the most profitable route for farmers in the short-term*" (Thorrold & Betteridge, 2006:3). The grazing study component of this research showed that removal of cattle between May and August reduced nitrogen leaching from 13 KgN/ha/yr to 5 KgN/ha/yr (Betteridge et al., 2007) but this result was not thought to be an economically viable option by the sheep and beef farmers that the authors talked to. Another proposal was DCDs[120] but their initial promise was not fulfilled, both because of cost, and concerns over food safety. The product was later removed from the market.

A study funded by FRST and the Sustainable Farming Fund[121], on a commercial farm in the western sector, looked at a range of options for improved nitrogen sensitive farming systems. In the first part of the study, begun in 2003, the investigation aimed to determine all potential options. In the second part of the study, members of Taupo Lake Care, in conjunction with the scientists, chose the 'best bets' from the options from stage one, and these were to be tested in a grazing trial on the same property from 2007 to 2010 (Ledgard et al., 2007). A full account of this research is yet to be published but interviewed farmers connected with the research claimed that no recommendations have resulted. One such farmer commented:

> *That 3-year research project was very practical. The farmer group had a lot of input into that to make sure it was practical - and it was useful. But there weren't too many tools in the toolbox and nothing's really changed. There's tinkering … But none of them [the tested potential tools] were really conclusive in terms of any major benefit.*

Other research has suggested that dosing cattle with salt in order to force them to urinate more frequently will reduce nitrogen leaching (Li, Betteridge, Cichota, Hoogendoorn, & Jolly, 2012) but some interviewed farmers expressed doubts about the ethics of such an approach.

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[118] This fund is managed by the Ministry of Primary Industries and is a contestable fund that invests in applied research and projects led by farmers, growers, or foresters. Retrieved February 20, 2017 from: http://www.mpi.govt.nz/funding-and-programmes/farming/sustainable-farming-fund/

[119] Sustainable Farming Fund project 05/114. Retrieved February 20, 2017 from: http://www.mpi.govt.nz/funding-and-programmes/farming/sustainable-farming-fund/

[120] An ammonium oxidation inhibitor that limits nitrate loss from soil. It was voluntarily withdrawn from the market in 2013 because of concerns about residues in milk. See https://www.sciencelearn.org.nz/videos/490-nitrification-inhibitors. Retrieved February 20, 2017.

[121] FRST – the Foundation for Research Science and Technology was a contestable Crown operated research fund. It was absorbed into the Ministry of Science and Innovation in 2011. Sustainable Farming Fund Project 10/088. Retrieved from: http://www.mpi.govt.nz/funding-and-programmes/farming/sustainable-farming-fund/sustainable-farming-fund-project-search/.

Beef + Lamb New Zealand came to the assistance of farmers in the Catchment by setting up Monitor Farms in 2008. One was on a commercial sheep and beef farm in the western sector and one on a Māori-titled sheep, beef and deer farm in the southern sector. The research project aimed to look at farming "…*sustainably and profitably under the nitrogen cap*" (Beef + Lamb NZ, 2012:3) and to disseminate information to other farmers through thirteen on-farm field days. At the last field day, held in 2012, Doug Edmeades (a science consultant and soil scientist) was asked to summarise the day's presentations. He commented as follows (Beef + Lamb NZ, 2012:23):

> *I guess in terms of the tools that farmers currently have I was disappointed with this section of today. I've heard of all these things [mitigation options] going back ten years and I was expecting and hoping to hear some really new initiatives from the scientists, some breakthrough ideas, some outside of the square thinking, but I did not hear that today and that disappointed me.*

The view that there are few mitigation tools available to farmers, particularly sheep and beef farmers in Taupo, is wide-spread. An interviewee, who was one of the government representatives on a Variation 5 consultation committee set up by the Waikato Regional Council, summarised the mitigation options for sheep and beef farmers as follows:

> *The big issue with nitrates of course is dairying. There is very little that sheep and beef farmers can do. They can play around – increase their sheep numbers and decrease their beef numbers - but you are not going to get big swings on that because you need both for income complementarity. So longer term the environmental restriction [Variation 5] may drag your farm down - which is a concern in Taupo.*

With few mitigations currently available[122], it seemed that a different approach to managing nitrogen discharges might be called for. The Sustainable Farming Fund provided funds for Taupo Lake Care to employ a consultant to look at the potential for individual environmental management systems[123] rather than a cap and trade system to regulate nitrogen discharges across the Catchment. The report, however, did not change the overall direction of Variation 5.

[122] The Waikato Regional Council have produced a series of booklets showing mitigations that are possible. One highly effective nitrogen mitigation suggested for sheep and beef farmers is more careful placement and timing of fertiliser applications and use of feed crops that actively grow through winter (Waikato Regional Council, no date b).

[123] The report recommended the establishment of a Catchment Management Group to facilitate a sound working relationship between stakeholders and ensure that the interests of each are fairly represented in achieving a reduction of 20% N output and a cap on N output from remaining pastoral land. Sustainable Farming Fund Project 03/210. Retrieved from: http://www.mpi.govt.nz/funding-and-programmes/farming/sustainable-farming-fund/sustainable-farming-fund-project-search/.

Other sector groups were also undertaking research on alternative land-use systems. The Sustainable Farming Fund provided funding for Pure Power Global to investigate energy farming in the Catchment[124] and the Lake Taupo Protection Trust funded projects looking at:

- the potential for hazelnut production[125],
- establishing the rate of nitrogen leaching under cut and export lucerne[126],
- establishing native trees as a woodlot[127], and
- using DCDs to reduce leaching from animal camps[128].

A member of the Lake Taupo Protection Trust suggested that the problem of lack of alternatives was a result of the "…*poor soils and short growing season*" which substantially reduced potential land-uses. The Group Manager at Waikato Regional Council who was responsible for Variation 5, however, suggested that a broader range of research was required:

> *All of the research that the Lake Taupo Protection Trust did about alternative land uses didn't show any silver bullet – but they were never asked to research miscanthus [for biofuel production] for instance.*

[124] Trial plots of willows were established in the southern sector and showed that it grows well in those conditions. The technology to produce biofuel from the willows, however, was still under development when the trial finished in 2008. Sustainable Farming Fund Project 05/058. Retrieved February 20, 2017 from: http://www.mpi.govt.nz/funding-and-programmes/farming/sustainable-farming-fund/sustainable-farming-fund-project-search/.

[125] The Hazelnut project showed that this crop will grow in the catchment and that there are some 4800 ha of suitable land there (with a further 4300 ha of possibly suitable land). However, the lack of a processing facility in the North Island, the high initial costs and the volatile market conditions make it a risky venture despite the good returns predicted in later years. Retrieved February 20, 2017 from http://www.laketaupoprotectiontrust.org.nz/page/lake_58.php

[126] By far the most promising results for Catchment land-use alternatives have come from this lucerne trial, which has shown that N leaching is well below previously established values. Once the results are incorporated in Overseer®, lucerne may offer an alternative crop for farmers in the catchment either as a feed source for e.g. housed animals or for a sale outside of the catchment. The economic viability is not established. Retrieved February 20, 2017 from: http://www.laketaupoprotectiontrust.org.nz/page/lake_65.php. A second stage of this project is being funded by the Sustainable Farming Fund (Project entitled "Lucerne grazed by stock" and received funding in the 2016/17 funding round).

[127] The native trees establishment trial has shown that a variety of natives can be used as alternative tree species in the catchment at a cost not too far above radiata pine or eucalyptus. One of the Māori Incorporations (located in this Western sector) has sold N to the LTPT and is planting 153 ha in native species. Retrieved February 20, 2017 from: http://www.laketaupoprotectiontrust.org.nz/page/lake_60.php

[128] The project has been stopped since DCDs are currently withdrawn from the market. The first of these studies has shown that intensive use of DCDs during feeding-out during winter reduces N discharge. The second established that camp sites for animals can be predicted and thus potentially treated with DCDs to reduce N discharge. This latter would reduce the cost of DCD application for e.g. sheep and beef farms. Retrieved February 20, 2017 from http://www.laketaupoprotectiontrust.org.nz/page/lake_59.php

In the end, all of the research undertaken both within and outside of the research community did not come up with any alternative farm practices, useable mitigations, or viable, low nitrogen farm systems that could be adopted by farmers in the Catchment.

Researchers were not the only people that were looking for a solution. Numerous well-meaning 'experts' descended on Taupo in the mid-2000s, set up meetings, were interviewed by local newspapers and suggested a variety of farm practices and new land-uses to farmers. However, as this farmer explains there is a crucial gatekeeper in the regulation system:

> *You get every witch doctor and snake oil salesman trying to sell you something - saying this will solve the problem. Whether it may or may not work is irrelevant. It's whether or not OVERSEER® accepts that it works or not. There may be some technology that's absolutely brilliant, but until it goes into OVERSEER®, it's irrelevant … [this is] farming at the whims of OVERSEER®.*

Eventually, the patience of farmers was worn out by this constant stream of advice from sector and interest groups and lack of progress from the science community. An ex-member of the Lake Taupo Joint Committee who has been closely associated with the Taupo implementation from its inception, summed up the situation as follows:

> *There is very little that sheep and beef farmers can do [about nitrogen discharge]. They can play around … but for sheep and beef farmers I think that there are limited options open to them.*

Further, if there were answers to be had, they had to be included in the OVERSEER® model that was used to implement the new regulations and monitor the performance of consented farmers.

7.3.6 OVERSEER®

The OVERSEER® model is the tool that has been accepted by the Waikato Regional Council and the Environment Court for calculating the NDA for a farm and for monitoring compliance with allocated NDAs. All land-uses, including any new land-uses or farm practices that involved nitrogen discharges therefore needed to be included in it[129].

The OVERSEER® model was developed as a tool for tracking nutrient movements on an individual farm and its use as a monitoring tool has been controversial (e.g. Edmeades, 2015). None-the-less its use for the calculation of nitrogen leaching from farms in the Taupo Catchment was confirmed by the Environment Court (Environment Court, 2008:13) in its interim ruling in 2008 (and later confirmed in

[129] The Variation 5 regulations allow other models to be used in place of OVERSEER® as long as they provide results of a comparable robustness to those produced using the OVERSEER® model (Waikato Regional Council, no date a).

2011). The model is regularly updated and scientific developments are incorporated[130] but given the nature of research, and the level of proof required, it cannot include all land-use or farm practice alternatives. For example, outlier situations are reportedly not included in the model. A Trustee of one of the Māori-titled Stations in the south believes that their Trust has been disadvantaged by the NDA it was allocated. OVERSEER®, they claim, was unable to allow for the heavier sheep and higher lambing rates that occurred on this farm.

> *Our sheep are different from other sheep. We have put a lot of effort into improving the genetics of our sheep by selecting those that are good for sheep milking and so they were 15-20 Kgs heavier than other sheep in the Catchment. We classified our sheep as 1.2 stock units rather than the normal 1 stock unit … Our benchmark is the same as the Station next door and their ewes only weigh 55kg.*

Similarly, growing non-grazed lucerne as a cut and export crop is currently problematic in OVERSEER®. Initial research within the Catchment found that lucerne leached 19KgN/ha/yr (Thorrold & Betteridge, 2006). This high leaching rate was incorporated in the OVERSEER® model and is used in the monitoring of farmers against their consented discharge allowances. Recent research, however, has found that once lucerne is established it leaches no more nitrogen than does ryegrass/clover pasture (i.e. around 5 KgN/ha/yr)[131]. It is not known whether the substantially higher value in the OVERSEER® model has disadvantaged farmers but the potential is there – as it is for land-uses that are not included in the model. Staff at the Waikato Regional Council, being aware of this problem, make every effort to model novel uses so that the options open to farmers are not limited to those available in the OVERSEER® model that is in use in the Catchment (i.e. Version 5.4.3) (Megan Coup, Waikato Regional Council, personal communication). But this modelling, the same Council source advised, could require substantial and expensive input from researchers (e.g. AgResearch) and the farmer concerned would be liable for the cost.

New entrants, looking to invest in the Catchment, it is reported, are also deterred by the need to have land-uses and farm practices included in OVERSEER®. The CEO of the Lake Taupo Protection Trust explained:

> *I mean, I'm dealing with investors in Auckland who will invest maybe $30 or $40 million into a packaged biofuel plan. And what is the stumbling block? Finding out what nitrogen miscanthus leaks [to include in OVERSEER®]. Businessmen, they run for cover around that sort of stuff.*

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[130] OVERSEER® is jointly owned by the New Zealand Ministry for Primary Industries (MPI), the Fertiliser Association of New Zealand (FANZ) and AgResearch Limited and these owners are responsible for keeping the model up to date with new developments in land-uses and farm practices (OVERSEER Ltd, 2013).

[131] Nitrogen leaching from cut and carry lucerne. Retrieved February 20, 2017 from: http://www.laketaupoprotectiontrust.org.nz/page/lake_65.php

OVERSEER®, therefore, has become both an enabler and gatekeeper. It enables cap and trade because it is the mechanism for calculation of farm-level discharges (and thus the source of Variation 5 being an exemplar implementation). However, it controls the land-uses and farm practices that investors/farmers can implement. Despite the assistance that local staff of the Waikato Regional Council offer innovative farmers and investors, there is no way round the need for scientific studies to be undertaken before such land-uses and farm practices can be granted a consent to operate in the Catchment. As many interviewees commented, "…*If it is not in OVERSEER®, it doesn't count*". Or as one interviewee exclaimed, "…*If you can get your 'thing' into* OVERSEER®*, you're home and hosed – it is almost like a 'golden goose'".*

OVERSEER® is constantly being updated. While the version that is mandated by the Environment Court for use in the Taupo Catchment is version 5.4.3, the version in use outside of the Catchment is version 6. Reconciling these two versions is not simple, and there are expected to be effects on individual farm NDAs and on the farm practices that can be undertaken. For example, pastures need to be renewed on a regular basis to maintain productivity but the ploughing of pasture is not included in version 5.4.3. At study by AgResearch (Betteridge, Crush, Ledgard, Barton, & Barton, 2011), however, showed that high levels of N (63 kgN/ha) are leached as a result of the mineralisation of organic N (associated with soil disturbance such as ploughing) during pasture establishment. If ploughing is included in the version of OVERSEER® in operation in the Taupo Catchment then, the study concluded, either stocking rates would have to be reduced to enable pasture renovation or pasture would deteriorate over time. Thus OVERSEER®'s role as enabler and gatekeeper is likely to be long-term, and to apply to both innovation and to current farm practices.

7.4 Local, community-level effects of farming under a cap

As noted in the previous biography of the northern sector, farmers were very uncertain about how the regulations would play out and what the effects would be on the capital value of their land or on their long-term future. Many chose to exit and their farms, including the Landcorp farms, were sold – some to the Lake Taupo Protection Trust and others to new entrants. By 2013 in the west, only a handful of the original farmers remained. Of the estimated 22 properties in this area in 2002, 17 were sold and seven new entrants moved into the area. Of the original farmers that stayed on, one had by then semi-retired, one (a Trust) reduced stocking levels to a very low level and became a permitted activity and just one commercial farmer remained operating.

Farmers interviewed in 2013 remained concerned about their economic survival[132], particularly since there were only minor land-use and mitigation alternatives available. Concern was also expressed

[132] See Chapter Six Section 6.7.4.

about changing social conditions. The tight knit community created by the ballot system and continued (at least in the west) by new entrants when ballot farmers retired or sold appears to have been severely negatively affected by the introduction of Variation 5. Prior to the regulations farmers exchanged tools, assisted each other at peak periods and interacted regularly. Families would get together for social occasions, support school events and provide assistance with children. However, since the regulations were signalled,

> *Social networks have broken down. There are not enough young farmers around now to get things up and running. Normally when farmers (owners) leave they are replaced by another farmer – often a young farmer – so the social network would continue. But now there is no opportunity for someone else to come in.*

Such effects are not limited to the western sector. Two interviewees from the southern sector also suggested that there will be social effects, in this case on the local economy. A farm manager commented as follows:

> *The other thing about the nitrogen cap is that it will take a lot of money out of the [local] economy. We have dropped 5000 stock units - which is one labour unit [on farm] - but it has flow on effects in trucks, shearers and other contractors. These stock units have not been transferred outside of the Catchment – they have been dropped completely.*

This point of view was supported by another interviewee, a Trustee in the southern sector:

> *The Stations and the Forest Trust are the big income earners for our people … the major social effect [of the regulations] is that there is less money flowing through the community … Dividend payments [to owners] are lower, there's lower levels of support for community groups [like the marae] and in some cases, fewer jobs.*

The entry of new comers could be expected to compensate for the exiting farmers and farm workers but this did not occur. One new entrant in the west explained why social networks have broken down in the west.

> *The people that have moved into the community (like [Name] and ourselves) don't add much to the community. The money that we make doesn't stay here. We employ a skeleton staff and what they earn is what they need to live on and this is very bad for Taupo because there is no new investment here … Our farm has taken 11 families out and replaced them with five [unmarried] employees.*

Farmers in the north commented on the 'hollowing out' of the farming community that had taken place there because of lifestyle developments already under way. Such community changes may have already been underway in the west. This real estate agent suggested that low returns in the

sheep industry were already leading to social changes, with fewer young farmers starting out and more farm owners (and workers) being located outside of the Catchment.

> *So farms in this area were selling as "starter packs" for new farmers to build up capital and then sell and move to a bigger unit*

The negative effects of the regulations on the social communities in the Catchment may have amplified changes already underway due to demography changes, economic pressures on sheep and beef farms, and the reduction in farm size due to lifestyle block developments.

7.5 Local, community-level land-use changes

At the community level, there are two major changes discernible in this sector and both have occurred in response to the regulations. The first involves amalgamation of Landcorp and neighbouring farms. As explained in the previous chapter, this study suggests that the regulations were an influence on the decision by Landcorp to exit the Catchment. For other farmers in the western sector, the uncertainty created by the delay in implementing the regulations, and the worry that long-term viability would be compromised by the regulations, were drivers of the decision to exit. Thus, the amalgamation of farms that resulted from these two groups of exiting farmers can be attributed, at least in part, to Variation 5.

The second response that is evident at this level is the amount of de-intensification[133] that has taken place. This response is the direct result of trading nitrogen (mostly with the Lake Taupo Protection Trust) and, as will be shown, this explains the trading that took place on farms that have not changed land-use. It is of concern because, without intervention, it signals a lowering of income to the Catchment.

In the following two sections these farm system changes are considered in more detail. The last section considers another, less prevalent, farm system change i.e. intensification of land-use[134] that does not involve increasing NDA levels.

7.5.1 Farm amalgamations

Changes of ownership since 2000 have resulted in a reduction in the number of farms in the western sector. One of the reasons for this is that two new entrants in this area purchased multiple farms

[133] Van Vliet, de Groot, Rietveld, & Verburg (2015) define de-intensification (or disintensification) as a reduction in the intensity of land management. See definition of intensification below.

[134] Lambin, Rounsevell & Geist (2000) define agricultural intensification as an increase in output production from, or input use on, the same land area. Input variables include fertiliser and pesticide use and outputs refer to measures such as food tonnes or calories produced per hectare. In New Zealand, intensification tends to be associated with increased animal stocking rates and/or increased numbers of cattle (Watters, Rowan & Williams, 2004) but it can also be used to refer to increased output (e.g. meat production) per ha.

and amalgamated them into larger farm operations. The first involves the amalgamation of three ex-ballot farms, and the second is centred on ex-Landcorp farms.

Landcorp had two farms in this sector: Motere at 1450 ha and Otaipuhi at 1333 ha. These farms were sold by Landcorp to the Hikuai Trust in 2008 who then on-sold them to a North Island based, sheep, beef and deer farming family. One of the owners explained that the attraction of moving into the Catchment was the cheapness of the land, its suitability for deer and being able to purchase a large farm:

> *We came here because we saw the opportunity. For the same cash we got a bigger property - going from 8,000 su to 24,000 su. We are in sheep and beef and because of the cap here in Taupo there is no competition from dairy - we can't pay their prices … We knew when we came that because of the cap we would only ever be able to farm to a certain level – but for what we want to do this is the best farm in NZ.*

The other attraction of the Catchment was the ability to trade nitrogen. This farmer saw nitrogen as a saleable asset so if the farming venture did not work out he "…*could sell the nitrogen out of here and put it into trees*". This, however, is a last resort because the future of sheep and beef, according to this interviewee, is positive, and as evidence to support this view he suggested looking at the larger sheep stations in the south.

> *They [the big sheep farms] are doing OK – they just keep quiet about it. Sheep farms need size.*

Since moving into the Catchment, this farmer has purchased three neighbouring sheep and beef farms and has amalgamated them with his original purchases to give a farm of roughly 3600 ha in 2013.

Chapter Six describes how the purchaser of the ex-Landcorp farms in the north-west of the Catchment also purchased neighbouring land to amalgamate with their dairy farm, and how a dairy farmer (located outside of the Catchment) had leased and purchased several properties to provide a non-contiguous dairy support unit. This pattern of non-contiguous titles being brought together to form a 'farm' was repeated by other consent holders. However, such amalgamations may be of a transitory nature as the largest of these farmers explains below:

> *The land that I lease will become a lot less viable when the nitrogen lease runs out – and I may not renew my lease on the land. (Because I won't be able to farm the way that I want to). If I choose not to renew it then this landowner has a problem because his NDA is only 12 – which makes it sheep and beef [not dairy support].*

This construction of different, non-contiguous parcels of land into larger corporate farming enterprises is a notable feature of the northern sector.

The largest amalgamations involve ex-Landcorp farms. Purchasers of these farms mentioned the cheapness of the land and the business certainty provided by the number of years that consents are granted for. The General Manager of the dairy platform in the northern sector of the Catchment explained the drivers of their decision to purchase as follows:

> *We managed to buy land cheaply, we've converted it to a land-use which is the best land-use for that land and we get a return on our investment – knowing that we can live on that for 25 years doing what we are doing.*

If amalgamated farms are assumed to be more economically viable than smaller farms, then the ability to trade nitrogen, combined with the sale of Landcorp and neighbouring farms, have contributed to improved economic wellbeing for these localities. Comments from one of these new entrants and farmer interviewees, however, suggest that this may not be the case for the social well-being of some localities.

7.5.2 De-intensification

A more common response has been to de-intensify. Since the introduction of the regulations over half of the farms in the western sector have sold nitrogen, either to the LTPT or to a dairy farmer in the northern sector. The consents associated with these transactions show that the sellers have either contracted to convert the land-cover to trees or to reduce their stocking rate from their benchmarked level. Often the stock type and stock mix are not changed (or are marginally changed) and thus it appears that no land use change has taken place. Stocking rate reductions are important, however, because they suggest a reduction in the productive capability of the land in perpetuity (assuming the same or similar land-use) that may not be balanced by other (potential) income earning land-use change.

The reality of operating a pastoral farm on a low NDA was described by a ballot farmer, located in the northern sector. A mistake in the benchmarking process led this farmer to sell more nitrogen than he intended and now he has a ballot farm with a very low NDA. His intention, at the time of the sale, was to fatten beef and raise lambs on the better land and to plant all land of low productive capability in trees. With a much lower than expected NDA, however, he finds that he cannot raise sufficient animals to be profitable, despite having no mortgage. He has tried to purchase NDA to boost the pasture NDA level (and therefore enable him to carry more stock), but so far has only managed to purchase a small amount and to lease, short-term, a larger amount. To live off a low NDA, he suggests, a farmer would have to be "…*fulltime, mortgage free, not raising a family*" and even then it would be "…*existence living*". This low NDA farmer concluded, "…*after my experience I wouldn't recommend anybody sell any NDA*", particularly if it involved a reduction in stocking rates, because over time the farm becomes less financially viable, as he explains below:

> *Today, 150 beef cows [and lambs] do not make a living but I sold down to that level because I wanted to [semi-retire] … But time has moved on, expenses have moved up and the price of cattle has not moved up to match … I am now in a position where cost increases have caught up with me. I am working harder than ever before – but over winter I will have little to do.*

Research has shown, in the dairy sector, that lower stocking rates can lead to higher incomes because with fewer animals and extra feed on the farm, higher levels of production per animal can be achieved (Dewes, 2014). But, as the farm manager below explains, in sheep and beef this type of system is risky, and requires a high degree of technical skill:

> *There is a fine line between the stocking rate coming down too far and the grass exploding in the spring and not being able to graze it sufficiently. If that happens everything grows slowly because the pasture quality has gone down … To run this kind of a system you have to be constantly going into OVERSEER® … and you have to be calculating the feed (in the feed budget) … and you have to be watching the markets…*

Outside of the western sector, sales of nitrogen have also been accompanied by reductions in stocking rates. The table below lists farm practice changes involved as well as the percentage of nitrogen that has been sold in the western sector. Data for the northern and southern sectors can be found in Appendix I.

Sale to LTPT or private	% N sold from farm[135]	Land-cover change	Land-use change	Land-use system change
LTPT	85	Forested 235 ha	To plantation forestry	
LTPT	20	Forested 800 ha	To mixed farming – woodlots and pasture	Change stock type Amalgamation of ex-Landcorp farms and ballot farms
LTPT	43		To sheep/beef	Change stock type Amalgamation of three ballot farms
LTPT	80	Forested 1150 ha and created four lifestyle blocks.	To plantation forestry	Amalgamation of four ballot farms

[135] The percentage of nitrogen sold from the farm approximates the reduction in the productive capacity of the farm (since NDA and farm production levels are closely linked) but it does not consider other land-uses that have been established and which may compensate for lowered production. Where woodlots have been planted, for instance, productive capacity may increase again once the trees reach a harvestable size and assuming harvesting costs (because of the small area involved) are not prohibitive (Park, Manley, Visser & Morgenroth, 2012). In another instance, a cut and carry operation has been established. Under this system, pasture is harvested and is sold as feed outside of the Catchment, but the profitability of the system is unknown. An interviewed farm consultant, when asked about the economics of cut and carry, said that he was "…*doubtful*" about the viability of such a land-use on a large scale. Dairy farm profitability, he explained, is sensitive to the cost of brought in feed (see Beukes, Gregorini, Romera, & Dalley, 2011), and, in-addition, the carbon emissions involved in harvesting and transporting the feed may be problematic when agriculture is required to enter New Zealand's Emissions Trading Scheme.

LTPT	12	Forested 153 ha	To mixed farming	
Private	37		To dairy support	Reduction in stock numbers
Private	60		No change	Reduction in stock numbers

Table 17: On-Farm changes resulting from sales of nitrogen in the western sector
(Source: LTPT, WRC and interviews)

In summary, in the western sector:

- Two farms changed stock type (i.e. from dairy support to sheep and beef and from sheep and beef to sheep/beef/deer). The amount of nitrogen sold was 43% and 20% respectively of their initial allocation.

- Five farms have been converted to forestry and are now owned by two landowners

- Two farms have de-intensified by reducing stocking rates, one by 60% (but this is a lifestyle farm).

Thus, in the western sector, there has been a substantial reduction in animal numbers but this has been compensated by an investment in other farm systems or land-uses. In one case amalgamation of ballot farms with ex-Landcorp farms has resulted in an extensive operation, and economies of scale. In a second case, land has been converted from sheep and beef to forestry.

This compares with the situation in the southern sector where sales of nitrogen have resulted in substantial reductions in stock numbers, and reductions in NDAs (ranging from 7 to 44%, see Appendix I), often apparently without investment in other income earning ventures. De-intensification of this type has enabled farms to raise capital at the same time as contributing to reduced levels of nitrogen entering the Lake, but the flow on effects to the community are unknown. Although no owners or Trustees in the situation described in the quote below were interviewed, one Trustee of a farm in the southern sector commented that:

> *The worry is that the money that they [other Trusts] have received will be spent and not available for reinvestment [on farm] … So the issue is not about costs outweighing expenses it is more about how much capital gets reinvested in the farm or whether that capital gets diverted to other uses.*

The trend to de-intensification identified in the table above may prove problematic for the viability of farming in the Catchment if alternative, viable, income sources are established.

In the northern sector sales of nitrogen resulted in the establishment of forestry blocks (one with a carbon contract) of between 25 and 930 ha, of lifestyle subdivisions and, in one case, of a less intensive feeding system for cattle.

Alternative income sources that would enable a viable economy in the Catchment are currently limited. In the wider district, there is an acknowledgement that farming (particularly dairy farming) underpinned economic growth in recent years and that this income source is preferable to tourism because of the low wages paid and the itinerant nature of employees in this latter industry. The Chair of the Economic Development Agency (Enterprise Great Lake Taupo) commented:

> *Although tourism is still number one in terms of jobs in terms of GDP agriculture, forestry and geothermal have really come up. There has been quite a rebalancing in this economy … The amount of dairy cows in this region now is what is keeping us afloat.*

The comments were supported by a Taupo District Council Councillor who suggests that

> *We need stability because of the up and down nature of the tourist business and stability comes from having higher paid jobs. Tourism is renowned for paying lower wages although it is as high as the industry can afford. But if you had some better industry that needed a higher skill set you would end up with higher paid people in the community with more money in their back pocket to spend and there is the trickle down that comes from that. So that is what Council are trying to do – to get a higher paid type industry in the district. Tourism staff are also transient because it is so seasonal.*

Thus tourism, often considered an alternative source of income for the district if environmental restrictions lower farm production (McDermott Fairgray, 2001), may not be problem free, and the contribution of farming and forestry may be valuable.

7.5.3 Intensification without increasing NDA levels

Chapter Six outlined two significant land-use changes in the northern sector of the Catchment, i.e. the conversion of sheep and beef land to dairy platform and the establishment of dairy support units. Both of these involve a change of stock type and a move from a low nitrogen emitting animal (sheep) to a higher nitrogen emitting one (cattle). Under conventional definitions of intensification (e.g. Watters, Rowan & Williams, 2004) increasing the number of cattle is a form of intensification and generally is associated with increased profitability. However, in a capped situation, intensification and profitability are potentially decoupled. Thus the land-use can be changed from sheep and beef to dairy support but, because of the discharge limit that applies to the farm, intensification i.e. higher numbers of animals and/or higher use of nitrogenous fertilisers (Watters et al., 2004:4) and higher levels of nitrogen discharge, have not occurred. Several farmers suggested, however, that such a land-use change improved profitability (see Section 6.3). The term 'intensification', therefore, aptly describes the conversion of sheep and beef to dairy platform, facilitated by trading of nitrogen, that occurred in the northern sector, but does not adequately describe the change from sheep and beef to dairy farming, dairy support or similar where extra NDA is not required.

In the western sector, three farms have undergone a change of this type. One changed stock type from sheep and beef to 100% cattle, but the other two are dairy support farms. As one of these farmers explained, dairy support is a more profitable land-use than sheep and beef:

> *I don't like sheep, they're too much work and there's not enough money in them … The thing is with dairy grazers and that - it gives you a meaty cash flow on a monthly basis. Whereas with beef you're either waiting 12 months or 18 months and with lamb you're waiting once a year for a lamb cheque.*

Although this farming couple changed the stock type of the farm, they found that they were not using all of their NDA allocation and so sold the surplus. In a sense this was a windfall allocation because their benchmarked year was one where they happened to have a higher level of stock on the farm than they planned to have over the long term. Although the income that the farm now produces (on the lowered NDA) was adequate for their needs, this couple agreed that "*you'd be hard pushed*" to raise a family on such an income. If they had not sold the NDA, however, the income from the farm, they suggested, would be sufficient and there would be room to "*wind the farm up with even more stock*". In Chapter Six (section 6.7.2) another case of 'intensification' without raising the NDA level of the farm was outlined. In this case the owners of a station in the south have expanded their dairy farm (intensified their land-use) and reduced the size of their sheep and beef unit. Last, a dairy farmer in the northern sector reported that he had purchased land outside of the Catchment so that he could "…*grow*" his operation. Thus he has 'intensified' without increasing the NDA level of his farm within the Catchment.

In the Catchment, therefore, both intensification (by increasing the NDA of the property) and 'intensification' (without increasing the NDA of a property, but improving the profitability) are occurring.

7.6 Chapter summary and conclusions

This section describes the landscape transitions that have taken place in the western sector, notes key drivers of the changes and concludes by considering the consequences of the land-use changes that have taken place.

The western sector was, in many ways, a model SES. Since the 1970s when ballot farms were first sold in this area, social, economic and environmental factors had all melded to produce farm systems that functioned well for the farmers concerned. Thus the ballot farm community, the last such community in the Catchment, thrived in this area. Unfortunately these farm systems became less and less economically viable due to exogenous changes such as reductions in international product prices and the removal of farm subsidies. Farmers in this area did not subdivide to the same extent

as happened in the north because the area is remote from townships and the potential for lifestyle subdivision and tourist developments is limited. Consequently farm sizes remained unchanged and on-farm practices and land-uses became the focus for financial progress. Improvements in on-farm productivity (e.g. carcass weight and lambing percentage increases), however, proved not to be a complete solution and many farmers were turning to cattle farming as a means of improving incomes on small/medium sized farms. Several farmers increased their cattle to sheep ratio, one new entrant raised 100% beef, and another established a dairy support unit. A third farmer bred bulls in addition to running sheep and beef. Signalling the introduction of Variation 5 in 2000 caused huge concern amongst these farmers since under Variation 5, continuing to increase cattle numbers was no longer possible, and they believed their financial viability was threatened. As in the north, this proved to be the point at which the landscape changed paths and a new landscape transition began.

Farmers in this sector were active in the farmer lobby group (Taupo Lake Care) that was formed to represent farmer interests. Discussions between this group and the Waikato Regional Council centred on how farming could continue under environmental limits and, in part, led to a burst of scientific studies. Research into mitigations and alternative land-uses, however, did not find any significant land-use or farm-practice alternatives. Further, OVERSEER®, the model that enabled the establishment of nitrogen discharge limits for individual farms, now became the gatekeeper that determined the practices that could be undertaken on-farm. Innovation by individual farmers was almost impossible because of the cost of the scientific proof that would be required to get new uses/mitigations into the model.

Some farmers were so discouraged by the situation they found themselves in that they chose to exit the Catchment. Out of 22 properties in the western sector, only one original (commercial) farmer remained by 2013. Although several of the farmers that left were ballot farmers close to retirement, others, including Landcorp, also exited this sector in the mid-2000s. The sale of the two large Landcorp farms located in this sector, however, offered an opportunity for a new entrant to establish a large deer/sheep/beef farm (selling nitrogen and undertaking carbon trading in the process). Another new entrant purchased Landcorp farms in the northern sector and established a dairy farm (using nitrogen trading to augment the farm's NDA) and both new entrants amalgamated their ex-Landcorp farms with neighbouring ballot farms to achieve economies of scale. The drivers for these purchasers included attractive land prices, large land parcels and, for the dairy farmer, certainty around the environmental rules and therefore improved business certainty (unlike elsewhere in New Zealand). Nitrogen trading facilitated the land-use and tenure changes that occurred. Other amalgamations that occurred were on a smaller scale and involved uniting three or four ballot farms into a single enterprise. Thus amalgamation was one farm system change that occurred which had potential for ensuring a viable agricultural sector and the change was facilitated by trading.

Another farm system change that occurred, de-intensification, was the direct result of nitrogen sales and thus a response to the regulations. The de-intensification is of two main types. In the first, one land-use is replaced by another (potentially) income-earning land-use. The change from sheep and beef farmland to plantation forestry is a common example of this in the western sector (and in the Catchment) and the income potential is enhanced if there are carbon contracts attached. In this case one type of community may, in time be replaced by another type as income sources move from pastoral farming to forestry. This scenario, however, is dependent on the cost of logging of forests since some of the plantings in the Catchment have been quite small, ranging from 23 ha to 1150 ha. Research elsewhere in New Zealand (Park, Manley, Visser & Morgenroth, 2012) suggests that small blocks of forest may be uneconomic to harvest.

The second de-intensification type, however, is a subtler change but also with far reaching effects. It involves those farms that have reduced stocking rates but do not appear to have invested in alternative ways of making up for the reduced income that follows from the reduction in stock numbers. It appears that these farms have traded nitrogen but have not changed land-use. Thus the answer to the anomaly pointed out in the previous chapter about farms that have not changed land-use, but have traded nitrogen, appears to be that these farms, particularly in the south, have sold some of the productive capacity of the land by reducing stocking rates in perpetuity. In other words, they have withdrawn capital from the farm but have not reinvested on-farm. It is difficult to see what the future for these farms might be, given the remote and climatically challenging nature of the western (and southern) sector, the gatekeeping nature of the OVERSEER® model and the poor outcomes of research studies into alternative land-uses to date. The experience of one sheep and beef farmer, who received a very low NDA because of an accidental mistake in the benchmarking process, suggests that farming at this level of NDA is "…*existence living*" and that there is little ability to compensate for increased farm costs. This view was supported by an award-winning farm manager on one of the southern stations who suggested that a sheep and beef farm, even a large one with economies of scale, needs an NDA of at least 18 in order for a farm to absorb farm costs increases and market changes over the next 10 to 15 years. The median NDA in the study area is currently 14 and the median NDA of farms that have de-intensified is 11. Thus, if the farmer manager is correct, the farms that have sold NDA and not reinvested in other productive land-uses may already be in financial difficulty. De-intensification, therefore, while contributing to the environmental goal of Variation 5, could potentially have a negative effect on achieving a viable agricultural sector. The drivers of this de-intensification were found to be primarily nitrogen and carbon trading, but there may be other drivers that are not apparent at this scale of analysis.

Intensification, on the other hand, could potentially contribute to the sector's viability under Variation 5. Chapter Six considered the case of a dairy farmer that moved into the Catchment and

established a large dairy platform, using nitrogen trading to increase the NDA of the farm, and of other farmers that have converted sheep and beef properties to dairy support. In the western sector a small number of farms have 'intensified' by increasing cattle numbers (and potentially their profitability) without increasing their NDA level, in the south a station has similarly 'intensified' by expanding its dairy farm and reducing its sheep and beef unit, and in the north a farmer has purchased land outside of the Catchment in order to 'intensify' their operation. Moves to 'intensify' in this way, may contribute positively to a viable agricultural sector if profitability improvements eventuate as expected.

Both amalgamation and de-intensification have led to a reduction in the number of families resident in the Catchment and, reportedly, an increase in the number of itinerant, single, farm workers. The new entrant who developed the amalgamated farm in the western sector spoke, for example, of how the money that the farm earned was largely spent outside of the Catchment, and in other parts of their business enterprise, rather than within the Catchment. Such changes are in addition to the labour force changes that conversions to forest or woodlot will engender. While it is possible that this change in demography was already underway because of the difficult economics of sheep and beef farming, it appears that the Variation 5 regulations have amplified the trend.

The drivers of change in the western sector appear to revolve around the economics of sheep and beef, the small/medium farm sizes, lack of viable land-use alternatives and the uncertainty that farmers experienced during the regulatory development process. With such bleak prospects it could be expected that farmers would have retained the productive capacity of their land (rather than sell NDA) and would look for ways to increase their incomes, perhaps by amalgamating farms, by 'intensification' that may or may not involve increasing the NDA of their property or, as in Chapter Six by changing land-use. In order to understand the reasoning behind the farm system and land-use choices that have been made, this following chapter turns to the local (farm) level and to exploring farmer motivations.

Chapter 8: Sub-Catchment Case Three: Landscape change and farmer values and motivations in the southern sector

8.1 Introduction

In the last chapter it became evident that there were more subtle and nuanced land-use changes occurring in the Catchment than aggregate land-use figures would suggest. The western sector case reported evidence of structural changes in farm practice and prime amongst these was a reduction in stocking rates. This change has occurred where landowners have sold nitrogen allowances and have, as a consequence, been obliged to reduce the amount of nitrogen discharged from their property, and have chosen to do this by reducing the number of livestock they carry on the property. In some cases, this livestock reduction has been coupled with an increase in the area planted in trees. This suggests that the reduction in income from animal production may potentially be balanced by increased income from carbon sales and future income from wood harvest. However, this is uncertain. In addition, there are farms where reduction in stocking rates does not appear to have been balanced by a land-use change. Thus it appears that overall productivity in the Catchment may have decreased. Such a response is counter-intuitive. Given the financial difficulties that they have faced historically, why would farmers voluntarily choose to lower their production levels? This question is explored in the third case, focused at the farm level and located in the southern sector. The chapter centres on the attitudes, values, motivations and goals of the landowners in responding and adapting to Variation 5. Have farmers found other ways to achieve their farming goals under a cap and trade regime? In previous periods of change farmers have restructured their farms and overcome financial difficulties by strategies such as earning income off-farm and cutting costs. Perhaps farmers have employed similar strategies in the Taupo Catchment in order to overcome the difficulties they perceive in operating under a cap.

The southern sector was chosen to highlight this aspect of Variation 5 because it is an ethnically and economically diverse sector of the Catchment. Most land is Māori-titled and there is a mixture of high intensity land-use (dairy) and low intensity sheep and beef.

8.2 Sector description

The southern sector lies close to the mountains located in the central North Island, and almost directly across the Lake from Taupo itself. It is sparsely populated with the only urban area being the township of Turangi, on the banks of the Tongariro River. With a population of around 3500, Turangi services the forest enterprises on the eastern side of the Lake and provides for tourists, particularly

trout fishermen. There are four[136] marae[137], located at the southern end of the case-study area. Also in this southern sector, are the holiday home settlements of Omori, Kuratau and Whareroa, located on the edge of the Lake.

Most farms in this area are large or very large sheep and beef farms (1700 to 4500 ha), owned by Māori Trusts or Incorporations. Eight of these Māori-titled farms run sheep and beef, sometimes with deer and with woodlots as well. The ninth farm is mixed dairy and sheep and beef. In addition, there are seven smaller European-titled farms in the area (130 to 840 ha), mostly located towards the Lake edge. Of these seven farms, two are dairy farms, four are primarily sheep and beef and one is the only arable property in the Catchment. This latter grew potatoes but has recently changed to growing barley.

The climate is wetter than the rest of the Catchment, particularly towards the mountains on the western boundary. NIWA[138] data shows that the median rainfall in Turangi from 2004 to 2013 was 1380mm (compared with 943 at the Taupo airport for the same period), but areas towards the edge of the Lake in the west and south-west generally receive a lot less rain than Turangi which is located close to the mountains of the Tongariro National Park. Because of the proximity to the mountains, winters can be difficult and long, with a short growing season for pasture. The contour is generally rolling, with deep, very free-draining volcanic soils (Betteridge et al., 2007). The rolling contour means that substantial areas of land are able to be cultivated by tractor.

The map on the following page shows the location, settlements and land-title boundaries of this sector in 2002.

[136] They are Waihi, Tokaanu, Pukawa and Te Mahau Marae. Retrieved February 20, 2017 from www.Māorimaps.com

[137] Marae are the meeting places (and refuge) of the tangata whenua (i.e. the local people who by genealogy or by association have turangawaewae (situational identity) to the marae. Retrieved February 20, 2017 from: http://www.awataha.co.nz/About+Us/What+is+a+Marae.html.

[138] The National Institute of Water and Atmospheric Research (NIWA), Climate database, http://cliflo.niwa.co.nz/ Retrieved July 3, 2015.

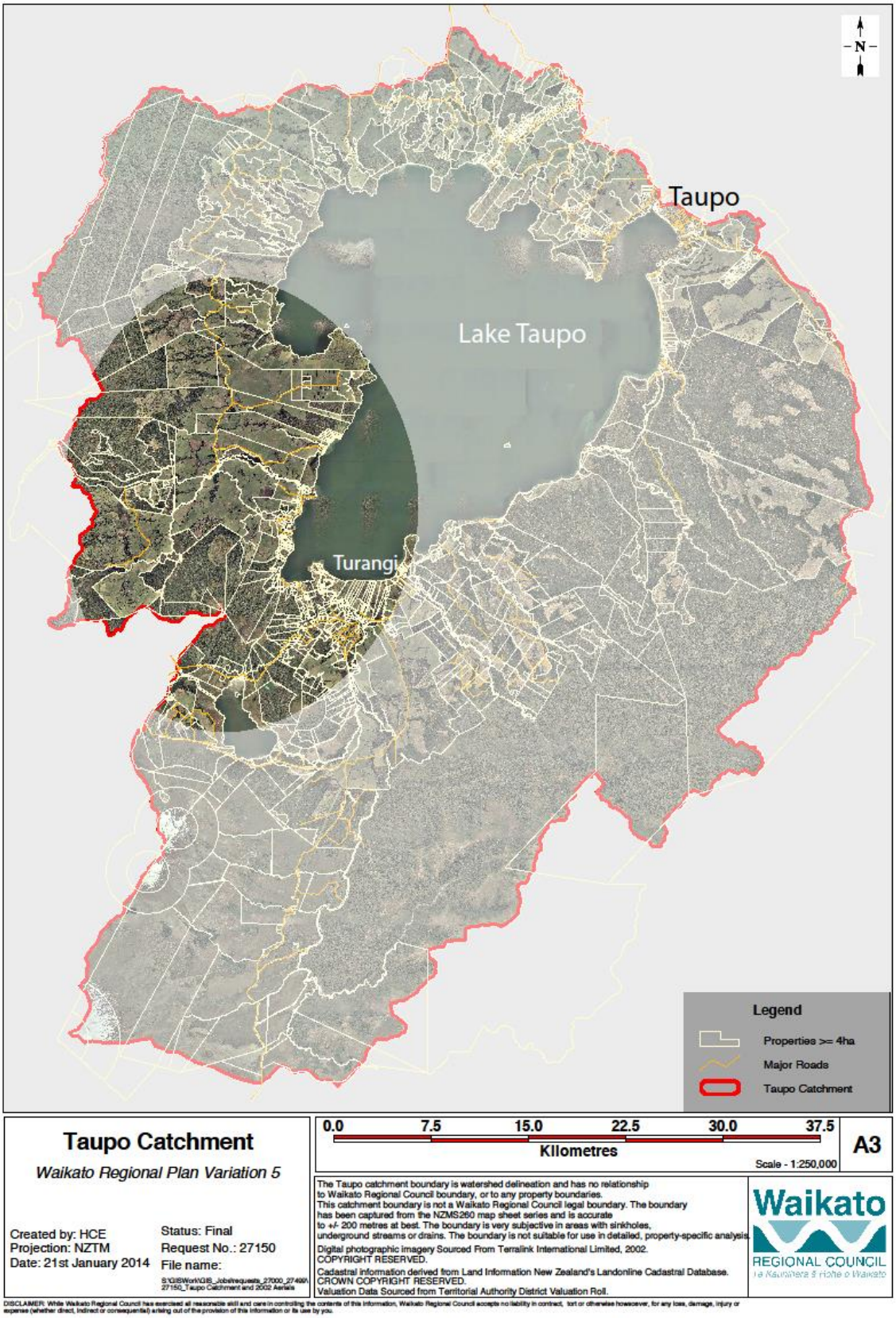

Figure 17: Map showing the southern sector in 2002
(Source: Adapted from Waikato Regional Council. Reproduced with permission)

Nearly 47% of all nitrogen sold to the Trust by 2013 came from this sector and almost all of that was from Māori-titled farms. Of the nine consented Māori-titled properties in this sector, seven have sold nitrogen allowances, and all was sold to the Lake Taupo Protection Trust (LTPT). Of the seven consented, European-titled properties in the sector, only one has sold nitrogen allowances and this was also to the LTPT.

8.3 Recent history and the influence of landowner values

Sons of the Māori ancestor Tuwharetoa moved from the Bay of Plenty to the Central Plateau area in the 16th Century (Ngāti Tuwharetoa Agricultural Group, 2006:26), thus establishing Ngāti Tuwharetoa as the tribe with authority over the land (Henry, 2014). By the 20th Century, the tribe had numerous settlements around the Lake which, in the south, were supported by extensive communal gardens. These gardens were destroyed when Lake levels were raised in the early 1970s for hydroelectricity generation (Ngāti Tuwharetoa Agricultural Group, 2006:3)[139]. During the early 1920s, around 2000 milking cows on farms around the Lake were supplying a Tuwharetoa butter factory at Waihi (Ngāti Tuwharetoa Agricultural Group, 2006:3) and the houses in Waihi village had electricity, flush toilets and running water (Laracy, 2007) (unlike most of the rest of rural New Zealand at the time). By the late 1920s, however, the milk supply began to dwindle and in 1928 the butter factory was converted into a timber mill managed by the Tuwharetoa Timber Corporation (Laracy, 2007).

Native timber logging provided the capital for some family groups to develop pasture on their traditional land, as a Trustee explains below.

> *The owners themselves did all of the logging, built all of the sawmills, and had distribution outlets over in the Taranaki. As they logged it, the decision that the owners made was to put it into farmland, and that was largely because there were concerns about the period of time you had to wait to get a return from forestry. They had cash flow coming from the native logging to develop the farm … Harvesting continued from the 1940s to the 1970s.*

But for most Māori owners, conversion of forest to pasture on their traditional lands did not get underway until after the enactment of the Māori Affairs Act (1953)[140], which established Trusts and Incorporations as legal structures for multiple owned land (Kingi, 2008). The government, keen to increase farm production after World War Two, undertook to convert Māori-titled land to pasture. Once the consent of the Māori Court and the owners had been obtained, either the Department of

[139] The amount of land inundated is estimated at 2200 ha (Ngati Tuwharetoa Agricultural Group, 2006:33)
[140] Later replaced by the Te Ture Whenua Māori Act (1993) which saw the Trust category modified to incorporate specific types of Trust, the main one being Ahuwhenua trusts. Most Trusts in the Taupo area today are Ahuwhenua trusts. (Māori Land Court, 2017)

Māori Affairs or the Department of Lands and Survey were instructed to 'break in' Trust and Incorporation land (Ngāti Tuwharetoa Agricultural Group, 2006).

The profits of the developed farming enterprises were retained by the government in order to pay off the development costs, and interest (Ngāti Tuwharetoa Agricultural Group, 2006). While these developments were undertaken with good social intentions, the results were often less than satisfactory. In the 1980s pressure was put on the government to hand these farms back to their owners. The government agreed - but some farms were returned with substantial outstanding debts, with much underdeveloped land and having been poorly managed. One farm (of 2390 grazeable ha), for example, incurred development costs of £75,000 around 1955 ($2.03m in 1988 dollars[141]) and was handed back in 1988 with a debt of $1.48m (Ngāti Tuwharetoa Agricultural Group, 2006:21). As a Trustee of this farm explained:

> *Although Māori Affairs and Lands and Survey helped develop this land in fact they did nothing good – we got handed a lemon plus a debt. My father proved that to the Reserve Bank and they took $0.5m out of the debt that the government calculated that we owed.*

The role of the government in the mismanagement of these farms was commented on by other interviewees:

> *You could question how efficient they [the government departments] were. Because certainly a lot of these properties had questionable managers, there were all sorts of rumours about farm managers who had their own private farms elsewhere, and the equivalent in stock going missing all the time, that sort of thing.*

Compounding the problem of bringing these farms up to standard when they were handed back was the reluctance of banks to lend against Māori-titled land (Ngāti Tuwharetoa Agricultural Group, 2006:20). Because Māori-titled land is normally communally owned, it was not readily saleable and thus could not easily be used as collateral for a loan. Loans could, however, be taken out against livestock and other similar assets. A law change in 1993 (the Te Ture Whenua Māori Act) made the situation even more difficult because it required the agreement of 75% of landowners, for land to be sold[142]. With landowners spread nationally and internationally, this is a high threshold. The lack of development capital and accumulated development debts to be repaid meant that Māori have not been able to fully utilise their farms or bring their underdeveloped land into full production. A

[141] Calculated through Reserve Bank calculator. See http://www.rbnz.govt.nz/monetary_policy/inflation_calculator/ Retrieved February 20. 2017.
[142] Section 228 of the Te Ture Whenua Māori Act 1993. Durie (1998:138) points out that there is an alternative method for land sales. The Act allows for land to be converted to general title and then it can be disposed of without 75% of owner's approval.

consultant employed to assist with the Tuwharetoa submission to the Waikato Regional Council Hearings in 2006 explains:

> *Māori land has tended to be developed slower than land under European stewardship because of the lesser rate of capital injection … you can only do so much land development in any one year if you are trying to do it out of income, or surpluses, generated from the farming activity on the rest of the property.*

Much of the under-developed pasture is the result of the original logging operations. Foresters at the time pushed some of the cutover into windrows and because of the high cost of removing the stumps and debris ($1000/ha in 2013 according to one farm manager), these paddocks were only slowly being developed in the 1980s and 90s. The same consultant as above describes his first encounter with this situation.

> *When I went onto these farms [in the mid-2000s] the level of production was very obviously different from what one would expect to see. There were large areas of land where the stumps still needed to be removed and high producing pasture needed to be established. For some farms this was as high as 30% of their land area. On the balance of their land, stocking rates would be close to all of the other farms in the district … So the real issue was the <u>amount</u> of land that had been brought into production - not the performance on the land that had been developed.*

This development history is repeated amongst the Māori owned stations that were part of the Ngāti Tuwharetoa Agricultural Group submission to the Waikato Regional Council Hearings. Most of the farms in the Group are located in this southern sector and the table below summarises their experience.

Entity	Number of Owners (2006)	Debt when handed back?	Under-developed pasture (2006)	Developed area (2006)	Area of reserved or retired land (ha)
Whakarawa Farm Trust	935	Yes	700 ha	1180 ha pasture	482 ha
Hauhungaroa 2C	Not specified	Not specified	Yes	1120 ha pasture 1604 ha forest	447 ha
Hauhungaroa Partnership	443	Yes	273 ha	2390 ha pasture	538 ha
Whareroa Station	180	Yes	1100 ha	1500 ha pasture	242 ha
Oraukura No 3 Incorporation	1800	Handed back in 1980 free of debt	Not specified	1048 ha pasture	208 ha
Puketapu 3A	Not specified	Development funded by Puketapu 3A	483 ha	2150 ha pasture	972 ha

Waituhi Kuratau	132	Not specified	82 ha	1973 ha pasture	822 ha
Waihi Pukawa	4400	Not specified	Not specified	3144 ha pasture	466 ha
Hauhungaroa 1C	900	Yes (Taylor, 2009)	Not specified	1593 ha pasture	2213 ha

Table 18: Development of Pasture on Ngāti Tuwharetoa Agricultural Group farms located in the southern sector
(Source: Ngāti Tuwharetoa Agricultural Group, 2006)

The Waitangi Tribunal[143] investigated the process of farm development on Māori-titled land in the Central North Island and found that (Waitangi Tribunal, 2008; 1043) although Māori land development schemes were a "…*significant*" initiative that helped Māori to "…*sidestep difficulties of title, access to finance and lack of expertise*", they none-the-less

> *[They] were run in a way that largely excluded owners from participation in decision-making, despite their protest and the availability of mechanisms for their consultation and participation. As a result, the Crown took too much power to itself, and we are not satisfied that debts were always loaded fairly or that land was returned appropriately or promptly … Some land was returned too late to be properly developed now in commercial terms.*

The Tribunal considered that the farm development process, overall, was in breach of the Treaty of Waitangi and to the prejudice of Central North Island Māori (including Ngāti Tuwharetoa).

Compounding the problem of underdeveloped farmland was the problem of changing forested land (most of which is in the south and east of the Catchment) to another land-use. The proposed regulations would kerb such changes because there is there is no other commercial land-use that emits as low an amount of nitrogen as plantation and indigenous forests i.e. 3KgN/ha/yr. Forest landowners, it appeared, could never change land-use to a more profitable one, if they wished to do so, without purchasing substantial amounts of nitrogen. They saw this as a loss of property rights brought about by the willingness of one generation of landowners to sacrifice income for themselves for the benefit of the community and future generations. Thorp (2006:32) concludes that:

> *History will show that the 20th Century was a window of opportunity for land development in NZ. Many Māori landowners were not in a position to take advantage of this window, and their lands now look to be allocated the role of protecting the environment … EW [Environment Waikato aka Waikato Regional Council] is proposing to allow the polluters [of Lake Taupo] to continue their polluting, and to control total nitrogen emissions by ensuring that the non-polluters continue to protect the Lake.*

[143] Ruru (2009: 49) explains the role of the Waitangi Tribunal as being a permanent commission of inquiry that is empowered to receive, report and recommend on alleged breaches by the Crown (post 1975) of the principles of the Treaty of Waitangi. This document, signed by the Crown and over 500 Māori chiefs, resulted in the declaration of British sovereignty in 1840.

This was a difficult situation for Tuwharetoa. Some of its members were backing the right of forest landowners to change from trees to more profitable (and higher nitrogen leaching) land-uses. This, however, would disadvantage the farming members of the iwi, because they (and other farmers) would have to reduce the amount of nitrogen leached from their farms to compensate – and no-one knew how that could be profitably achieved.

Leaders within the iwi strove to reconcile the two points of view and for Tuwharetoa to present a united voice. Unfortunately, a key figure in this debate died suddenly (Yerex, 2009) and the two camps did not, in the end, unite. Further, the Tuwharetoa farming sector were initially part of the TLC farmer lobby group, but withdrew because of differing value sets, as this Trustee explains

> *We used to be involved in the Taupo Lake Care group but what some of the European farmers wanted was quite different from what we wanted so we broke away. They have the ability to pack up, sell and move and we don't and we have to worry about what will happen in the next hundred years and they don't - so our aims are quite different. So we broke away and submitted to the Court on our own.*

The Ngāti Tuwharetoa Agricultural Group was formed, and proceeded to employ a farm consultant to assist them at the Waikato Regional Council Hearing in 2006. A central part of their argument at these Hearings was that protection of the Lake was a core part of their belief system and therefore had already been incorporated into their land management. Further regulation, it could be argued, would only penalise them for the stewardship role that they had already undertaken.

For the European-titled land, development took a different path. The Te Hapua Development Block (see map above) was originally Māori land, but, reportedly, was taken by the government in lieu of survey fees. The scrub vegetation was cleared by the Department of Lands and Survey, farms developed and eventually sold to ballot farmers in 1981. The land here has always been difficult to farm, as explained by a member of one of the original farming families.

> *As you come up the peninsula it is harder country. The pumice is more prolific, there is far less topsoil, a lot less rainfall. From the ranges just over there you could get three times the rainfall that you get here. So this would have been developed just before the end [of the farm ballot system].*

The poor soils and harshness of the climate, however, did not deter two farmers in this block from converting from sheep and beef to dairying. One such conversion was undertaken by the Crafar brothers within the Te Hapua block and the other was a conversion by a ballot farmer, located on the road to Taumaranui. Both farms were eventually placed in receivership, but currently remain as dairy farms within the farming portfolios of two new owners, both new entrants to the Catchment.

The owners of these European-titled farms were almost all members of Taupo Lake Care and this group argued before the Waikato Regional Council Hearings (in 2006) that the cap would result in static production levels and thus static incomes (assuming no change in prices), but that farm costs would not be similarly fixed. If costs continued to increase as they had in the past then sheep and beef farmers would be put out of business with ten years, TLC calculated. While conversion to forestry was theoretically financially viable, few farmers in the Catchment would favour such a move because of the lack of an income until harvest and the uncertainty of log prices. Thus TLC was primarily concerned with the financial viability of farms under a cap and saw a bleak long-term future for farming.

By the early 2000s, therefore, land in this area was at widely varying levels of development. Some of the European titled land was being farmed intensively while some of the Māori-titled land was still only partway through a programme aimed at lifting the farm's performance. In recent years the fruits of these development programmes were becoming evident. The Waituhi Kuratau Station won a regional award in the Ahuwhenua Trophy competition in 2004 and Moerangi Station won the Supreme Award in the 2006 Ballance Waikato Farm Environment Awards[144].

Variation 5 would bring a halt to this development and these Stations, like all farms in the Catchment, would be 'frozen' at the level that they were operating at in 2001-5. For the European-titled farms this meant static production levels but for many Māori-titled farms it meant operating in perpetuity at a level below the carrying capacity of the land.

8.3.1 Owners of Māori-titled land and Kaitiakitanga

Māori-titled farmers believed their history of setting aside large reserves and forgoing intensification opportunities proved they had been careful stewards of their land and conscientious about protecting the Lake from harm. The Trustee quoted below recalls one of several instances of land development restraint.

> *This block here - that got planted into trees in the mid 1990's. There was a dairy proposal for that, and that was actually a better proposal, numbers wise, than the forestry proposals. But the owners there said "if we go dairy, we're going to end up polluting the stream and polluting the Lake, and we don't want that".*

Variation 5, therefore, was almost insulting, as the following Trustee (from another Station) explains:

[144] The Ahuwhenua Trophy is an annual, national award for farming excellence amongst Māori-titled farms. The Ballance Farm Environment Awards are annual, regional and national awards for sustainable land management. In 2011 another Māori-titled farm, partly located in the Catchment and owned by Waipapa 9 Incorporation, won the Ahuwhenua Trophy for sheep and beef farming.

> *We have always worked sustainably … So the very idea that we don't know how to look after our land was just not - well, it didn't go down well at all. So we were very upset about that.*

Further, the previously little-known problem of groundwater contamination, once in the public arena, would have been addressed, as this same Trustee explains.

> *I'm quite sure we could've worked [it out] together [rather than legislate], because otherwise the [tribal] elders would have heard about it, and said "Oi! You've stuffed up the groundwater, why don't you go up there and talk to those Council people".*

Underlying Tuwharetoa's objection to Variation 5 was the Māori tradition of stewardship or guardianship (kaitiakitanga), which embodies their world view and their approach to managing resources[145].

> *We all know the mantra –your job is kaitiaki, you're there to look after the land, you're there to make sure the Incorporation [or Trust] is in a better state than when you first got it and then you hand it on to the next generation. That's your job done.*

The centrality of this concept to Māori management of land is borne out by the lease agreements drawn up with the government for the eastern forest plantations, mentioned above. The first three objectives of this agreement stipulate that forest management must (a) protect streams, rivers and lakes by preventing erosion, (b) protect wildlife and fish habitat and (c) protect sacred sites (Rotarangi, 2011). Only after these conditions have been met can forest management turn to raising a commercial crop on the land. As a result, about a third of the land is retired or reserved (Rotorangi, 2011).

But kaitiakitanga has a social dimension as well, as explained by Kawharu (2000:349).

> *Kaitiakitanga should be defined not only as 'guardianship' as has been emphasised by the Crown, local government and some Māori, but also as 'resource management'. Kaitiakitanga embraces social and environmental dimensions. Human, material and non-material elements are all to be kept in balance … Moreover, kaitiakitanga is a fundamental means by which survival is ensured—survival in spiritual, economic and political terms*.

The aim of kaitiakitanga, then, involves both nurturing the land (and protecting the Lake) as well as nurturing society. These are both then handed on, in an improved state, to the next generation. The same Trustee quoted above, explained her interpretation of this balance as follows.

[145] The Te Ara Encyclopaedia explains Kaitiakitanga as *a* deep kinship between humans and the natural world since Māori see humans as part of the web or fabric of life. Retrieved February 20, 2017 from: http://www.teara.govt.nz/en/kaitiakitanga-guardianship-and-conservation/page-1

> *The land is the sustenance of the people. So yes, we'll do all of those things [that you listed] but better to leave the Incorporation in a better state than when we took it on – so that's not just land (although that's our core business). But we're more than that. It's about the wellbeing of our shareholders. So we've got to ensure our shareholders are in a better state, a better condition, when we pass it on.*

The vision statement for one Māori-titled farm, for instance, is "…*To develop and manage the resources of [Name] Incorporation in a sustainable manner for the maximum benefit of successive generations of owners*"[146].

Although groundwater contamination was not widely known before Variation 5 brought it to public attention, this new problem would simply have been added into kaitiakitanga according to one Trustee:

> *Nothing is simple – it's not linear. You've got to balance everything - yes it's about groundwater, but what about feeding the people? What about their wellbeing? So you balance all these things that you've got juggling in there.*

For the owners of Māori-titled land, then, the regulations presented something of a conundrum. Protecting the Lake is of prime importance – it is intimately bound up with how they view themselves and their place in the world - but they are also concerned about the well-being of their people, now and in the future.

The imperative to improve the wellbeing of the owners was demonstrated by the Ngāti Tuwharetoa Agricultural Group submission to the Waikato Regional Council Hearing in 2006. In their presentation the Hauhungaroa 2C Incorporation claim that only 30% of their owners owned their own home in 1996[147]. This compares with 70% home ownership nationwide (Statistics NZ, no date) in the same year and unfortunately, this has not changed in the intervening years. The Ngāti Tuwharetoa Māori Trust Board (2014) report that currently 26% of Ngāti Tuwharetoa own or partly own their own homes. Further, they report that in 2014, 16% of Tuwharetoa were unemployed compared with the national average, at that time, of 7%.

[146] Support Notes, Open Day Five, (p. 9) Lake Taupo Monitor Farm Programme, Meat + Lamb NZ, 25th February, 2010.

[147] A study by Houkamau & Sibley (2015) indicates that low rates of home ownership amongst Māori are widespread and so not limited to Ngati Tuwharetoa. They found that Māori (and particularly those of Māori appearance) are less likely than all other ethnic groups (other than Pacific Islanders) to own their own home, even when factors such as level of education are taken into account. Their study suggests that this is because banks are less likely to lend to those who are of obvious Māori appearance. If this is correct, then the ability of the Māori-titled farms to pay dividends to their owners is of increased importance.

The Tuwharetoa Agricultural Group wanted to continue to develop their land, as the Group submission states (Tuwharetoa Agricultural Group, 2006:99)

> *Our preferred position is to be able to continue to develop and use our resources for the betterment of our people. This proposal [Variation 5] is denying us the continued use of our land for that purpose.*

Thus the owners of Māori-titled land have been caught in a dilemma. They understand and support the move to protect the Lake, but they also want to increase production and income from their land in order to improve the financial situation and well-being of the owners/shareholders.

Thus kaitiakitanga, and the difficulties of reconciling this way of being with the scientific perspective of protecting the Lake, was the background context to the responses of the Māori-titled farms to Variation 5.

8.3.2 Owners of European-titled land and contemporary values and motivations

There are several farmers with NZ European land titles in this southern part of the Catchment, and three of them were interviewed. Like European-titled farmers of small/medium sized properties throughout the Catchment, one of these interviewees expressed three aims for their property: to make a profit (short and long-term), to provide a satisfying way of making an income, and, because of a sense of attachment, to provide an enjoyable place to live. The other two interviewees were owners of farming portfolios and the emphasis here was on profitability and cash-flow.

While long-term financial viability is important, interviewed farmers that had decided to remain farming under the regulations described how their love of farming and of living in the Catchment encouraged them to stay. Sheep and beef farming is non-routine, takes place entirely outdoors and is constantly challenging. The enjoyment in sheep farming, according to one interviewee, is measured in how well all the required activities are "…*put together right*" – so "…*it's a jigsaw puzzle*" with a new version to be solved each day. The outdoor lifestyle is important for both dairy and sheep farmers but, in the minds of interviewed sheep and beef farmers, dairy, with its set routines and "…*one mob of cows going round and round the farm*", compares unfavourably.

> *There are some things about milking (whether it be sheep or dairy) that are not attractive to sheep and beef farmers. Like being inside a shed, dealing with the effluent, the hours of work, the routine nature of the work. In sheep and beef many of the tasks happen only once a year … You only have lambing once a year, calving once a year, crutching.... every day is different.*

One of the ballot farmers alluded to the financial cost of this commitment to sheep and beef:

> *I farm sheep and beef because I like it. I enjoy dogs, I enjoy the lifestyle. I am a romantic - and what it costs, I don't know.*

Not all farmers were opposed to dairy farming. Several landowners in the Catchment are dairy farmers themselves or are associated with a dairy farm located outside of the Catchment. One dairy farmer, located in the northern sector described their aim as maintaining cash-flow but even so they were proud of their husbandry, and had undertaken an extensive beautification project on the farm. As the General Manager explained:

> *That block of dirt there is a very special block of dirt - in terms of… there are not many around there in terms of that size and scale and it's a source of pride. My directors have planted a lot of those trees themselves and we know we have obligations to the environment.*

But among some dairy farmers there was a feeling that further conversion inside the Catchment was unlikely because of public concern for the Lake. The quote below is from a dairy farmer whose dairy platform is located outside of the Catchment but who has run-off land inside the Catchment boundary:

> *I wouldn't put a milking platform in the Catchment. You probably can't buy enough N now to do it and I don't think that the public would let you.*

Kerr & Olssen (2012), in their study of the relationship of land-use change to product price changes in New Zealand, found that there is a lag period before change takes place and that sheep and beef farmers are the slowest to respond to a change in their product price. Whereas 50% of the land-use adjustment that dairy farmers made to a permanent change to commodity prices occurred within two years, it was 12 years before 50% of sheep and beef (and cattle) farmers had made a similar change. A farmer interviewee expressed this lag in land-use change in the following way:

> *The stupid idiocy of farming is that those that are in it don't want to get out – they don't want to do anything else. They were born to be farmers - it is in their DNA – like me – and they don't want to escape. I don't encourage my children to go into farming.*

In addition to the attachment to farming, interviewees expressed an attachment to their land and to its location. If they had been on the property for some time, the evidence of their husbandry was always visible to them. His farm, one ballot farmer explained, is the "…*measure of my success"*, and it is a felt attachment since "…*it's not even just to look and to touch".* Another farmer described the same type of attachment when he said that:

> *The farm is like gardening on a large scale – I can plant trees and I get a kick out of seeing them and the animals grow.*

Farmers did not want to leave the area because they "…*like it here*", particularly living close to the Lake. The quote below is from one such farmer, but in this case he describes a neighbour's reasons for staying in the Catchment:

> *And if it wasn't for where they are, the location, they probably wouldn't be farming here either. But they've got a bit of the 'X factor' - like you get on a farm overlooking the Lake or whatnot. You're not going to find a farm like that just anywhere.*

Many farmers didn't like the conversions of pasture to plantation pines that had already been undertaken and considered them "…*a disgrace*", that they "…*give a dark and dank look*" to a place and that the pollen cloud that they created in spring was already unacceptably invasive. They were reluctant to see their hard work in building up the pasture wiped out through the establishment of trees. This aversion was common throughout the Catchment. This comment from a Trustee from the southern sector:

> *Most of the farm managers – they hate trees. So if, when, we've been planting paddocks with trees, the looks on their faces and the word around town was, "Those dumb Trustees, they've been planting up all this good farmland in trees and blah blah blah… And that's the perception that a lot of people have. I look at the articles in some of the local papers about what a crime it is to see all this good farmland going into trees … unfortunately a lot of these people making commentary in the papers never bothered to ask us about it. They just wrote big long letters and they certainly didn't look at the economics of it.*

Farmers also expected the presence of forests to affect their ability to sell and, for one couple trying to sell their lifestyle block in the western sector, this proved to be the case:

> *When prospective buyers saw the trees so close to the boundary they made comments that they wanted to live in a farming community not a forest. We have received no offers since the trees were planted.*

Some farmers, therefore, had a sense of attachment to the way of life, their property and the pastoral landscape. Thus there were compelling reasons for these farmers to remain on their land. New entrants, on the other hand, were drawn by the opportunities that were available. One new entrant, who arrived in 2004, had been hunting and fishing in the area for many years and so was keen to farm close to his favoured recreational sites (NZ Farm Environment Trust, 2014). A beef farming couple who moved into the northern sector of the Catchment were attracted by the cheapness of the land and the opportunity to semi-retire in an area close to town. Two other interviewed new entrants were also attracted by land prices and the business opportunities provided by known environmental rules as well as the sale of large tracts of land because of the exit of Landcorp.

8.4 Farming under a cap

Trustees on several of the Māori-titled farms put a lot of time and effort into looking at the options for operating their farms under the V5 regulations. The owners then debated the options and made a decision on how to proceed.

On one station, the options that the Trustees put before the owners included conversion of part of the farm to dairy farming, or conversion of the whole farm to forestry. At meetings called to discuss these options, the owners were reluctant to consider tree planting. In part this was because many of them have worked directly on the land, as this Trustee explains:

> *They have very strong views about what actually happens on the land … Its just because sawmill villages are up on the block [Station], and a lot of the current generation of owners - or their parents or grandparents - worked or lived out there. So they have a very strong attachment to the block.*

A second problem with conversion to forest was that the owners, aware of their obligation to hand the land on, did not want to control the land–use options available to future generations. Forestry, being a long-term land-use, would effectively limit the ability of the next generation to take advantage of changes, e.g. in technology, that may occur in the near future. The owners were also reluctant to convert part of the farm to dairy, despite the farm's NDA allocation being sufficient for a reasonable sized dairy farm without buying nitrogen allowances. In part this was because of concern for the Lake but, in addition, the capital requirements were too large for the owners to feel comfortable about undertaking such a change.

Other, alternative land-use options were also considered. Options that have been widely suggested, particularly for this southern part of the Catchment, include blueberry, wasabi and biofuel production. The interviewed Trustee, however, pointed out that conversion to a new, perhaps risky, land-use may not be acceptable to the owners.

> *Again, you're going to have the same issues in convincing your land owners that that is a better proposition than what we're currently doing. The numbers quite often don't drive decisions - the financial return might not be the primary driver of 40 decision makers*[148]*.*

Essentially the owners wanted to continue with their current land-use but to also improve farm productivity and thus increase shareholder payments.

Based on the interview with this Trustee, the decision drivers for these owners included:

[148] The Trustee estimated that there are around 1400 owners but many are not actively involved with the Incorporation.

1. the owners' bias towards pasture (as opposed to forest),
2. that the land in the Catchment cannot/will not be sold,
3. a dislike of risk e.g. debt (possibly coupled with problems raising capital),
4. the Incorporation's ethic of care for the Lake,
5. the need to increase dividend payments to the current owners, and
6. the requirement to pass communal assets on to the next generation in an improved condition.

None of the interviewed owners of European-titled land, and few of the owners of other Māori-titled land, appear to have been through such a comprehensive process to determine how they would respond to the regulations. Indeed, some farmers appear to have not fully understand the significance of the changes afoot, according to an ex-Chairman of TLC and consultant to several Māori Trusts:

> *Some trustees and governance understood quite quickly how it [the regulations] might impact them and they made good decisions - like selling nitrogen. But others still are coming to grips with this issue. Maybe they haven't had the opportunity to sell nitrogen or didn't understand the opportunity that was being presented. Some should be buying nitrogen.*

This applied equally to the owners of European-titled land, as one ex-ballot farm owner explained:

> *During the years that all this was going on we didn't purposely change our stock to try to maximise our NDA – not a lot of people did. Most of the farming community thought that it wouldn't happen and that common sense would prevail – even up until the Environment Court.*

Farmers appeared to be focused on the discussions that TLC was holding with the Regional Council and on the (discouraging) results of the research studies that were underway. TLC negotiators, one of them explained, thought that all they could do was to "…*negotiate the best deal [since] the changes were going to happen anyway*".

TLC and Environment Waikato envisioned both European and Māori-titled farmers planting marginal land and concentrating their farming activities on the better parts. An ex-member of TLC who was a member of the group that consulted with the Council explained the thinking behind this farm practice option:

> *So [Name] retired their poorer areas which allowed them to intensify their better areas. That was certainly, in terms of the formation of the policy, what was discussed. This is what we wanted to see, - best land use if*

possible, - retirement of poorer areas, so that the better areas could be farmed more to their potential.

The Waikato Regional Council incentivised such an approach, according to this same interviewee, by making all land equal. That is, marginal land located far from the Lake was assumed to leach the same amount of nitrogen as highly productive land located close to the Lake, under the same conditions (e.g. soil type, climate and farm system). In this way farmers gained no extra benefit from retiring highly productive land because of its location, e.g. proximity to a water body. This left the way open for farmers to sell nitrogen and reduce their stocking rates on land of a lesser productive value.

Farmers, however, responded in a much wider variety of ways. For TLC and the Council, the sale of nitrogen allowances could be used to facilitate farm practice changes such as stock reductions and woodlot planting, but for the farmers this was not necessarily sufficient. To achieve their underlying aims, additional changes may be required. The question that farmers asked themselves was 'how could they achieve their aims under the umbrella of the regulations, given the biophysical environment and development history?' While the Waikato Regional Council saw farms becoming a mixture of woodlots and pasture i.e. that farmers would make decisions based on land capability and might trade nitrogen to achieve this, farmers appeared to have a different set of criteria. Interviewees were clear about their preference for pasture over forest (although woodlots in marginal sites were probably acceptable), and about the need to protect the Lake. Further, they expressed a preference for the lifestyle involved with sheep and beef farming. A sense of place attachment was strong for most of those that remained in the Catchment, even for European-titled farmers. Although almost all farmers mentioned the need to improve the profitability of farming, some saw capital gain as the means to making a profit while others emphasised cash flow, or moving land to a higher use in the sense that profitability had been increased without the need to increase the number of animals, the amount of nitrogenous fertiliser or increase the NDA.

Landowners already in the Catchment seemed to be looking for solutions that would provide them with '*satisfaction'* (Fairweather & Hunt, 2011). That is, deliver on one or more of the following criteria:

- retaining their farm (because it is ancestral land and/or because of place attachment and lifestyle),
- retaining pasture and sheep/cattle/deer stock types (because extensive plantation forests are not favoured and sheep/beef/deer/dairy support farm systems are preferred and provide work satisfaction),

- making sufficient profit (because dividend payments need to be increased, and/or in order to stay ahead of rising farm costs, and/or to make an adequate return on investment and/or to make sufficient income for an acceptable lifestyle),

- diversification (because that reduces the risk involved in relying on a single income source), and

- care of resources (including the Lake) and intergenerational transfer (because a long-term view (i.e. sustainability) is fundamental to owners of Māori-titled land).

Dooley, Smeaton, & Ledgard (2005) undertook a study of preferred farm systems, and the criteria used to distinguish between them, in the Taupo Catchment. Their results confirm most of the criteria listed above. Although the authors warn that the sample size is small (and therefore could be biased) participants in the study overwhelmingly favoured profit (and dividend payments) as their top criteria, followed by farm sustainability (i.e. continuance), labour, enjoyment, risk (for Māori participants[149]) and lifestyle. Environmental sustainability was also ranked as important by some but other participants felt that the Variation 5 regulations had taken care of this factor and therefore they did not need to take it into account in their personal decision making.

The means of delivering the strategic criteria listed above, under a cap, were elusive. As noted above, land-use change, such as selling nitrogen and planting plantation forest, or conversion to dairy, was rejected by the owners of the Station that was featured in the previous section. The owners felt that the risks were too high and that land-use flexibility for the next generation would be reduced. The interviewed Trustee expands on this below:

> *We had enough N on the property to have a reasonable sized dairy unit … [but] the capital requirements were a bit scary … [The owners] have the view that they'd rather see farmland than see forest [and] they also wanted to ensure that future generations weren't encumbered, - that they had some land use flexibility. So hence they weren't keen on selling all the nitrogen. Cause at the time, the numbers suggested we sell all the nitrogen and plant the whole place in trees. That would have been the most rational economic decision to make, but there was no way that was ever going to be acceptable to our ownership. Even now we have people say - the accountants - they look back and say, you should've done this. Well, maybe,*

[149] Also supported by Morgan (2009).
The aversion to risk may be reinforced by the publicity that surrounds financial failures. For example, in this southern sector, a property development scheme (involving ex-Landcorp land near Turangi) failed and was featured in the local and national press. Unfortunately, around $6m of Treaty of Waitangi settlement money had been invested by Ngati Turangitukua (McMicheal, 2009) into Te Whenua Venture Holdings, with the intention of developing a 2500 house town on the land, in conjunction with ex-cabinet minister Richard Prebble. The money was lost when Te Whenua Venture Holdings was placed in liquidation in 2009 (McDonald, 2009) and the case was highlighted for several days in the media.

> *but what about the future generations? They'll look back and they're locked into trees, and trees may become unprofitable at some time in the future.*

Farm practice changes were similarly unlikely to deliver on the decision making criteria listed above. Reductions in stocking rates, and minor mitigations were not likely to provide an improved profit and offered nothing in the way of risk reduction or farm sustainability for the next generation. Amalgamation was a possibility and two Stations did, in fact, form a partnership shortly after the start of this study in order to gain economies of scale.

8.5 Structural changes in the southern sector

For many landowners the solution to the tension between care for the Lake and increasing profits lay in a conceptual change to the nature of a farm. Farms were redefined. The traditional concept of a farm, being pasture based and located in space no longer served the interests of the owners because that view limited what could be done with the land and with the capital tied up in the enterprise. 'Farms' that are no longer place or land based could be viewed as having multiple locations or be composed of multiple industries (rather than just primary production). Sometimes 'farms' became a set of several income sources, rather than the sole income source for the landowners, as had been the case before the intervention of the regulations. The station featured in this section chose this approach, as a Trustee explains:

> *The 'farm' is now a managed fund. It is an investment in shares and property - and we see that as coming, over time, more significant than the farming operation itself. What we're trying to do is develop an inter-generational 'farm'. We've got the foundations - as what it is - to build on over time.*

Other stations in the south have taken a similar approach and have looked for alternative sources of income, rather than alternative land-uses or farm practices. This quote is from a Trustee of a small station in the south:

> *It makes sense for us to start putting our money in other things [other than farming], without degrading our fundamental, core asset [i.e. the farm]. Personally I can't see a period when we won't be doing sheep and beef farming, it's just how much we'll be doing.*

Thus the structure of these two farms is changing. They are now (or becoming) just one part of a portfolio of income sources. Whereas, before the intervention of the regulations, these location-based farms were the prime focus of the Trust/Incorporation, now they are merely one contributor. Emotionally the farms remain important because they are ancestral land, and owners have lived and worked on them, but financially there is potential for them to become less important.

Similarly, the owners of European-titled farms looked for ways in which their aims, goals, values could be achieved under a cap and they were forced to look beyond the traditional approaches of increased farming production and productivity. Thus there were found to be a number of ways in which both Trusts/Incorporations and European-titled landowners adapted their farm enterprises to accommodate a cap on their production levels. One choice was to exit (see Chapter Seven). Another was to carry on as before and hope that science would catch up (see Chapters Six and Seven). A few changed land-use, mostly to forestry (see Chapter Seven), but for some farmers, particularly the landowners highlighted in this chapter, the solution was to 'reorganise' the farm. The ways in which farmers in the study area went about this are outlined in the following sections.

8.5.1 A farm that crosses the regulatory boundary

For the owners of the southern Station that has been featured in this Chapter, it was imperative that both environmental and societal factors were included in the decision making process. The farm could not be sold, the owners preferred to retain the pasture, future generations needed to be taken into account and large debts were not favoured. In addition, however, it was imperative that the farm produce a higher income so that the owners could be properly recompensed for the use of their asset. The solution that the owners arrived at was to sell nitrogen and use the money to purchase (previously ancestral) land outside of the Catchment. Any intensification needed will be undertaken there. As a Trustee explains:

> *Our productivity in the Catchment, for the farming operation, is capped. So we have mitigated the risk around that by buying these properties outside of the Catchment to help grow our farming business.*

Thus the Incorporation 'farm' has now been decoupled from its location. One of the consequences of this, however, is that the Incorporation will not reinvest in the Catchment farm. The same Trustee expands on this below:

> *We're not looking at doing any serious investment within the Catchment. It makes no sense to us to sell our nitrogen and then use our nitrogen payment to reinvest back into the farm.*

Thus the station, which was the focus of the Incorporation at the beginning of the regulatory process, has been transformed into a multi-location 'farm' with the land inside the Catchment now secondary to, or supporting, the land outside of the Catchment.

This strategy is not limited to the southern case. A farmer, on European-titled land in the northern sector, has also purchased land outside of the Catchment in order to increase production. This farmer describes growth as an essential part of any business – farming or otherwise:

> *Definitely – you have to increase production to survive because the costs keep going up … we either get paid a premium or we have to produce more. It's the same as any business. So if the price drops you have to produce more to get the same outcome. It doesn't matter if you're selling widgets or whatever, any business has to do that. That's just reality.*

The only way to achieve this in a capped situation, this farmer said, is to purchase land in an area without such restrictions. Thus in the main leaching months (in winter), this farmer was able to move a large proportion of his animals out of the Catchment. This reduces his leaching rate substantially, gives him management flexibility inside the Catchment (e.g. increase summer stocking rates or bring in supplementary feed) and offers an avenue for future intensification.

8.5.2 Portfolio approach

Variable meat prices, the low profitability of sheep and beef and recent droughts have all highlighted the risk involved in relying on farming as a prime source of income. Some farmers have chosen to sell nitrogen from their farms and invest the money outside of farming.

An agricultural consultant, with several Māori-titled Stations as clients, was at this time advising clients to reduce their dependence on farming, as explained in the quote below:

> *I have suggested that they sell some nitrogen but rather than put it into more farming in the Taupo Catchment they should stick it somewhere else - not even necessarily farming. Take that money and diversify. Have another string to your bow.*

Farmers in the Catchment, particularly in the south, appear to have taken this advice to heart since several interviewees described how they had sold nitrogen and invested the money in the stock-market or other businesses, thus decreasing the importance of the farm as an income source. This quote from a Trustee of a station in the south:

> *We are absolutely driven to find other things to put our money into, so that we can lessen our dependence on farming.*

Another approach is to build the ability to switch land-uses and stock types, in line with market changes, on farm. One European-titled farmer has taken this approach and has the paper-work in place to both subdivide and to convert to dairy:

> *I have a resource consent for this land to be divided into 91 lifestyle (10 acre) blocks. That and the consent to milk are insurance – I am insuring my future. It is risk management.*

In a further example of 'non-pastoral' farming, a station in the south is extending its successful holiday home subdivision on the edge of the Lake (Taupo District Council, 2013:48), reportedly using capital raised from nitrogen sales to fund the scheme extension.

Thus for these farmers the traditional approach of sourcing income from one primary land-use has been replaced by multiple sources of income. In some cases, these new sources are outside of the farming sector but in others they arise from a multi-land-use approach to land management. Some of these changes were initiated before the implementation of the regulations (such as the initial holiday home subdivision) but for others the regulations provided both the impetus to change and, through trading, the capital with which to do it.

8.5.3 Investment and lifestyle farms

Some farmers that were operating pre-2000, have reduced their farming operation and plan to semi-retire[150]. This quote is from one of the owners of a ballot-sized farm in the south:

> *We have sold some NDA but we are not planting anything. We're changing our management practices over time and farming down over time.*

Although this was the only example of 'farming down' in the southern sector, it was common in other sectors to find interviewees with European-titled farms saying that they have reached a stage where they are "…*comfortable*" or no longer needing to "…*push the system*". A farming couple from Southland, for example, purchased an ex-ballot farm and established a dairy support unit. Their intention, however, was to semi-retire, as this couple explain:

> *This is where we wanted to come … We're in the process of slowing down. We milked cows for 20-30 years, and now we've decided to make a break … So we came up to have a bit more time with family … It's a lifestyle that suits us.*

As part of the 'slowing down' process, this couple have sold NDA from the property, and subdivided off one farming block and a small lifestyle block. Thus the original farm is now of an uneconomic size but provides a support service to family members farming outside of the Catchment.

Another new entrant that was interviewed had similarly moved into the northern sector with a view to semi-retirement. The aim of the farm, he explains below, is to cover farm running costs but not to maximize production:

> *Our aim is to make this the most easy-care operation possible rather than the most profitable or highest producing. I am not far off 60 now so I want to set this up for my old age and not have to run around from daylight till dark.*

[150] Wilson, Harper, & Darling (2013) identify lifestyle farmers as those that have a second income stream but in this study this category includes those whose income needs are reduced through semi-retirement.

Other farmers plan to sell their farm as a large lifestyle block or as a corporate investment so the new owner of the farm is unlikely to be reliant on income from the farm for living costs.

One of the first new entrants to the western sector after the regulations were signalled in 2000, purchased and amalgamated three ex-ballot farms into one 770 ha sheep and beef, low intensity operation with 80% sheep. The nitrogen discharge level of this farm system is sufficiently low that the landowner was able to sell some of the nitrogen from the farm. Although the farm is apparently viable, the long-term aim for the farm is to sell it as a corporate investment. It is surrounded by trees and reserve, has extensive views of the Lake and is one of the few European-titled farms of that size, and, consequently, the owner claims, is an unusual farm in the area. As this farmer explains:

> *I know it's going to be a valuable bit of real estate. Sooner or later, someone will step in and want to buy it – a trophy farm - fellow with a big cigar.*

Another landowner has taken the idea of lifestyle properties to a new level. An investment company has converted four ex-ballot sheep and beef farms to a lifestyle forest, with a long-term return from harvesting, in the western sector. As the manager of the venture explained, the plantation is seen as an opportunity for the Fund to both invest in carbon (although that market is "…*not looking too flash at the moment*") but also to develop a game hunting retreat:

> *We see it as ultimately saleable to a wealthy individual who wants to have an investment as well as have a bit of fun – like ride mountain bikes or horses or go hunting water fowl or deer. A richman's playground with access to the snow and the Lake – those are its attractive features.*

To this end, the Fund have developed lakes and planted vegetation attractive to birdlife. In another example from the northern sector of the Catchment, a farmer currently running a medium sized dairy support farm, is aiming to sell it as a lifestyle farm:

> *There are beautiful views of the Lake up the back of the farm so I am waiting for a corporate that also wants a lifestyle block - and they will probably be from overseas. (I have an agent looking for me now). The people that have viewed the place to date don't buy because we haven't found one yet with that extra need - like an interest in trout fishing or skiing.*

Thus some of the farms that were operating commercially before the intervention of the regulations have been restructured into lifestyle farms. A few of these are now small properties because they have been subdivided but some are still of a commercial size. It is anticipated by the interviewees that these latter will be sold to purchasers looking for a lifestyle as well as some return on their lifestyle investment, but the commercial enterprise may be secondary to the goal of recreation and lifestyle. While this structural change is not necessarily a direct result of the regulations, for some of the farms the trading facility has provided the funds to enable this change. In other cases, new

entrants have been attracted to the area for the sole purpose of reducing their workload and thus, potentially, the commercial potential of their farm.

8.5.4 Vertical integration in the supply chain

Traditionally farmers raise animals and then sell them (or their milk) to a food manufacturing company. In two instances in the Catchment entrepreneurial[151] farmers have challenged this model by taking on part of the supply chain themselves. Thus, the manufacturing step of the supply chain has been brought under the umbrella of the farm. In one case, that of a beef farm, this move was a direct response to the regulatory cap – that is it was a move to increase the profitability of the farm in a capped situation. In the other case, that of the sheep milking operation, the manufacturing arm was already in operation but sale of nitrogen assisted with the development of a yoghurt manufacturing plant. Other farms may be taking steps in this same direction. For example, a station in the south has invested in a specialised meat processing business (Taylor, 2009).

Beef production – Eco-labelling: In 2004 a part-time farmer, employed in the education sector and keen on the hunting facilities that the area offered, decided to purchase a block of 140 ha in the western sector. The owner quickly came to understand the importance of the proposed regulations, played a leading role in the farmer lobby group (TLC) and was one of the farmer negotiators that met with the Waikato Regional Council and their technical advisors at regular intervals. This level of discussion with regulators, scientists and others led the farmer to conclude that the only way for a farm to operate long-term under the regulations (since intensification is not possible) is for consumers to pay a premium for produce raised in the Catchment (Piddock, 2013). Thus this farmer grows the value of his product rather than (more traditionally) increases the amount of product produced. By paying a premium, consumers are sharing the responsibility for protecting the environment. Piddock (2013) quotes this farmer as saying:

> *We have spent the last 100 years mortgaging the environment in order to produce cheap food. At some point, we are going to have to pay that mortgage back … If you [as a consumer] are not prepared to pay a premium then you don't have the moral authority to talk about dirty dairying or the like.*

The idea that consumers should pay more for their food is not new. One agribusiness consultant claimed that the power of supermarkets has worked for consumers but against farmers:

[151] Jostein & McElwee (2011:394) define farming entrepreneurs as those that engage in diversification through transforming or expanding farm activities by unconventional uses of on-farm resources. In this study the term is used interchangeably with 'new economy' changes - a broader but similar term to 'biological economies' (Campbell et al., 2009). Both entrepreneurial and 'new economy' categories denote changes that encompass new ways of making money from rural land.

> *The average household about 40 years ago, used to spend 40% of its income on food, now it is about 12%. Perhaps it is because we all shop at supermarkets and they ratchet down the price … they have screwed farmers down so much that it is becoming uneconomic. So the world is starting to talk about farmers needing to be paid more for their product and certainly in the Taupo Catchment that is the only option to solve this squeeze that is occurring.*

This farmer set up a brand – 'Taupo Beef' – in 2011 under which meat raised in accordance with regulations protecting the Lake could be processed, marketed and sold. The brand aims to "*…guarantee commercial and high-end retailer outlets a consistent quality, and supply of product proudly sourced from the nitrogen capped area*" (NZ Farm Environment Trust, 2014) and the owners are active in both managing the farm and the beef supply business. In this operation the supply chain has been shortened and the potential exists for the owner to capture more of the overall value of their product. In a report to the Lakes and Waterways Action Group in 2014[152], the owner stated that it would be another year before the success of the business could be fully assessed. He acknowledges that, while it is relatively easy to sell to customers that connect with the Lake[153], it may be more difficult to extract a premium from customers unaffected by the Lake e.g. in Auckland (McKenzie, 2015) or Wellington. But of equal importance, he explained, is an increase in volume which is needed to gain entry to these markets, even before customer preference for Lake care can be tested.

At the field day held in association with their entry into the Balance Farm Environment Awards in the Waikato in 2014, this farmer listed the changes that he has made on farm to improve the nitrogen efficiency of the operation. Prime amongst these is no longer having breeding stock on farm since adult animals discharge more nitrogen than do young, fast-growing stock. Consequently, the farmer now buys young stock (often rejects from dairy farms) born by adult female stock located outside of the Catchment. Thus, this nitrogen intensive operation has been moved beyond the regulated boundary. Second, no nitrogen fertiliser is used and last, only lighter stock, e.g. weaners, are carried through the high leaching months of winter. This farmer calculates that the Taupo Beef operation (i.e. the farm and the meat supply business) returns $68 per kg of nitrogen leached compared with their previous, traditional beef, system which returned $44 per kg of nitrogen leached[154].

While the owner appears unwilling to claim this to be a successful business at this point in time, there is optimism about its future. Demand for their eco-labelled meat, they claim, exceeds supply

[152] Lakes and Waterways Action Group, Meeting held on 5th February 2014 and included in the minutes of the meeting for Wednesday 5th March 2014. Available from Taupo District Council, Taupo.
[153] A trial conducted in two restaurants in Taupo showed that customers were willing to pay a $7.50 premium per meal for Taupo Beef produce (McDonald, 2011).
[154] From a handout provided at a field day held at Glen Emmreth Farm. Ballance Farm Environment Awards Field day Programme, Wednesday 21st May, 2014.

(NZ Farm Environment Trust, 2014). The operation, however, is reliant on being able to buy in young replacement stock and it is not known what the effect of locating the breeding function inside the Catchment would have on farm viability or on profit per Kg of nitrogen leached. Overall, as the owner explains, "…*we are taking what was an imposition [the cap] and using it to grow a brand*" (Rural Delivery, 2012).

Milk production with a manufacturing plant on site: In the south of the Catchment one of the Māori-titled stations has turned part of its sheep and beef farm into a sheep milking unit. The Trust concerned aims to develop a vertically integrated, sheep milking and milk manufacturing operation. Sheep milking is, an interviewed Trustee believes,

> *…the next big thing for sheep and beef farmers in New Zealand – and that is whether there is a cap in place or not.*

Developing a milking herd began on this station in the early 2000s when, as a result of a push to improve flock genetics, it was noticed that some of the sheep had very large udders. A previously held investment seminar[155] had included a recommendation to consider sheep milking as an alternative land use and thus the notion of breeding a herd of milking sheep on the Station was born. There was an extensive investigation into milking sheep production, and into improving genetic strains with many visits to milk manufacturers before milking finally began in 2009. But, as a Trustee explains below, finding an outlet for their milk was problematic.

> *We visited every dairy company in NZ but couldn't find one that would take our milk. We could have had it dried in Invercargill but that is too far to send it so we bought our own cheese factory in Thames.*

The Trust tried producing cheese for several years but found it to be a "…*hard market*" and is currently (in 2013) freezing most of its milk for export to Australia and producing yoghurt with the rest (Edwards, 2013). To this end a manufacturing plant has been set up on the Station – a move which did not require NDA, as a Trustee explains:

> *We can control the N discharge from the milking shed and the yoghurt factory – it's sprayed back onto the land - so we didn't have to use any of our NDA to set these operations up within the Catchment.*

The problem of how to market their milk remains, however, because for many products a sufficient supply is required to break into worthwhile markets. While the Trustee interviewed expects moderately increased returns from sheep milking in the short-term, it is not expected to be the main income earner for the Station for some time. The General Manager of a sheep milking venture,

[155] Industry representatives from dairy, deer, pip fruit, wine, olives, property and finance presented cases for investment by the Trust at a three-day seminar in the early 2000s.

established in the Catchment after the study period, warns that there is considerable genetic improvement required in the NZ flock and until this has been achieved farmers should be cautious about conversion (Tipa, 2016), despite it being a low-nitrogen-discharging land use with a growing demand, particularly in American and Asian countries (Griffiths, 2015).

To date other farms in the Catchment are not intending to move to sheep milking. When asked, farmers in the Taupo Catchment indicated that there were significant barriers to changing to this land-use, including the following:

- *the economics [of sheep milking] is really difficult*[156]*,*
- *it is too intensive and I prefer to be extensive*[157]*,*
- *we would not invest – not until you can show us that it will give us consistent double digit returns*[158]*,*
- *sheep milk and products are probably luxury items so those farmers could be quite vulnerable to market forces*[159]
- *sheep milking belongs on small blocks because it is an intensive operation and needs a lot of labour input – like goats*[160]*.*
- *we don't want to be the first ones to venture down that road – not at this stage anyway*[161]*,*

Maui Milk NZ Ltd., however, are sufficiently encouraged by this industry to invest. In 2016 they purchased 770 ha and set up a sheep milking operation in the south west of the Catchment. The General Manager, however, cautions farmers that it will be some time before conversion is a viable option (Tipa, 2016).

Although development of the sheep milking flock was unrelated to the regulations, Variation 5 has provided encouragement for the integration of farming and manufacturing because of (a) the opportunity to raise development capital through the sale of nitrogen allowances and (b) because nitrogen discharge from manufacturing is relatively easily controlled.

[156] European-titled farmer, Southern sector
[157] European-titled farmer, Western sector
[158] Trustee, Māori Incorporation, Southern sector
[159] European titled farmer, Western sector
[160] Trustee, Māori Trust, Southern sector
[161] Trustee, Māori Trust, Southern sector

8.6 Chapter summary and conclusions

This section summarises the landscape biography of the southern sector, the motivations of farmers and the consequences of the inte3rsection of motivation and development history on farming under a cap.

Ngāti Tuwharetoa established themselves as the tribe with authority over the Taupo Catchment area around the 16th Century. Although they established gardens in the south of the Catchment and had dairy farms and a butter factory by the 1920s, it was not until after World War II that extensive pasture development took place. A significant proportion of that development was undertaken with government assistance but it left many Trusts and Incorporations in a difficult situation. When the land was finally handed back it was found to have been poorly managed, underdeveloped and often there was a residual development debt attached. The Trusts and Incorporations tried to repay debt and develop their land (mostly out of farm earnings) and were part way through this process when the regulations were first signalled. Several stations had made enormous improvements but for many there was still some way to go. Thus by 2000 the farms in this southern region, the majority of which are Māori-titled, were running extensive sheep and beef operations, and producing less than the land and climate were capable of supporting because of their development history.

Ngāti Tuwharetoa station owners had contributed substantial areas of potential farmland to reserves, particularly around the edges of the Lake. They had also, at times, rejected plans to move out of sheep and beef and into more intensive land-uses such as dairying. They preferred a land-use that would not pollute streams nor harm the Lake since their kaitiakitanga ethic required them to be cognisant of the kinship between the human and natural worlds and to be aware that they hold resources in keeping for the next generation. Kaitiakitanga can also be understood to require consideration of the needs of the current generation, and in this view resources should be used to benefit both current and future generations. These views were a significant input into the decision making of the owners of Māori-titled land over a long period.

Although there are relatively few European-titled farms in this sector, interviews with a southern sector farmer and other similar farmers elsewhere in the Catchment showed the values that they held also contributed to their decision making. Most European-titled landowners placed emphasis on attachment to place, an extensive farm system and a way of life – similar to the findings of Fairweather & Hunt (2011) i.e. satisfaction, production and control (with the farmer as decision maker). Thus, an important driver for all of these farmers up until 2000 appeared to be the achievement of their management goals rather than the more narrowly focused aim of achievement of a profitable enterprise. The effects of these drivers could be seen in the landscape, with a predominance of owner/operators, an emphasis on production, and careful husbandry including

riparian and erosion plantings. For Māori-titled landowners there was the added dimension of the ethic of kaitakitanga and the achievement of balance between the needs of the environment and current and future generations. The overall emphasis was on production by employing extensive farm systems, care for the Lake and bringing under-developed land into full production.

After the regulations were signalled, the influence of farmer goals and management aims came even more sharply into focus. Landowners, of both European-titled and Māori-titled land, appeared to be asking how they could achieve their goals now that production levels would be capped. While most landowners in the Catchment were concerned for the health of the Lake, the regulations were threatening to take decision making control away from the landowners. Further, the science world was unable to provide any substantial help with viable land-use alternatives or on-farm mitigations. Thus the choices available to landowners were few and often unpalatable.

A significant number of farms in the southern sector chose to sell nitrogen to the Lake Taupo Protection Trust and thus extract capital out of unsaleable land. Some of these sales were a key part of a plan to revive the incomes of the Trusts/Incorporations involved through investing where there are no regulatory caps on the amount of income (or production) that their investment money could achieve. Such landowners invested in farms outside of the Catchment, or businesses not involved in farming or they broadened their farm system to include non-farming activities such as holiday housing. In two cases in the southern sector, reinvestment on farm has taken place in the form of planting of woodlots and investment in an on-farm, secondary processing facility but, as pointed out in Chapter Seven, other landowners in the southern sector have sold nitrogen and do not appear to have reinvested in alternative forms of income, at this stage. The changes that have taken place are, however, not evident in the Catchment landscape because many involve no outward change in land-use or land-cover.

Elsewhere in the Catchment it appears that European-titled landowners have found different ways of achieving their farm goals and management aims. Chapters Six and Seven highlights the number of farmers (including Landcorp) that chose to sell and exit the Catchment. Those that remained and are continuing with their previous farm system reported (in Chapter Six) that they are not confident of being able to achieve their goals under a nitrogen cap and are particularly concerned about not being able to increase production levels or being able to change to a more intensive land-use in accordance with market demands. Despite this drawback, many expressed a depth of place attachment that apparently (or at least temporarily) outweighed their misgivings about the future. Some of these farmers felt that their only choice was to lower their income expectations and to semi-retire. Some propose to turn their farm into a lifestyle farm (a lifestyle block on a larger scale) and look for a new type of buyer (probably wealthy and/or from overseas) attracted by the Lake and its environs. Once

again, these changes are not evident in the landscape because they do not involve any outward change in land-use or land-cover.

A further change, involving a new entrant and a Māori-titled farm, is a significant development for operating under a cap since these farming enterprises have looked for new ways to make money from rural land. Farm 'systems' have been redefined to include secondary processing of farm produce i.e. yoghurt from sheep's milk and beef processed and branded under the control of the farm. These changes are similarly not evident in the landscape as their land-use categories are standard sheep/beef categories.

By 2013, therefore, considerable landscape change had taken place in the Catchment. Some of this is visible in the landscape, such as conversion of sheep and beef to forestry or woodlots or farm amalgamations, but other change is less evident and including changes such as lowered production through semi-retirement, and secondary processing of farm produce.

The southern sector, therefore, is an apt example of how landowner motivations can affect land-use choices. The two primary drivers found i.e. achievement of non-financial goals (such as care for the Lake or attachment to place) and investing in a business opportunity, have led to some unusual solutions to the problem of how to operate in a capped environment. Over the whole study area, however, the number of enterprises that are attempting to find low nitrogen ways of farming (and thus freeing up nitrogen head room (a) for business expansion or (b) thereby enabling surplus allowances which could be sold) appears to be small.

Several interviewees hinted that the future landscape path for the Catchment (and particularly for the southern stations) may be one of limited reinvestment, a gradual winding down of production levels, possibly more amalgamations (formal or informal), and forestry. In the words of one Trustee, why would anyone invest in a location (or in a sector) where the income is capped and moving to a higher land-use is costly? Better perhaps to derive income from a less-regulated location or sector, or from retirement income, (at least until viable low nitrogen land-uses and on-farm mitigations become available). This approach protects the Lake, retains a resource to hand on to the next generation, and does not sever ties with a location and/or a farm system that for many has deep significance.

The biographies presented in Chapters Six, Seven and Eight form the core of the second part of this thesis. However, a Catchment-level focus is required to address the research objectives of the study. Accordingly, the discussion chapter that follows discusses the results of the investigation for the study area as a whole. It brings together the multiple threads of landscape change brought about by the cap and trade regime through the medium of the conceptual frame described in Chapter Three.

Further, it looks at the consequences for landscape of these changes within the context of the other driving forces that were in operation up until 2013. The first part of the chapter attempts to answer the question "How much landscape change has occurred and of what type?" The second part of the chapter considers the implications of the changes for policy and theory.

Chapter 9 Discussion and Conclusions

9.1 Introduction

This study used a landscape approach to investigate whether cap and trade is a policy regime that can meet the sustainability challenge of the Resource Management Act. That is, whether it enabled environmental limits to be achieved in a way that facilitated the continuance, and perhaps the expansion, of the agricultural sector. A landscape approach is an innovative way of undertaking such an investigation, so the study was also concerned with judging the usefulness of this approach.

While the study is concerned, in a general sense, with policies appropriate for sustainability, it is specifically concerned with implementing the NPS-FM in New Zealand. This newly-instigated water-quality policy limits pollution levels in waterbodies, and thus indirectly limits discharges from farms. The NPS-FM also theoretically ensures that the agricultural sector continues its significant contribution to the New Zealand economy. Currently, cap and trade is a favoured policy regime for this type of situation and so this study investigates the exemplar cap and trade scheme that has been implemented in the Taupo Catchment, New Zealand.

The Lake Taupo Nitrogen Trading Programme was chosen because, to date, it is the only implementation of cap and trade in the world that places limits on discharges at the farm level (Organisation for Economic Cooperation and Development, 2015). The environmental goals of this Programme are incorporated in the 'Variation 5' regulations that were confirmed by the Environment Court in 2011 (effective from 2007). These goals will be met, according to the regulations, by stopping any increase in nitrogen discharges from pastoral farms in the Catchment (i.e. farm discharges are capped at 2001 to 2005 levels) and by reducing the total amount of nitrogen discharged from farms in the watershed by 20% (i.e. some farms voluntarily reduce their discharge limits). In 2014, the Waikato Regional Council suggested that water quality was trending as anticipated (Waikato Regional Council, 2014)[162] and the Lake Taupo Protection Trust achieved the required 20% reduction in nitrogen load in 2015 (Organisation for Economic Cooperation and Development, 2015). Thus, the first part of the sustainability challenge of the RMA, meeting

[162] Waikato Regional Council signalled during the development of the regulations that water quality would probably worsen before improvements were apparent because of the historic load of nitrogen in the groundwater. Vant (2013) reports that nitrogen levels in the Lake deteriorated over the period 2002 to 2012 in line with expectations. Increases in nitrogen levels in some streams that flow into the Lake, however, were higher than was expected and may point to higher historic loads of nitrogen in the groundwater than was anticipated. The consequences of this for the Lake and for the 2018 review of the regulations are not explored in the Vant (2013) article.

environmental goals, appears to be on track although Vant (2013) warns that the historic nitrogen load may be higher than was anticipated.

The second part of the challenge is concerned with maintaining and expanding the agricultural economy in order to meet the government's aim of doubling agricultural exports by 2025 (see Chapter Two). To meet this aim, it must be worthwhile for farmers to operate within the environmental limits set out in the Variation 5 regulations, otherwise the sector may contract or decline. Thus the first research question of this thesis is concerned with changes that have occurred as a result of the Variation 5 cap and trade policy:

> *How are agro-ecological landscapes changing as a consequence of local 'cap and trade' policy and regulations?*

The research question is focused on the landscape consequences of this policy regime because the thesis has adopted a landscape approach to investigate the problem of maintaining a viable agricultural sector under environmental limits. This approach was chosen because landscape provides a holistic approach to the investigation of socially and biophysically embedded outcomes whose effects may be scale dependent. In particular it encompasses social and biophysical factors, socioecological systems, and temporal and spatial factors. Because this is a novel approach to the investigation of a policy setting, the thesis is also concerned with whether this method holds promise for other, similar investigations. Thus the second research question is:

> *How can a landscape approach assist in understanding the consequences of a local scale agro-ecological policy?*

This chapter sets out and discusses the findings of this investigation and the implications of those findings, in order to answer these research questions. The research frame that has been used to guide the study is briefly revisited in the first part of the chapter and applied specifically to the Taupo study. The findings of Chapters Six, Seven and Eight are then integrated and are reported at three spatial scales (farm, local and watershed) and over two time periods (up to the early 2000s, and from the early 2000s to 2013). These findings led to the identification of five landscape paths that appear to have evolved in the Catchment since the regulations were first signalled, and these are described along with their expression at the Catchment, local and farm scales. The section that follows discusses the implications of the study findings with reference to agricultural policy in New Zealand, cap and trade policy implementation and theory, and for the landscape approach itself. The chapter concludes by examining the limitations of this study, making recommendations for further research, and drawing overall conclusions for the study.

9.2 Research frame revisited

Investigating the consequences of a cap and trade programme required a new approach to policy assessment. Caps are set at a watershed level but, as Shortle (2012) explains, if the aim is to control agricultural pollution then the cap must also be applied at a farm level. Thus there are issues of scale involved and, since it is unknown at which scale effects are likely to be discernible, a multiscale approach is required. Further, a farm can be viewed as an integration of social and biophysical factors – a socio-ecological system - which is linked to systems operating at different scales in a nested fashion (Darnhofer, Fairweather, & Moller, 2010). Conceptualising farms in this way, and also taking account of issues of scale, requires an approach that is scalar, holistic and integrative. A landscape approach meets these requirements and so has been used to investigate the Lake Taupo Nitrogen Trading Programme.

The landscape approach was implemented through the landscape biography method. This method, while popular in archaeological and heritage studies, is rarely used in the field of policy studies. Thus a frame of reference was needed which integrated socio-ecological systems with landscape transitions, landscape paths, biographies, driving forces of change and spatial scale. The frame that was developed for this purpose was presented in Chapter Three. As explained in that chapter, landscape transitions, determined from research findings, form the overall landscape paths in operation and thus point to a potential, future trajectory at the watershed level. Thus, landscape transitions and associated driving forces (developed from landscape biographies) are the material from which landscape paths are determined. In turn, landscape paths contribute to discerning a potential landscape trajectory at the watershed level.

Landscape biographies were developed for three sectors in the Catchment using information drawn from farmer and key informant interviews, media reports, sector group information, and consent and trading data. A fourth sector (the eastern sector) of the Catchment was excluded from the study because much of the land is in plantation forestry (which is a permitted use under the Variation 5 regulations) and the largest pastoral farm in the sector is a prison farm. Thus outcomes in the eastern sector are not likely to be representative of the consequences of Variation 5.

The refined conceptual frame that emerged as a result of applying the landscape approach outlined above, is shown in Figure 18. The left-hand side of this diagram shows the spatial scales that were the focus of this study, i.e. the farm, the local (or community) and the watershed (or Catchment) levels. Each of the three landscape biographies was focused at one of these scales and reveals aspects of the outcomes of the regulations that are apparent at that scale. Thus the northern sector was chosen to investigate land-use/land-cover change because the widest variety of such change has occurred in this sector. Land-use and land-cover change is apparent at the Catchment scale and so

the northern sector was focused on such changes (see Chapter Six), before reporting land-use and land-cover change for the study area as a whole. The western sector (Chapter Seven) focused on the local level and on land-use *system* changes. Focusing on the local level enables the land-use change patterns that result from the collective actions of farmers to be revealed. Such patterns might include amalgamation of farms, and intensification or de-intensification of land-use. In the western sector farms were small, marginally economic and the farmers were nearing retirement. This sector, therefore, was appropriate for studying local-level changes because of the potential for new entrants to move into the area and to make tenure and production changes. The southern sector case (Chapter Eight) focused on the farm level and on farmer goals/motivations. The south of the Catchment is the area where different cultural approaches to farming are most evident. Many of the Māori-titled landowners in the area hold strong views on stewardship and passing resources onto the next generation. Consequently, the south was an appropriate sector to focus on the motivations and values of farmers. The diagram on the following page shows the three landscape biographies and the scale at which each was focused.

The biographies were developed using interviews with farmers located in the sector in question plus all of the key informant interviews and other secondary sources (see Chapter Four). The key informant interviews in particular helped to identify the driving forces that were fundamental to the changes found to have occurred at each of the focal scales. The main driving forces found are shown in the diagram on the right hand side.

The conceptual frame is three dimensional in that there is a temporal, as well as spatial, aspect to the biographies. Each biography traces changes from the time of pasture development in the sector to 2013 when interviews were undertaken. This temporal aspect enables the development of landscape transitions and paths (see sections 6.8, 7.6 and 8.6) at each spatial scale. This material has been used to develop overall landscape paths for the Catchment and these are presented in Section 9.4.

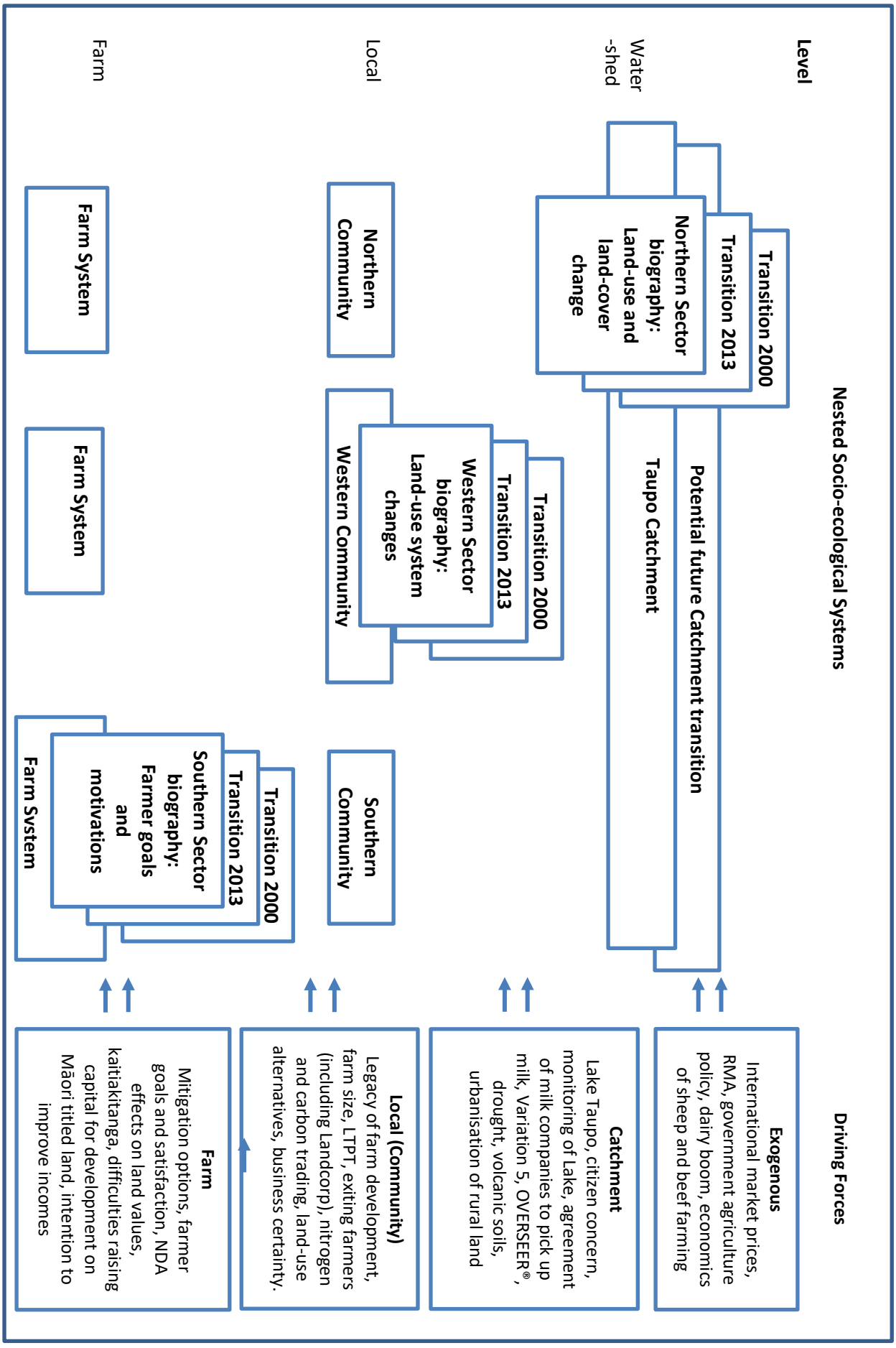

Figure 18: Landscape biographies and driving forces of landscape change, and their informational and spatial scale relationships

By focusing the biographies on factors that are expressed at different scales it became evident that more change had occurred over the 2000 to 2013 period than was apparent from the Catchment-level land-use and land-cover metrics. These changes were mediated by the historic development of pasture in the Catchment, and so in the following section the two major landscape transitions that have occurred in the Catchment since pasture development began in the 1950s are outlined.

9.3 Discussion of temporal and spatial findings of the study

The study found that there have been two major landscape transitions during the modern era and that the change from one transition to the other occurred just after the year 2000. This was the time when the Waikato Regional Council first introduced its plan to place limits on farm production in the Catchment and it was also the period on which baseline data used to calculate individual farm discharge limits was based. The landscape biographies showed that the early 2000s was a period of disruptive change but this was due to more than the proposed regulations alone.

The first transition, from pasture development up until the early 2000s, was largely concerned with the expansion of pastoral farming in the Catchment, and the development of forest plantations in the eastern sector. The second transition covers the period from 2000 to 2013. It includes the development of the regulations, their testing in the Environment Court and implementation (effective from 2007), as well as the purchase of nitrogen allowances by the Lake Taupo Protection Trust[163] and private trading of allowances amongst farmers.

Up until 2000, landscape paths in the Catchment followed one of two development tracks. The first began with the development of pasture from indigenous forest or scrubland, often (but not always) with the assistance of the Crown. Hapu land managed by the Crown (in order to recoup development costs) was often underdeveloped in comparison with the European-titled farms and therefore less productive, but returning the land to hapu control, in the 1980s, was not able to reverse this trend primarily because of lack of development capital. Thus Māori-titled land, mostly located in the south, was (historically) underdeveloped as a result of poor government management, bank lending policies and low returns for sheep and beef farming. In addition, this community of farms held strong stewardship views (encompassed in their kaitiakitanga ethic) which influenced farm system choices and resulted in some intensification projects being rejected in favour of more traditional land-uses.

The second development track also began with the conversion of indigenous scrublands into blocks of pastureland by the Crown, but most of this (European-titled) land was sold to 'ballot' farmers although some was retained by a Crown-owned entity known as Landcorp. While development

[163] Their first trade was made in 2009.

capital was less limiting for these farmers there was, nevertheless, significant financial hardship arising from the withdrawal of farm subsidies and falls in farm income. Farm sizes, initially determined by the government land settlement policy, were becoming too small to be economic. In the northern sector, demand for lifestyle blocks near Taupo, coupled with financial hardship, led to many farms being subdivided and farm sizes in this area dropped even further. What had been a strong community, built on the shared experience of ballot block settlements and children at the local school, began to disappear. In the west, distance from urban centres and the slightly younger age of the settled farmers meant that the sector was the last remaining area of traditional ballot farming in the wider district. This community of farmers, like those in the south, had a strong attachment to their farms and their community, and they also believed that they were taking good care of the waterways through riparian and erosion control planting and instituting reserves along the edge of the Lake. An important driver of their land-use choices was a love of extensive farming but with economic pressure mounting as a result of international prices and small farm sizes, this was under pressure by 2000.

Other factors affected both development tracks. First, biophysical factors played an important role. The free draining, easily erodible and relatively infertile soils, long winters, dry summer weather and resulting soil moisture deficits, all significantly influence farm system choices in the area. Pasture is not always easy to grow in this Catchment and stock type, stocking ratios, pasture renewal and many other management practices had been chosen over the years to accommodate these factors. Second, there was a high level of government involvement in the transition from indigenous vegetation to pasture right across the Catchment and, therefore, similar farm types (extensive sheep and beef, farm infrastructure and farm sizes) had been established. Third, international market prices (particularly volatile prices for wool and lamb and, later, increasing prices for dairy), farm input cost inflation, and the refusal of dairy companies to pick up or process milk from this area up until the late 1990s were influential decision drivers for all farmers in the Catchment.

During the second transition (from early 2000s to 2013), the two landscape development tracks described above have been fractured by multiple land-use, farm system and land-use system changes. These have been described in the conclusions of Chapters Six, Seven and Eight and are summarised for the Catchment as a whole below with reference to the scale at which they became apparent. Overall metrics for land-use, land-use system and farm system (i.e. landscape) change are summarised in Appendix F.

Broad-scale, i.e. at the **watershed level**, it is apparent that only a small amount of land-use change occurred. When this term is defined as a change to the purpose for which land is used (Briassoulis, 2000) it appears that only 24% of the land in the study area has changed land-use (see Appendix F).

Of the land-use and land-use system changes that have occurred, most involve conversion of sheep and beef land to dairy platform and dairy support, or conversion of pasture land to forestry and a mixture of pasture and woodlots. Apart from conversions to dairy support, most change was the result of nitrogen trading and the drivers were found to include the opportunity to extract capital from land that will not be sold for cultural/legal reasons (see Chapter Eight), carbon contracts that make forestry conversion attractive (see Chapter Six), the dairy boom that was occurring throughout New Zealand at the time, and a drive amongst sheep and beef farmers to improve incomes (see Chapters Seven and Eight).

Significantly, only a small amount of the change from sheep and beef to dairy support involved trading. Thus the cap and trade regime has both facilitated land-use change and not hindered market-led change. The driver of this latter change appears to be the significant amount of conversion of sheep and beef land outside of the Catchment border to dairy (see Appendix G), the need to spell pasture in winter in this low grass growth district (see Chapter Seven) and the cheapness of land in the Catchment (see Chapter Eight). Further, urbanisation, which was a significant land-use change (particularly in the north) in the first transition, is not a significant land-use change during the second transition period.

Around 76% of land in the study area has not changed land-use (see Appendix F) even though there appears to be sufficient variation in nitrogen surplus values to incentivise land-use change and sheep and beef farm incomes can be low. In Chapters Six and Seven it was suggested that the reasons for a lack of change include: lack of land-use and on-farm mitigation alternatives that can result in surplus nitrogen that could be traded or used to intensify land-use, the gatekeeping role of OVERSEER®, the connection between land-value and NDA level and, in some cases, farm size. In Chapter Eight, further factors, particularly place attachment and the satisfaction achieved from pastoral farming, were found to be involved. However, the strongest arguments against trading (and land-use change) amongst some farmers was the concern that selling nitrogen would negatively affect productive capacity, land values and ability to sell.

At the **local (community) level**, there were four main types of change evident during the second transition and they involved tenure type and land-use systems. Tenure changes involved farm amalgamations and a significant turnover in landowners resulting from the number of farmers that exited from the Catchment. Land-use system changes were de-intensification of production, and intensification (potentially leading to increased income). It is estimated that changes in tenure through amalgamation occurred on 14% of the study area, and exiting involved 22%[164]. Changes in

[164] Amalgamation and exiting are occurring on the same farms as other land-use system changes, and so have not been included in the landscape change table in Appendix F.

land-use intensity (de-intensification and intensification) occurred on over 60% of consented pastureland in the study area. This is a significantly higher amount of change than the land-use change figures alone suggest. It was found, from focusing on this spatial scale, that the amount of de-intensification that had taken place through the lowering of production levels was significant but not included in the land-use metric. Many farms, it was found, had not changed land-use but had changed their land-use *system* by reducing stock numbers and, apparently, not implementing an alternative land-use. Thus overall farm production (e.g. output per ha) is lowered and potentially can only be raised if low nitrogen land-uses or mitigations can be found and implemented on-farm.

Amalgamations were partly driven by farmers *exiting*, including Landcorp. The sale of large tracts of Landcorp farmland enabled economies of scale for the new purchasers, particularly once they were amalgamated with neighbouring farms. Other factors included increased business certainty under Variation 5 (in comparison with other areas around NZ where NPS-FM policy implementation has still to be undertaken) and relatively low land prices that are attractive to potential new entrants.

De-intensification was mostly driven by the government policy aimed at achieving a 20% reduction in nitrogen discharges via the Lake Taupo Protection Trust and was largely realised by reducing stocking rates. The underdevelopment of farms in the south was also a factor, since the sale of nitrogen was one way of extracting capital from poorly performing farms that could not be sold, whilst still protecting the Lake and ensuring intergenerational equity. Small, private trades that led to de-intensification were mostly the result of sales of nitrogen that was surplus to the current farm system (i.e. 'windfall' nitrogen) or retirees downscaling their operation. The other avenue of de-intensification was through a change in land-use. Farmland was converted to forestry, or mixed pasture/woodlots. Most of this latter change was facilitated by trading since this made forest land more price competitive with pasture land, particularly if carbon trading was also involved. In one case a hunting park addition to the forestry conversion may further increase the value of the property. Subdivision for lifestyle or tourist development has been popular in the past, particularly in the northern sector, but market demand declined after the Global Financial Crisis. Some farmers, however, appeared to be aiming for a new type of lifestyle development where the whole farm is sold as a lifestyle unit, rather than subdividing the farm for this purpose. In 2013, no properties were known to have been sold for this express purpose, but some farmers suggested that they are planning this type of land-use change which potentially could lead to some de-intensification if housing is mixed with pasture.

Intensification, on the other hand, was driven by international demand for dairy produce which led to an increase in dairy conversions in the Catchment and an increase in demand for dairy support from farmers located outside of the Catchment. After the regulations became effective there were

four ways in which intensification was performed. First the trading mechanism could be used to purchase sufficient nitrogen to convert sheep and beef farms to a dairy platform. One farmer used this route and was the only significant, private purchaser of nitrogen. The second intensification path involved conversion to dairy support when nitrogen needed to be purchased to make this change possible. This route was used by a dairy farmer from outside of the Catchment, who purchased NDA and converted land to a support unit for their dairy platform. Third, other farmers followed a limited type of intensification in converting land to dairy platform or dairy support in that they did not purchase nitrogen to facilitate the land-use change (although one has leased NDA for a short period) and thus did not permanently increase the NDA level of the farm. These non-trading farmers, therefore, have arguably moved this sheep and beef land to a 'higher' land-use, that is one where (according to interviewees) the cash-flow or capital gain from the land is increased. A large farm in the south of the Catchment achieved this (see Chapter Seven) by converting part of the farm to dairy, whilst also decreasing sheep and beef numbers by an amount sufficient to cover the increase in dairy cattle. While the NDA for the farm remained unchanged, the converted land potentially produces a higher income and its overall nitrogen discharge level is unchanged. Last, a small number of farmers purchased land outside of the Catchment which was not subject to the same stocking rate restrictions. Thus, a dairy farmer in the north and two stations in the south have intensified their *overall* farming operations without affecting the NDA level of the farm inside the Catchment boundary.

Farm-level changes did not involve change to farming methods but were found to involve changes to income sources and ways that income is earned from rural land. Other authors (e.g. Fairweather, 1989; Wilson, 1994; Le Heron et al. 1996; Johnsen, 2004) have found that farmers have in the past adjusted to external events by reducing farm costs or obtaining off-farm employment, but, these were not evident in this Taupo study. Here, adjustments took the form of investing outside of farming, moving nitrogen-intensive farm practices or part of the farm to land outside of the Catchment or including manufacture within the farm system or developing a brand or provenance. Le Heron et al. (1996) suggested that expansion into non-traditional forms of earning income from rural land has been underway in New Zealand for some time, particularly by those farmers for whom return on capital invested is important. However, the difference in Taupo is that the changes are not only aimed at achieving an acceptable rate of return, but equally at mitigating the production cap effect of the regulations while taking account of the need to protect Lake Taupo. In order to expand their future farming operation, another avenue (or location) of income generation that will not harm the Lake is required and business expansion can then take place in the new location or through the new business. The drivers of this change, therefore, are the need to improve farm income, the variability in sheep and beef product prices, lack of mitigation and low nitrogen emitting land-use

alternatives and concern for the well-being of the Lake. A major driver, however, was found to be the achievement of farmer goals.

It has been assumed in this study that the requirements of a viable farming operation are similar to those determined by the farm system mapping work of Fairweather & Hunt (2011) - i.e. decision making control, satisfaction and quality and quantity of production. While the results of this study (see Chapter Eight) confirm that these are important, it also found that farmers placed importance on retention of pastoral farming (preferably sheep and beef), making a profit sufficient to achieve their strategic goals, on place attachment, on care of resources (including the Lake), and on passing those resources on to the next generation.

9.4 Landscape paths from 2000 to 2013

The temporal and spatial analysis has pointed to five landscape paths occurring in the Catchment after 2000. First is the 'business as usual' path which includes landowners that are continuing with the same farm and land-use systems, or it is unknown whether change has occurred. Second is de-intensification through reduction of production levels with no apparent reinvestment on farm. Examples of this include semi-retirement and farms in the south that have sold nitrogen and lowered stocking rates. Third is the land-use change path where investment has been made in on-farm production mostly through conversion to dairy, dairy support (if NDA is purchased), or forestry. This contrasts with the fourth path where land-use and farm system changes are undertaken that don't require the purchase of nitrogen. This includes converting to a more profitable farm system or stock type but without a change to the farm NDA level. Last is the path in which the adjustment strategy involves restructuring the farm and finding a new way of making money from the farm. These paths are summarised in the table below. The implications of the landscape paths are discussed, with reference to relevant spatial scales, in the section following the table, and the paths are visually represented in the map found at the end of this section.

Landscape Path	Land-use, land-cover, farm practice or land-use system change	Estimated % of study area	Adjustment strategy
Business as usual	Nil	25%	Continue with sheep and beef at the same stocking rate (SR) Continue with dairy farming, same SR Continue with dairy support, same SR

Farm production reduction	Farm practice change	42%	Reduce stock units/ha (SU/ha) and semi-retire Reduce SU/ha and farm more extensively Reduce SU/ha and invest outside of farming Reduce SU/ha and cut and carry Reduce SU/ha in Catchment and intensify on additional farm out of Catchment
Land-use change	Land-use change Land-cover change Tenure change	21%	Convert to dairy platform through trading Convert to dairy support through trading Convert to trees - plantation forestry/carbon forest/hunting park through trading Subdivision, including trading nitrogen Farm amalgamation, and trading nitrogen
Change without trading	Land-use change Farm practice change	6%	Convert part of farm to dairy without trading Convert to dairy support through leasing NDA (for fixed term) Convert to dairy support without trading Subdivision without trading nitrogen Continue with dairy farming, same SR and intensify on additional land out of Catchment
Restructure farm	Nil	5%	Secondary processing on farm Developing a brand or provenance

Table 19: Landscape Paths in the Taupo Catchment from 2000 to 2013.

The **business as usual** landscape path describes the situation of the 25% of consented landowners that have either not changed their land-use, level of production or the farm practices that affect nitrogen discharge levels, since the early 2000s, or it is unknown whether such changes have been made. This grouping is mostly made up of sheep and beef farmers but includes one dairy farm and several dairy support units. Interviewed sheep and beef farmers that have made no changes were concerned about their long term future under a nitrogen cap because of increases in farm costs, volatility in product prices, a cap on production, small farm sizes and the lack of nitrogen-lowering technologies and/or low nitrogen land-uses on the horizon that might result in a step change in the industry[165]. Further, interviewed farmers were reluctant to sell nitrogen allowances because of the likely effect on land values. The views of these farmers are summed up in the words of one consultant who, when asked what the Catchment might look like in 50 years' time, replied as follows:

> *I would have to reluctantly say more and more pine trees – I hope that I am wrong – I hope that farm profits and productivity go up.*

The **farm production reduction** landscape path includes all those landowners that have not changed land-use but are currently operating substantially below their initial NDA level either because they have sold some of their nitrogen allowances and appear to have not invested in an alternative

[165] In 2017, the Ministry of Business, Innovation and Employment and DairyNZ are jointly funding a research project aimed at identifying plant species and farm management practices that could result in lowered nitrogen leaching from pastoral farms (T. Petch, Personal Communication).

income producing land-use, or because they have semi-retired. This path mostly applies to the south of the Catchment where many farms sold nitrogen to the LTPT and reduced their stocking rates as a consequence. This could be a transition phase if landowners eventually decide to reinvest on-farm, as this Trustee suggests below:

> *Your ability to move away from that core [sheep and beef] business is dependent on your leadership. I guess that's what I'm saying. With each of the different [Māori-titled] farms, we're each at different points along the pathway to moving towards more non-farming activity.*

This view is echoed by a farm consultant who said that he advised some of his clients in the Catchment to sell nitrogen and diversify by investing the proceeds in businesses outside of farming in order to "…*have another string to their bow*".

The **land-use change** path is perhaps closest to the type of change that theoretically would be expected in a cap and trade implementation - i.e. that landowners use the trading facility to enable a land-use change or to introduce mitigation practices, if these are available. NDA levels therefore change from the levels that were initially allocated.

Some landowners in the Taupo Catchment have sold allowances and have used the proceeds to convert land to plantation forests (some with carbon contracts) or to achieve an economic sized unit through farm amalgamations. Three farmers have purchased allowances in order to intensify, although two were for only small amounts. Several key informants suggested that this 'land-use change' path would be the dominant one in future years, but perhaps in a modified form, as suggested below by the General Manager of one of the larger farms:

> *I think you will find that there will be pockets of very good farms, there will be a hell of a lot more trees and there will be run down properties with rank grass that guys have gone broke on.*

The landscape path in which land-use and farm-system **change** occurs **without trading** is a market led change. This path includes businesses that increased farm incomes by changing stock type without trading, mostly to dairy support but in one case to dairy platform. One farm has leased NDA in order to make this change but the lease is for a fixed term so a permanent change to the farm NDA has not been made. Another farmer has maintained the same stocking rate inside the Catchment but has purchased land outside the Catchment on which they can intensify their farming operation. Many of the dairy support farms in this category are subsidiary to land outside of the Catchment. That is, the land is owned or leased by a dairy farmer from outside the Catchment boundary and, according to the real estate agent quoted below, this is an ideal use for land in the Catchment:

> *As a standalone operation a ballot sized farm is marginal. But as a support unit for an existing operation (like a dairy farm) it is economical. And particularly so in the Catchment because land is so much cheaper here – but you need the NDA to go with it.*

The last landscape path involves **restructuring the farm**. Restructuring is a common response to disruptive change (Le Heron et al., 1996) but in this case it has taken a slightly different form because the aim is not just to make a profit from rural land but to find a new way of doing so while also protecting Lake Taupo. A cap on nitrogen is a cap on pastoral production and consequently business growth needs to take on a new form. A Trustee from the station in the south that is milking sheep explains the place he sees for this industry in the Catchment:

> *As a farmer, I would like to see a new industry in this catchment … Obviously I think that sheep milking is the next big thing for sheep and beef farmers in NZ – and that is whether there is a cap in place or not. The problem is to decide what to turn the milk into but, for example, sheep milk could take over the baby formula market. I hope that some of the other Stations around here will join us in milking sheep so that we can get sufficient supply to break into good markets.*

Thus restructuring in the Catchment currently includes undertaking secondary processing on farm and building a brand or provenance (see Chapter Eight) but may expand in the future to include other ways of producing an income from land that is remote from townships and tourist routes.

The map below shows the distribution of these landscape paths across the study area in 2013, and in the section that follows, the implications of these paths are discussed in relation to the spatial scale at which many of the path effects are apparent.

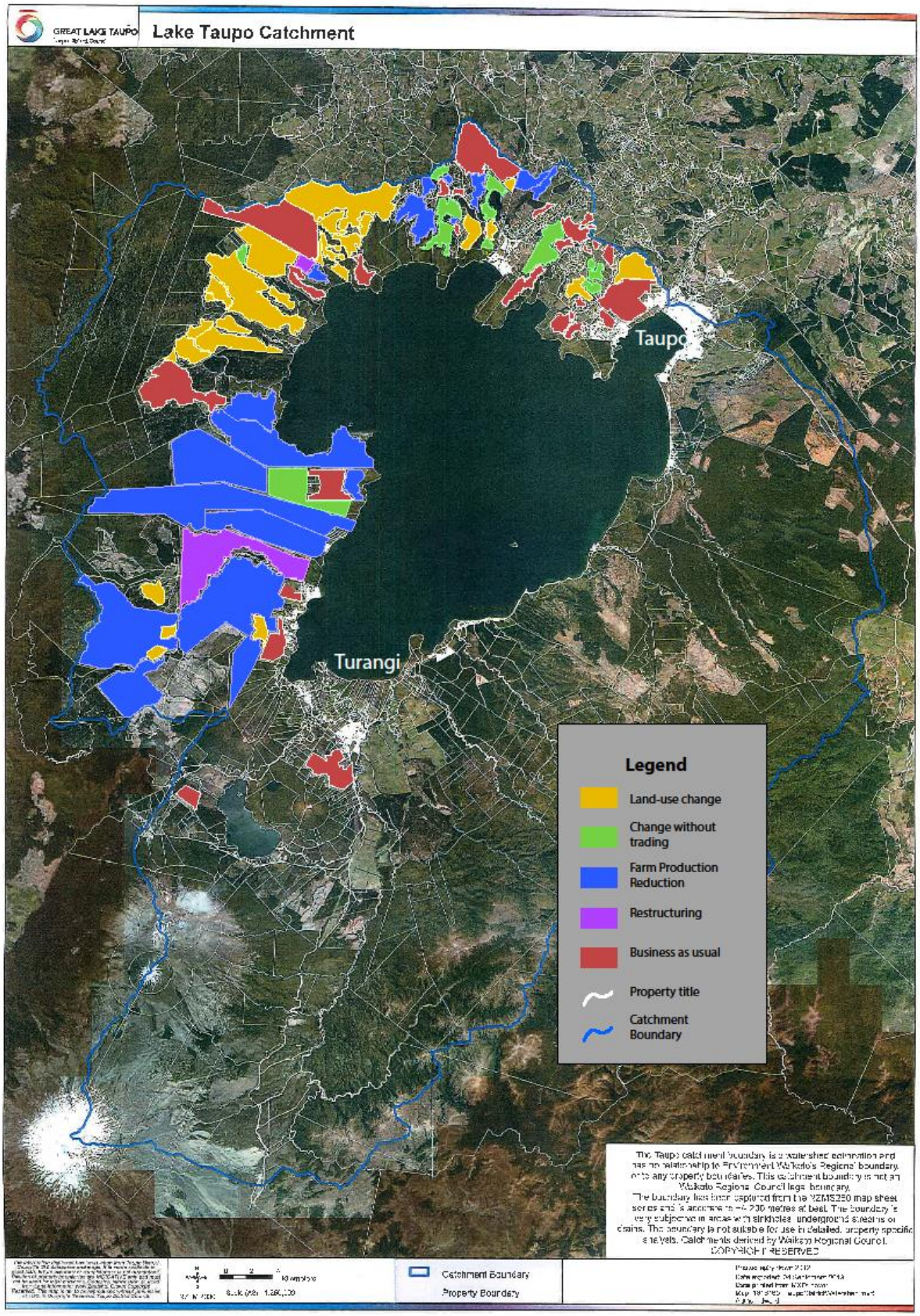

Figure 19: Map of study area showing landscape paths (indicative only)
(Source: Adapted from Taupo District Council. Reproduced with permission)

(See Appendix J for full copyright information)

9.5 Study Implications

This section explores the implications of the five landscape paths outlined above, and other study findings, for the Catchment, for agricultural policy in New Zealand and for cap and trade theory and implementation. Last, the usefulness of the landscape approach is considered.

9.5.1 Implications within the Catchment

This study has shown that operating a farm, particularly a small/medium sized traditional sheep and beef farm, under a nitrogen discharge cap is not straight forward. In part this is because the economics of such farms are challenged by current international prices, but the cap also adds another layer of complexity onto the complexity that already exists in socio-ecological systems.

At the farm scale, the influence of farmers' goals and motivations in determining an adjustment strategy was apparent. Many authors have attested to the influence of farmer goals (Le Heron et al., 1996) or management styles (Fairweather & Keating, 1994) and operating under a cap proved to be no exception to this. The two landscape paths most apparent at the farm scale are the 'restructuring' and the 'farm production reduction' paths. The implications of these landscape paths for farming in the Catchment in the future are considered below.

Restructuring path. The restructuring adjustments (sheep milking/processing and processing/brand development for beef) are focused on business growth through niche marketing. This approach has been recommended by various authors over many years. Recently, Campbell et al. (2009) make a case for thinking about rural regions as 'biological economies' and the Taupo Catchment could present such an opportunity. It is a place where environmental rules, intersecting with a demanding biophysical situation, are contributing to a relatively pristine Lake, back-dropped by attractive mountain ranges. These factors could be used to add value through provenance branding. The beef business included in this category is following this line of reasoning by marketing beef as being grown in such a way that it protects the Lake. This branding is still in the early stages of development, but if customers respond to the sustainability ethic it may provide a differentiation for pasture and forest produce originating from the Catchment.

Campbell et al. (2009) also suggest tourism, film/advertisement making, hospitality and similar enterprises as potential economic activities but, other than trout fishing, the western and southern areas have attracted few such ventures over the years. Tourism, for instance, tends to favour the east of the Lake because access to, and views of the Lake, are not common on the western side, and the east is a more direct route to the National Park in the south. Interviewees reported, however, that a new mountain bike cycleway is being developed around the west of the Lake. The concept of biological economies adds weight to the suitability of the restructuring path for the regulated

Catchment if manufacturing and provenance development are successful or other income producing avenues are found.

Farm production reduction path. For landowners who felt a personal responsibility for the health of Lake Taupo but also saw a need for business growth, an obvious alternative was to reduce their pastoral farming operation in the Catchment and move part of the farm out of the Catchment, or move capital out of farming altogether, and this is the adjustment that some landowners in the south chose to make. Another, larger group of landowners have reduced the production level of their farm by selling nitrogen and reducing stock units per ha. A few of these farmers, on smaller properties, have used the capital from nitrogen sales to semi-retire. Most, however, appear not to have reinvested the capital in on-farm ventures. It may be that the sale of nitrogen was seen as a way of raising capital from land that cannot be sold – perhaps it was an opportunity that had to be taken while the government was still offering to buy nitrogen, and so plans for the reinvestment of the capital were to be made at a later date. Consequently, reduced production for these farms may be a transition phase while landowners gather information about their options for farming under a cap, and land-use change could follow in the future. Equally, the capital raised might be invested outside of the Catchment and/or farming. If land-use change does not occur, the productive capacity of the Catchment is significantly reduced.

There is little evidence of any momentum for continued change at the **local level** through change to land-use systems or tenure. As has been mentioned, there are no longer large tracts of pastureland potentially available for sale and amalgamation of small/medium sized farms was reported to be difficult and expensive. Amalgamation may take a different form, however, through partnership agreements, as has happened recently with two Stations in the south. Intensification through trading is unlikely, even if nitrogen is available to purchase and despite the relative cheapness of the land. Dairy farmers, and sheep and beef farmers wishing to increase their stock units per ha, may be deterred from further investment in the Catchment, not by the need to buy nitrogen, but rather by the difficulties of amalgamating multiple small and low NDA farms and the recent introduction of limits on water takes (Variation 6[166]), as this General Manager explained:

> *The issue with Taupo catchment - to buy in there again - is variation 6. There is a property for sale at the moment and it is very nice and its best use is dairy farming but I can't survive on 15 cubic metres of water a day - you've got to have more. Water is now the impediment in Taupo not the nitrogen.*

[166] Variation Six to the Waikato Regional Plan addresses water allocation. See https://www.waikatoregion.govt.nz/council/policy-and-plans/rules-and-regulation/water-allocation-variation. Retrieved March 25, 2017.

In addition, de-intensification through conversion to forestry appears to be sensitive to the availability and value of carbon contracts, and with carbon prices currently low, conversion may not be attractive.

At the **watershed level** pastoral land-use change options for the Catchment are not evident and so maintenance of a viable agricultural sector under a nitrogen cap is questionable at this stage. It is apparent that there is a real need for new ways of making money from rural land that discharge low levels of nitrogen. Land-uses, such as hazelnut and Manuka honey production, were investigated by researchers but found not to be viable. However, prices may change and bring these, or other rejected land-uses, back into focus. Similarly, if carbon prices rose, planting of 'carbon forests' could increase. Biofuels, it appears, remains an unknown quantity and, like other potential uses, must overcome the hurdle of inclusion in OVERSEER®. At the current level of technology, however, land-use change options are limited and so further nitrogen trades may also be limited. Three landscape paths involving land-use change are evident at this scale and the potential projections of these are considered below.

Land-use change path. Despite predictions, the landscape path of investing in land-use change appears unlikely to become a dominant path in the Catchment unless investment in forestry becomes a favoured option or alternative low nitrogen land-uses are found and included in OVERSEER®, thus making nitrogen available for potential purchasers. Without the additional attraction of carbon contracts, however, it is difficult to see how current landowners would accept a land-use where planting costs must be paid up front, which gives them no financial return for around twenty-five years and, for landowners in the south, potentially limits the choices of future generations. Kaitiakitanga, for at least part of the southern community, is concerned with the wellbeing of both the people (i.e. the current generation as well as following ones) and the Lake. Further, even if NDA becomes available for sale, potential purchasers may not exist. As mentioned above, dairy conversions are likely to be limited by Variation 6 and other, profitable land-uses are not currently available or are not included in OVERSEER®. One unknown is the 2018 review. Should this review require further reductions in discharge limits then planting trees is one of the few low nitrogen land-uses currently available and so more plantings could result[167], particularly on larger properties in the south.

Change (without trading) landscape path. This hybrid path involves land-use as well as farm system change and occurs when change can take place without the need for trading nitrogen. In particular,

[167] Forestry, however, requires scale (Manley & Lane, 2013) as well as access to processors or ports and many of the woodlots established since 2000 may prove too small or too remote to harvest (see Park, Manley, Visser & Morgenroth, 2012) or be of an un-merchantable species.

conversion of sheep and beef land to dairy support and to dairy platform has occurred without trading (although sufficient NDA is required for this to occur). Thus the regulations have not impeded market-led change from occurring and this suggests that it could continue to occur. The regulations have also not impeded the export of nitrogen intensive operations being transferred out of the Catchment. Instances of this that have occurred in the Catchment include: purchasing land outside of the Catchment on which to intensify, using land inside the Catchment as a support unit to an intensive farm outside of the Catchment, and locating high leaching breeding animals outside of the regulated area. In addition, there is an advantage, if a farm crosses the Catchment boundary, in locating some farm practices (such as cropping that requires nitrogen fertiliser) across the boundary. Although such 'leakage' has not been high at this stage, it potentially could increase, particularly if production limits that are eventually imposed outside of the Catchment are less onerous than those in the Variation 5 regulated area.

Business as usual path. While a significant number of farmers have not sold nitrogen and have made no land-use or farm practice changes at this stage, many of these farmers may not be open to land-use change or to selling nitrogen in the future. Interviewees explained how lowered nitrogen levels negatively affected land values and saleability – a position that was endorsed by a real estate agent familiar with the area. In addition, their antipathy to trees and their attachment to sheep/beef/deer farming, to the farming way of life, and to the location, all contributed to their decision to not change land-use. This reluctance to change applied to interviewed European-titled landowners and reportedly to Māori-titled landowners as well.

Some farmers, however, were keen to change land-use but were unable to do so because of the low NDA value of their land. Sheep and beef farming, some suggested, cannot support the purchase of nitrogen, even if there was nitrogen available for sale. These farmers, therefore, may be open to land-use change in the future if low nitrogen land-uses (or on-farm mitigations) become available. Until this occurs, or a further disruptive change happens (such as lowering all NDA levels as a result of the 2018 review), this landscape path is expected to continue.

In summary, at this point, the landscape trajectory for the Catchment appears to be one of lowered pastoral production, which may have flow-on effects for the resident communities. As one interviewee suggested, the Catchment is "…*definitely drifting to a lower stocking scenario, either trees or fewer cattle*".

9.5.2 Implications for agricultural policy and science in New Zealand

The study suggests that policy has outstripped the ability of agricultural science to provide answers about technological fixes (or information about whether there are any) to the problem of nitrate

leaching. The landscape biographies pointed to the role of science in uncovering the environmental problems of nitrogen pollution of Lake Taupo and, more recently, in attempting to find land-use and farm practice solutions. Since the 1960s, scientists have warned that the health of Lake Taupo is dependent on land-use practices in the Catchment. By the 1990s these warnings had become urgent and, at that time, both local government and the public were receptive to the message. Unfortunately, other parts of the science world had not prepared for this increased interest. A review of research undertaken on hill country farm systems between 1951 and 2014 (Stevens, Casey & Cousins, 2016) noted that most research had been directed at biophysical processes and productivity improvement. Very little environmental research had been undertaken at the farm system scale and, overall, environmental outputs were the focus of only 5% of productivity-based studies. Research, the authors concluded, has been production focused since (p. 75) "…*the purpose was to provide practical answers to the questions farmers were facing*". The needs of other stakeholders, and of future farmers, appear to have been overlooked. Campbell et al. (2009) suggest that this approach has resulted in a lack of research on ways of earning a living from rural land (p. 95); that is, ways "…*which place less emphasis on productivity and more on the environmental and social impacts of production*". This view is borne out by experience in the Taupo implementation. In 2001, Ledgard, Thorrold, Petch & Young suggested that the only ways to reduce nitrogen discharges from sheep and beef farms was to reduce stocking levels (with a potential loss in income), reduce cattle numbers (although cattle are needed for income complementarity and for pasture management) or move animals out of the catchment during winter (i.e. move the problem somewhere else). Despite a flurry of studies about mitigation methods and alternative land-uses for Taupo[168], the advice had changed little, leading Quinn, Wilcock, Monaghan, McDowell, & Journeaux (2009) to suggest that (p. 79) "…*the most expedient practical measure [in Taupo] would be to retire some of the land from pastoral farming and plant trees*"[169]. Doug Edmeades, after listening to presentations by scientists at a Beef + Lamb NZ field day, concluded that there had been no new initiatives or break through ideas coming from scientists for over ten years (Beef + Lamb NZ, 2012).

Unless new technology intervenes or more on-farm manufacturing takes place, or a new biological economy evolves, it appears unlikely that a viable agricultural sector can exist long term under a cap and trade programme (that limits nitrogen discharges at the farm-level), particularly given the difficult biophysical conditions of the Taupo Catchment, and the economic circumstances of extensive farming such as sheep and beef.

[168] See Chapter Seven for outlines of the research projects undertaken

[169] This advice does not appear to take into account the difference in overall value for the farmer (Chapter Seven) nor the minimum area of land needed for such a conversion (Park, Manley, Visser & Morgenroth, 2012).

If this was a problem limited to the Taupo Catchment then that would be unfortunate, but the National Policy Statement on Freshwater requires limits to be placed on farming activities throughout the country, and this raises the question of how the farm output increases promised by politicians[170], can be achieved on sheep and beef farms in a range of different environments. It is apparent from this study that more research into low nitrogen land-uses, for example sheep milking and biofuel production, and farm practice mitigations for sheep and beef are urgently required.

The outcomes of the Lake Taupo Nitrogen Trading Programme indicate that caps applied in other areas of New Zealand may be faced with similar responses. While it will be less possible for farmers to move to an unregulated area (since eventually all regions will be subject to environmental limits via the NPS-FM), they will still be able to move farm reinvestment money into other industries, to semi-retire on potentially productive land or to sell their land as lifestyle farms/blocks. As an economy dependent on income from agricultural sources, it is to be hoped that farmers will instead choose to undertake secondary manufacturing on-farm, raise product prices through provenance branding or find other ways to decouple profitability from the discharge of nitrogen and so maintain the contribution of agriculture to the economy. Thus cap and trade may be appropriate for fulfilling the NPS-FM in some watersheds, but it is not a panacea for reconciling an agriculture based economy to environmental limits.

9.5.3 Implications for the theory and application of cap and trade

Cap and trade, unlike many command and control regimes, does not prescribe which practices farmers should undertake on-farm in order for water quality goals to be achieved. While the cap sets a limit on discharge levels (and in the exemplar Lake Taupo Nitrogen Trading Programme these are set at both the Catchment and farm levels), farmers are free to choose how they operate their farm within the assigned limit. Because of the ability to trade and to adopt new technologies, land-use within the regulated area is not locked in a time warp, and land-use in the Catchment can move with market demand and technology change. However, in reality, there are significant barriers to this occurring.

Breetz et al. (2005) and Mariola (2012) make the case for the social embeddedness of farmer decision making and this study extends these findings by suggesting that farmer decisions are embedded in a socioecological system which includes biophysical, economic and social factors. This was confirmed by many interviewees, such as the one quoted below, who spoke of the multiple factors that they have to take into account:

[170] See Chapter Two, Section 2.2.1

> *I had a group of ten professional people here and they went away amazed at how hard farming is. They are predominantly manufacturers and the like. They know how much it is to buy their inputs. They know what price they can sell the product for [and] they were astonished by the [number of] things in the middle that farmers cannot control.*

Thus the cap and trade regulations are one of a network of factors that together result in farm and land-use system change. As outlined in Chapter Two, few ex-post studies have been undertaken to investigate the changes that do occur and the behaviour of farmers under a cap and trade regime for water quality. In part this is because, other than the Lake Taupo Nitrogen Trading Programme, there are no cap and trade implementations where water quality discharge limits for diffuse pollutants are set at the farm level. Since cases to study (i.e. ones where a cap is applied at the farm level) are not available, most studies rely on theoretically derived predictions of farm and land-use system change and farmer behaviour around trading. As Marsh (2014) points out, such predictions need to be verified. The Lake Taupo Nitrogen Trading Programme, therefore, presents a unique opportunity to research farmer responses to operating under a water quality cap and trade regime. Overall, farmer responses appear similar to their responses to other exogenous drivers (such as the removal of subsidies) in that they include land-use and land-cover change, and restructuring. But there is also evidence of unexpected responses such as farmers refusing to trade, and of sale of nitrogen without implementing mitigating farm practices other than stock reductions or investing in low nitrogen land-uses.

Key insights from the Taupo study for cap and trade theory, therefore, involve: market-led land-use change that did not involve trading, low trading activity because of lack of both supply of allowances and lack of demand for them, the effect of grand-parenting of allowances, and problems incorporating cap and trade within a farm system. These are discussed below.

Land-use change without trading. A small amount of land in the Catchment has changed, without the involvement of nitrogen trading, to a potentially higher land-use such as dairy support and dairy platform. Thus the cap and trade regulations have not impeded market-led change, and farmers have been able to respond to drivers such as demand for areas where dairy cows can be wintered away from the dairy platform despite cattle being a higher emitter of nitrogen than other pastoral animals.

A small number of instances of 'leakage' were found, where farmers have purchased land outside of the regulated area in order to intensify their operation, or they have moved nitrogen intensive operations out of the Catchment. While these instances were low, their occurrence points to the potential for moving beyond the reach of regulations rather than finding ways to farm profitably within environmental limits.

Low Trading Activity. Trading activity has been shown to be low in many cap and trade programmes and, as outlined in Chapter Two, authors have speculated on the reasons why this is so. Many suggested reasons, however, do not appear to apply to the Taupo Catchment because: transaction costs are low (see Duhon, Young, & Kerr, 2011 and Appendix H), information sharing costs are low (Barnes & Young, 2013), variation in nitrogen surpluses exist (see Section 6.6), and property rights are well defined (Barnes & Young, 2013).

The exiting of the LTPT is an unusual feature of the Taupo case, and so when considering the trading arm of Variation 5 it is important to separate the effects of trading with the Lake Taupo Protection Trust from the effects of private trading. The Trust withdrew from trading in 2014 because its objective of a 20% reduction in total nitrogen discharged to groundwater had been achieved (Organisation for Economic Cooperation and Development, 2015). Consequently, records of trading with the Trust is not indicative of long-term trading activity in the Catchment nor for trades undertaken for the purposes of changing a farm system[171]. Only private sales demonstrate the management flexibility which is a feature of cap and trade. Data provided by the Waikato Regional Council shows that there were three private purchasers of nitrogen up until 2013 but only one of these purchased significant amounts. There were nine private sellers[172]. The level of private (i.e. market) trading under Variation 5 to 2013 was, therefore, low.

The map below shows the location of the nitrogen sales (although two private sales were from properties too small to locate on this map). The arrows show where nitrogen was moved to because of the sale. Most nitrogen was removed from the Catchment (from properties shown in blue), and private sales (shown in red) resulted in a transfer of nitrogen to the property shown in green on the map.

[171] The trades with the Lake Taupo Protection Trust were voluntary reductions in farm production funded by local and central government and thus, unlike the private trades, were not related to moving allowances from lower value land-uses to higher value ones.
[172] See Chapter Five Section 5.5.2

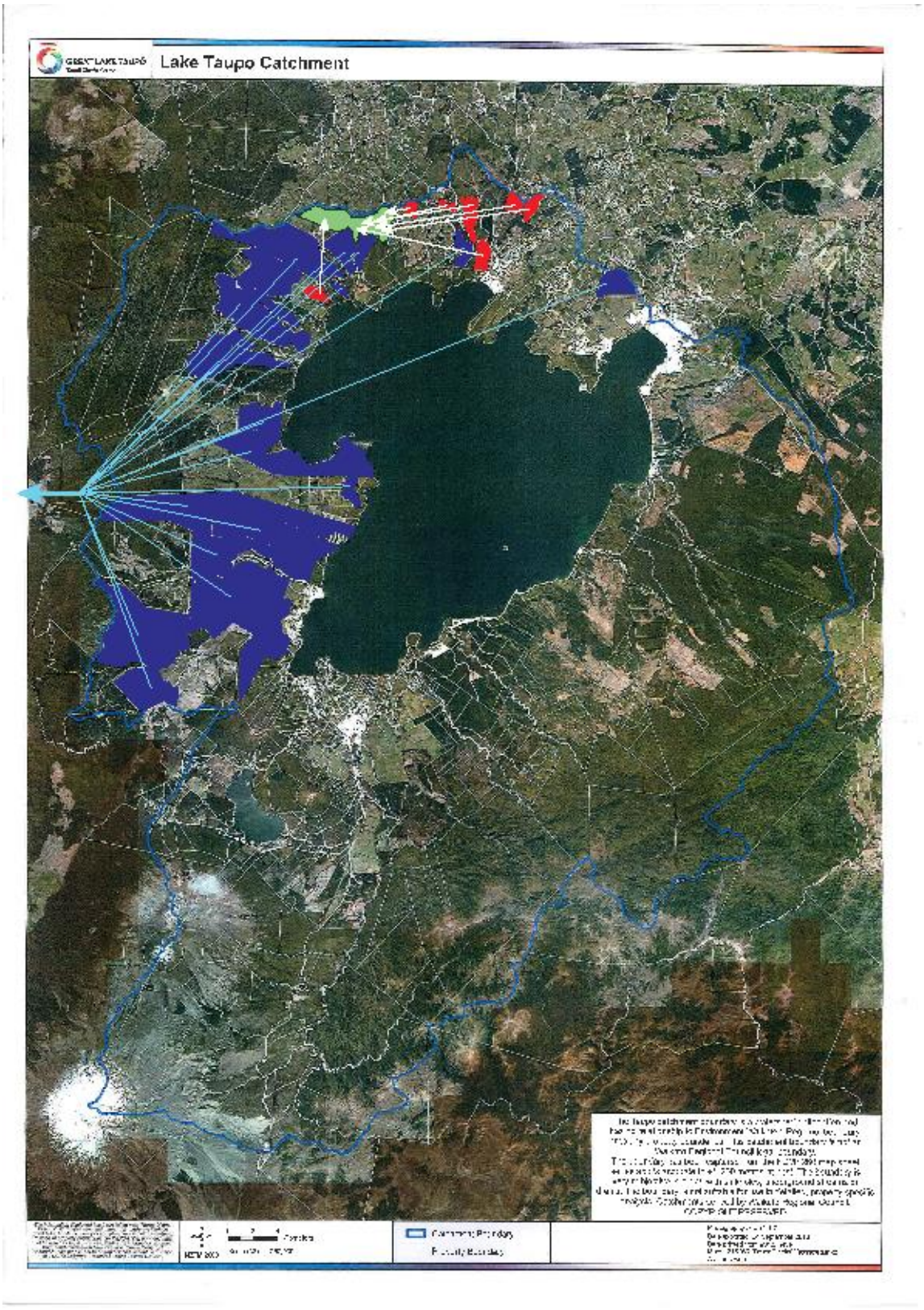

Figure 20: Map indicating source and destination of nitrogen trades to 2013
(Source: Waikato Regional Council and Taupo District Council. Map reproduced with permission)

NB: The arrow pointing left indicates that nitrogen from these farms has been permanently removed from the Catchment. For farms highlighted in red, nitrogen has been transferred within the Catchment. Two trades are too small to show at this scale.
(see Appendix J for copyright information)

One reason for low trading volumes, suggested by King & Kuch (2003), that may be applicable to the Taupo case, is lack of supply and demand. European-titled landowners have reported a reluctance to supply allowances because of the potential negative effects on land values, ability to sell and production levels. Māori-titled landowners may also be reluctant to sell. Given the kaitiakitanga values of these owners in the south, sales to facilitate intensification by private owners elsewhere in the Catchment, particularly dairy farming, may not be acceptable. Further, some Trustees in the south are waiting until after the 2018 review of Variation 5 to see whether NDA levels will be further lowered, as this Trustee explains:

> *We know already that that target is incorrect and that more nitrogen will have to be taken out of the system (maybe another 20%). So every person in the Catchment will be forced to give up more land – people will be forced into a corner where they have no option but to plant more trees. Some farms will struggle – especially the small farmers.*

Thus the number of farmers willing to sell nitrogen may remain small for some time to come. Certainly the ballot farmer who had accidently sold more NDA than he intended to was, in 2013, having problems finding farmers that would sell him sufficient NDA to make his property a viable enterprise. This was despite the Trust having effectively exited from the market at that time[173].

Lack of demand may also be contributing to low trading volumes. Only three private purchases of nitrogen allowances had been undertaken up to 2013 and only one of these was for a significant amount. The General Manager of this latter enterprise, while currently looking to expand their operation, is doubtful about the potential for further purchases in the Catchment since, as previously mentioned, Variation 6 to the Waikato Regional Plan now regulates the amount of water farms can access. So although the largest dairy enterprise in the Catchment reported that the Variation 5 regulations were 'business friendly', it appears unlikely that their dairy farming operation will be expanded in the Catchment because of water availability. As reported in Chapter Seven, other ventures have similarly been deterred from investing in the Catchment. A prime deterrent was the need to have sufficient scientific data to be able to include a proposed/novel land-use within OVERSEER®. Thus OVERSEER® and water availability are two impediments to further intensification of land in the Catchment. Even though the LTPT, the largest purchaser of allowances, is exiting from the market and thus potentially leaves a gap for other private purchasers to fill, if no other routes to intensification are identified, demand for nitrogen allowances may continue to be low into the foreseeable future.

[173] Although the Trust had not purchased all of the NDA that it aimed to do by 2013, it subsequently became apparent that they had effectively withdrawn from the market by 2013 pending a decision on one large NDA purchase in the eastern sector. This trade was successfully concluded in 2014 (Organisation for Economic Development, 2015).

Grand-parenting of the initial allocation. A further suggested reason for low trading volumes is that grand-parenting of the allocation of allowances based on an excellent production year has meant that the cap is not currently binding (Kerr, Greenhalgh, & Simmons, 2015; Duhon, Young, & Kerr, 2011). The cap, these authors suggest, is not currently causing farmers to reassess their production methods, although the pressure to increase production in order to cover rising costs is likely to make them do so in future. Interviewed farmers were almost unanimous in the view that the cap on production will make farming under the traditional model (of countering increasing costs by increasing production) untenable in the longer term and thus are in agreement with the authors referred to above. Where these two sources differ, however, is in how farmers may respond to this situation. Duhon, Young, & Kerr (2011) suggested that trading could increase over time but in the present study, interviewees argued otherwise. Although some recommended improved feeding of animals[174] as a way of making further productivity gains and creating nitrogen 'headroom', and others suggested continued increases in productivity (such as higher carcass weights and lambing percentages), most (including key informants) were of the view that there is not a great deal that individual sheep and beef farmers can do to improve their situation under a cap, without purchasing nitrogen. Thus while the cap may become binding in the future, it may not increase trading levels because of the lack of viable mitigation alternatives. Science might improve this through development of better pasture grasses or improved genetics (Betteridge, Crush, Ledgard, Barton & Barton, 2011) or similar, but this is uncertain.

Incorporating cap and trade into a farm system. The results of this study also suggest that the lack of profitable, alternative land-uses or farm practices has led some farmers away from concentrating on implementing lower nitrogen ways of operating or moving land to a higher land-use, to applying unconventional solutions that sit outside of expected responses to cap and trade. Examples include semi-retirement and investment outside of farming. These and other chosen solutions appear to be linked with the overall motivations and goals of the farmer.

Many authors have suggested that farmers aim to achieve more than just a profitable enterprise (Le Heron et al., 1996; Chouinard*,* Paterson*,* Wandschneider, & Ohler*,* 2008*;* Darnhofer, Schneeberger, & Freyer, 2005; Wandschneider, & Ohler, 2008; Howley, 2015; Brown, Bakam, Smith, & Matthews, 2016). Fairweather & Keating (1994) concluded that these non-pecuniary motivations result in different management styles. While this study did not investigate management styles in the Taupo Catchment, clear differences between the goals and motivations of farmers and farm system changes suggest that this could be a useful way of differentiating between farm-level responses, and thus of predicting nitrogen allowance trading patterns. For example, farmers that have chosen an

[174] For example, increased weighing of animals and improved pasture growth measurement as a way of matching stock numbers to the amount of feed that will be available in the near future, or resowing pastures.

intensified land-use or are developing a secondary manufacturing business appear to relate to the 'dedicated producer' typology identified by Fairweather & Keating (1994) since they are business orientated, with profit maximisation and the production of top-quality products being important. This type might be expected to see trading as a normal part of managing their business. On the other hand, European-titled landowners of extensive-type farm systems appeared to place more emphasis on way of life as well as earning 'sufficient' income and on the potential negative effects of nitrogen sales on the capital value of land. For Māori-titled landowners, effects on Lake Taupo and not limiting the choices of the next generation were important. Thus these extensive-farm-system landowners might be expected to be less receptive to nitrogen allowance trading unless they were aiming to raise capital for a particular purpose. In this study, capital raised was found to be used for projects that varied from assisting children, to funding retirement, investing in the stock market or moving part or all of a farm outside of the regulated area[175]. Incorporation of farmer goals may assist in understanding how farmers choose to respond to production limits resulting from environmental goals. This aspect is considered further in the 'further research' section at the end of this chapter.

In summary, the cap was seen by farmers as an important additional consideration in their farm system. Whether it was seen as a limitation, as an enabler of their farming business or as a minor component of their farm system appeared to depend on their personal goals and motivations, and on farm system goals – which together might usefully be described as their 'management style'. For some the cap was seen to threaten their long term viability, the capital value of their land and their ability to move their land to a more profitable (or less labour intensive) land-use such as dairy support if their NDA was insufficient (since little NDA was available for sale). For others, it offered business certainty and management flexibility. For a few, the cap was central to their business strategy, such as the landowner who is using the cap as a marketing tool to attract sustainability-minded customers.

King & Kuch (2003) pointed out that cap and trade markets can only operate if there are willing buyers and sellers. In the Taupo Catchment there are factors which are potentially dissuading both sellers and buyers of NDA. As discussed above, there is little incentive for purchasers, with OVERSEER® and water restrictions acting as gatekeepers to potential investors. Similarly, there are few incentives for sellers of nitrogen. The 2018 review means that long-term allocations of nitrogen are uncertain, and the relationship between NDA and the productive capacity of the land (and therefore land value) means that many farmers are reluctant to sell nitrogen. This situation may

[175] This latter response type is known as 'leakage' (Tietenberg, 2003)

change if low nitrogen discharging land-uses are established[176] or if carbon contracts again become available.

This is not to suggest that significant landscape changes have not occurred in the Catchment. Rather it suggests that change was, in part, the result of drivers that no longer exist (primarily, the one-time purchase of NDA by the Lake Taupo Protection Trust that resulted, for example, in conversion to forest and investment outside of farming), and the one-off sale of large tracts of land by Landcorp.

Potential improvements to Variation 5. There are some changes to Variation 5 that may improve the current situation. Should the 2018 review determine that more nitrogen needs to be taken out of the system, then a further buy out of NDAs could be implemented in preference to reducing all NDA allocations. If the government is unwilling to fund such a buyout then those that benefit from high quality Lake water, such as the tourist and energy sectors and possibly environmental groups, could be offered the opportunity to buy and permanently retire NDAs. This would raise some capital to contribute to farmers converting to low nitrogen land-uses, such as forestry (if sufficient scale can be attained), investing in sectors outside of farming, or to research alternate land-uses. Second, while farmers continue to operate in the Catchment, the lack of a safety valve in the system makes operating under cap and trade more risky than for those operating similar systems outside of the Catchment. Tietenberg (2003; 410) explains that in unexpected and extreme circumstances the lack of a "…*safety valve*" can cause the cost of achieving a cap to "…*skyrocket*". Safety values can take the form of a penalty payment for exceeding the cap (as opposed to being prosecuted for non-compliance), or the right to average nitrogen discharge amounts across more than one year (e.g. drought and non-drought years). Should the 2018 review consider implementing such a component, it could, as outlined above, take the form of rolling averages for NDA limits, or similar.

The most significant improvement that could be made to the implementation of Variation 5, however, lies outside of the scope of cap and trade since it involves the generation of research results that can be included in OVERSEER® for alternative land-uses and on-farm mitigations. At the present time, as many interviewees (including key informants) reported, there is little that sheep and beef farmers can do to reduce their nitrogen discharge levels and thus create 'spare' allowances that could be traded or used to intensify their own operation[177]. It is apparent, therefore, that a policy regime cannot be implemented in isolation from other, related policies. Cap and trade assumes that technologies are available or that they will be produced to fulfil a proven need but unfortunately, that has not eventuated at this stage in the Taupo Catchment and points to the need for policy

[176] Suggested examples include sheep milking, biofuels, Manuka honey production. However, all of these have been shown to need significant research input and development before they are viable for farmers.
[177] Some research in this area has been initiated. For example, in 2016 funds were allocated through the Sustainable Farming Fund to investigate the reduction of nutrient run-off from low land farms (Guy, 2016).

integration. Caps on the discharge of nitrogen from farms, for example, need to be coupled with sustained investment into research on low nitrogen land-uses and farm practices.

9.5.4 The lessons of the landscape approach

Investigating a policy regime in its real world setting is complex. Some researchers choose to tackle this complication by narrowing their sphere of interest, perhaps to a limited number of indicators or to particular issues. Increasingly, however, researchers are turning to more holistic approaches that embrace complexity and seek to integrate a whole range of information. Landscape biographies are one approach to resolving the problem of complexity, and they proved their worth in this study of the Variation 5 policy. The sections below outline the areas where this method proved to be particularly beneficial. The limitations are then considered in the following section.

Information is understandable and accessible. In this study the Taupo Catchment is viewed as multiple, interacting socioecological systems that are influenced by driving forces at different levels (one of which is the new regulations). This conceptual approach means that the researcher must contend with large amounts of data from different sources in many disciplines. Information from the Waikato Regional Council, the Lake Taupo Protection Trust, the Taupo District Council, popular press articles, and farmer and key informant interviews needed to be integrated with published research and analysed in a way that the overall consequences of Variation 5 could be identified. It is the nature of a biography to start 'at the beginning' and tell the story of the subject over time. The story enables a confusion of information about a particular place to be ordered in understandable ways and makes evident the landscape transitions that have occurred. Events are considered in the context of their history, drivers, biophysical setting etc. and this leads to a better understanding of the decisions that farmers made regarding their farm systems both pre- and post- the announcement of the introduction of Variation 5. It was from the landscape biographies that the five landscape paths were drawn. Thus the landscape biography approach made the complexity of interacting sociological systems in a particular place, over different time periods, understandable, accessible and analysable.

Responsive to the unexpected. Landscape biographies do not pre-determine the issues covered, such as responses to the regulations or which driving forces are influential, but instead focus on the experiences and the data that is presented. Thus landscape biographies are open to the unexpected. This aspect was particularly important in this study. For example, the researcher was expecting to find significant innovation in farm practices, either implemented or planned. "*Farmers*", a member of the audience at a conference on cap and trade had stated, "*are an innovative lot – they will find a solution*". The term 'solution', at the beginning of this study, was interpreted as an on-farm response i.e. a change to farm practices, or possibly a new land-use. An entirely unexpected outcome of the

landscape biography building process was to discover the move to non-pasture solutions, such as product processing and investing outside of farming, even from farm owners with strong ancestral ties to their land.

Similarly, since the regulations were only one of several driving forces that were acting on farm systems at the time of this study, the landscape biography approach helped understand how farmers respond to the regulations within the context of other exogenous influences. Thus, as reported in Chapter Six, some farmers were clearly of the view that the regulations were not as influential as international product prices or recurring droughts, and that if, for example, technology changes, their response to the regulations might alter.

Balanced portrayal. While it was up to the farmers to determine the issues covered in an interview (within the bounds outlined in Chapter Four), the biographies are not a simple reporting of farmer opinions. Rather they are a synthesis of historical and contemporary factors with farmer (collectively determined) issues. Challenges to established understanding were also provided by key informants (including the Waikato Regional Council and Lake Taupo Protection Trust) and explanatory material from other sources. An example is provided by the issue of land values. Many farmers expressed concern about falls in land values which they linked to the regulations and some backed up their claim with proof of drops in rateable value[178]. It was the key informants that pointed out that farm price falls were not related to the regulations but rather that the Global Financial Crisis had caused life-style block and tourist venture developers to retreat from the market, and thus were no longer causing farm prices to escalate. In a further example, key informants constantly suggested that few farms changed hands because although '*everything*' was for sale, no-one was buying. Farmers, however, pointed out that many farm sales did occur, but since they did not go through conventional (real-estate) channels the extent of farm turnover was unknown to people outside of the local area. This farmer information proved to be more reliable than even official data on real estate sales, since several of the sales involved amalgamation with other properties and so tracking individual farm turnover was not possible once the land title had been changed.

Plural and Inclusive. As alluded to in a previous point, landscape biographies integrate multiple sources of data and plurality of views. Thus landscape biographies allow the interweaving of qualitative with quantitative data, of personal stories with Catchment level accounts and information from media sources with academic research. In this way a fuller and richer understanding of the cap and trade regime in operation in Taupo is gained than would be possible from a study involving a limited number of indicators or issues pre-determined by the literature. One of the problems of the

[178] Rateable values are for local tax purposes and do not necessarily relate to sale prices although the perception from many land owners is that rateable values and sale value are related.

indicator approach to ex-post studies is that their narrow focus can overlook unexpected change and unintended consequences which, by their very nature, cannot be anticipated before the start of the study and therefore be specifically included in the data collected. The case-based landscape approach, with its eclectic mix of data sources, spatial and temporal sensitivity, ability to handle large amounts of data and full understanding of a case is an approach that is likely to reveal unanticipated effects.

Multi-scale. One very important attribute of a landscape approach is that of scale and the perspective that different aspects of a problem are apparent at different scales. Thus in the Taupo study, the land-use change metric, applied at the Catchment scale (see Chapter Six), shows that over 70% of consented land in the north, west and south of the Catchment had not changed land-use since the benchmarking years (2001-5). However, investigation at the community level (see Chapter Seven) showed that some of the farms in the 'no land-use change' category had undergone significant de-intensification and others, amalgamation. Focusing at the farm system level (see Chapter Eight) showed that some of the de-intensification was a result of movement out of the farming sector, out of full-time farming or partially out of the Catchment itself.

Implications. The landscape biography approach adopted in this study has enabled a deeper understanding of the Taupo cap and trade regime than might have been obtained through conventional social science methods such as structured questionnaires with an emphasis on indicators (for example see Thurston, Smith, Genskow, Prokopy, & Hargrove, 2012), or from focusing the investigation on theoretical issues (for example see Tietenberg & Johnstone, 2004). The emphasis on landscape transitions helped to position changes in their proper context and also helped to ensure that what turns out to be an important issue, for example one that may seem minor at the level of one farm, is not missed. The strength of landscape biographies is that they portray the collective wisdom of multiple interviewees and data sources, located at nested spatial scales and over time. This method has proven to be of benefit in other disciplines, particularly in the area of heritage management (Roymans, Gerritsen, Van der Heijden, Bosma, & Kolen, 2009; Kolen, Renes, & Hermans, 2015) and, as this thesis shows, it may be of benefit in other applications, such as land-use change, and human-landscape interactions. Environmental policy research is one case where researchers have identified the need for new integrated, interdisciplinary approaches (Wolff & Schönherr, 2011; Harden et al., 2014), and narrative based methods (Lambin, Geist & Lepers, 2003; Eiter & Pothoff, 2007; Verberg, 2014), and this thesis has pointed to the potential value of a landscape biography approach to investigating localised policy.

9.6 Limitations of the research

This study would have benefited from a more thorough investigation of farmer goals and motivations. In particular, the motivations of landowners in the southern sector in selling down the productive capacity of their land is not well understood. It is possible that these owners have long term plans that are yet to be implemented and so land-use change could still be evolving. Similarly, a better understanding of the motivations and management styles of farmers might lead to more understanding of whether farmers in the Taupo Catchment will be open to trading nitrogen in the future if, for instance, the cap becomes binding, or it is lowered, or new land-uses and mitigations become available.

The landscape approach used in this study involves coping with a large amount of data and managing complexity. While a PhD study is by its nature the work of an individual (supported by supervisors), in a research setting it could be beneficial if a study of this sort involved more than one researcher. Thus, landscape biographies could be the product of several researchers and judgements about what to include and the appropriate emphasis could benefit from the input of more than one person.

An interpretive research strategy, such as used in this study, requires the researcher to "make sense" of the experiences of participants and to integrate those experiences into a cohesive landscape story. This approach means that the story produced can never be impartial even though every effort to reduce subjectivity can be made. This situation was recognised at the outset of this study and so sector experts were used informally to challenge the validity of the developing narrative.

This is a qualitative study and so exhibits the benefits and drawbacks of this methodology. The major benefit has been talking to farmers in their language – and on their own terms – and the interaction between the researcher and interviewees. Many puzzles were able to be clarified on the spot. A drawback of qualitative studies is that many scientists consider generalisation from a single, in-depth study to be difficult. In my view, no single study ever fully answers complex questions, like that of sustainability. But each study adds to the total sum of knowledge and offers new insights. Consequently, this study is not a complete answer to whether cap and trade enables sustainability. The conclusions could be different in a predominantly dairy farming watershed, in an area where farmers are young and unlikely to consider semi-retirement as an option or where bio-physical factors were less extreme. Despite this, some generalisations can be drawn because this is an exemplar case. Such cases allow for generalisations of the type "if environmental and farming needs cannot be met simultaneously in this exemplar case, then it is unlikely that they will be met in other cases". Thus, the study conclusion, that cap and trade is not a panacea and needs the support of other policies, can be generalised to other cap and trade implementations and to agricultural policy as a whole (in New Zealand).

9.7 Future research needs

As Verberg (2014) points out, case studies are most powerful when the results of several cases can be combined in a meta-analysis. This type of multi-case analysis enables generalisations to be made about policy settings and land-use change because they can identify commonalities across different locations and circumstances. In order to do this, however, more cases need to be researched using similar, narrative, methods. Studies of other agricultural cap and trade programmes would help to clarify how influential such regulations are, in comparison with other driving forces. For example, they could further explore whether the trading arm of cap and trade is sufficient to ease a transition to a lower nitrogen form of farming and the land-use changes that are involved. The conclusion in Taupo is that nitrogen trading alone is not sufficient to transition to currently-available, low-nitrogen land-uses/mitigations, nor is it sufficient to encourage innovation in land-uses/mitigations, but this needs to be tested across a range of cap and trade implementations.

While there are no other cap and trade programmes (to date) that control the discharge of non-point source pollutants from agriculture, landscape-based investigations of other policy settings that limit (through caps in various forms) agricultural production would also be useful (Henderson & Norris, 2008). Such studies would contribute to the gap in understanding of farmer responses to local and catchment scale limitations on production levels. While a few studies have been undertaken on this topic, some authors have concluded that farmers resort to an avoidance of responsibility (see summary in Barnes, A. P., Willock, J., Toma, L., & Hall, C., 2011). This study suggests that avoidance and resistance could be a simplistic summation of the multiple drivers faced by farmers, but more studies would be needed to confirm or reject this. The implementation of the NPS-FM around New Zealand will require that farm discharges are capped and consequently, in future years, will provide ideal material for such studies.

There are also implications for research into different farming systems. For sheep and beef farms there is an urgent need for research into viable low nitrogen farm systems so that farmers can increase production levels but still remain within a nitrogen discharge limit. If no such technology is forthcoming, then farmers need a wider range of low nitrogen land-use options. Pannell (2001) concludes, in relation to the salinity problems in agriculture in Australia, that pollution problems are too big and too urgent for individual farmers to resolve through on-farm innovation, and that farmers need substantial support from government in the form of research and development, and infrastructure. In the Taupo case this is particularly evident for small farms on low NDAs which may be marginally economically viable under a sheep and beef regime. While they could be suitable for a dairy platform or a dairy support unit, this option is no longer possible unless water is available and sufficient NDAs can be purchased for conversion. Amalgamation is an option but it was the

experience of a forestry investment company that amalgamation of such small units, to achieve economies of scale, was difficult and expensive. For owners with an existing medium to large operation amalgamation was reportedly less problematic. Small sized properties, however, are typical of many areas in the North Island and if production limits are placed on them that require significant reductions in production then they may face the same problems, such as lack of suitable mitigations or land-use alternatives, as have been encountered by the farmers in the Taupo Catchment.

A group that is underrepresented in this study is the lifestyle block owner and, given the large number of such blocks in the Catchment their ability to care for their land and operate at a very low NDA level needs to be understood. They were not included in this study because the focus is on cap and trade (and these landowners are not eligible to trade) but their numbers suggest that their responses should be investigated.

Last, there is a need for studies that could help clarify the role of farmer management styles in decision making under production limits. Such behavioural studies are scarce in the cap and trade field (Marsh, 2014) and would complement studies aiming to ascertain whether theoretically derived behavioural responses can be achieved in real world settings. They would be particularly useful to policy makers as the NPS-FM is implemented around New Zealand and similar limits become operative in other countries. With this in mind, in the Taupo Catchment, there is a need to gain a full understanding of the management styles and decision making of Māori-titled owners. This is a significant gap in this current study which requires further research in the near future. Māori-titled landowners own a significant portion of the pasture land in the Catchment (and elsewhere in the North Island) and often their farms are sufficiently large that they have a range of land-uses open to them that may not be available to smaller farms. They could, for example, be a source of supply of NDA for trading in the future or, as some farms already hold sufficient NDA, they could convert to dairy platforms without the need to trade. The owners of these farms, however, hold strong stewardship values, often coupled with an obligation to assist current and future owners. In Taupo these values significantly influenced land-use decisions both before and after the regulations were first mooted. As owners of a significant amount of land their contribution to the future of the Catchment and of Variation 5 needs to be acknowledged and better understood.

9.8 Conclusions

Overall, this study concludes that cap and trade is a policy regime that is potentially suitable for achieving the environmental goals of the NPS-FM. Coupled with the OVERSEER® programme (or similar means of assigning farm discharge limits) and appropriate monitoring, it appears to be able to control headline pollutants such as nitrogen and has been accepted by the farming community in the

Taupo Catchment to the extent that compliance levels are high (Waikato Regional Council, 2014). However, the evidence of this study suggests it is unable on its own to ensure a viable agricultural sector operating under these goals. Cap and trade appears to require a suite of other policies/factors to be in place to support its successful application. In particular, it needs to be preceded by research projects aimed at finding alternative land-uses and farm practice mitigations. While some research studies of this type were undertaken in the Taupo Catchment in the early/mid 2000s, the research effort appears to have ceased without producing outcomes that are helpful for sheep and beef farmers in harsh and remote environments. This forces the farmer into a difficult situation. They may have to become de-facto scientists –technology innovators– but without the training or resources. One farmer summed up the situation as follows:

> *The government are telling farmers that they want them to increase production but on the other hand other government departments are putting limits on –they cannot have it both ways. The view that farmers will find a way out of this paradox is a bit patronising.*

In the Taupo situation farmers have found several 'ways out', and these are encompassed in the five dominant landscape paths that evolved after the early 2000s. These paths are:

1. Business as usual – i.e. continue with the same land-use and farm system, at the same stocking rate,

2. Reducing farm production levels – as a result of selling nitrogen and reducing stock units/ha, often without apparent reinvestment on-farm (although investment in land outside of the Catchment or outside of farming might occur)

3. Changing land-use - by trading nitrogen and either intensifying land-use (such as converting to dairy) or de-intensifying (by planting trees),

4. Changing land-use or farm system without trading– by intensifying on part of the farm, or intensifying on land outside of the Catchment, or by changing to a more profitable stock type,

5. Restructuring the farm - by introducing non-traditional sources of income such as undertaking secondary processing, and developing a provenance or brand,

An estimated 25% of the land in the study area has not changed land-use nor farm practices since the early 2000s (i.e. the benchmarking years). This business as usual category includes sheep and beef farmers, dairy support farms and dairy platforms. Some of these farmers were comfortable operating under a cap but others reported concern about their future since cost increases can no longer be accommodated through practices such as stocking rate increases, and there is currently

little technology to implement that will improve productivity without increasing nitrogen discharges. Current suggestions, such as increasing the ratio of sheep to cattle, may not fit with farm system requirements such as income complementarity, drought response, or pasture management needs. Further, some of these farmers reported a reluctance to change land-use through trading nitrogen because of the likely negative effects on land values and the ability to sell, and because the 2018 review of the Programme may require further reductions in farm discharge levels.

Landscape path two (reduction in production levels) is estimated to have occurred on 43% of the consented land in the study area and therefore makes a significant, but potentially negative, contribution to the government's aim to double agricultural exports by 2025.

In the remaining landscape paths listed above (i.e. changing land-use with or without trading and farm restructuring) farmers have undertaken adjustment changes that may contribute to the achievement of the government's aim. These farmers have converted sheep and beef farms to dairy platform or dairy support, converted sheep and beef farms to plantation forest (including 'carbon forests'), amalgamated sheep and beef farms to give a farm of economic size, and introduced secondary processing and product branding. Changes of this type are estimated to have occurred on around 32% of the land in the study area. Expanding these groups further, and thus enabling a viable agricultural sector in the Catchment, appears to be limited by low levels of nitrogen trading as well as by factors such as the current level of technology, getting research undertaken and into OVERSEER®, water availability, the scarcity of carbon contracts, the economics of small sized forestry conversions, small farm sizes and farmer goals.

Of note are the number of instances where the latter three landscape paths are reliant on support from outside of the Catchment. Dairy support farms often form part of a larger farm unit where the dairy platform is located beyond the Catchment boundary. Further, one farm has maintained its stocking rate within the Catchment and purchased land outside the Catchment on which to intensify, and at least one farm has located nitrogen intensive practices beyond the Catchment boundary. This further emphasises the difficulties involved in achieving a viable agricultural business under regulations that limit production levels, given current levels of technology.

Some important driving forces that resulted in landscape changes (such as the Landcorp sales, high carbon prices and the Lake Taupo Protection Trust) have ceased to operate or are not operating at the current time. Further, new driving forces that are not conducive to landscape change have become apparent. These include recent reductions in dairy prices and the introduction of Variation 6 to the Waikato Regional Plan. These factors, together, suggest landscape change on the scale that happened in the 2000s is unlikely in the future and so nitrogen trading volumes may well stay at low levels. Interventions such as technology changes, new profitable land-uses that are included in

OVERSEER®, improvements in carbon prices and further secondary processing on farm, may change this situation, and in consequence the dominance of individual landscape paths. At this stage and at this level of technology, however, the landscape trajectory for pastoral land appears to be one of reduced agricultural production from the Catchment, and little revival of rural social networks.

This study makes three contributions to the literature. First is its contribution to the cap and trade literature, second the policy assessment literature and last the landscape biography literature.

In the cap and trade literature, ex-post studies have focused on the achievement of economic objectives, such as cost effectiveness and trading volumes. They have seldom taken a wider view and considered aspects such as the integrated nature of social and biophysical factors, the importance of context, the scale at which policy effects are perceptible, nor the non-pecuniary motivations of regulated landowners. In this study all of these factors were found to have a direct bearing on changes that resulted from the implementation of an exemplar cap and trade regime. Focusing on the local (community) level, for instance, showed that de-intensification through stocking reductions has often not been compensated by investment in another income producing land-uses or farm system mitigations. Similarly, farmer motivations have been shown to affect trading behaviours and responses to the cap. As far back as 1967, evaluations have been criticized for focusing on goal attainment (Scriven, 1967) since, it was suggested, vital information will be overlooked. An emphasis on economic goal attainment, for example, is likely to miss a wealth of information that could be used to extend the understanding of the circumstances in which cap and trade is an appropriate policy regime, and when it is not. The results of this study support this argument.

In addition, an investigation that focuses on the achievement of pre-determined goals would be unlikely to assist in the development of context-dependent knowledge such as highlighted by Flyvberg (2006:221) - i.e. knowledge which "*…allow[s] people to develop from rule-based beginners to virtuoso experts*". From the perspective of this study, the Taupo cap and trade programme has demonstrated that taking account of spatial and temporal aspects, and making the integration of social and biophysical factors central to the investigation, results in a rich and full understanding of the implementation being studied. Without such a broad approach unintended consequences and counter-intuitive outcomes would be difficult to discern.

Last, this study has extended the use of landscape biographies. Most studies in this area have involved heritage studies, although authors have suggested that it has wider application. This study has brought the method fully into the area of policy assessment and demonstrated that it is highly suited to this purpose.

Overall, this study finds that using a landscape approach to assessing the effects of a cap and trade policy leads to a rich understanding of the landscape change that has occurred, the driving forces involved, the landscape paths that have emerged and the Catchment-wide landscape trajectory that appears to be evolving. This approach has demonstrated that the exemplar cap and trade policy implemented in the Lake Taupo Catchment is insufficient, on its own, in achieving a viable agricultural sector in the regulated area. The support of complementary research and technology policies is essential, as well as the capacity to find new ways of making money from rural land. Without these the full potential of cap and trade appears difficult to achieve.

Appendix A

Farmer and Key Informant Questionnaires

This Appendix contains the questionnaires and the consent form that were approved by the Lincoln University Human Ethics Committee, and that were used in the interviews.

A.1 Farmer questionnaire

The questionnaire reproduced below was used when interviewing farmer respondents.

Farmer and Farm Manager Interview

Assessing the Consequences of agro-environmental regulations

You are invited to participate in a project called "Assessing the consequences of environmental regulations" by completing the following interview.

This project looks at the effects of environmental regulations on both producers and on the catchment agro-ecological system. Many studies that tackle this kind of question use a narrow focus (e.g. they consider the environmental effects only) but in this study the aim is to include all of the effects that each individual respondent considers to be important. Lake Taupo has been chosen as the case study area because the regulations introduced in July 2011 to limit nitrogen discharges are a world, and New Zealand, first and, because other Regional Councils are indicating that they wish to implement similar policies, there is an urgent need to track the consequences of such policies.

The interview is anonymous, and you will not be identified as a respondent without your consent. You may at any time withdraw your participation up until a month after the interview including withdrawal of any information you have provided. If no such communication is received and you complete the interview, it will be understood that you have consented to participate in the project and consent to publication of the results of the project with the understanding that anonymity will be preserved.

A: Information Sheet to read and then sign the consent form
B: Introduction: I am a social scientist – I focus on people and their lives and on landscape change. I have only a limited knowledge of farm systems (I used to work in forestry and in IT in the dairy industry) so I have come to learn about farm management, soils and animals from you because you are an expert in how farms work.

Question One:

Could you please tell me the story of this land up to 2001? (NB some people have bought their land post 2001 so they can only give the history that they are aware of).

Prompts:

1. How did the landcovers come to be as shown here?
2. What is the history of the landcovers, the property boundary, the streams and the fences?
3. How would you describe the contour of this land and has it had any effect on the landcover or on landuse?
4. What has been your involvement with the land?

5. What were the landuses on this property in 2001 and what is the history of those landuses?
6. What is the maximum stocking rate that you have ever carried? When was that and why?
7. What are the historical links between yourself and other people in the local area? What about with others in the catchment or the Region?

Question Two:

What changes have happened on your farm since 2001? Were these changes as a result of the regulations or were they because of other factors such as weather, financial conditions, meat/wool/dairy industry conditions or something else?

Prompts:

1. How has your farming operation altered since 2001?
2. What was your stocking rate in 2001? What is it now?
3. Which is your benchmark year? What was your stocking rate that year? Do you expect to reach that figure again? Under what circumstances?
4. Do you expect to reach the same level of production as you achieved in your benchmark year? Profitability?
5. How has your farming operation altered because of the N cap?
6. Are you still applying nitrogen fertiliser? How and when?
7. Have you retired any land either by planting in trees or by allowing it to revert to scrub?
8. Have you bought/leased more land within the catchment? Have you sold land?
9. Have you bought or sold nitrogen allowances?
10. Have you considered changing stock types (e.g. deer) or age class (e.g. young animals only)?
11. What in farming gives you satisfaction? What are the kinds of things that happen that make you feel happy with what you have achieved?
12. Where did your information come from in order to take the actions or make the changes that you have described above? To whom or where do you go for information and advice?

Question Three:

What are your plans for the farm?

Prompts:

1. What would you like to achieve with this farm? What is your aim/strategic direction?
2. Do you intend to increase stock numbers? Do you expect to reach the stocking rate that you had in your benchmark year again? Under what circumstances?
3. Would you increase stocking rates beyond your benchmark year stock numbers? How will you stay within your NDA?
4. Any plans for yourself and/or your family with regard to the farm?
5. What do you think this farm will look like in 10 and 50 years' time? What about the farms around you?

Question Four:

What do you think the future holds for pastoral farming in this catchment? In the country?

Prompts:

1. Other Regional Councils are considering introducing similar regulations, what message would you like to convey to them?

Question Five: Other

2. Is it possible to have a copy of the Overseer printout that was approved by the Regional Council as part of your consent process?

Is there anyone else that you think I should talk to?
Would I be able to mention that you referred them to me?

A.2 Key informant questionnaire

The questionnaire reproduced below was used when interviewing key informants.

Non-farmer Stakeholder Interview

Assessing the Consequences of agro-environmental regulations

You are invited to participate in a project called "Assessing the consequences of environmental regulations" by completing the following interview.

This project looks at the effects of environmental regulations on both producers and on the catchment agro-ecological system. Many studies that tackle this kind of question use a narrow focus (e.g. they consider the environmental effects only) but in this study the aim is to include all of the effects that each individual respondent considers to be important. Lake Taupo has been chosen as the case study area because the regulations introduced in July 2011 to limit nitrogen discharges are a world, and New Zealand, first and, because other Regional Councils are indicating that they wish to implement similar policies, there is an urgent need to track the consequences of such policies.

The interview is anonymous, and you will not be identified as a respondent without your consent. You may at any time withdraw your participation up until a month after the interview including withdrawal of any information you have provided. If no such communication is received and you complete the interview, it will be understood that you have consented to participate in the project and consent to publication of the results of the project with the understanding that anonymity will be preserved.

A: Information sheet and sign the consent form
B: Introduction: I am a social scientist – I focus on people and their lives. I have only a limited knowledge of farm systems (I used to work in forestry and in IT in the dairy industry) so I have come to learn about the wider effects of implementing environmental regulations and about the effects on farm systems, soils and animals from you.

Question One:

Could you please tell me the story of the land in this catchment up to 2001?
Prompts:

1. When I look at maps of this area – and this is just one (unnamed) example – I notice a mosaic of landcovers –areas of trees (exotic and indigenous) and scrub (often quite small) broken up by exotic grassland. What is the history of these landcovers?
2. What is the history of the property boundaries, the streams and the fences?
3. How would you describe the contour of this catchment and has it had any effect on landcovers or on landuses?
4. What has been your involvement with the land?
5. What are the historical links between people in the local area? What about with others in the catchment or the Region?

Question Two

What changes have happened in pastoral farming in the catchment since 2001? Were these changes as a result of the regulations or were they because of other factors such as weather, financial conditions, meat/wool/dairy industry conditions or something else?

Prompts:

1. Are there changes in stocking rates?
2. The benchmark years were highly productive years. Do you expect production levels to reach those figures again? Under what circumstances?
3. How have pastoral farmers altered their operations because of the N cap? Are they still applying nitrogen fertiliser? Have they retired portions of their land (either by planting in trees or by allowing it to revert to scrub)? Have they changed stock types or stock age classes?
4. Are you aware of land sales or purchases in the catchment? Sale or purchase of NDA? Are there particular circumstances surrounding these activities? Are they being carried out for a particular reason?
5. Where do farmers get their information from about how to farm under an N cap? To whom or where should they go for information and advice?

Question Three:

Where is pastoral farming in the catchment heading?

1. Prompts:
2. What gives farmers satisfaction? What do you think they aim to achieve? Can this still be achieved under an N cap?
3. Do you expect stocking rates to rise beyond the benchmark years in this catchment? Production? Profitability?
4. What do you think this catchment will look like in 10 and 50 years' time?

Question Four:

What do you think the future holds for pastoral farming in the country?

Prompts:

1. Other Regional Councils are considering introducing similar regulations, what message would you like to convey to them?

Question Six: Snowball contacts

2. Is there anyone else that I should talk to and can I mention that you referred them to me?

A.3 Information sheet and consent form

An information sheet was used to describe the aims of the project but also to make interviewees aware that taking part was voluntary, and that permission to use the interview material could be withdrawn after the interview.

A.3.1 Information sheet

Farmer interviewees and key informants were supplied with an outline of the research project (i.e. the information sheet reproduced below) both at the time that an interview was first requested and immediately before the interview took place.

Lincoln University

Faculty, Department or Research Centre: Faculty of Environment and Design

Research Information Sheet

You are invited to participate as a subject in a project entitled "*Assessing the consequences of agro-environmental regulations*". A person who has already been interviewed has suggested that you have much to contribute on this subject and that you may like to be included in this study. However participation in the study is entirely voluntary.

This project looks at the effects of environmental regulations on both producers and on the catchment agro-ecological system. Lake Taupo has been chosen as the case study area because Variation 5, introduced in July 2011, is the first policy in New Zealand to combine an ecological limit and a market-based instrument with the aim of controlling water pollution. The consequences of its implementation on the community of primary producers, their viability and the flow-on effects on society and on land use practices are largely unknown and need to be understood. Other Regional Councils in New Zealand are indicating that they wish to implement similar policies, so there is an urgent need to track the consequences of the Variation 5 regulations.

Your participation in this project will involve an interview of about an hour's duration at a time and place of your choosing. As a follow-up to this activity, you may be asked to provide a little more detail so that your answer to a question can be properly understood. The interview will be recorded to enable an accurate transcription to be made of the discussion that takes place. A copy of the transcribed interview will be sent to you and arrangements will be made to keep you informed of progress and, at the end of the project, of the research findings.

In the performance of the tasks, and application of the procedures, there is a risk of distress if the impacts of the Variation 5 regulations are difficult or stressful for you. In this case you will have the choice of terminating the interview and having all information provided up to that point deleted and destroyed.

The results of the project may be published, but you may be assured of your anonymity in this investigation. The identity of any participant will not be made public, or made known to any person other than myself (the researcher), my supervisors and the Human Ethics Committee, without the participant's consent. To ensure anonymity *all* contact details, and the consent form, will be kept in

a locked cabinet and will not be available to anyone other than myself and supervisors. Interviews will be transcribed and allocated a number. Any reference in published documents to the information provided will refer to the number only.

This project is being carried out by me, Anne Spicer, as part of my PhD study. My contact details are:

Anne.Spicer @lincolnuni.ac.nz

Phone 03 325 3838 extn 8988
0210 720 535

I will be pleased to discuss any concerns you have about participation in the project.

Supervision Team

Professor Simon Swaffield	Professor of Landscape Architecture, Faculty of Environment, Society and Design	simon.swaffield@lincoln.ac.nz
Dr Kevin Moore	Senior Lecturer , Faculty of Environment, Society and Design	kevin.moore@lincoln.ac.nz
Professor John Fairweather	Professor of Rural Sociology - Agribusiness and Economics Research Unit	john.fairweather@lincoln.ac.nz

The project has been reviewed and approved by the Lincoln University Human Ethics Committee.

A.3.2 Consent form

Farmer interviewees and key informants both completed a consent form at the start of an interview.

Consent Form

Assessing the consequences of agro-environmental regulations

I have read and understood the description of the above-named project. On this basis:

1. I agree to participate as a subject in the project and I understand that I may withdraw from the project any time up to a month after the interview, including withdrawal of any information I have provided. I further understand that this interview is anonymous, and that I will not be identified as a respondent without my consent.

2. I ***agree/disagree*** (please delete one) to the audio recording of the interview with the understanding that only Anne Spicer and her research assistant will have access to raw data including these sound files.

Name: _____

Signed: _____ Date: _____

Appendix B

Consents issued under the non-complying activity rule

Consents that were issued under Variation 5, up until October 2013, are listed in the tables below. Consents to farm are issued under Rule 3.10.5.9 (Non-complying Activity Rule – Land uses and associated discharges of nitrogen to land. See WRC, no date a). In total 81 consents were issued but in this study a total of 83 consents has been assumed because two surrendered consents have been included. One consent was surrendered because of conversion to a permitted activity and, in the second case, two farms formed a partnership and operated under one consent. The total regulated area in the Catchment is 65704 ha, the average NDA is 10.6 and the median is 13. The total area in the study area is 49492 ha and the median NDA is 14. Dairy farms in the study area have a median NDA of 27, dairy support of 16, sheep and beef of 12, and the median for plantation forests is 4.

B.1 Consents in the northern sector

Consent Number	Area in Catchment (ha)	Farm NDA range (2013)
117527	10	3 - 10
119379	926.1	3 - 10
119828	107.7	3 - 10
120236	301	11 - 15
120260	926.8	3 - 10
120302[179]	0	0
121406	3.4	3 – 10
121412	29.9	11 - 15
121525	175	16 - 20
121736	244	26 - 30
122504	280.9	3 – 10
123020	22.9	16 - 20
123387	108.5	11 - 15
123483	49.6	3 – 10
123685	296	3 – 10
123745	344.3	11 - 15
123846	128.9	16 - 20
124174	218.5	16 - 20
124244	231	16 - 20
124248	48.8	21 - 25
124348	52.9	11 - 15
124349	107.1	26 - 30
124383	121.9	11 - 15

[179] Technical consent

124423	903.1	11 - 15
124449	313.3	11 - 15
124507	112.8	21 - 25
124585	115.8	16 - 20
124640	94.7	3 - 10
124658	119.6	11 - 15
124663	112.8	11 - 15
124714	29.6	16 - 20
124743	5	11 - 15
124748	103.3	11 - 15
124802	271.8	11 - 15
124813	4.9	16 - 20
124890	66.6	11 - 15
125087	62.1	11 - 15
125111	510.3	26 - 30
125114	261.1	3 - 10
125129	382.2	11 - 15
125160	978.4	3 - 10
125188	612.5	11 - 15
125210	108.7	16 - 20
125404	2003.2	26 - 30
126790	24.5	3 - 10
Surrendered	488	3 - 10
Total	12419.5	

Table 20: Consents issued in the northern sector
(Source: Waikato Regional Council)

B.2 Consents in the western sector

Consent Number	Area in Catchment (ha)	Farm NDA (2013)
119976	770.6	3 - 10
120476	40	16 - 20
120794	3642.5	11 - 15
121839	1851	11 - 15
122467	1072.8	3 - 10
122613	158	16 - 20
122796	142.1	16 - 20
122861	246.1	3 - 10
123405	328.8	16 - 20
123782	20.2	3 - 10
126323	58.3	16 - 20
Total	8330.4	

Table 21: Consents issued in the western sector
Source: Waikato Regional Council)

B.3 Consents in the southern sector

Consent Number	Area in Catchment (ha)	Farm NDA (2013)
120272	2389	3 - 10
120976	1257	11 - 15
120976	3290	3 - 10
121983	4145.2	11 - 15
122797	3845	3 - 10
122932	1773	3 - 10
123407	627.5	21 - 26
123857	2538	11 - 15
123887	378.3	11 - 15
124263	315.3	20 - 25
124276	3228.2	3 - 10
124347	3480.9	16 - 20
124564	841	16 -20
124619	264.4	21 - 25
125094	133.5	11 - 15
125463	235.6	26 - 30
Total	28741.9	

Table 22: Consents issued in the southern sector
(Source: Waikato Regional Council)

B.4 Consents in the eastern sector

Consent Number	Area in Catchment (ha)	Farm NDA (2013)
119389	917.4	3 - 10
123402	8462	3 - 10
123500	185.3	3 - 10
124084	4257	3 - 10
124492	647.3	3 - 10
124567	1060	3 - 10
124576	78.6	3 - 10
124716	249	16 - 20
125639	317.5	3 - 10
125696	37.9	3 - 10
Total	16212	

Table 23: Consents issued in the eastern sector
(Source: Waikato Regional Council)

Appendix C

Consent to subdivide

A search of subdivision consents data provided by the Taupo District Council and issued from 2000, shows that five farms were subdivided between 2000 and 2007. A further eleven consents were issued for farm subdivision but these had not been actioned by 2013.

Key rural land developments, since 2000, are listed below. Of note are the number of developments that are only partly sold or have not come to fruition.

1. Otutira Drive – Part of a sheep and beef ballot farm was subdivided into 18 blocks. Of the 18 blocks 7 have sold over the last 6-7 years and the rest remain unsold in 2013. The second part of the farm was to be subdivided in stage two of the development but sales were so poor that the developer sold the land to a neighbour and it has been amalgamated into his farm. The original consent was for a total of 43 titles. Taupo District Council, Consent Number 050105B

2. Acacia Bay - A subdivision of 231 ha into five blocks ranging from 14 to 94 ha in 2006. A further consent was granted in 2007 to establish 57 four ha blocks. In 2013 only 9 remained unsold (real estate agent, personal communication). Taupo District Council, Consent Number 050500.

1. Poihipi Road – Approval was given in 2009 to subdivide 431 ha into 87 rural allotments ranging in size from four to ten ha. This subdivision has yet to proceed. From Taupo District Council, 2009, Notice of Decision, Subdivision Consent.

2. Hingarae Road – A resort development, approved in 2006, consisting of 28 accommodation modules, an 11 room hotel, entertainment hub (including gym and pool), a health spa, sports facility and helicopter pad. The development was not built and the consent has expired. From Taupo District Council, 2006, Application for Resource Consent, Copy of letter to applicant.

3. Hurunui Road – a subdivision of a 119 ha farm above Kinloch. The consent application was lodged in 2000 and in 2013 the unsold sections were the subject of a mortgagee sale. Taupo District Council, Consent Number 040380.

4. Kawakawa Road – a proposal to develop a farm park on a 280 ha farm, including 78 residential dwellings. Although consent was granted in 2006 and a second consent granted in 2008, the proposal did not proceed. Taupo District Council, Consent Number 080228.

5. Whangamata Road – in 2006 consent was given to establish 63 residential dwellings on a 296 ha farm. The subdivision did not proceed. Taupo District Council, Consent Number 070007.

6. Otake Road – In 2006 consent was granted to subdivide five, 4 ha blocks from a 301 ha farm. The subdivision did not proceed but in 2011 approval was granted to divide off four lots of less than 10 ha. Taupo District Council Consent Number 060279.

7. Otake Road – In 2007 consent was granted to subdivide a 126 ha farm into 23 blocks ranging in size from four to 30 ha. Taupo District Council, Consent Number 060400.

8. State Highway 41 – In 2008 consent was granted to subdivide a 54 ha parcel (a part of a farm) into twelve titles of approximately four ha each. By 2013 this subdivision had yet to be actioned. Taupo District Council, Consent Number 060524.

9. Whakaroa Road – In 2008 consent to subdivide 112 ha into twenty one blocks was granted ranging in size from four to ten ha. By 2013 this had not been actioned. Taupo District Council, Consent Number 060537

10. Montgomery Crescent – In 2008 approval was given to subdivide 68 ha into 56 allotments. By 2013 this had not proceeded. Taupo District Council, Consent Number 060451A.

11. Whangamata Road – In 2011 consent was given to subdivide two existing lots (66 ha total) into ten lots varying from 5 to 54 ha. Taupo District Council, Consent Number 100242.

12. Ross Rise – in 2003 consent was granted to subdivide into 4 ha blocks. This subdivision proceeded and, by 2013, most have houses built on them. Taupo District Council, Consent Number 030570.

13. Karangahape Rd - in 2004 consent was granted for stage one of a subdivision of 4 ha blocks. Taupo District Council Consent Number 030860.

14. Kaiapo Road – In 2010 consent was granted to subdivide 155 ha into 11 allotments. This property was still for sale in 2013. Taupo District Council, Consent Number 060547.

Smaller subdivisions have also been undertaken in the catchment with farms being divided into smaller lifestyle farm units or with lifestyle blocks being 'carved off' the edges. Examples of these, post 2000, include:

1. Poihipi Road – In 2007 consent was granted to divide a 175 ha block into two lots with one lot being 15 ha. Taupo District Council, Consent Number 060589.

2. Tukairangi Road – In 2007 consent was granted to divide 210 ha into two lots of 79 ha and 131 ha. Taupo District Council, Consent Number 010215.

3. Waihaha Road – In 2008 approval was given to divide a 214 ha farm into three lots of 10 ha, 30 ha and 175 ha. Taupo District Council, Consent Number 080278.

4. Whangamata Rd – In 2009 approval was given to subdivide the farm into two lots, one being 140 ha and the other 478 ha. Taupo District Council, Consent Number 090095.

5. State Highway 32 – In 2013 consent was granted to subdivide a house block of 8 ha off a 497 ha property. Taupo District Council Consent Number 130038

Appendix D

Farmer interviewees

Farmer interviewees are listed in the table below. Some of these interviewees covered more than one consented farm and, for some farms, more than one person involved with that farm was interviewed (e.g. the farm manager as well as a Trustee).

Predominant land-use	Interview number	Size of farm (ha)	Ownership type	Interviewee Location
Sheep and/or Beef	1	100-500	European title	Western Bays
	2	100-500	European title	Southern sector
	3	> 1000	Māori title	Southern sector
	4	> 1000	Māori title	Southern sector
	5	500-1000	European title	Northern sector
	6	100-500	European title	Western Bays
	7	500-1000	European title	Western Bays and Northern sector
	8	100-500	European title	Northern sector
	9	<100	European title	Northern sector
	10	<100	European title	Western Bays
	11	100-500	European title	Northern sector
Sheep/beef and/or deer	12	100-500	European title	Northern sector
	13	> 1000	European title	Western Bays
Dairy and/or dairy grazing	14	100-500	European title	Northern sector
	15	100-500	European title	Western Bays
	16	500-1000	European title	Northern sector
	17	100-500	European title	Northern sector
	18	> 1000	European title	Northern sector
	19	100-500	European title	Northern sector
Mixed dairy and sheep/beef	20	> 1000	Māori title	Southern sector
	21	> 1000	Māori title	Southern sector
mixed sheep/beef and woodlot	22	> 1000	Māori title	Southern sector
Plantation forest	23	> 1000	European title	Northern and Eastern sectors
	24	> 1000	European title	Western Bays
	25	100-500	European title	Northern sector and ex-Western Bays

Table 24: Farmer interviewees by the predominant land-use at the time of interview

Appendix E

Key informant interviewees

Key informants are listed in the table below, along with their relationship to the Lake Taupo Nitrogen Trading Programme.

Sector	Organisation or sub-sector	Interview number	Relationship to (or input into) Lake Taupo Nitrogen Trading Programme	Interviewee Location
Governance	Waikato Regional Council	1	Responsible for administration of V5 and for monitoring the implemented scheme	Taupo
		2	Managed the development and implementation of V5	Hamilton
	Lake Taupo Protection Trust	3	Chair	Taupo
		4	CEO	Hamilton
		5	Trustee and agricultural consultant	Hamilton
		6	Foundation chair	Cambridge
	Taupo District Council	7	Valuer contracted to undertake rating valuations	Tauranga
		8	Planner	Taupo
		9	Chair of the Economic Development Agency, Enterprise Great Lake Taupo	Taupo
Farm Advisors	Banking	10	Agribusiness partner since 2005, rural banking advice and assistance	Taupo
	Accountant	11	Accountant for farming clients and, owner of farm just outside the Catchment	Taupo district
	Farm consultants	12	Consulting in the region since mid-80s	Taumarunui
		13	Consultant and was the Ministry of Agriculture and Fisheries representative during the development of V5	Hamilton
		14	Consultant to Ngāti Tuwharetoa Agricultural Group	Hamilton
		15	Consultant to Māori Trusts and Incorporations and ex-farmer in the Catchment	Taupo
Farm sector groups	Federated Farmers	16	Area representative of farmer lobby group	Taumarunui
	Taupo Lake Care	17	Secretary of group representing farmer interests	Taupo district
	Beef and Lamb NZ	18	Environment Extension Manager - North Island	Hamilton
Local Businesses	Real Estate	19	Retired real estate agent. Ex-sheep farmer	Taupo

		20	Real estate agent with 35 years' experience in the Catchment	Taupo
		21	Lifestyle block real estate agent husband and wife team	Taupo Catchment
	Land Valuation	22	Ex-farmer in the Catchment, Full time valuer since 2006	Taupo
		23	Valuer that calculated the effect of the regulations on land prices for AgResearch	Hamilton
	Restaurant	24	Owner, promotes Taupo Beef (see Chapter Seven) and is a TDC councillor	Taupo
Science	Social scientist	25	At AgResearch, and has undertaken social research on farmers in the Taupo Catchment	Hamilton
	Water scientist	26	At Geological and Nuclear Sciences. Expert in nitrification of Lake Taupo	Taupo
Community	Lakes and Waterways Group	27	Foundation member	Taupo
		28	Foundation member	Taupo
		29	Secretary and member of Royal Forest and Bird Protection Society	Taupo
	Waikato Regional Council Councillor	30	Elected community representative on WRC during the development and implementation of V5. Also a Health Board member for Taupo.	Taupo
	Conservation Board	31	Chair	Taupo

Table 25: Key informant interviewees

Appendix F

Land-use change from the early 2000s to 2013

In this appendix land use change from the time of benchmarking (2001 to 2005) till 2013 is shown for both the Catchment as a whole and for the study area i.e. the northern, western and southern sectors.

F.1 Land-use change in the Taupo Catchment

The table below shows land-use change in the Catchment since benchmarking. Of note is the 78% of consented area that has not changed land-use.

Land-use change	Consented area (ha)	Consented area (%)	Number of consents
No change	51254	78	41
To mixed farm (pasture and woodlots)	2041	3	5
To plantation forest	5286	8	11
To dairy platform	2433	4	2
To dairy support	2356	4	10
To sheep and beef	1328	2	3
To Cropping	721	1	3
To Subdivision	175	0	4
To other	111	0	4
Total	65705	100	83

Table 26: Land-use change in the Taupo Catchment from early 2000s to 2013
(Source: Waikato Regional Council)

F.2 Land-use change in the study area

The table below shows land-use change in the northern, western and southern sectors from benchmarking (2001 to 2005) to 2013. Of note is that 76% of the consented area has not changed land-use but on 44% of that land a nitrogen trade has taken place.

Land-use change	Consented area (ha)	Consented area (%)	N trading involved in change (ha)	N trading involved in change (%)
No change	37,368	76	22,015	44
To mixed farm (pasture and woodlots)	2,041	4	2,041	4
To plantation forest	3,038	6	3,038	6
To dairy platform	2,433	5	2,003	4
To dairy support	2,356	5	389	1
To sheep and beef	1,328	3	1,032	2
To Cropping	643	1	378	1
To Subdivision	175	<1	157	<1
To other	111	<1	0	0
Total	49,493	100	31,055	63

Table 27: Land-use change and nitrogen trading in the study area from early 2000s to 2013
(Source: Waikato Regional Council)

Appendix G

Stocking rates in the Taupo District

The table below shows stocking rates in the Taupo District (which includes the Catchment) and the changes in rates over the period of development and implementation of the regulations. Of note is the increase in dairy cattle numbers and the decline in sheep numbers which corresponds with the number of sheep and beef farm conversions that took place in this period just outside of the Catchment boundary. The scale of conversions is evident when the percentage of change in dairy cow numbers in the Taupo district is compared with the change for the North Island as a whole.

Total revenue on sheep and beef farms in the Taupo District over the same period fell 6% (Beef + Lamb NZ Economic Service), partially because of severe drought.

Year	Sheep (000s)	Beef cattle (000s)	Deer (000s)	Dairy cows (000s)	Total stock units (000s)[180]
2000-01	495	76	43	53	1,340
2001-02	449	74	48	59	1,341
2002-03	442	72	54	64	1,361
2003-04	436	74	60	67	1,391
2004-05	455	74	60	77	1,496
2005-06	475	76	58	81	1,540
2006-07	504	76	52	79	1,544
2007-08	488	76	60	83	1,564
2008-09	377	61	53	96	1,503
2009-10	363	66	56	113	1,669
2010-11	330	52	47	110	1,519
2011-12	334	52	47	92	1,384
2012-13	286	44	42	99	1,346
2013-14	336	47	50	111	1,523
% Change Taupo District	-32.1%	-38.2%	16.3%	110.5%	13.7%
% Change North Island	-23%	-16%	-41%	7%	-12%

Table 28: Changes in stock numbers and types of stock in the Taupo district from the early 2000s and comparison with change in the North Island
(Source: Beef + Lamb NZ Economic Service)

[180] total SU refers to total sheep, total beef, total dairy, and total deer.

Appendix H

Transaction Costs

Negotiation and monitoring costs to farmers, as at 2013, have been estimated as shown below.

Benchmarking	The cost of obtaining an NDA value (both lifestyle and farm properties) was covered by the Lake Taupo Protection Trust. Consequently the consented farmers in this study were not required to pay for their benchmarking.
Consent application or change	Waikato Regional Council charge a set fee of $1207.50 for a new application for a consent. A change[181] to a consent costs $500 (plus an hourly fee if extra work is involved). Farmers reported a total cost ranging from $1500 (with a land change involved) to $3000 (with a nitrogen trade involved)
Annual consent holder fee	Properties less than 20 ha $179 Properties between 20 and 100 ha $209 Properties larger than 100 ha $306 This charge covers the cost of administration
Auditing	Farms are audited annually and there is an hourly charge for auditing. Most audits are desk audits but if farm visits are involved (such as having sold nitrogen to the Lake Taupo Protection Trust) travel and visit time is charged. Few audits had been undertaken by the end of 2013 but two farmers that had been audited reported charges of $400 and $500. The Waikato Regional Council (pers. comm.) reports that audit charges in 2014/5 ranged from $150 to $1300.
Nitrogen Management Plan preparation	Waikato Regional Council charge to prepare a Nitrogen Management Plan and they report (pers. comm.) that most plans require 1 hr to 3 or 4 hrs hours to prepare. Farmers are able to prepare their own Plans but these must be approved by the Council.

Table 29: Transaction Costs for regulated farmers in the Taupo Catchment
(Source: Waikato Regional Council)

An estimate of the direct on-going costs to the farmer of a 100 ha property with no complications is around $800 (i.e. an annual consent holder's fee plus an annual audit fee of say $500). To sell, lease or purchase nitrogen, a consented farmer would pay $500 for a change to their consent plus between one and four hours of Council staff time to produce an amended Nitrogen Management Plan.

Daigneault et al. (2012:22) looked at ex-ante transaction costs for a proposed cap and trade system in Canterbury. The costs that they estimated were based on the Taupo experience but they added a cost for hiring a consultant to investigate and prepare a plan to improve nitrogen management and

[181] A change to a consent is required if a land-owner sells, leases or purchases nitrogen, or changes their land area. A change to their farm system requires a new nitrogen management plan only.

estimated that 80 hours would be required for such a plan. In the Taupo investigation, farmers were not directly questioned about this matter when they were interviewed. One of the Māori Incorporations, however, volunteered that they had undertaken such a study in order to estimate the amount of nitrogen that they could sell. None of the other interviewed farmers mentioned undertaking such an exercise.

Appendix I

On-farm changes resulting from sales of nitrogen

The tables below list nitrogen sales in the northern and southern sectors and the land cover, land-use and land-use system changes that resulted from the sales.

I.1 Northern sector

On-farm changes resulting from nitrogen sales in the northern sector are shown in the table below.

Sale to LTPT or private	% N sold from farm	Land-cover change	Land-use change	Land-use system change
LTPT	65	Forested 950 ha	To plantation/ carbon forestry	Carbon contract
LTPT	73	Forested 454 ha	To plantation forestry	
LTPT	33	Forested 307 ha	To mixed use – forestry and pastoral	
LTPT	84	Forested 221 ha	To plantation forestry	
Private	82		To subdivision	Lifestyle blocks
Private	32		No change	Unknown
Private	28		No change	Change stock feeding (from feedlot cattle to dairy support)
Private	40		To subdivision	Lifestyle blocks
Private	86		To sheep and beef	Change stock type
Private	2		No change	Unknown
Private	50	Forested 12 ha	To forestry	

Table 30: On-farm changes as a result of nitrogen sales in the northern sector
(Source: Lake Taupo Protection Trust, interviews)

I.2 Southern sector

On-farm changes resulting from nitrogen sales in the southern sector are shown in the table below

Sale to LTPT or private	% N sold from farm[182]	Land-cover change	Land-use change	Land-use system change
LTPT	44	Forested 510 ha	To woodlots	1.Removal of stock in winter months to outside of catchment 2.Reduction in stock numbers 3.Change in stock ratios
LTPT	30		No change	Reduction in stock numbers
LTPT	7		No change	Reduction in stock numbers
LTPT	31		No change	Reduction in stock numbers
LTPT	19		No change	Reduction in stock numbers Subdivision planned (Taupo District Council, 2013)
LTPT	10		No change	Reduction in stock numbers Change in stock ratios (Taylor, 2009)
LTPT	33	Forested 278 ha	To woodlots	Reduction in stock numbers
LTPT	44		To cropping	Reduction in stock numbers Cut and carry operation (Harvest pasture and export)

Table 31: On-farm changes as a result of nitrogen sales in the southern sector
(Source: Lake Taupo Protection Trust, interviews)

[182] The NDA that was allocated at the time of benchmarking has been reduced by the amount shown in this column as a result of the sale of nitrogen.

Appendix J

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