

Identification and Analysis of Drivers of Significant Land Use Change

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1 Introduction

Managing the adverse environmental effects arising from major land use changes has proved difficult for Environment Waikato. Recently in the Waikato region there have been significant areas of production forest converted to pasture for dairying and further large scale conversions are anticipated. To date, the organisational response to these changes has been reactionary and Environment Waikato is keen to explore whether any proactive steps could have been taken to better anticipate these changes.

The purpose of this project is, therefore, to investigate whether Environment Waikato could improve its understanding of the main drivers behind any foreseeable significant land use changes that could occur in its region. This report explores the feasibility of identifying and analysing key economic, regulatory, environmental or social drivers significant for land use changes. In addition, the report explores the question: "If forecasting information is available, then can it be used effectively by Environment Waikato in order to proactively manage land use change?"

The project objectives were stated as:

1. Identify the key potential drivers for future land use changes
2. Investigate the feasibility of regularly analysing these drivers to predict changes; and
3. Provide recommendations about additional or alternative responses Environment Waikato could consider and any requirements for further investigations.

2 Methodology

The following methodology was used in undertaking this project.

Step 1 – Workshop with key Environment Waikato staff

A facilitated workshop was held with a range of Environment Waikato Policy and Science staff to:

- Identify the most plausible land use changes for the Region
- Clarify the generic environmental effects arising from these land use changes that are of most concern to the Council
- Identify the key potential “drivers” for these changes
- Identify relevant experts from other agencies and any existing relevant information.

Step 2 – Interview a range of external stakeholders

A range of external stakeholders were interviewed by phone, email or in person, about this project (refer to Appendix 2 for the list of organisations or agencies contacted). The list of interviewees were identified at the workshop in Step 1, and expanded through further investigation and discussion as the project progressed.

Depending on whether the person interviewed was a sector representative or had a research or policy role, they were asked slightly different targeted, open questions relating to land use change, its potential drivers and knowledge of any other relevant information or forecasting.

During the interviews a number of additional stakeholder contacts were identified. While some of these were followed up, many were not. This decision was based on the similarity of the contact’s role to those already interviewed and a balancing of resources and scope for this project.

Step 3 – Collate and review existing information

Information sources that were identified either during the workshop or interviews were collated and reviewed. A search for web based resources and information on drivers of land use change was also undertaken. Relevant resources are listed in Appendix 1.

Step 4 – Analyse findings and prepare draft report

The findings from the previous steps were subsequently analysed and the results presented within this report. Some further interviews for clarification were undertaken where information from different sources led to conflicting or unclear results.

Step 5 – Workshop on draft findings with key Environment Waikato staff

The initial findings were presented to a workshop of key Environment Waikato staff. The purpose of the workshop was to discuss and critique the findings and determine if any further steps in the investigation should be undertaken. Subsequently this report was finalised.

3 Land use changes

3.1 Plausible land use changes

In the context of this project “land use change” is defined as a change in the productive or non-productive *use* made of land. It is not focused at change at an individual or property title level; rather it is focused on trends occurring across several properties or across different industry groupings.

A range of plausible land use changes were identified at the initial Environment Waikato workshop (as identified in Step 1 of the methodology). These land use changes were subsequently reviewed based on feedback from stakeholder interviews and the second Environment Waikato staff workshop.

Table 1 sets out and prioritises the identified plausible land use changes that could occur in the Waikato region in the foreseeable future (column 1). They have been prioritised on the basis of the likely scale of the change (geographic area) and the extent of likely environmental effects. This provides an overview of the types of land uses that currently occur and which could be subject to change in the future. It also provides an indication of the resource management issues that are likely to be of significance for Environment Waikato (columns 2 – 11). Lastly, the table assesses the likelihood of change and the anticipated scale of such changes within the region (columns 12-13). The scaling used in these last two columns is broadly indicative only.

NB: The “drivers” for these land use change trends are discussed further in section 4 of this report.

Priority 1 – Land use changes

The five most likely and significant land use changes were identified as:

- Forestry to dairy/ pasture (while this is a current trend it is also noted that it is likely to be cyclical)
- Current dairy to intensified dairy (there is a clear trend occurring to intensify dairying practices – i.e. larger farms and herds as well as increased production per hectare)
- Any land to renewable energy (this includes cropping for biofuel purposes)
- Pasture to forestry (climate change and the cyclical economy of the forestry industry is likely to see further plantings in the future)
- Any land to urban/ rural residential/ infrastructure.

The common theme emerging from the indicative assessment of environmental effects is that water quality (ie impacts of direct or indirect discharges), water quantity (i.e. access to taking water for production purposes or increase in flood flows) and decline in soil health are the three key areas where environmental impacts are likely to be significant. A range of other environmental impacts while identified, were often related to one type of land use change or were of indeterminate scale.

Table 1: Land use change by anticipated resource effects, likelihood and scale of change

Land use change	Water quality (nutrients)	Water quantity (take, use, dam, divert)	Soil quality	Land disturbance (excavation, drilling)	Soil erosion	Depositions into/onto land	Bio-diversity	Natural hazards	Air quality/ climate change	Land-scape/ amenity	Transport/ energy demand	Sub-division	Likeli-hood of change	Scale of change ¹
PRIORITY 1														
Forestry to dairy/pasture	decreased WQ	Inc demand Inc discharges	Inc fertility	clearance	Poss inc erosion	Inc discharges		Poss inc flooding	Decrease carbon sinks Inc air discharges	change	Change in truck type Increase in energy demand	Poss smaller lot sizes	High	Large
Current dairy to intensified dairy	decreased WQ	Inc demand	Poss decrease soil health			Inc discharges			Inc air discharges		Poss increase in trucks & energy demand		High	Large
Any land to renewable energy (cropping biofuels/ wind)		Poss inc demand		Periodic clearances/ some structures		Inc discharges	Poss decrease		Contribute to sustainable energy policies	change		Poss increase in lot sizes	High	Med - Large
Pasture to forestry	Inc WQ			Periodic clearance	Decrease erosion		Poss inc	Poss dec flooding	Inc carbon sinks	change			High	Medium - Low
Any land to urban/ rural residential/ infrastructure	decreased WQ	Inc demand	Decrease soil quality	Clearance + structures		Inc discharges	Dec biodiversity	Poss inc in hazards	Poss dec in air quality	Significant change	Increase in transport and energy demands	Smaller lot sizes (urban & rural)	High	Medium - High
PRIORITY 2														
Any land to mining/ extractions/ flooding for dams	Poss decrease in WQ	Inc demand	Dec soil quality and availability	Clearances/ structures/ flooding		Inc discharges	Poss decrease			Significant change		Restricted future uses	Medium	Low - Medium
Any land to "extensification" ²				Clearances/ structures/ other activities			Poss increase			Poss change	Poss increase in energy demands		Medium	Low

¹ Scale of change includes an assessment of both size of land area and significance of change to the environment.

² "Extensification" in the context of this document, means diversifying land uses to encompass a range of uses such as production, tourism, lifestyle options etc. or a reduction in the intensity of the use of land.

Land use change	Water quality (nutrients)	Water quantity (take, use, dam, divert)	Soil quality	Land disturbance (excavation, drilling)	Soil erosion	Depositions into/onto land	Bio-diversity	Natural hazards	Air quality/ climate change	Land-scape/ amenity	Transport/ energy demand	Sub-division	Likeli-hood of change	Scale of change ¹
Any land to protected areas	Inc in WQ				Poss dec in erosion		increased	Poss decrease in hazards	Inc carbon sinks	change		Poss increase in contiguous protct. areas	Medium	Low
PRIORITY 3														
Pasture to horticulture	Inc chemical use/ run-off	Inc demand	Inc fertility	Frequent clearances	Poss inc erosion	Inc discharges				change	Poss increase in energy and transport demands	Poss smaller lot sizes	Low	Low
Pasture to vege cropping	Inc chemical use/ run-off	Inc demand	Inc fertility	Frequent clearances	Poss inc erosion	Inc discharges				change	Poss increase in energy and transport demands	Poss smaller lot sizes	Low	Low
Any land to indoor crops		Inc demand		Clearance + structures		Inc discharges				change	Poss increase in energy and trans. demds.	Poss smaller lot sizes	Low	Low
Any land to factory farming	Inc discharges	Inc demand		Clearance + structures		Inc discharges			Inc air discharges	change	Poss increase in energy and trans. demds.	Poss smaller lot sizes	Low	Low
Any land to abandonment	Poss inc in WQ						Poss increase			change			Low	Low

Urban and rural residential expansion is resulting in the loss of land available for primary production. Most of the land being used for population and lifestyle expansion tends to be high quality flatter lands surrounding existing urban areas.

For each of the above land use changes, the scale of change is likely to be significant (i.e. requiring large tracts of land and potentially occurring in several locations within the region). This combined with their environmental implications identifies them as being priority 1 land use changes.

Priority 2 – Land use changes

The three land use changes identified as being of medium likelihood for involving land use changes include:

- Any land to “extensification”
- Any land to protected areas
- Any land to mining/ extractions/ flooding for dams.

These land use changes are likely to occur at varying scales in different parts of the region. It is suggested that overall the impact of such land use changes on the environment (from a regional perspective) is not likely to be significant.

There were no common concerns identified relating to adverse environmental effects. However, cumulatively they would impact on land available for primary production.

Priority 3 – Land use changes

Five other plausible land use changes that could occur were also identified as follows:

- Pasture to horticulture
- Pasture to vegetable cropping
- Any land to indoor crops
- Any land to factory farming
- Any land to abandonment (ie land not being used productively or for lifestyle purposes).

The likelihood of these land use changes occurring and the potential for adverse environmental impacts is expected to be minor, as the activities would generally be small scale (in comparison with the priority 1 land uses) and site specific. Common environmental concerns could however be the cumulative demand for water for productive purposes and possibly water quality resulting from any related discharges.

General comments across all plausible land use changes

There is a range of plausible land use changes that could occur within the region in the future. It is clear from Table 1 that some of these changes are more significant than others in terms of Environment Waikato’s management of environmental impacts.

While those land use changes identified as being of medium and low likelihood for occurring, are considered to have medium/ low adverse effects on the environment, cumulatively the incremental effects on the environment could be of concern.

The most significant environmental pressures anticipated (as indicated in Table 1) are likely to be on water quality (direct and indirect discharges) and water quantity (i.e. the demand for water is expected to increase and flood run-off is expected to increase). The demand for increased productivity is also likely to result in some environmental impacts on soil health and erosion.

In addition, there is an anticipated overall trend relating to changes in the size of land parcels. Smaller lot sizes, in particular for semi-rural/ peri-urban uses (i.e. primarily

non-productive or lower-productive uses of land) will impact on the future availability of land for primary production. Amalgamating land areas for larger farm/ forest units may also result in impacts on the social and economic structures of rural areas.

3.2 Land use change – investigations and research

There is currently a high level of interest in land use change from land owners, from industry and from local and central government agencies. Regionally there is significant pressure from land owners to intensify land use and/ or undertake land use change. In addition, there are also national interests in land use change, particularly in relation to water and soil issues.

There are also international interests in the effects of land use change. This interest is predominantly focused on the links between land use change and its contribution to global climate change, for example through carbon and green house gas emissions and carbon sequestration.

Central government agencies (in particular the Ministry of Agriculture and Forestry (MAF) and Ministry for the Environment (MfE)) are currently undertaking a range of investigations and policy development under the sustainable land management and climate change portfolios. Similar to overseas, this work is primarily focused on the role of land use change in relation to climate change. The issues of water and soil sustainability have been expected to be addressed at a regional or local level, through the Resource Management Act. National initiatives are now emerging around these issues (e.g. water plan of Action) or through industry initiatives (e.g. strategic or marketing plans).

Examples of land use change research

Motu economic and public policy research

Motu currently have a work programme which is researching drivers of rural land use change (Kerr et. al., 2007; Hendy and Kerr, 2006; Hendy et. al., 2007). This research has developed econometric modelling methods that have been calibrated using historic data sets. These models then provide information about the effects of drivers on land use change and inform potential future responses. This work is primarily driven by climate change objectives, but is also considering other implications such as nutrient runoff.

Department of Sustainable Environment, Victoria, Australia

The Department of Sustainable Environment and the Department of Primary Industries in Victoria Australia have worked jointly on a project looking at the drivers of land use change. This project has been focused on the biodiversity implications of land use change.

The project has produced a series of reports(see Appendix 1) that outline how landowners view and respond to opportunities and what motivates them to make change. They specifically look at the issues for broad acre cropping, plantations and lifestyle land uses.

Choosing Regional Futures

The Choosing Regional Futures project is a Foundation for Science Research and Technology funded project managed and supported by Environment Waikato (see Appendix 1 for a description of the project). The project is developing tools (deliberation matrix, spatial decision support system [SDSS]) to assist the decision making process for local government planning and policy development. The SDSS development will involve the predictive modelling of land use change as part of an integrated model framework.

The process of developing the SDSS will include identifying the drivers for land use change and testing assumptions about how they influence specific changes of land

use. The SDSS will have the potential to test policy strategies to understand the implications on key environmental, economic and social indicators.

Ministry of Agriculture and Forestry (MAF)

MAF has a strong interest in the changes that occur in land use over time. They have investigated changes to determine the implications and effectiveness of policies on land use (MAF 1996) and have been involved in key land management initiatives such as the East Coast Forestry scheme. As part of this scheme, they have undertaken work to assess the effectiveness of incentives under this project and what influences land owners to change practices. MAF is also undertaking work on the extent, future trends and implications of deforestation in New Zealand.

Key points – plausible land use changes

- Five key land use changes of significance are:
 - forestry to dairy/ pasture
 - current dairy to intensified dairy
 - any land to renewable energy
 - pasture to forestry
 - any land to urban/ rural residential/ infrastructure
- Water quality and water quantity and soil health are the key environmental resources most likely to be adversely affected
- Cumulative effects from other land use changes may result in incremental adverse effects on the environment
- There is a high level of interest in land use changes (industry and government agencies)
- Internationally and nationally interest in land use change is directly linked to climate change issues
- Some research is being undertaken within NZ

4 Drivers of land use change

4.1 Overview of drivers for land use change

Any land use change is primarily the result of a business decision by the land owner, be this a personal decision for a family farm or a corporate decision for an agricultural or forestry business. Decisions for change are generally taken when an opportunity is seen that is likely to satisfy a long-term motivation (return on investment, business certainty, ensuring succession). These motivations are influenced by personal or “corporate” drivers such as values, behaviour and circumstances (Figure 1).

It is the personal and “corporate” drivers that direct business decisions that then influence land use changes. The long-term motivations of land owners are generally stable over a lifetime. Therefore, to change land owners’ responses requires a change to the opportunities available to them.

The personal and “corporate” drivers are directly and indirectly influenced by a range of external or mega-drivers. These drivers are outside the control of the land owner. The mega-drivers can be divided into three levels (Figure 1), regional or local, national, and global. Global drivers can influence personal drivers directly, but can also affect national drivers. Likewise, national drivers can directly influence personal drivers and regional/local drivers.

The external or mega-drivers influence the availability and suitability of opportunities that the land owners might take up. The global drivers are essentially out of the control

of national agencies and similarly the development of national drivers often has minimal influence from regional/local agencies or land owners.

This report primarily focuses on the external or mega-drivers, which are predominantly economic and policy based. The personal drivers that influence land owners are not covered in this report in any depth. The drivers governing personal and business decision making is a complex field and should be considered separately from this report.

Understanding how land owners see and respond to opportunities associated with external or mega-drivers is important as this can indicate how organisations can purposefully influence the actions/behaviour of land owners.

Table 2 sets out further detail of the key drivers that are expected to lead to or contribute to the land use changes identified in Table 1. This table is indicative only and an attempt has been made to identify priority drivers (indicated by ▲). In most cases all the identified drivers contribute to some extent to land use changes. The drivers must also be considered in the context of Figure 1 above. The key drivers outlined in Table 2 are described as follows:

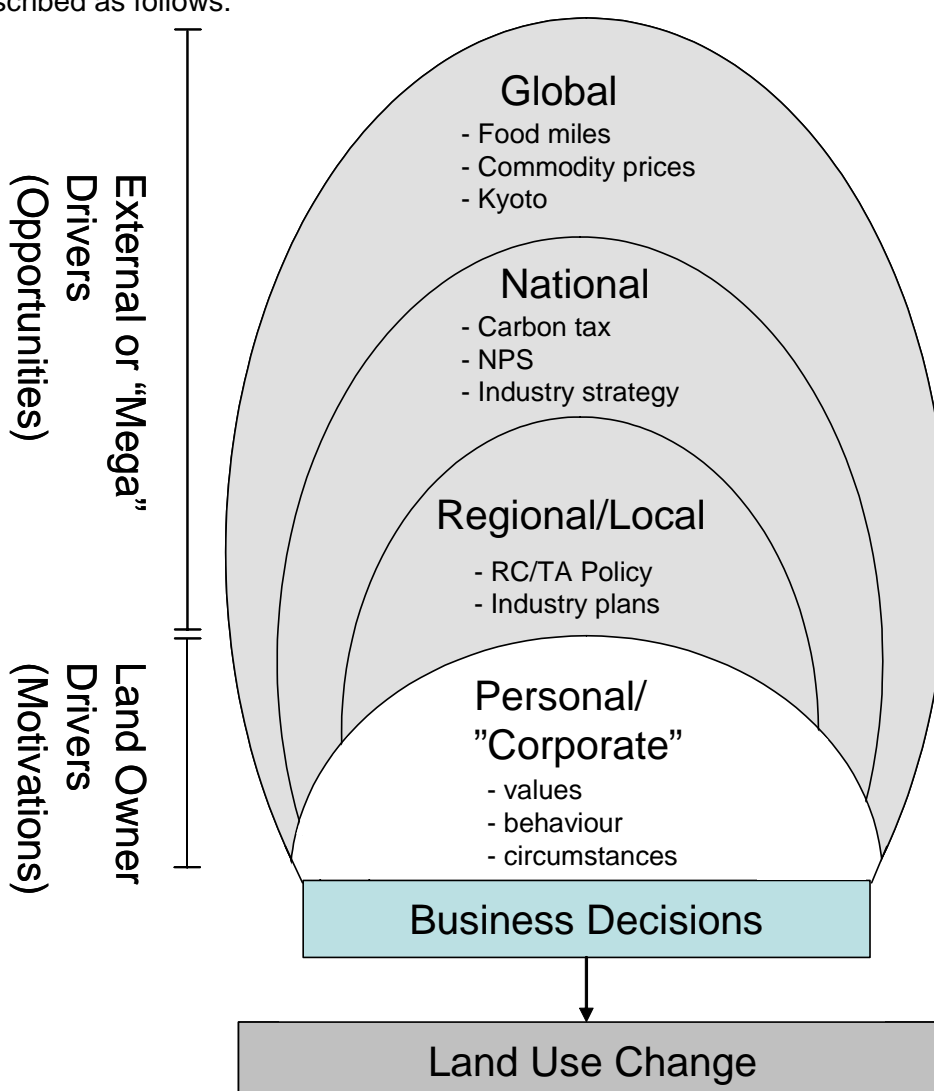


Figure 1: Influence of drivers on land use change

International commodity prices: This driver is linked to New Zealand's position in the global economy: international markets, export prices, demand for quality produce, and seasonal advantages (northern vs. southern hemisphere). It is a major driver for New Zealand's primary industries. It would have a significant impact on most of the identified land use changes.

New Zealand commodity prices: This driver is linked to internal markets and especially secondary industries i.e. those industries which have a value added focus, to the primary industry goods. Internal markets are limited by willingness to pay (compared to prices available from overseas markets) as well as population limitations (demand vs. cost of production). This driver is closely linked to overseas commodity prices.

Market demands: This driver is primarily linked to consumer demands and preferences and is strongly influenced by economic and population growth. It is clearly linked to both international and local commodity prices. This driver can be influenced by factors such as consumer awareness (eg organics), emergencies (eg crop failures), seasonality (year-round demand) or government policies (eg demand for biofuels). This driver can potentially have a significant impact on demand for specialty products.

New Zealand Government policy: This driver reflects national incentives/disincentives for different land use activities. It includes for example: tax provisions, climate change policies (e.g. carbon credits), overseas investment provisions (eg land ownership/ industry ownership). Policy on carbon emissions (which is also influenced by international policy) is expected to be a significant driver in future land use decisions. Population and labour market policies also influence productivity of primary land uses and of secondary industries.

Regional and territorial policy: This driver is strongly linked to the local authority roles set out in the Local Government Act and the Resource Management Act (RMA). The former is focused on meeting community outcomes (social, environmental, economic, cultural), while the latter is focused on environmental resource management. To date, policy directives have not been a strong driver for land use change. However, this is being tested in the Lake Taupo catchment (where regulatory controls under the RMA will influence land use decisions) and in future local government policy could be a more influential driver.

Individual preferences: These include (in the context of Table 2) individual lifestyle blocks or alternative land use decisions (generally involving smaller units of production), and specialty markets or innovative produce (ie trialling new products).

For example this is linked to demand for organic produce, or to utilising land for a range of different income purposes. Overall it is not a significant driver for land use change. However, incremental changes towards these land uses could impact on the overall availability of land for primary production. It may also result in intensive use of smaller parcels of land.

Community preferences: This driver is influenced by wider social and economic issues and is closely linked to market demands. For example, an increase in population will influence the demand for dwellings; the demand for locally grown fresh produce has resulted in an increase in farmers markets. Likewise there are community decisions made about the use of land e.g. Maori land in multiple ownership; land for conservation purposes; land retired for hazard reasons. Urban expansion and rural residential lifestyle options have a significant impact on land availability for primary production.

Technological changes: This driver is about new ways of influencing productivity. It can relate for example to new species grown/ farmed; to equipment used or to land use practices. This can be a significant driver for land use change, particularly as it can enhance or intensify the productive use of some land.

Land value: The cost of land is a fundamental driver for any land use. It is strongly linked to productivity (industry driven) and to the willingness of communities to forego

productivity (protection driven). It is also a significant component in the cost structure of any land-based business.

Climate change: This is expected to become a more significant driver in the future. The IPCC (Intergovernmental Panel on Climate Change) regularly updates data on likely climate change. This information is used by NZ to further refine likely impacts at national, regional and local levels. Extreme weather events (increased frequency and intensity) are likely to be of most concern, in particular, storms, floods and droughts.

Table 2: Land use change by key driver³

Land use change	International commodity prices	NZ commodity prices	Market demands (global and local)	NZ govt policy	Regional council policy	Territorial authority policy	Individual preferences	Community preferences	Technological changes	Land value	Climate change
Forestry to dairy/pasture	▲	▲	▲	▲	▲				▲	▲	
Current dairy to intensified dairy	▲	▲	▲	▲					▲	▲	▲
Any land to renewable energy (cropping biofuels/ wind)	▲	▲	▲	▲					▲	▲	▲
Pasture to forestry	▲	▲	▲	▲						▲	▲
Any land to urban/ rural residential/ infrastructure		▲	▲	▲		▲	▲	▲		▲	
Any land to mining/ extractions/ flooding for dams	▲	▲	▲	▲	▲				▲	▲	
Any land to “extensification”	▲	▲	▲				▲			▲	▲
Any land to protected areas							▲	▲		▲	
Pasture to horticulture	▲	▲	▲						▲	▲	▲
Pasture to vege cropping	▲	▲	▲							▲	▲
Any land to indoor crops	▲	▲	▲		▲	▲	▲	▲	▲	▲	▲
Any land to factory farming	▲	▲	▲			▲		▲	▲	▲	▲
Any land to abandonment/ retirement		▲		▲			▲	▲		▲	▲

³ NB: these drivers are presented in the context of current trends/ policies/ directives. In this context it is recognised that catastrophic events (such as volcanic eruption, or biosecurity threats) could have major impacts across all land uses.

4.2 Analysis of land use drivers

The fundamental drivers of land use change are economic, e.g. commodity prices, capital gain, and return on investment. While these economic drivers are influenced by other factors (e.g. global drivers, national drivers etc), they are nevertheless fundamental to the “land owner’s” decision to change land uses. Most parties interviewed for this project identified the key driver for land use change as being the comparative profitability that could be gained from a different use of land and the cost of undertaking a change (ie economic return).

Global drivers

Global drivers have a significant influence on primary producers within New Zealand, due to the globalisation of consumer markets. International commodity prices are also influenced by political and environmental issues. For example:

- The Kyoto protocol on carbon emissions is expected to have significant impacts on NZ’s primary producers.
- Climate crises (such as droughts, floods, storms, unseasonable weather events) can have a significant global impact on the market availability of primary produce.
- “Food miles” and “carbon footprints” are increasingly being raised internationally and locally. Given New Zealand’s physical location in the world, this raises significant challenges for future marketing of primary produce.
- Political decisions may result in repercussion in world market demands. For example, Russia is expected to significantly increase its “log” tax. It is expected that this will impact on NZ log returns in a way that will see increased forestry plantings being undertaken in NZ.
- NZ dairy farming corporate interests are expanding into South America and China. Notwithstanding the drive for intensification to increase production levels, this could also stabilise the demand for dairy land within a NZ context.

Global drivers are outside the control of any landowner or industry group. Likewise, the NZ Government has a limited influence on global drivers. However, New Zealand primary producers recognise the need to be flexible and responsive to global drivers in order to remain competitive.

National and industry drivers

National Government policy initiatives can have significant impacts on land use decisions through incentives or disincentives. Example – land improvement grants in 70s However, these tools do not always work as planned For example, while there are incentives for planting forestry for erosion control purposes, the up-take is not always comprehensive (Bayfield & Meister, 2005). Policy can direct or control certain actions; however, it can also result in unintended consequences. Industry can set national strategies or objectives that influence an industry sector. These drivers contribute to a land owner’s decision on the most “preferred” land use.

Examples of national or industry drivers include:

- The current discussions on the “sustainable land management and climate change” policy has raised the option of a “cap and trade” for carbon emissions. The outcomes from such policy directions are difficult to influence and the effects are hard to predict.
- National policy directions on carbon credits may be a strong disincentive to forestry, as plantings may be seen as being “locked up” for the future.
- The Government has ratified the Kyoto protocol and is subsequently introducing policy/ regulation that will impact on primary producers.

- Land pricing influences decisions on the “best use” of land ie the current pricing of land in the Waikato region makes conversion from forestry to dairy a profitable venture (i.e. the decisions to change land uses is not only based on expected commodity payout). Likewise, it is noted that the cost of land is a major barrier to new entrants into primary industries.
- Electricity line companies are required to maintain existing connections until 31 March 2013. The requirement is contained in s62 of the Electricity Act 1992, which expires on that date. The expiry of this section will remove the obligation on line companies to continue to operate in “uneconomic” rural areas.
- Industry drivers are generally set through strategic planning exercises, such as Fonterra’s objective for a 4% increase in productivity, 3% increase in milk solids per year. Growth (internal to NZ) can only arise from the use of more land in dairying, or from increased productivity per hectare/ per cow.
- Technological change is often driven locally or from within an industry. For example, it is likely in future that pasture based systems will have a market advantage over pad systems (as used in US and Europe) based on inputs. However, feed pads may also be used more as “wintering over” options. As productivity increases, even marginal land can be seen as being potentially profitable.
- Labour availability (especially for seasonal requirements) can impact on the expansion and profitability of farm/ horticultural units.

National government and industry drivers can impact on land use decisions and in particular the comparative economics of different land uses. National drivers, such as tax regimes and compliance costs, while not drivers in their own right, can contribute significantly to land use change decisions.

Regional and local drivers

To date local government policy is not a key driver for land use changes. Signals on regional policy changes - such as those indicated in the Lake Taupo catchment (i.e. nitrogen restrictions on farms) could, however, become a strong disincentive for some land uses. The use of more directive and influential policy is likely in the future.

Industry strategies can also dictate local land use trends.

Local environmental drivers that contribute to decisions about land use, but which are not in themselves (as yet) key drivers for land use change include, for example, water availability, erosion, pests, climate change. While these are major drivers for land use change in Australia, they have not to date, contributed significantly to land use change decision-making in NZ.

Personal drivers

Personal drivers can have a significant influence over a landowner’s decision to change land uses. For example:

- Land use change within an area is generally driven by a few “early initiators” who take the “risk” to try something new. Their success subsequently encourages others to adopt the same changes.
- Personal circumstances were identified through discussions as a fundamental driver for land use change decisions. This included retirement decisions, succession/inheritance decisions, affordability of farms, changes in lifestyles, etc. In addition, it was anecdotally noted that there are fewer people now entering the dairy sector.
- Personal decisions cumulatively reflect a social change that is occurring in primary industries. For example, the age structure of individual land owners involved in primary production was changing, with the average age of farmers increasing and

the average age of entry into the industry also increasing. Likewise the overall number of farms was dropping (reflecting larger farming units and the sale of properties to other uses).

There was a wide range of individually driven (and anecdotal) reasons identified for making a change in land use activities. This supported the findings in section 4.1. Thus while economics was seen as a lead driver, it was often considered in combination with personal drivers.

The drivers identified in Table 2 are also influenced by different timescales. Commodity prices fluctuate regularly and are generally cyclical. They can be influenced by shorter-term factors such as climatic events, government policies, fuel/ transport prices etc, or by much longer timeframes, such as climate change (water availability), or social changes (altering the structure of production units) (refer also to section 5.2).

In addition, the scale of an activity is also a key consideration for any land use change. Some of the drivers identified in Table 2 are strongly linked with corporate structures for undertaking primary production (eg large scale land uses, industry objectives), while others are more linked to individual decision-making (eg smaller scale farming practices, alternative land uses).

Key points – drivers for change

- The drivers for land use change are a complex mix and cannot easily be isolated from each other or from other social and economic trends.
- The fundamental drivers for land use change are economic.
- The personal/ corporate values, circumstances and behaviours of the land owner are considered to be the main drivers for deciding upon land use changes.
- External or mega-drivers (global, national, regional/ local) contribute to decision-making by providing opportunities that motivate change, but of themselves they are not fundamental drivers for change.
- Personal and external drivers are influenced by different timescales – e.g. political, climate, commodity cycles.
- Any driver on its own or in combination with other drivers can trigger a land use change, if other circumstances are also favourable.

5 Monitoring change

5.1 What forecasting data is currently available

(See Appendix 1 for further information on forecasting data that is available)

Forecasting criteria

When considering research into this project to determine whether suitable indicators for land use change drivers were available to predict plausible futures, the following criteria was developed to assess forecasting indicators:

- Robustness, i.e. is there a good cause effect relationship existing between the indicator and the land use change.
- Availability of data, can it be acquired easily, timely and cost effectively.
- Complexity of analysis and the cost/benefit of doing so.
- Assess methodology for undertaking trend analysis and evaluate the ability to predict changes.

Forecasting data

Key industries, such as forestry and dairy, undertake internal forecasting exercises focused on the potential for production over time into the future. This information is not made publicly available.

Trend monitoring is undertaken by various parties, but it is primarily focused on changes that have already occurred (ie back-casting). The Ministry for the Environment is currently undertaking a trend assessment of land use change as a part of its State of the Environment report.

MAF undertake some forecasting and publish this in the "Situation and Outlook for NZ Agriculture and Forestry" (see Appendix 1). These reports are produced annually with a six monthly update. They also provide sector and regional monitoring reports. These are a short-term financial and physical forecast reflecting farmer and industry perceptions of farming figures, trends and issues.

MAF has also started to provide the Forest Industry and Wood Availability Forecasts. These provide information about plantation forests and the wood processing industry in each wood supply region. They include forecasts of wood availability from 2006 to 2040, and comment on the opportunities and constraints facing the forestry industry. In response to current deforestation specific work has been done to look at future changes in forestry (Manley, 2006; Smith and Horgan, 2006).

MAF also provides on their website a range of statistics on primary industries, "goods producing" industries and international trade, including a 10 year overview of agricultural statistics.

The NZ Treasury provide a range of economic forecasting information via their website. The site provides monthly economic indicators which provide a wide range of economic information including quarterly indicators. There are also several national fiscal updates provided.

Dexcel conducts an Economic Survey of New Zealand Dairy Farmers every year to estimate dairy farmers' financial performance for the most recently completed dairy season. Surveys are based on actual physical operational data and associated financial accounts.

Further economic information can also be obtained from a number of other sources including the Reserve Bank, Ministry of Foreign Affairs and Trade, OECD, and NZ Institute for Economic Research.

Results

Through this project it was found that:

- there is limited forecasting data publicly available on land use change;
- the most useful data for Environment Waikato's purposes would be that produced by MAF;
- there is no comprehensive approach to monitoring or predicting land use changes within or across various primary industry sectors;
- there appears to be no consistent data base kept by any national agency or industry group recording changes between land uses;
- there is limited trend data available at a consistent and robust level across all primary industry sectors; and
- there was strong interest from most parties interviewed in having "inter-sectorial" forecasting or monitoring information available.
- there is a need to have a better understanding of the economic indicators.

5.2 Rate and scale of changes

Primary production is well recognised as being economically cyclical, as a result of international and local commodity prices. This has a significant impact on the rate and scale of land use changes.

In the agricultural sector there is a trend towards larger farm units and the increased use of technology on farms. These types of changes are in part a response to redefining “economic units” and the rate of change will depend on the pressure from economic drivers (e.g. Effective farm surplus).

It was generally considered by those interviewed, that there would have been no realistic way to forecast the more recent forestry to dairy land use change that is occurring in the Upper Waikato catchment.

Often the land use drivers (Table 2) are strongly linked with corporate structures for undertaking primary production (eg large scale land uses, industry objectives), while others are more linked to individual decision-making (eg smaller scale farming practices) this can strongly influence both the rate and scale of specific land use changes.

Commodity prices for primary production can be highly variable, hence it is fair to assume that land owners will not alter their price expectations significantly in response to short-term price changes. This “buffered” land owner response means that commodity prices are required to shift and hold for a period before any momentum for land use change will occur.

The potential effects of a commodity price shift on land use can be seen in Figures 2 and 3. Figure 2 represents a heuristic model developed by Motu Economic and Public Policy Research (Kerr et. al., 2007). The horizontal axis represents the hectares of rural land in New Zealand (ranked from left to right in terms of land quality). The vertical axis indicates the expected return to the land owner from each hectare of land. Each curve represents the possible return on that land in one particular use. Where each curve intersects with another curve, and a line is dropped to the horizontal axis, this indicates where a potential change in land use at that level of land quality could occur. This is a conceptual model and land “quality” is not a simple traditional land quality indicator. Land of lower quality could be used for dairying, say through additional fertiliser and water input, this would be seen as making that land a higher “quality” and it would still reduce the land proportion under its original land use.

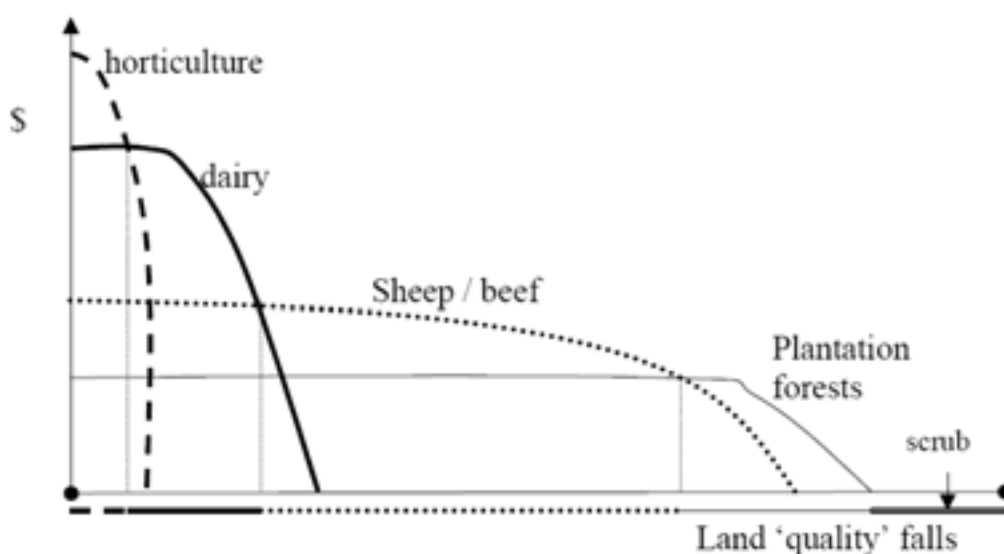


Figure 2: Economic returns and land use (Kerr et. al, 2007)

As returns change, the shape of the curves will change also. This can result in a change to the optimal land use. Figure 3 shows the possible effect of a fall in sheep/beef prices, being a reduction in the share of land used for sheep/beef. The good quality sheep/beef land is converted to dairying, while the poorest quality sheep/beef land is converted to plantation forests.

This model does not take into account the cost of conversion between land uses. However, it does provide a useful conceptual insight into the dynamics of land use change in response to long term price changes.

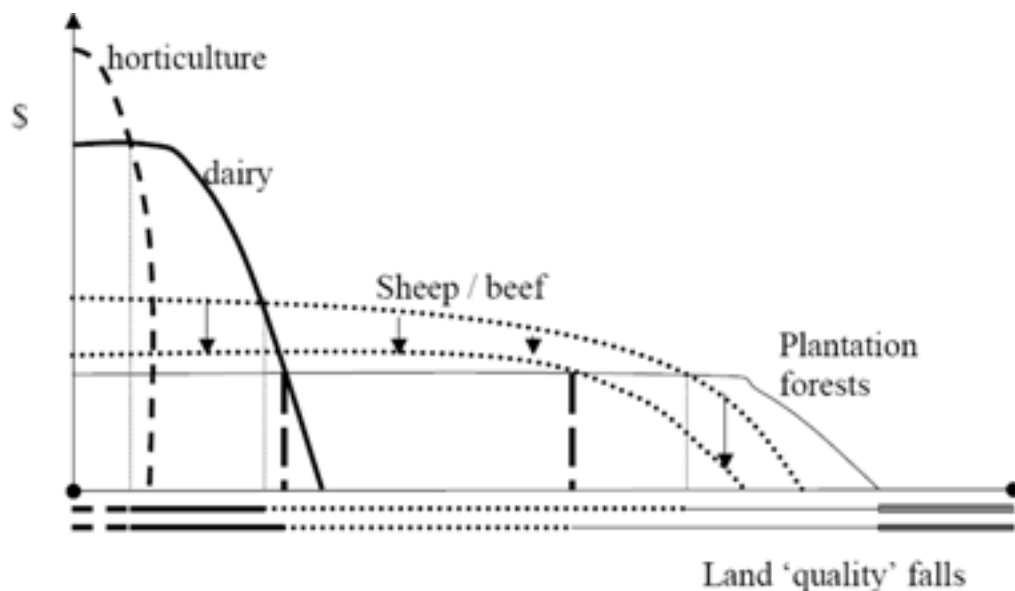


Figure 3: Effects of a fall in sheep/beef export prices on land use (Kerr et. al, 2007)

This model represents the important concept that land is a finite resource and that changes in land use must occur within this limit. An issue it does not portray is the impact of urban and peri-urban expansion on high quality land. This is occurring at a growing rate under the current economic conditions and therefore “squeezing” land in primary production.

5.3 Possible forecasting indicators

As a result of the interviews and literature search, it was evident that there is no available set of forecasting indicators that could be readily used by Environment Waikato to forecast land use change into the future.

However, it is considered that there would be benefit from a regular assessment of economic trend information. This would provide an overview of economic trends impacting on the various industry sectors and land uses. Environment Waikato could use this overview information as one basis for considering the implications of such trends on its environmental management role.

In this context trend monitoring could include:

- Economic indicators: (e.g. relative commodity prices; share market trends; international and NZ political policies)
- National and international trends: (eg economic, political and environmental policies and triggers)
- Existing publications: (e.g. MAF monitoring reports, industry annual reports, Regional Economic Monitoring report).

In addition, there could be value in mapping land use capability against environmental risks for different land uses. This could assist Council to identify those areas where

there would be the most significant concerns with any future land use change. It is acknowledged that while this is not forecasting per se: it could assist Environment Waikato to be more proactive about potential high risk areas.

The Choosing Regional Futures project was also raised (MfE, PCE) as being a potential significant source of useful “forecasting” information. However, the tools from the project, especially the Spatial Decision Support System, will be used for scenario and strategy testing, to allow planners and strategists to investigate or test plausible futures. This is different from trying to forecast the expected future.

Key points – monitoring change

- There is no available set of forecasting indicators that can be readily used.
- The land resource is finite – the proportion used by primary production vs non-productive uses is under continuing pressure to change (particularly given population and economic drivers).
- Trend monitoring could be used to provide Environment Waikato with an overview of economic trends influencing primary production.
- Priority areas for Environment Waikato to focus are those that are particularly vulnerable to land use change. These should be identified.
- The outcomes and learnings from the Choosing Regional Futures project should be captured internally and used for further issue assessment and policy development.

6 Conclusions

6.1 Overview comments

A number of interesting points were raised during the preparation of this report. Although not directly related to the drivers of land use change, the following is an overview of some of the key overview points:

- The land resource is finite, but primary production is a key economic land use in the Waikato region.
- Any significant change in land use will impact on land available for other land uses. For example, dairying and horticulture land is being “squeezed” by urban and rural residential developments; while dairying is “squeezing” sheep and beef land uses.
- While primary industries tend to be economically cyclical, increased global population and demand for quality products will reinforce NZ’s positioning as a primary producer.
- The price of land has a significant influence over the use of land, driving intensification or change to a comparatively more economic use.

6.2 Forecasting

While the key driver for land use change is the economy – in particular commodity prices (both national and international), personal drivers have the strongest influence over decisions to change land uses and the rate at which such changes occur. Key contributing drivers include: technological change, consumer demand and lifestyle changes.

There is limited data available for forecasting land use change. What data is available is fragmented across industry sectors and of variable quality.

To date, there has been limited research undertaken on land use change and its drivers or indicators. Additional research would be required to make forecasting a more effective and robust tool. In particular baseline data would need to be collected consistently and across time i.e. unless there is robust data to feed into a forecasting model, the forecasting results may be variable. Likewise access to data to assist in “back-casting” or trend monitoring is also not always available in a consistent and robust format.

Predictive indicators for the drivers of land use change can be many and varied, but again, it has variable degrees of robustness (e.g. there is no clarity on what is the best indicator for predicting international milk prices) and this may also change over time.

The Choosing Regional Futures project will provide tools and skill in assessing plausible futures for the region. Although not strictly forecasting, the ability to test policies and strategies in plausible futures can add considerable value in developing robust policy and minimising any unintended consequences.

A further difficulty with forecasting is that the whole system that drives land use change is not fully understood. This is not only about understanding the drivers as outlined in section 4, but also understanding the wider social and economic systems that influence personal or corporate decisions and the linkages between the main land use sectors. There is currently no robust model that can accommodate all the drivers that may influence different land use changes. Indeed, it was considered that the economic, social, political and environmental system driving any land use change is complex enough when considering one industry sector – let alone trying to understand several different sectors and the interplays between them.

Notwithstanding the above comments, some forecasting is being done within some industry sectors (e.g. Fonterra, Forestry), but this information is commercially sensitive and not available for public use.

While it is acknowledged that it is particularly difficult to forecast land use change with any degree of certainty, there is a range of information sources that could be accessed by Environment Waikato to be better informed about potential changes. This could include:

- Economic indicators: (e.g. relative commodity prices; share market trends; international and NZ political policies)
- National and international trends: (e.g. economic, political and environmental policies and triggers)
- Existing publications: (e.g. MAF monitoring reports, industry annual reports, Regional Economic Monitoring report).

6.3 Policy and regulation

Central Government sets the policy and regulatory framework for “sustainable” land use. From a regional policy perspective, the rate at which changes can be made to policy documents in an RMA environment is considered to be sufficiently slow that it is fundamentally “non-responsive”.

Therefore all policy documents should be reviewed to ensure they currently have robust and proactive policy that would address plausible future land use changes. These should focus on the fundamental outcomes required and not merely address the symptoms of the current issues. Vulnerable areas or resources, or resources potentially under pressure should be identified and managed in a manner independent from any particular land use activity or any significant land use change. In this respect water quantity (allocation and flooding issues), water quality (point and non-point source discharges) and soil health are fundamental to a wide range of potential and plausible land use changes. Where practicable, it is also considered that there should be an emphasis on setting thresholds relating to acceptable environmental limits, not focusing on controlling specific uses. This would assist in providing opportunities for on-site innovation to avoid unacceptable environmental effects.

One example provided during the interviews of an unintended consequence related to dairy discharges – it is a permitted activity (strong incentive) to undertake on-site disposal. However in a low lying area, while disposal ponds may have been an environmentally better option, the cost of the resource consent can be significant (strong disincentive). Therefore, extreme care is also required to analyse potential “unintended consequences” of any policy or regulation and to proactively enable flexibility for innovation.

Planning responses need to be sufficiently robust to be able to adapt and deal with the plausible land use changes. While to date, regional policy has not been a key driver for land use changes, it does not preclude the use of more directive and influential policy in the future.

6.4 Inter-relationships with industry sectors

There was no single message from each of the different industry sector groups on what may drive land use change. Rather, there were some contradictions in the views expressed between and within different sectors. There appeared to be a limited exchange of information between sectors on the reasons or drivers for land use (and often industry) changes. In addition, there is no monitoring of land owners exiting a sector and inconsistent data on new entrants into a sector.

While no systematic system exists to forecast land use change it is noted that there was significant interest in this project by those interviewed and particularly in whether forecasting information was available.

Given the lack of clear forecasting mechanisms, there could be value to Environment Waikato and to the industry sectors, to facilitate a regular exchange of information on land use change trends and drivers. This would enable Council and industry sectors to keep a watching brief on trends, but also to focus on ensuring RMA regional plans have robust policy and regulation.

6.5 Other management options

In considering an organisational response to significant land use changes, Environment Waikato should also consider management options that lie outside the RMA framework.

Information gathering from sector groups is identified as a key option under the above section 6.1.4.

Working with District Councils to facilitate proactive and regular information exchange on plausible land use changes, would enable more timely discussions to be held, particularly where there are conflicting regional-district implications for land use changes.

Decisions about land use change primarily occur at the land owner level. Generally, land use change is initially driven by a small number of people prepared to take a risk, followed by others over time. These decisions involve values, behaviours and circumstances which can be variable and location specific. These personal drivers contribute significantly to decisions on land use change (including entering or leaving a sector). Gathering information about the reasons for and the implications of decisions made, and the behavioural components of land use change would be beneficial to better understanding the land owner motivations or drivers. It is anticipated that this would provide Environment Waikato with information on matters such as demographics, industry stability, career pathways, lifestyle, rewards, and perception of community.

6.6 Recommendations

It is recommended that Environment Waikato:

- Commission a six-monthly “forecasting view” of economic indicators and trends affecting primary industries. This should focus on international national and regional issues.
- Incorporate regional and local climate change predictions into any forecasting assessments
- Establish a regular opportunity to meet with industry sectors (singly or jointly) to discuss industry and environmental trends
- Reconsider the Regional Policy Statement and the Waikato Regional Plan provisions to assess whether they are providing adequate protection against the significant adverse impacts of land use change – in particular rules relating to water quality, water quantity and soil health. Ensure rules are robust across a range of plausible land use changes, and not reliant on assumptions about existing uses.
- Ensure geographic areas that are vulnerable to plausible land use changes are identified and appropriately managed. (i.e. map land use capability against

environmental risks, to identify areas or catchments at high risk from land use change).

- Work with District Councils (particularly where they are seeking to promote industry/ economic development that is in potential conflict with environmental concerns), to discuss implications of regional rules and controls on land use change.
- Undertake further information gathering in relation to land owner decision-making and the values, behaviours or circumstances that contribute to land use change decisions, as well as in relation to the influence of external or mega-drivers.
- Identify options available for improved management of cumulative effects of activities through consents and plans.

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Appendix 1: Sources of information related to drivers

Forecasting information

NZ Treasury

The Treasury produces forecasts of the New Zealand economy and of the financial position of the Government of New Zealand at various times during the year for publication in Economic and Fiscal Updates:

- Budget Economic and Fiscal Update (BEFU) - published at the time the Budget is presented;
- Half Year Economic and Fiscal Update (HYEFU) - previously a December Economic and Fiscal Update (DEFU);
- Pre-Election Economic and Fiscal Update (PREFU) - published generally four to six weeks before a general election;
- Current Year Fiscal Update - published with the Supplementary Estimates.

<http://www.treasury.govt.nz/forecasts/>

Monthly Economic Indicators: is a regular stock-take of economic data releases prepared by the Macroeconomic Forecasting and Analysis section in the Budget and Macroeconomic Branch. The MEI comprises a commentary on the major data releases over the previous month and an annex with more detailed charts and source data. The MEI will be of interest to those seeking a regular update of developments in the New Zealand economy.

<http://www.treasury.govt.nz/mei/>

MAF

Primary Industry statistics on these pages include livestock numbers, planted production forest, land use, horticultural crops, etc. Dairy cattle numbers, for example, can be found by selecting the category called Livestock and Grain Crops. For information on the number of farms in New Zealand select the category called Land Use and Farm Counts. Hectares of organic land are under the category called Land Management. Also included are Situation and Outlook forecasts for agriculture and forestry.

<http://www.maf.govt.nz/statistics/primary-industries/index.htm>

Dairy Insight

The Strategic Framework for Dairy Farming's Future" is the industry's strategy

<http://www.dairyinsight.co.nz/investments/strategic-framework.php>

Environment Strategy

<http://www.dairyinsight.co.nz/investments/environment-strategy.php>

This annual dairy statistics publication is available on the Livestock Improvement website.

http://www.lic.co.nz/main.cfm?menuid=1&sub_menuid=113

Dexcel

Economic Survey of NZ Dairy Farmers

Dexcel conducts an Economic Survey of New Zealand Dairy Farmers every year to estimate dairy farmers' financial performance for the most recently completed dairy season. Surveys are based on actual physical operational data and associated financial accounts

<http://www.dexcel.co.nz/main.cfm?id=74>

Agri-fax

Agri-Fax is a commercial information service, which provides an independent non-attributed trusted source of export trends, pricing and data services across New Zealand's agricultural sector at both the farmgate and the overseas marketplace.

Agri-Fax uses an extensive database, which dates back to 1987, covering farm and export prices for lamb, beef, venison, dairy products, wool, wheat, forestry, seafood and horticultural products.

Along with weekly price reports and commentaries, historical data is available.

<http://www.agri-fax.co.nz>

http://www.agri-fax.co.nz/full_database.cfm

Regional Economic Bulletin (Waikato New Zealand):

Warren Hughes. University of Waikato: Waikato Management School/ Economics Department

A regular bulletin is published by W Hughes relating to a range of economic issues occurring in the Waikato region.

<http://www.mngt.waikato.ac.nz>

Land use studies

Drivers of Land Use Change Project – Department of Sustainability and Environment (Victoria Australia)

The Drivers of Land Use Change Project was an initiative under the Ecologically Sustainable Agriculture Initiative (ESAI), a collaborative exercise between the Department of Primary Industries and the Department of Sustainability and Environment. The full title of project ESAI 05116 was Achieving Biodiversity Gains in Conjunction with Land Use Change. Six ESAI projects focused on native biodiversity in agriculture.

<http://www.dpi.vic.gov.au/dpi/nrenfa.nsf/LinkView/EF4814D4E2DC5E3ACA256C130005ECECDA58345469F7EEC1CA256E7600113BD8>

<http://www.dse.vic.gov.au/DSE/nrence.nsf/LinkView/6AE191EB78650803CA256BDC007C59E3F72BD1C27F393C6E4A256DEA0012F9C2>

Motu Economic and Public Policy Research

Land Use, Climate Change and Kyoto: Human Dimensions Research to Guide New Zealand Policy

Summary

This programme is funded by the Foundation for Research Science and Technology, New Zealand.

<http://www.frst.govt.nz>

This research programme aims to understand human-induced land-use change processes, understand their implications for the environment, and model possible management systems at a national policy level. The team is closely linked with the international research and policy community and our work addresses a global gap in the understanding of land-use change processes and the appropriate policies to address land use and climate issues at national and international levels. The research programme has two main components. The first is to build an integrated socio-economic/natural-science land-use model and the second is to provide policy design and analysis, both by using this model and through additional qualitative research.

http://www.motu.org.nz/land_use_nz.htm

Choosing Regional Futures

Choosing Regional Futures is a new and innovative 4-year research project aimed at developing, testing and implementing integrated tools designed to inform communities of the long-term effects of current development patterns and trends and to enhance choosing and planning for desired futures.

The project brings together an interdisciplinary team of community workers and stakeholders (Environment Waikato as the lead agency) and social, environmental and economic researchers within New Zealand.

The project has two specific objectives:

1. Developing processes to enable evaluation, deliberation and choice of alternative futures for social, environmental, economic and cultural changes through the use of scenario analysis linked to multi-criteria evaluation frameworks.
2. Developing a spatial decision support system (SDSS) that:
 - integrates cultural, economic, environmental, and social components
 - quantitatively forecasts plausible future scenarios of regional development as part of long-term integrated planning
 - helps monitor progress towards achieving long-term sustainable community goals and outcomes.

The tools developed through the project will expose links and trade-offs between economic, environmental and social/cultural outcomes, including cumulative effects over space and time. The information, knowledge and tools from the project can be widely used and applied for councils' (and other organisations') planning and decision-making. The research project and resulting SDSS will be designed to closely link to councils' strategic planning. This provides a direct pathway for uptake of the information, tools and knowledge gained from the project. Building councils' capacity and capability for integrated planning for the future is a key aspect of the project.

<http://www.choosingfutures.co.nz/index.asp?pageID=2145837126>

Appendix 2: List of contacts – organisations contacted during the development of the report

Sector/organisation	Role of person interviewed
AgResearch – Hamilton	Programme Leader
Crop and Food – Palmerston North	Scientist
Dexcel – Hamilton	Environmental Programme Leader, Policy Advisor
Ecologic – Christchurch	Researcher
Fonterra – Hamilton & Wellington	Policy/Research Analyst
Hort NZ – Wellington	Scientists
Landcare Research – Hamilton	Scientists
MAF Policy – Hamilton and Rotorua	Manager and Policy Advisor
Ministry for the Environment – Wellington	Policy Analyst
Ministry of Economic Development – Wellington	Policy Analyst
Motu Economic and Public Policy Research	Researcher
Parliamentary Commissioner for the Environment – Wellington	Policy Analyst
Oram, R – website	Website
Rabobank – Hamilton & Wellington	Rural Manager
Regional Councils	Senior Staff
Research Institute for Knowledge Systems (RIKS) – Netherlands	Director
Scion – Rotorua	Science leader and Researcher
Sharebroker – Hamilton	Director
University of Waikato – Economics Department – Hamilton	Senior Lecturer
Wrightsons – Hamilton	Rural Manager

Note: Specific contacts were identified in the organisations listed above. These contacts were interviewed about the drivers of land use change. Although their comments assisted in creating the report they are not quoted directly in the report. Their input was not to be taken as representing an organisational position on the issues and drivers of land use change, as raised in this report.