



OUR LAND AND WATER NATIONAL SCIENCE CHALLENGE

Think Piece on impact of
policy on sustainable
land use options

Executive Summary

This Think Piece tested the proposition that current national and regional policy frameworks, and their implementation, may act as barriers to the Our Land and Water National Science Challenge (OLW) achieving its objective “*To enhance primary sector production and productivity while maintaining and improving our land and water quality for future generations*”. The reason being, that these frameworks, including how they are implemented, may discourage (or insufficiently encourage) change at the scale and diversity needed.

Although the original focus was *public national and regional policy frameworks, the scope of the inquiry was expanded beyond public policy because private sector policy and implementation significantly influence current and future land use, and associated environmental outcomes*. We interviewed 27 subject matter experts across sectors, as well as conducting desktop research and leveraging the considerable experience of the team and peer reviewers. There was a consistency of opinion from interviewees; this aligned strongly with the views of the team, as well as all peer reviewers.

Through the course of the Think Piece possible constraints on how policy may or may not influence land use choices have been explored, with a focus on identifying research gaps (knowledge & tools) and the outlining of new research questions for OLW challenge to pursue.

Overall Finding

Our overall finding is that current national and regional policy frameworks and implementation do act as barriers to the Our Land & Water objective.

There is a need for more targeted science to close knowledge gaps in policy, practice and outcomes for land and water use and management. For decision makers in both the public and private sector, the knowledge available and accessible at the point of decision making has a direct impact on the quality of decisions. To be more effective, the provision of OLW-generated science needs to be integrated and embedded into networks that are centered on the management of, and dependent on the use of land and water resources. It also needs to focus more on long term transformation and look across research disciplines and science challenges, and megatrends¹ to present a new vision for food and farming in New Zealand.

Questions and Findings

Question 1:

Is the OLW Challenge view, that improving the capture of value from consumers to producers through the operation of value chains that reward sustainable land use choices and practices, compromised by current and emerging national and regional policy?

- *If so:*
 - a. *Are there regional variations in the way this occurs? How would we go about assessing the factors that account for those differences?*
 - b. *What are the common policy elements that are antithetical to the “value chain lens” as a driver of behaviour change?*
- *If not:*
 - *How does current or proposed policy support or encourage the Challenge objective with respect to transitioning to new high value land uses and practices?*

¹ Megatrends refer to changes such as shift in diets, emerging technologies, automation, urbanisation and factory production of food.

National and regional public policy frameworks do compromise the opportunity to capture value from consumers to producers.

The extent to which this is the case depends on the particular value chain and the regional context.

There are regional variations in the way emerging and current policies impact on sustainable land use and the capture of value from consumers. For regional councils, policy that achieves both economic growth and improves environmental outcomes is a challenge. Regional councils do not always have the capability, skills or knowledge (and this is not a function of regional councils) to match long term value creation with sustainable management of land use. There are examples when environmental policy has led to higher land use performance and product value add i.e. Taupo Beef; however, a similar context in Rotorua catchment

There are a number of common factors that account for regional variations, including:

- A lack of systematic assessment of externalities and true / full cost accounting (specifically linked to land use for food and fibre production and consumption) acts as a barrier to diversification and shift to sustainable land use. Concern about externalities has led to increased interest in organic, regenerative and sustainable agriculture practices. Better sharing of value needs to be based on understanding of externalities and true / full cost accounting in food and fibre production and dynamic value chain optimisation of ecosystem services – from producer to consumer.
- Current research and science agendas that support policy development and implementation tend to have short timeframes and often seek outcomes a few years ahead that is reflective of short government, business and investment cycles.
- Government agencies make limited use of economic instruments as a means to shift land owner and farmer behaviour vis a vis natural capital and resource use.
- Complex policy, institutional frameworks and the number of actors involved can inhibit the ability to drive behaviour change and / or support move up in the value chain. For example, private and public investments for growth and environmental outcomes can encourage the status quo and land use lock-in.
- There is insufficient focus in policy or implementation on new and novel value chains, and the business model and infrastructure need to support sustainable land use and capture more value.
- The capability (and political willingness) to conduct effective compliance enforcement and oversight is limited in some regions and nationally, with more compliance challenges expected as a result of new policy and to meet increasing public and stakeholder expectations regarding environmental impacts.
- The ‘value chain lens’ requires greater knowledge of international consumer expectations. This should be supported by engagement internationally to effectively co-opt international consumers to take a ‘global citizen’ role to influence the transformation that is required.
- Market driven credence attribute requirements flow back down the value chain and require producers through certification and audits to adopt international best practices.

Question 2

What shifts would be needed in the process of designing and design of limit-setting policy interventions to ensure complementarity with the OLV objective, and what would be their impact on regional policy objectives?

To date, limits setting processes tend to provide a ‘bottom line’ approach that may not move land use beyond a “Business as Usual” approach. Land use and management systems would benefit from

operating against a set of 'values' (or well-beings) rather than a single issue such as water quality in limit setting.

The water-climate change-land use nexus is overlooked in policy and needs to be prioritised in the limits setting framework.

In the New Zealand context, the environmental limits set for freshwater are often not translated into value chain credentials since environmental performance achieved in terms of sustainable land use is not easily communicable to consumers and markets. The Taupo Beef is an exception to this as the business was able to receive a water quality endorsement from WRC which was a helpful credential to in support of the producer's market proposition. Conversely, nitrogen limits in Rotorua catchment have yet to enable the emergence of credentials and capture of value from consumer.

Question 3

In what ways might a Te ao Māori perspective inform this discussion? Does Māori land ownership in a kaitiakitanga framework change the way limit-setting policy might impact on land use practice?

The Māori land ownership in a kaitiakitanga framework can change the way limit-setting policy may impact on land use practice. This could be manifested through the intergenerational perspective and the holistic & systems thinking of the te ao Māori perspective to provide transition to sustainable land use over long horizons.

However, the wider economic and institutional / policy framework in which Māori operate in the agricultural sector puts pressure on exercising kaitiakitanga and manawhenua.

Knowledge and capacity issues slow the uptake of development opportunities within environmental, social and cultural limits.

Question 4

What are the key research questions that come out of this analysis, and how should the Challenge address them?

Our recommendations do not follow each question posed by OLW sequentially, as many of the recommendations cut across more than a single question. We have grouped them by themes instead.

Long Term Research, and more Cross-disciplinary Research and Collaboration is needed

There is a need for a long-term (2050) research working group to look across research disciplines and science challenges as well as societal landscape and megatrends to develop a new vision for food, farming, as well as land and freshwater use and management in New Zealand.

Collaborations with the other National Challenges as well as with government agencies is necessary. Based on future scenarios for New Zealand, new science and tools will be needed *to explore and manage the impact of changes in land use and land condition on food, water, climate change mitigation and biodiversity.*

More emphasis on the Water-Carbon-Land Use Nexus is required

The interface between land use and water limits (quantity, availability), and climate mitigation and adaptation are an area of immediate interest that has already created regulatory pressure in New Zealand as well as overseas to reduce emissions and the impact of climate on land use and food production. There needs to be research co-design with the goal to better connect research on implementation of National Policy Statement on Freshwater Management with the upcoming Zero Carbon Bill, examine the synergies and feedback loops between the two policy frameworks and possibly consider the proposed NPS for Biodiversity as well.

Assessing Externalities is essential to understand the true cost of production

Understanding and valuing externalities (including true cost / total cost accounting in food and farming) is a critical area of research that would strengthen the knowledge base and robust policy and business decision making, including potential innovation. The Challenge could develop and apply a comprehensive evaluation framework (see for instance TEEBAgri-food) to understand the hidden costs and benefits of food and fibre production and consumption in New Zealand, and the knowledge gaps and uncertainties. A focus on externalities would support the research requirements to determine the true value of regenerative agriculture and natural capital – and it is also a pre-condition to more accurately generate and share value in value chains (see recommendations below).

Natural Capital Accounting is needed to properly understand the linkages between land use / land use change and natural capital

Natural capital and natural resources accounting are increasingly used concepts in policy making due to importance to economy and people's wellbeing. Significant research and science is still needed in relation to assessment tools and methodologies at different spatial and temporal scales. To understand conditions and trends, this work needs to be undertaken alongside New Zealand's system of economic and environmental accounts.

The Value Proposition of Organic, Restorative and Sustainable Agriculture needs to be better understood

A clear research opportunity exists in quantifying the value proposition of organic, regenerative and sustainable agriculture systems as tools to reduce environmental impacts in primary production systems. In its strategy for 2019-onwards, the Challenge has indicated that it intends to set up a new research project or programme to *“quantify the environmental, economic, social and cultural benefits of regenerative agriculture”*. This Think Piece recommends a few areas of focus.

Pathways to Value at Scale are important to facilitate change

Further exploration of pathways to facilitate the capture of value from consumer to farmer and the generation of investable propositions at scale for sustainable land use are needed. Linked to the ongoing work on Value Chains by the Challenge, there is a need to explore new business and investment models to attract appropriate investment in transformative change in food and farming in New Zealand and provide examples how transformation can be achieved.

The development and testing of landscape level investment models as well as mixed land use enterprise, based on sound ecological-economic analysis, present strong opportunities for the Challenge to demonstrate the potential transition pathway. This would provide value to existing and potential stakeholders while at the same time stimulating an uptake of research.

An example of investment proposition at scale is the Upper Waipā catchment – which is also a case study for this think piece. Waikato River Authority and Waikato Regional Council have supported feasibility and due diligence work that shows that significant environmental improvements can be achieved through market-based solutions i.e. targeted land use change combined with premiumization of pastoral production (in this case through conversion to organic production of dairy land). The due diligence work involved detailed environmental analysis combined with economic and farm financial analysis – to understand the implications of (bio-physical) interventions to farm output and operating profits under different scenarios. To bring this to scale, a hybrid bond instrument is being proposed as an innovative investment opportunity to materially improve water quality in the Waipā and Waikato Rivers.² More details are included in the case study to this think piece.

Gap Analysis of product and process standards is needed

² <https://waikatoriver.org.nz/wp-content/uploads/2018/11/Impact-Investment-Bonds.pdf>

Research priorities need to consider a gap analysis of the product and process standards required by high margin export market segments against the environmental impact on New Zealand's land and water resources for a given food and fibre chain.

Knowledge and tools for value creation & sharing, and as enablers for sustainable value chains

In relation to environmental impacts, there is value in integrating New Zealand's major food and fibre chains into global input-output models that are based on the agricultural land and freshwater use embodied in global value chains. This helps benchmarking and can identify opportunities to create 'plus' standards that meet and/or exceed the current high value market segment standards and give New Zealand food and value chains a verifiable competitive advantage.

Also, there is a need for research on better understanding how value is created and shared within value chains. This research needs to include a fuller accounting of costs, as well as how these costs can equitably be communicated and shared alongside the value-added components (see earlier recommendation) based on whether the value chain is in a surplus or deficit regarding the economic resources available to offset its environmental impacts.

While sustainable intensification of New Zealand's land and water resources has been the primary means of capturing the value associated with our food and fibre products, achieving further progress require land users and regulators having access to new tools and/or existing tools that are more available, effective or are more accessible. To be more effective, a whole of value chain approach needs to be taken to determine where best tools should be developed and deployed, including the collaborations needed to effect further change in sustainable intensification. For example, to account for food and fibre wastage between production and end-use, additional land and water resources are required to ensure enough product is available to meet market demands³. Reducing these losses at each point in the chain requires significant coordination between chain participants as well as inputs from knowledge providers.

Co-design and engagement beyond traditional OLV Stakeholders offer significant opportunity to increase impact and effectiveness of Phase Two of OLV

OLW should enhance its impact and seek innovation in sustainable land use through a focus on research co-design and engagement with non-traditional stakeholders in small and medium sized enterprises (e.g. farmers and growers, rural consultants and farm advisors, entrepreneurs) and sectors that are impacted by policy (such as tourism) or impact the rate and degree of land use transformation (such as the investment and banking).

³ Sun, S.K., Lu, Y.J., Gao, H., Jiang, T.T., Du, X.Y., Shen, T.X., Wu, P.T. and Wang, Y.B., 2018. Impacts of food wastage on water resources and environment in China. *Journal of Cleaner Production*, 185, pp.732-739.

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1 BACKGROUND AND CONTEXT

Why this work

Our Land and Water National Science Challenge (OLW) is one of the 11 National Science Challenges that have been established to address issues that matter to all New Zealanders and whose outcomes are expected to have major benefits for the country⁴. To achieve their objectives, all Challenges are cross-disciplinary, mission-led programmes that require collaboration between researchers from universities and other academic institutions, Crown Research Institutes, businesses and non-government organisations.

Funding for the Challenges has been allocated for ten years in two five-year tranches, with the first tranche finishing 30 June 2019. All Challenges are subject to a mid-point review of outcomes to date and the plans for next period.

OLW has the mission *“To enhance primary sector production and productivity while maintaining and improving our land and water quality for future generations”* and the vision that *“New Zealand is world-renowned for integrated and successful land-based primary production systems, supported by healthy land and water and capable people”*.

OLW operates on the basis that achieving its objective will require change on a transformational scale. This will involve major shifts in the social and institutional systems that will be driven by fundamentally different approaches to the generation and sharing of knowledge. The theory of change for the OLW research portfolio reflects on the land use context and takes the view that:

“the value chain holds the key to driving shifts to land uses and land use practices that will achieve sustainable outcomes”

The Challenge is interested in understanding the incentives and mechanisms by which land use as well as the products and services of land use can transition to novel and high value. There are two core assumptions underpinning this theory of change (OLW 2018):

- consumers will reward producers for sustainable methods/systems of production;
- the prospect of better capturing current or potential value by producers will continually reinforce behaviours and choices that lead to better environmental performance, provided⁵:
 - our agricultural value chains are appropriately designed and orientated
 - options are identified and accessible, and
 - enabling mechanisms are available.

As OLW is preparing for the second funding period, there is an opportunity to revisit the validity of the theory of change and the importance of different types of incentives in driving shifts in land use and practice. The recommendations of this Think Piece could be considered in the refresh and scope process for the investment of the second OLW funding tranche.

⁴ MBIE, 2018. Highlights from the National Science Challenges. Published by the Ministry of Business, Innovation and Employment.

⁵ These pre-conditions identified by the Challenge are viewed as risks in this Think Piece and the recommendations are reflective of this.

The questions this Think Piece addresses

The goal of this think piece is to test the proposition that current national and regional policy frameworks, and their implementation, may act as barriers to achieving the challenge's objective, because they discourage change at the scale and diversity needed.

Specifically, we have been asked to address the following questions:

Question 1:

Is the OLV Challenge view, that improving the capture of value from consumers to producers through the operation of value chains that reward sustainable land use choices and practices, compromised by current and emerging national and regional policy?

- *If so:*
 - *Are there regional variations in the way this occurs? How would we go about assessing the factors that account for those differences?*
 - *What are the common policy elements that are antithetical to the “value chain lens” as a driver of behaviour change?*
- *If not:*
 - *How does current or proposed policy support or encourage the Challenge objective with respect to transitioning to new high value land uses and practices?*

Question 2

What shifts would be needed in the process of designing and design of limit-setting policy interventions to ensure complementarity with the OLV objective, and what would be their impact on regional policy objectives?

Question 3

In what ways might a Te Ao Māori perspective inform this discussion? Does Māori land ownership in a kaitiakitanga framework change the way limit-setting policy might impact on land use practice?

Question 4

What are the key research questions that come out of this analysis, and how should the Challenge address them?

By exploring possible constraints how policy may or may not influence land use choices, the focus has been on identifying research gaps (knowledge & tools) and outline new research questions for OLV challenge to pursue.

What we mean by policy

For the purpose of this think piece, policy is being considered in a wide sense to include processes, plans, strategies, statements, tools or methods that are being deployed by public (central and local government), private (industry, finance), iwi and non-government actors to achieve specific outcomes and benefits (economic, environment, social and cultural).

National, regional and local (including catchment level) dimensions

In respect to regulatory policy, we are referring to the broad hierarchy of instruments that government agencies (national, regional and local) use to manage land use activities and discharges. At the broad level this includes the Resource Management Act 1991 and the Local Government Act 2002. This includes the National Objectives Framework and the National Policy Statement for Freshwater, through the linkage they provide to implementation by regional councils.

At the discrete level it refers to objectives, policies and statutory or non-statutory methods in regional and district plans as well as the rating and charging policies administered under both the RMA 1991 and the LGA 2002. It also should include regional and local growth strategy considerations.

This broad definition of policy was necessary because of the reach of the subject at hand: preserving New Zealand's land, water and associated ecosystems while producing economic value from those natural assets. As a result of land use, the strong connection and inter-dependencies between public and private benefits also supports a greater policy purview. More specifically, policy intervention can lead to net benefits for the public or private interests, or both. Furthermore, because of the agreement to broaden the scope of this think piece, a wider interpretation of policy would better reflect the questions asked and the ideas around the 'toolbox' used to affect land use.

Private sector policy

The role of private sector policies and approaches as well as value chains is considered throughout this piece. The private sector has had great influence on land use and land management, including driving intensification in response to economic opportunity over the last decade. Therefore, business and investment can lead change through their response to public policy pressure or market opportunities. Voluntary agreements such as the Sustainable Dairying Accord or the decision by Open Country Dairy to shift to organic production⁶ are examples of how land use and freshwater outcomes can be pursued collectively or individually by businesses as result of different drivers.

Long term carbon targets and bi-partisan commitment

Through its focus on climate mitigation and adaptation, the proposed Zero Carbon Bill is a policy initiative expected to have significant implications for land use and freshwater outcomes. The proposed Bill takes a carbon budgeting approach to achieve reduction targets by 2050 and relies on a bi-partisan commitment to delivering on these targets. Although the bill is still going through the process and final decisions are yet to be made, it represents a new approach for policy making. Here, tangible targets are being in place over a long time through a "statutory process that would maintain pressure on policy makers to keep the long-term goal of emissions reductions at the centre of their attention." (PCE 2018). Hopefully, such an approach will overcome the issue of short electoral cycles that can bring uncertainty in terms of policy focus and implementation. However, more importantly, it provides for a quantified outcome over the long term.

Policy tools and methods

At a more granular level, depending on the tools and methods being deployed to achieve specific outcomes, policy approaches can vary markedly. For example, in implementing the NPS for freshwater, a wide range of tools are being used, informed by the regional and catchment context working alongside statutory or partnerships as well as voluntary commitments or investment opportunities by public and private interests. The case study analysis and evidence in literature suggest a broad range of tools and methods can be deployed as well as options that are not yet available. While results to date vary, the overall benefits and costs of the differing approaches may take some time to emerge. The policy cycle is iterative, and often the success of a plan or policy is indicated by how long it can be

⁶ <https://www.opencountryorganics.co.nz/> accessed on 26 October 2018.

consistently relied upon as a sound basis for action. When compared across differing polities, the performance of a given policy is a key measure of success.⁷

Approach: how we did it and why we did it this way

Increasing Scope

In addition to answering the core questions above, we considered a broader scope than solely national / regional **public** policy and land use choices. The rationale for this is that while the current OLW objective is to enhance primary sector production and productivity, maintaining and improving our land and water quality for future generations requires much broader consideration of policy approaches (see section above) and the broader systems (social, ecological, climatic, and economic) within which OLW operates.

We do not believe the OLW vision can be achieved **solely** by limiting efforts to water, land use, and product value-add. Instead, there will need to be a focus on the agri-food system as a whole (TEEB 2018). This would include the tangible and intangible links between all capitals (natural, human, social and manufactured capital) on which food and farming depend and impact is required (see Annex 1 for comments and considerations on OLW positioning).

In NZ, to achieve transformation of primary production at scale, will require the development of future-oriented solutions. To this end, we believe there needs to be greater focus (in addition to the role of public policy) on, for example:

- quantifying and valuing the impacts and dependencies of the farming and food system on all well-beings (environment, social, economic and human);
- better alignment with SDGs, OECD Standards of Living, and specifically the NZ's Living Standards Framework (note: the latter provides a potential opportunity for the Challenge to influence and enhance the LSF recently published dashboard⁸);
- farmer & grower capability to respond to market and consumer trends (including the dominance of a few major supply companies);
- local investment practices and access to finance;
- availability of extension services and the pressures put on farmers and land owners, workers, livestock and the environment (beyond water and land use);
- climate change and biodiversity.

Method

In addition to desktop research, the following have been used to elicit perspectives and seek insights into research gaps and opportunities:

1. Interviews and workshops with selected stakeholders, knowledge holders and influencers.

About 30 people (see Acknowledgements list) have been interviewed to help address the questions in this think piece and take an inclusive approach towards research recommendations. Interviewees cover a broad range of perspectives and experiences; from farm solutions and on the ground

⁷ Marsh, David & McConnell, Allan. (2010). Towards a Framework for Establishing Policy Success. Public Administration. 88. 564 - 583. 10.1111/j.1467-9299.2009.01803.x.

⁸ <https://treasury.govt.nz/information-and-services/nz-economy/living-standards/our-living-standards-framework/measuring-wellbeing-lsf-dashboard> accessed on 8 December 2018.

implementation of policy at regional or catchment level to Māori land owners, investors, innovative thinkers and advocates for change and transformation in the food and farming system.

The framework for the interviews was semi-structured and focused on the research gaps and opportunities linked to OLW, and land use and food production & consumption. The context for change in New Zealand (see Annex 2 for detailed information) was used as a guide for interviews.

The input and perspectives from those interviewed were summarised and core themes were captured. Research options that could support solutions for the future emerged by exploring with the interviewees their understanding of the current state of research and how OLW might help address and remove some of the impediments for sustainable land use choices.

2. Catchment case studies at varying scale, location and context

Three catchment case studies were included that showcased different processes, approaches, limits-setting and stakeholder collaboration. The three NZ case studies were geographically dispersed. Analysis of each case considered the questions being asked by OLW as well as the additional factors beyond public policy such as private investment drivers.

Table 1. Case studies list and rationale

Location	Scale⁹	Rationale for case study
Upper Wāipa River Catchment	Catchment	The Vision & Strategy for Waikato River catchment' long term management (which has the significance of a national policy statement) Co-governance arrangements Regional (catchment based) Healthy Rivers Plan Change (HRPC) to give effect to NPS FW Significant water quality issues (sediment, e.coli, nutrient) and ecosystem degradation Innovation through impact investment approach in Upper Wāipa catchment
Gisborne District / Wāipaoa	Catchment	Freshwater Plan Development Challenges to address co-governance and iwi rights and interests Influence of public funding initiatives Water scarcity and climate change resilience Diversity of land use
Te Waihora	Catchment	Catchment under significant freshwater limits (quality and quantity) and strong tension with economic growth through land use intensification. The catchment is linked to Lake Ellesmere, which is a site of international significance (Ramsar Site) and unique in New Zealand. A co-governance model iwi-government is in place.

⁹ Multi-scale is an option as well since vertical integration will be considered – i.e. how regional and national policy support each other.

The case study approach was combined with a targeted literature review to address the Challenge's interests in understanding:

- What the national and regional 'toolbox' looks like, including regional variation and commentary on private sector influence and Te Ao Māori perspectives.
- Identifying the impediments (barriers) to the change envisaged by the Challenge are (both public and private and including Te Ao Māori perspectives)?
- How could the Challenge remove or reduce the impact of these impediments (and therefore achieve the objectives of OLW)?

Te Ao Māori perspective: why it is important to consider specifically in the context of land use and water

The importance of the Te Ao Māori perspective is critical in terms of obligations under the Treaty of Waitangi but equally in terms of the inspiration, experience of practice and potential of applying a Māori world view and values to land and water solutions.

This is a significant policy challenge and the genesis of initiatives like the Living Standard Framework of the New Zealand Treasury, which seeks to align stewardship of the public finance system with an intergenerational well-being approach.¹⁰

The Māori view of the world is largely defined as a series of states or dimensions (physical, mental and spiritual, experience and co-existence), and land, water, and air are special taonga that require special care and attention in their management and use.¹¹

From a Māori perspective the management of land and water across different scales, such as catchment, is driven by the fundamental notion that human and non-human communities are familial related. This worldview creates an ethic of care for the environment that is both instrumental and intrinsic in its motivation. Increasing the mauri of the land and water is not just important because there is a duty to do so, but also because it has a long-term beneficial outcome for those who are sustained by the land and water and the socio-economic system around them.

The case studies included in this Think Piece provide insights into how the Te Ao Māori world view has been put in practice and the relevance for the specific questions being explored, including with a view to limits setting:

- Māori values are interconnected, so as well as requiring kaitiakitanga, or guardianship of the land, there is also a need for rangatiratanga, or the appropriate authority to care for the land.
- Knowledge of interconnections, interdependencies, and the resultant cascading impact of actions on an ecosystem.
- Long-term intergenerational perspective that restricts the short-term financial gain focus.

Positioning OLW in the wider research agenda for agriculture and the food system

Because the challenges in agriculture and food system are complex, transformation at scale in New Zealand requires systems thinking and deep understanding of the tangible and intangible links

¹⁰ <https://treasury.govt.nz/information-and-services/nz-economy/living-standards> accessed on 10 November 2018.

¹¹ <https://www.landcareresearch.co.nz/science/living/indigenous-knowledge/land-use/maori-values>

between all capitals (natural, human, social and manufactured capital), and the dependencies and impacts of food and farming.

Research to date shows that sustainable solutions cannot be developed by focusing on the impacts and dependencies of primary production (such as water and land use) in isolation from the rest of the food system (TEEB 2018, Poore *et al.* 2018). The value chain approach of the Challenge from land to the end consumer is also a recognition of that. Such an approach recognises the value of fundamental science, research and empirical evidence, but it goes beyond that to seek new knowledge and tools for decision making. This recognizes the interconnections and interdependencies between social, economic and environmental problems. See Annex 1 for more information on the reasons for this suggestion.

Assumptions and limitations

Some broad assumptions and limitations were confirmed in discussions with OLW prior to this work commencing and include:

- The Challenge supports the proposition that widening the scope of the think piece could help devise more effective research recommendations in the context of agriculture, food systems and the environment.
- A purpose of this Think Piece is to revisit how the Challenge can best be positioned to achieve its statutory objective. While there is a focus on value chains, other mechanisms to achieve this object will also need to be considered.
- Policy is not interpreted solely as public policy but also incorporate private policy and drivers, including tools and methods for implementation.
- Individuals, corporates and collectives (such as tribal entities, NGOs, sector groups) each have different drivers and views regarding policy implementation and outcomes, or the availability of suitable knowledge and research.
- Associated regulatory and non-regulatory methods (including national / regional public investment / funding) in achieving synergies (or otherwise) with OLW objectives have been considered. The 'toolbox' used at both a national and regional level is effectively the implementation of policy and is therefore an essential part of what the work must consider.
- The availability of research capability on a topic (for example economic instruments, taxation or new business and revenue models) is not considered when research questions and recommendations are made.
- The key limitation was the timeframe and resources available to carry out this exploration.

2 FINDINGS, OBSERVATIONS AND IMPLICATIONS FOR THE CHALLENGE

Interviews

We found a significant level of consistency in responses from interviews, regardless of sector, personal or professional background. A range of general observations and findings have emerged that went beyond the immediate questions asked. These were either cross cutting issues or aspects that highlighted the need to examine linkages and more holistic approaches to solutions for sustainable land use.

In providing their perspectives on the questions explored by this think piece, some of the interviewees have also queried whether the questions asked are the right ones in the face of complex challenges and influences, as well as the need to be innovative and forward looking:

“We are continuing to encourage farmers to look down instead of up with such questions, too much navel gazing instead of more visionary research agendas” Interviewee, agri-sector

General observations and findings

- The Challenge’s objective to enhance production and productivity is seen as a valuable undertaking. However, overall it was considered *Business as Usual* approach and insufficient when the long-term aim is transformation and transition to novel and high value systems.
“productivity is important but not as an overarching theme. There are bigger questions to ask like what should we be producing and why” Interviewee, financial and services sector
- The interviewees were passionate about the topic and were keen to have deeper conversations going beyond sustainable land use and value chain - to explore the transition that New Zealand needs to make, as well as the role science can play in supporting decisions by farmers, producers, policy makers, consumers and politicians.
- The findings and recommendations included in this think piece are not intended to reflect a consensus of all those interviewed but rather the range of themes and needs that emerged.
- In the New Zealand context, positioning land use in the context of an agriculture and food system is deemed more appropriate given an export-oriented economy based on primary production – particularly since competition for land is increasing as result of demand from urbanisation or afforestation (for biofuels, carbon sequestration, biodiversity conservation).
- A broader agriculture and food system approach is more conducive to innovative solutions, as is working across sectors and stakeholders – which is seen as a critical step in the success of the Challenge.
- Soil and carbon can play a more central role in this context.
- The disconnect between the short investment and business cycles which drives land use decisions versus the long-term policy intervention and outlook for ecosystem restoration as well as inter-generational equity and well-being appears to be a significant omission in the research agenda. This includes accounting for externalities and the risk of burden shifting between regions, catchments or products. For example, afforestation that leads to job loss in farming.
- Multiple interviewees express reservations about how the research and science sector relates to traditional ‘end users’ first and foremost. These ‘end users’ tend to be central government organisations, industry and regional government and more effort could be made to engage, broker knowledge and translate research outcomes into innovation and know-how that can

be applied more broadly along the value chain. This approach could start with the NZ sphere of influence starting with farmers and other land users and then move on up through the value chain to the consumer.

- More research focus on the potential application of economic and fiscal instruments (including taxes or incentives) was needed if the tension between primary sector growth and environmental impacts, especially water, carbon sequestration or biodiversity, was to be effectively addressed.
- Regional councils were perceived as being somewhat familiar with research direction and outcomes. However, this was less so for sectors like investment, finance and insurance who can potentially affect change at a faster rate than public policy due to their influence on farmers/farms via capital. A similar claim could be made for rural consultants, accountants or lawyers.
- The Challenge needs to think more in terms of models for research uptake and be more 'inclusive' in identifying and collaborating with stakeholders and avoiding being captured by vested interests. There needs to be more focus on doing research projects 'with' farmers and not 'on' farmers, where the thinking of people-profit-planet is applied consistently.

“intellectual engagement of farmers and land owners needs to be respected. Researchers need to ask: what do you need support with...” Interviewee, agri-sector

- Regional and local councils are instrumental in implementing public policy but they do not have the role under the RMA to operate from a value chain mindset, which is more the focus of private policy.
- There needs to be more explicit analysis of assumptions and pre-conditions for the Challenge's success – should the Theory of Change (ToC) stay the same.
- The Challenge's ToC is based on assumptions and pre-conditions (linked to value chain) that are actual risks for achieving its objective. Other preconditions and uncertainties need to be considered and examined for the OLW to be successful in delivering radical transformation. These include:
 - Externalities of agriculture (and specifically for the food system) and risks across the entire value chain need to be identified, including understanding the linkages to human health, diet and nutrition, equity and ethics.
 - All points of entry for driving change in the value chain will be considered (for instance better regulation and certification, demand for food quality, diet, nutrition and health, investment).
 - Governance in the value chain is anticipatory to enable better alignment between key actors and influencers along the entire value chain. For example, alignment between NZ rules and regulations, investment and chain audit requirements for sustainability.
 - Power relations and consumer-orientation in food and fibre chains that enables shared responsibility and allows for innovation and entrepreneurship.
 - The role of fit-for-purpose technology and its accessibility, as well as end-user upskilling and rate of technology uptake.

Each of the Think Piece questions are addressed separately below. This allowed a consistent structure of providing context for the question, listing key findings followed by implications for the Challenge.

Case studies

The selected case studies have been instrumental in providing a broad perspective on how public and private policy approaches and institutional frameworks – including the economic growth pre-requisite – can either constrain or enable environmental outcomes. These studies have also highlighted that the regional/local context has a significant bearing on those outcomes. They present a diverse range of approaches, drivers and issues (including catchment-specific environmental, social and cultural aspects) linked to limits setting, role of private sector, and Te Ao Māori. Many of the findings to the Think Piece questions and subsequent recommendations are informed by the case study insights. The detailed case studies are included in Annex 3. A summary is presented below.

Te Waihora, Canterbury

The current institutional framework in Te Waihora/wider Canterbury has incentivised intensive, irrigated dairy which has seen billions of dollars invested into dairy infrastructure. The existing capital investment represents a significant constraint to land use change which is exacerbated by the framework's lack of a singular actor and mechanism through which significant change could be effected as well as the vested interests in maintaining the income from this dairy model. Ngāi Tahu possesses culturally unique insights regarding the management of the Te Waihora catchment, which it attempts to put into practice through its own commercial farming activities. However, it has limited influence over land use within the catchment and it is subject to the same pressure of achieving commercial returns. Under current rules, nitrate levels in Te Waihora have continued to increase but ECan hopes to limit the increase to 4800t by 2037, a fifty percent increase on current 2017 levels. Other estimates project these increases to reach 5600t by that date.

A shift to organic dairy is a possible option to mitigate impacts under the current intensive model as this utilises the existing infrastructure while reducing environmental impacts and maintaining commercial viability.

Upper Waipā River Catchment, Waikato Region

The Upper Wāipā Catchment, within the wider context of Waikato River Catchment, represents a coordinated, long term approach and the strategic combination of statutory processes and obligations, with finance and investment to pursue the Vision and Strategy for the river and its people. This is a unique process in New Zealand and the focus on restoration, local indigenous biodiversity and cultural values also means that the catchment is in a better position to respond to upcoming policies linked to carbon and biodiversity.

Whereas the Waikato River Authority and Waikato Regional Council both measure the progress in terms of people and ecosystem health,^{12,13} there seems to be an opportunity to provide for more responsibility and accountability at catchment level, beyond setting policy frameworks and strategies. The impact investment opportunity, where market-based solutions are applied to pursue additional environmental mitigation, would be in alignment with greater initiative and responsibility at catchment level. All farming activities whose nitrogen reference points (NRP) is above 75% percentile, not just dairy farming activities, will be required to reduce their discharges to the 75th percentile, by July 2026. Impact investment could help expedite meeting the targets or go beyond them.

Devolved accountability can be an area of research for the Challenge. Likewise, the process for limits setting, while avoiding a grandparenting approach, needs inquiry in terms of delivering nutrient reduction outcomes. For Maniapoto, a lack of capability and access to knowledge about sustainable

¹² <http://versite.co.nz/~2016/19099/files/assets/basic-html/page-1.html>

¹³ <https://www.waikatoregion.govt.nz/community/waikato-progress-indicators-tupuranga-waikato/>,

land use, including the policy context, as well as difficulty in accessing capital for the development of Māori free hold land are continuing challenges.

Waipaoa Catchment, Gisborne District

It has taken over 10 years to partially implement the NPS for freshwater. The investment of time and resources has been significant. While significant consensus has been established on a number of issues, there are still legitimate concerns regarding iwi rights and interests in freshwater and the potential for appeals regarding the forestry sections of the plan. A greater emphasis on communication of very complex issues is required.

The Gisborne region and the Gisborne District Council have undertaken a highly complex process in good faith with limited resources compared to other councils. The shortage has only partially been offset by external funding from central government in recognition of the economic situation in the region.

The Gisborne District Council is now faced with implementation of catchment management plans for the rest of the region. This will occur alongside a future process to complete implementation of the NPS for freshwater management prior to 2025. The integration of climate change policy in the prediction of climate change impacts on infrastructure and investment is expected to be a major challenge.

Question 1

Is the OLV Challenge view, that improving the capture of value from consumers to producers through the operation of value chains that reward sustainable land use choices and practices, compromised by current and emerging national and regional policy?

- *If so:*
 - *Are there regional variations in the way this occurs? How would we go about assessing the factors that account for those differences?*
 - *What are the common policy elements that are antithetical to the “value chain lens” as a driver of behaviour change?*
- *If not:*
 - *How does current or proposed policy support or encourage the Challenge objective with respect to transitioning to new high value land uses and practices?*

Context for the question

In recent times national and regional policy has broadened its focus from point to diffuse impacts associated with effluent and nutrient loss. Implementation of this broader policy has resulted in trying to maintain or lock-in current land use while reducing such losses.¹⁴ While such policies highlight the parts of the value chain associated with environmental impacts related to nutrient loss, they do not appear to adversely compromise the ability of a value chain to capture more value and reward sustainable land use choices. However, increasing the value captured from sustainable land use choice and practice does require transparent and reliable information sharing along the value chain.

Key insights and findings

Impact of national and regional policy to capturing value for sustainable land use

Finding #1 National and regional public policy frameworks can impact directly or indirectly the opportunity to capture value from consumers. However, the extent to which this is the case depends on the regional context and the value chain.

The interviews and the three case studies have shown that there are many factors at play within regional councils, including:

- Inconsistent signals from central government in relation to national direction and assistance with implementing national direction.
- The knowledge and resources being available for (freshwater) policy implementation, including the science and economic knowledge put into the process.
- The availability of, and application of natural capital accounting frameworks to understand trade-offs - in the absence of nationally identified standards for performance of natural resource accounting frameworks.

¹⁴ AgFirst 2017. Analysis of drivers and barriers to land use change. A Report prepared for the Ministry for Primary Industries.

- Lack of a consistent definition for intensification across multiple attributes critical to identifying positive environmental outcomes.
- Lack of information about historical land use patterns and trends.
- The influence of historically important sector interests on the design of natural resource policy, and the impacts of existing investment on policy decision making.
- Ability to accurately forecast the impact of emerging and future innovation in land use on regional and local economies.
- Fragmentation of policy function between regional and local resource managers.
- Specification of standard rights and responsibilities to use public resources; particularly in the allocation of contaminant discharges.
- The level of recognition applied to resolving the rights and interests of iwi in freshwater decision making and resource allocation.
- The skills, capacity and political will to enforce compliance with natural resource policy.

The above elements notwithstanding, access to high value market segments by a value chain is often determined by product and process standards driven from the market end of the chain.¹⁵ Where the value chain standards relating to environmental impacts are aligned or lower than those required within the New Zealand regulatory environment, then it is unlikely such chains are compromised in their ability to capture more value and reward sustainable land use choices. The real challenge for these value chains is how to allocate any increased value across the chain.¹⁶ Those parts of the chain most associated with value adding often do not create the degree of environmental impact when compared against other parts of the chain, such as production.¹⁷ If the environmental impacts are not monetised, incentives to transfer the proportion of value-added returns from one part of the chain to another to offset the environmental impacts can be limited unless the chain operates under a more altruistic internal governance policy.¹⁸

By itself, current and emerging national and regional policy does not constrain improving the capture of value from consumers to producers through the operation of value chains that reward sustainable land use choices and practices. The implementation of policy at district and urban scales can create significant transactional costs in the change of land use for new production or processing activities due to knowledge gaps as well as community concerns regarding perceived impacts. At the regional scale, over-allocation of water resources or community concerns regarding declines in water quality can result in large scale plan changes to land use for existing and new land use. In these cases, the mix of value chains in each catchment may change depending on a given value chains ability to adapt to new environmental regulation.¹⁹

¹⁵ Trienekens, J. and Zuurbier, P., 2008. Quality and safety standards in the food industry, developments and challenges. *International Journal of Production Economics*, 113(1), pp.107-122.

¹⁶ Wagner, S.M. and Lindemann, E., 2008. Determinants of value sharing in channel relationships. *Journal of Business & Industrial Marketing*, 23(8), pp.544-553.

¹⁷ Clift, R. and Wright, L., 2000. Relationships between environmental impacts and added value along the supply chain. *Technological Forecasting and Social Change*, 65(3), pp.281-295.

¹⁸ Vurro, C., Russo, A. and Perrini, F., 2009. Shaping sustainable value chains: Network determinants of supply chain governance models. *Journal of business ethics*, 90(4), pp.607-621.

¹⁹ Abell, J.M., Hamilton, D.P. and Paterson, J., 2011. Reducing the external environmental costs of pastoral farming in New Zealand: experiences from the Te Arawa lakes, Rotorua. *Australasian Journal of Environmental Management*, 18(3), pp.139-154.

“Don’t think Regional Council policies have as big of an impact on transitioning to high value industries as do the District and City Council policies. Good examples of high value processing options stopped after progressing through RMA processes by District and City Councils.” Interviewee, local government sector

Finding #2 The role of councils in both economic growth and sustainable environmental outcomes is difficult to reconcile given their mandates are under the Resource Management Act and Local Government Act; neither of which require a focus on value chain.

Regional Councils are expected to drive regional growth and protect water quality. At present, these are two conflicting goals and outcomes are uncertain. The approach in Wāipa River catchment (in fact, the entire Waikato catchment as part of the Healthy River Plan Change) and Te Waihora case studies, as in many of the other freshwater processes around New Zealand, has been to assess the impact of limit targets on economic output at different scale.^{20, 21} In the absence of consideration of externalities (or applying true/total cost accounting approaches to natural and social capital or GHG emissions) and the application of ‘polluter pays’ principle, such approach is at best incomplete.

“To date, much of the planning has been focused on addressing problems, such as nutrient loss, and trying to maintain the current land use while reducing such losses. However, there is a risk that all this does is support land uses that may not be sustainable in the long term.” Interviewee, local government sector

An alternative approach for Councils would be to ask the question what economic opportunities are available in terms of land use diversification that can mitigate environmental impacts and over-use of resources while also providing for the four wellbeing (environmental, social, cultural and economic).

This presents an opportunity for the Challenge in terms of research but it may also require a re-examination of the pre-conditions for the ToC (see earlier section on General Observations and Findings as well as section 4).

Finding #3 There are regional variations in the way emerging and current policies impact on sustainable land use and the capture of value from consumers.

Collectively, the three case studies have shown that there are many factors at play in the region as results of local context (environmental pressures, land use, community concerns), policy, funding base, targeting of funding and the separation of key water and land use planning policies. The list below represents the cumulative insights from the case studies; it is not comprehensive.

- Inconsistent signals in relation to the national direction as well as assistance with implementing national direction.
- The knowledge and resources being available to (freshwater) policy implementation, the science and economic knowledge put into the process.
- The availability of, and application of natural capital accounting frameworks to understand trade-offs - in the absence of nationally identified standards for performance of natural resource accounting frameworks.
- A lack of a consistent definition for intensification across multiple attributes critical to identifying positive environmental outcomes. (Note: intensification is not a concept that is

²⁰ Doole, G.J. (2012), ‘Cost-effective policies for improving water quality by reducing nitrate emissions from diverse dairy farms: an abatement-cost perspective’, *Agricultural Water Management* 104, pp. 10–20.

²¹ https://www.landcareresearch.co.nz/__data/assets/pdf_file/0020/74432/Policy-Brief-6-Eco-Modelling.pdf.

broadly understood or accepted and more discussions are needed regarding how to define it and whether it is a concept that stakeholders would want to apply).

- A lack of information about historical land use patterns and trends.
- The influence of historically important sector interests on the design of natural resource policy, and the impacts of existing investment on policy decision making.
- An ability to accurately forecast the impact of emerging and future innovation in land use on regional and local economies.
- Fragmentation of policy function between regional and local resource managers.
- Specification of standard rights and responsibilities to use public resources; particularly in the allocation of contaminant discharges.
- The level of recognition applied to resolving the rights and interests of iwi in freshwater decision making and resource allocation.
- The skills, capacity and political will to enforce compliance with natural resource policy.

“Where we do see Regional Differences is in policy that restricts or encourages tree planting because of policies around water use (discourages trees) and nitrogen (encourages trees)”. Interviewee, local government sector

Further to this, a wide range of tools were applied in efforts to improve environmental management driven by public policy or private sector. The overview below includes tools applied in the three case studies:

Overview of tools deployed at regional and catchment level to enable policy implementation (in particular NPS FW)
Regulation (expansion of requirements for resource consents and permitted activities that were linked to limits)
Resource and pollution rights allocation (linked to above)
Farm environment plans (linked to certified consultants and Certified Industry Schemes)
Voluntary agreements (such as the Sustainable Dairy Accord)
Business production requirements (farmers supply contracts, good management practices)
Performance standards and disclosure
Financial support (grants, rate rebates)
Financial incentives (premiums - certified organic) or pricing of externalities (carbon credits).
Accounting frameworks (catchment, region, product level)

Finding #4 Regional Councils do not have the capability, skills or knowledge to match long term value creation with sustainable management of land use.

Whereas there is interest and realisation at council level that sustainable land use and natural resource management requires a shift away from current patterns of production (and consumption), there is limited capability to assist with this. Also, a loss of independent extension services has made it difficult

to access outsourced capability. Resourcing and time constraints limit the ability of in-house staff to undertake in-depth investigation of alternative land use options.

However, initiatives like the impact investment project in Upper Wāipa River Catchment, shows that local government can play a significant role in supporting feasibility assessments aiming to attract investment (especially from non-government sector) to address local environmental and social issues in productive landscapes on the basis of revenue from novel or low input value chains.

Councils have the Geographic Information Systems (GIS) to analyse land use, land cover and capability as well as explore new uses and mitigation that is financial viable and decreasing pressure on natural resources.²²

“Regional Council does not have the resources to keep track of science for future solutions but is identifying solutions available now for implementing the next 15 years of land use planning.”
Interviewee, local government sector

The Challenge is well positioned to further the impact investment agenda by working to improve data, tools and metrics for accountability, and help develop catchment level opportunities for investment such as combining the bio-physical knowledge and tools with value chain propositions.

Finding #5 Diverse and un-aligned public and private sector policies and strategies are not conducive for innovative and effective solutions to capturing of value for sustainable land use.

The primary sector has been developing sector specific growth strategies that are focussed on the development of export opportunities, encouraged by central government growth agendas and until recently, infrastructure investments aimed at increasing production (such as irrigation – see Te Waihora case study)^{23,24}. The environmental NGOs and others have consistently voiced concern and opposition to the lack of coordination on the growth agenda, threat to New Zealand country brand (which is vital from a value chain perspective) and increasing externalities and risks such as declining freshwater quality and climate change impacts. The fragmentation of strategy across the productive sector (dry-stock, dairy, horticulture, forestry) is also not conducive for wider solutions and capturing of value for sustainable land use. This is changing somewhat with better engagement at catchment level brought about by collaborative processes for freshwater management²⁵.

“Now that they see it as a collective problem, fertilizer companies, horticulture, dairy, sheep and beef as well as regional and district councils who working alongside the community are starting to collaborate within the catchment to reduce sedimentation, flooding, bacterial and nutrient inflows.”
Interviewee, local government sector

Accounting for externalities

Finding #6 Lack of systemic assessment of externalities and true cost accounting (specifically linked to land use for food and fibre production and consumption) is acting as a barrier to diversification and shift to sustainable land use.

²² <https://pureadvantage.org/news/2018/11/20/generating-investable-propositions-for-sustainable-land/>

²³ Ballingall, J. and Pambudi, D., 2017. Dairy trade’s economic contribution to New Zealand. NZIER report to DCANZ

²⁴ Rowarth, J.S., Scott, A.P., Macdonald, T.O.R., Wilson, S.C. and Scrimgeour, F.G., 2013. Critical success factors when going global: the basic challenge. In *Proceedings of the New Zealand Grassland Association* (Vol. 75, pp. 45-48).

²⁵ Cradock-Henry, N.A., Greenhalgh, S., Brown, P. and Sinner, J., 2017. Factors influencing successful collaboration for freshwater management in Aotearoa, New Zealand. *Ecology and Society*, 22(2).

Limited transparency in the cost structure of food and fibre production in New Zealand masks the true value of primary production. This includes the 'external' costs or benefits, which in this case are costs and benefits that do not accrue to those responsible for creating them, like water pollution, GHG emissions, soil erosion or ecosystem loss.

These information gaps can hinder better decision making and investment in ecosystem restoration and sustainable land use. Costing and pricing as mechanisms for behavior and practice change (including the application of royalty taxes and other economic instruments (including different taxation models) – see next finding) and initiatives to identify the true costs of production and consumption is broadly missing in terms of NZ research and analysis; international experience is relatively limited too.

This understanding is important in order to leverage / challenge investment to 'shift the system'. If externalities are not factored into a land use activity, then these costs can end up being picked up through interventions undertaken by communities or government seeking better outcomes (OECD 2017).

'The current dialogue does not talk about food production systems and the fact that the environmental cost of food is not built into the price consumers pay. If the dialogue continues on its current path any change in food producer behaviour or in land use will merely be seen as a prerequisite to market access rather than a pathway to gaining more value.' Interviewee, agri-sector

Globally, there are increasing efforts by business and advocacy group to improve the accounting of externalities (TEEB 2018, WBCSD 2018). At a value chain level, true cost approaches²⁶ are used by companies like Nestle to better understand the value for business and society generated from different by different investments. In turn, this helps the company better prioritise its investments and calculate the social return on investment as well as the (true) benefits the company creates.

The New Zealand Treasury, through the Living Standards Framework, is focusing on holistic measuring of well-being and accounting (valuing) natural and social capital²⁷. True cost accounting is also used to advocate for regenerative and organic agriculture.²⁸ The NZ investment and finance sector also expressed their interest in costing of externalities to understand and manage investment risks better at a sector, catchment or individual business level.

Finding #7 There is limited use of economic instruments by government agencies as means to shift land owner and farmer behavior vis a vis natural capital and resource use.

The main tool available to councils for the purposes of dealing with externalities is regulation under the RMA and cost recovery policy under the LGA. However, regulatory tools are not adequate for dealing with the issues faced by resource managers. For example, the Waikato Freshwater Strategy/Te Rautaki Waimāori mō Waikato²⁹. As a result, there are significant externalities that are leading to an overuse of resources and the loss of natural capital that could undermine all other forms of capital and the wellbeing of New Zealanders.

²⁶ True cost accounting is defined as "identifying, categorizing, quantifying, and putting a price on costs and benefits arising from different production systems" – Sustainable Food Trust, UK.

²⁷ NZ Treasury 2018. The Start of a Conversation on the Value of New Zealand's Natural Capital.

²⁸ IFOAM 2019. Full Cost Accounting to Transform Agriculture and Food Systems. A guideline for the organic movement, developed in collaboration with the Sustainable Organic Agriculture Action Network, www.ifoam.bio/sites/default/files/tca_paper_final.pdf

²⁹ <https://www.waikatoregion.govt.nz/council/policy-and-plans/waikato-regional-freshwater-strategy/>

Beyond applications like the nutrient cap and trade system used in the Taupo or Rotorua Lake Nitrogen reduction (both of which benefit from significant tax payer funded financial support), there is a significant gap in the application and impact of economic instruments such as taxes, rebates and remissions. The need to fund infrastructure such as flood protection or water storage provide further opportunities to explore protection of natural capital.

“We are now seeing the Nitrogen Reference Points system being used within the valuation calculation for farms” Interviewee, agri-sector

The Challenge could assist with new knowledge development and tools testing in this space, recognising the critical role played by regional councils in catchment management and planning. This includes an understanding of the economic capacity of regional councils to manage natural resources and reform.

Finding #8 Interest in organic and regenerative agriculture is picking up as result of concern about externalities.

There is resurgent interest in sustainable agriculture based on biological or regenerative practices such as soil carbon storage and no till farming alongside integrated weed and pest management. Organic production and revenue has increased in New Zealand.³⁰

Soil health is a primary focus of these biological or regenerative practices³¹. Increasingly, organisations are undertaking revegetation of land and this is likely to continue given the Governments current programme and incentives. Farmers are interested in comprehensive, whole of farm approach to sustainability solutions provided there is a market pull and there is knowledge and tools available to make such transition possible. The connection between soil health, resilience and consumer health makes the proposition of biological and regenerative agriculture appealing not only to land owners but also investors and value chains.

“I have been asked many times over the last year what I think about regenerative agriculture and whether applying such production system makes investment and business sense. It is a marked change from previous years that shows that farmers and land owners accept the importance of sustainability.” Interviewee, financial and professional services

However, the level of knowledge and practice uptake is low and empirical evidence of benefits is lacking in New Zealand, if not globally. Research approaches include combining small-scale component research and whole systems research alongside farmers who are achieving environmental and financial outcomes³². There is concern about the unproved ability to make significant changes at scale. The Challenge could dedicate more resources to this (including the trialling of the ROC standard as a point to market and consumer credibility).

There is a prospect of capturing premiums from consumers recognising the regenerative practices on farm, including the launch of the first Regenerative Organic Certification (ROC) in US³³. There are already several tools and approaches in New Zealand like GMPs on farms, soils restoration and associated animal welfare guidelines that are creating a moment for change and receptiveness

³⁰ See the New Zealand Organic Market Report 2018, www.oanz.org/publications/reports.html.

³¹ Sherwood, S. and Uphoff, N., 2000. Soil health: research, practice and policy for a more regenerative agriculture. *Applied Soil Ecology*, 15(1), pp.85-97.

³² Teague, W.R., 2017. Bridging the Research Management Gap to Restore Ecosystem Function and Social Resilience. In *Global Soil Security* (pp. 341-350). Springer,

³³ <https://rodaleinstitute.org/why-organic/organic-basics/regenerative-organic-agriculture/>;
<https://regenorganic.org/>

amongst land owners, farmers as well as food producer-oriented chains. Several Māori trusts and collectives have expressed interest in regenerative agriculture because of the seamless synergy with the Māori world view.

The value chain lens

Finding #9 Complex policy, institutional frameworks and the number actors involved can inhibit the ability to drive behavior change and/or support move up in the value chain.

Whereas this finding may not fully apply across New Zealand, the Te Waihora case study shows that institutional framework and institutional actors have developed in a largely ad hoc and reactive way rather than adopting a planned and proactive nature. Consequently, rather than acting in a coordinated and nested manner with jurisdictions that match the spheres of interest and concern there can be areas of conflict, overlap or mismatch. Te Waihora and its catchment manifest all of these issues and this inhibits the use of policy as an effective means of harnessing the value chain. The intensification of land use and as well as increasing impacts have also raised questions regarding the integrity of the production and expectation of reward in the value chain.

Finding #10 Existing private and public investments for growth and environmental outcomes can encourage the *status quo* and land use lock-in.

Whereas there is more sustained effort by the government and private sector to look at high-value – low input land use and value chain opportunities,³⁴ historic capital investments such as water storage and irrigation infrastructure, industry processing facilities, and farm infrastructure (sheds, fencing, etc.) make the shift away from current land uses (especially dairy) difficult.³⁵ High leverage at farm level (for example, the average dairy farmer in Canterbury has an equity to total asset ratio of only 33%, one of the highest in the dairy sector.) puts further pressure on land owners and constrains their options for change. For more details, see Te Waihora case study with detailed insights regarding the impact of investment on land use intensification.

Further to this, the current approach by many regional councils to offer financial incentives for environmental mitigation (e.g. erosion control, riparian planting) can inadvertently maintain the *status quo* instead of pursuing more dramatic land use changes.

There are significant knowledge gaps at catchment and enterprise level that can combine bio-physical knowledge with economics and investment to assess options for change that can be used to develop mid to long-term scenarios. This will include how to address the role of capital gain in distorting land use economics and applying the same rigour to environmental reporting to that of economic reporting, including the need to create open data with open access that increases the transparency of this work.

Finding #11 Better sharing of value needs to be based on understanding of externalities and true /full cost accounting in food and fibre production – from producer to consumer

Current dialogue in New Zealand is focused on the land owner as a key cause of environmental degradation and the need to change behaviour or land uses to improve environmental outcomes (water quality, conservation, soil erosion). The value chain lenses and food production systems' approaches can provide for a broader perspective where the sharing of value is based on an

³⁴ see for example the recently launched investment programme at MPI, Sustainable Food and Fibre – Futures, or the Provincial Growth Fund.

³⁵ AgFirst 2017. Analysis of drivers and barriers to land use change. A report prepared for the Ministry for Primary Industries.

assessment of externalities combined with a value chain governance to address these externalities by sharing of the burden from the producer to consumer (WBCSD 2018).

Finding #12 Market driven credence attribute requirements flow back down the value chain and require producers through certification and audits to adopt international best practices.

National and regional policy is unlikely to directly inhibit the adoption of credence attributes unless they offer a lower requirement than such policies advocate and producers lobby for the lower standard, or adherence to these credence attributes requires adoption to technologies and practices where no policies currently exist. However, the challenge is to be able to align certification requirements in value chains with policy requirements in NZ to reduce the costs to those farmers and producers demonstrating better environmental performance (see #Finding 18 with reference to Taupo Beef). To facilitate the closing of knowledge gaps to support implementation of new policies, national and regional government could provide co-funding in the evaluation and assessment of new practices.

Reinvestment by producers in more sustainable land use could be facilitated by an increased proportion of the whole of value chain revenue being available closer to the producer end of the chain.

‘Spill in’ of global best practices through domestic producers integrating with global value chains or through foreign ownership of parts of the producer end of the value chain is unlikely to be inhibited by NZ national and regional policy unless barriers to foreign ownership or issues with the technologies and practices relating to current policies occur.

Finding #13 There is insufficient focus on new and novel value chains, and the business model and infrastructure needs to support sustainable land use and capture more value.

Significant national and regional policy barriers exist for the introduction of such value chains due to the high transaction costs of providing the information needed to comply with policies that are not ‘fit-for-purpose’ in relation to these chains. Risk from over-scaling of value chains, or ‘boom-bust’ of value chains, leaving stranded assets and environmental legacies may result in national and regional policies taking a precautionary approach to future value chains due to past experiences.

“While there are lots of new value chain and sustainable land use ideas being offered by the private sector, a lack of scientific detail on the actual impact of these ideas on sustainable land use is limiting their consideration at the regulatory level.” Interviewee, financial and professional services

There is a need to explore new value chain business models including business and NGO or culture-based (ethnic or religious) partnerships, or multi-land use cooperatives. Particularly, when these models provide more revenue for producers to support more sustainable land use as well as being based on more sustainable land use options. Moving up the value chain or the introduction of new or novel value chains can increase the competencies and capabilities available to support sustainable land use and the adoption and uptake of new technologies.

Finding #14 The ‘value chain lens’ requires great knowledge and engagement to co-opt international consumers to take a ‘global citizen’ role in being a patron of the country where their food and fibre originates from.

A significant challenge for NZ is that although global consumers for NZ food and fibre have more spending power than the NZ citizens, global value chains have operated for a long time on the ideology of providing quality food at low prices (UNCCD 2017).

Co-opting the global consumer to make up the shortfall of domestic funds for sustainable land use is not easily legislated or able to be taxed – including sharing the responsibility with NZ producers. This

is another reason why counting the true cost of food production and consumption and taking stock of externalities along the entire value chain is necessary. Understanding the optimum global consumer / citizen vs NZ citizen funding split to sustain our land and freshwater resources under a national / regional food and fibre export growth policy is therefore a key research question to address.

“The value chain needs to be assessed across multiple capitals / well-beings – a dynamic optimisation using an ecosystem services lens. This could also be a true cost accounting lens, but the critical point is that it needs to be done dynamically at each point in the chain we optimise for true costs.”
Interviewee, agri-sector

Considering that 90% of NZ agri-sector production is exported, there is an opportunity for the Challenge to explore ‘value-add’ and value chains, including understanding how government policy leverages international and domestic private sector and investor policies and expectations as well as the UN Sustainable Development Goals, and environmental versus trade policies. To deliver fundamental change, examination of policy processes needed to more effectively engage national and international actors along the entire value chain are required.

Finding #15 Overall, increasing the value captured from sustainable land use choice and practice requires transparent, timely and reliable information and data sharing along the value chain.

Much progress has been made on making water and land use monitoring and reporting consistent. But the ability to support decisions on land use practice is still hampered by timely flow of accurate data about uptake of practice and the effects of practice on natural resources. The risk to the value chain is particularly high if the breach of minimum performance standards is not addressed. This applies equally to urban and rural actors, and government cannot be exempted.

“I would see the value chain proposition a valuable tool if it factored all the elements and was understandable to the community.” Interviewee, environmental NGOs

At the national level it is becoming critical to establish enduring consistent frameworks available to inform the whole community for decision making at the national, regional, local and catchment levels. This includes the provision for data handling at scales previously not envisaged. For example, reducing food wastage is a whole of value chain approach that reduces water demand at the site of production and processing, while at the same time increasing the amount of value captured³⁶.

These systems are critical for supporting policies that incentivise better land use choices by targeting the cost of water and land degradation more accurately; and forecasting of water and climate futures to support integrated catchment management and resource allocation.

Without these frameworks and a more holistic approach to water, climate and biodiversity, development of policy and integrated management of catchments will be difficult. None of the efforts made to date are devoid of value; and existing systems must eventually be incorporated into any consistent framework developed. The ability to continually improve freshwater and land use information requires more consistent analysis of resource use trends and the freshwater outcomes that result from those trends. Natural capital (and other capitals) frameworks for assessment and valuation (at different scale) that better reflect the externalities of land use need to be explored.

³⁶ Lundqvist, J., de Fraiture, C. and Molden, D., 2008. *Saving water: from field to fork: curbing losses and wastage in the food chain*. Stockholm: Stockholm International Water Institute.

Outcome measurement & monitoring, enforcement

Finding #16 The capability to conduct effective enforcement and oversight is limited and more challenges are expected as result of new policy initiatives.

Interviewees have consistently raised the point that monitoring, compliance and enforcement needs to occur effectively. There is a requirement for consistent treatment of business across local government. Better information on compliance and enforcement is necessary to inform policy decisions and change operational priorities in time to avoid long term consequences (OECD 2017).

It is also likely that this information will be necessary for assessing the compliance of Councils with national direction. If a strong signal on resource limits is required to inform investment decisions, the implementation of rules and policy by Councils is a fundamental necessity. For example, with farm planning likely to become a universal requirement, Councils will need improved tools to assess compliance and uptake of good management practices. This again heralds a need for better data and information analysis to support natural capital accounting (see separate finding on this).

The Challenge could focus more on exploring incentives-based mechanism or setting restrictions as approach to effective monitoring and enforcement.

Finding #17 It is unclear how accountability and oversight is exercised in relation to application of rules and regulations resulting from policy implementation (above and beyond limits setting) by regional councils.

The case studies as well as recent evaluations of enforcement raise the question of how to enhance the application of rules and regulations and whether an overarching authority is needed to ensure that regional councils are accountable for delivery of regional plans and NPS FW.

Question 2

What shifts would be needed in the process of designing and design of limit-setting policy interventions to ensure complementarity with the OLV objective, and what would be their impact on regional policy objectives?

Context

Setting limits for freshwater objectives is currently a primary focus for Regional Councils. There are efforts to take stock of experience to date and assess options and prerogatives for effective objectives and limits setting, starting with good science (see for example the 2018 report by Environment Southland on Science Preparedness for Limit-Setting). Experience to date shows that processes for NPS FW implementation have been resource intensive and lengthy. There is uncertainty regarding monitoring and enforcement outcomes³⁷, including accountability for freshwater outcomes and frameworks for allocation, transfer and charging for water and nutrients (LAWF 2017).

The government has asked regional councils to identify a strategic set of priority catchments for intervention, based on their risk factor.³⁸ These 'priority catchments' should be the starting point for

³⁷ Brown, M (2017). Last Line of Defence a summary of an evaluation of environmental enforcement in New Zealand. Accessed from https://www.victoria.ac.nz/__data/assets/pdf_file/0006/1175082/Brown.pdf

³⁸ www.mfe.govt.nz/fresh-water/what-government-doing/freshwater-work-programme/prioritising-action-risk-catchments

more integrated use of tools to measure and report the use of resource; and compliance with objectives and limits. Funding to address these catchments may require additional resourcing and support. Potentially there are more efficient ways to fund and standardise catchment interventions; particularly if deployment of economic instruments such as resource use taxes result in a more consolidated revenue stream.³⁹

The implications for regional policy objectives would be significant, particularly in terms of how procurement occurs, and funding is directed to nationally set priorities.

The proposed NPS on Biodiversity and the Zero Carbon Bill are going to add new dimensions to the 'objectives and limits' conversation.

This presents an opportunity for the Challenge to develop new knowledge and tools for more holistic management of natural resources to increase resilience and reduce impacts.

The insights and findings below are largely based on the (limited) experience with NPS for Freshwater for limits setting, which are not fully implemented and most limits have not had sufficient time to effect change.

Key insights and findings

Limits setting processes

Finding #18 Limits setting processes to date appear to lead to a minimum performance approach and do not move beyond *Business as Usual* incremental change.

Collaborative processes for limits setting have been the common approach applied for NPS implementation. Such processes of stakeholder consultation involve bio-physical science input as well as economic studies to inform the objectives and assess the impact of potential limits under different scenarios. With a few exceptions where limits could be transformative out of utmost necessity (like in Taupo or potentially Rotorua catchments), such processes generally lead land owners and water users to focus on those limits with no drivers or interest for greater change.

Further to this, due to the complexities involved and high uncertainty of modelling work, it is difficult to take limits through the regulatory processes i.e. uncertainty is high and can be easily challenged.

“Regional councils do not have the analytical capability to work through a high level of complexity and try to navigate their way through this based through low cost consultancy (less integrated, less holistic) and then fight it out in the courts against well-funded organisations who, for the most part, have only maintaining the BAU as their objective.” Interviewee, local government sector

Whereas limits in themselves cannot be expected to shift the system, the Challenge could explore complementary options for enabling greater transformation in the context of limits setting.

The example in Annex 4, though not from the primary sector, shows how standards are used to seek continuous performance improvement at product level. Such model could be adapted for farm level performance, on the basis of existing assessments and plans that farms have to put in place to meet limit targets but seeking to innovate and improve beyond that.

Finding #19 There is a close correlation between land values (and by extension production and capital gain) and environmental impacts, which inhibits diversification of land use.

The case studies in this Think Piece have pointed to this as have the statements made by many interviewees. This is a very complex area to consider and some of the shifts to date include a move

³⁹ Note by authors: this aspect may be addressed under the review led by The Tax Working Group which is being prepared but not available at the time this Think Piece was completed.

away from grandparenting rights to pollute (see for instance the Wāipa catchment case study where a nitrogen reference point is applied).

There is a strong interest and need to explore limits setting processes where land value and pollution rights are decoupled altogether (linked to externalities – see the related findings). Planned transitions and de-risking strategies are potential structural solutions to address this that the Challenge can explore.

“If land values truly accounted for multiple capitals, I expect that this correlation would be less – the point however is that our measuring of land values is based on potential use of the land in purely economic terms. A wider valuation, encapsulating other capitals, would be significantly better.”
Interviewee, professional service sector

Finding #20 The water- carbon-land use nexus is overlooked and needs to be addressed with priority.

Freshwater outcomes are intrinsically linked to greenhouse gas emissions and carbon sequestration from land use and land use change.⁴⁰ Interventions for water quality or quantity have consequences for GHG emissions as well⁴¹. There is insufficient knowledge and tools that can be used to determine simultaneously the impact on water and GHG emissions to seek multi-benefits at farm, catchment or land use level.

Furthermore, for the case study catchments, no analysis has been carried out to determine whether the freshwater target limits are consistent with New Zealand’s existing commitments to Paris Agreement. In the case of Te Waihora specifically, where high water contamination of the lake has led ECan to ask central government to exclude the lake from national standards, under the Zone Implementation Plan, the allowable threshold of 4500t of nitrogen leaching into the lake annually has been lifted to 4800t. Such increase in one part of New Zealand would in principle involve greater interventions to reduce emissions somewhere else. The issues of equity and transferring of burden becomes ever more relevant.⁴²

There is interest by regional councils and private sector in joint and synergic solutions – especially for water-carbon given the NPS FW and the upcoming Zero Carbon Bill. Continuing with silo approaches not only will be more resource intensive but it can also miss opportunities for innovative solutions in land use and create inequity.

From single value to ‘values’ in limits setting

Finding #21 Managing land and farming to a set of ‘values’ and not just single issue.

Currently there is limited or no ability to credibly and efficiently assess land use choices across the full range of impacts. For example, biodiversity impacts, climate change impacts, contaminant discharges and water use. A focus on individual attributes of contaminant discharge as a proxy for measuring intensification is often adopted in the absence of more sophisticated tools for defining intensification across a range of attributes. Some attributes are currently easier to measure, for example nitrogen.

⁴⁰ Zhao, R., Liu, Y., Tian, M., Ding, M., Cao, L., Zhang, Z., Chuai, X., Xiao, L. and Yao, L., 2018. Impacts of water and land resources exploitation on agricultural carbon emissions: The water-land-energy-carbon nexus. Land use policy, 72, pp.480-492.

⁴¹ See for example the study A national riparian restoration programme in New Zealand: Is it value for money? Landcare Research (2016).

⁴² PCE (2018). A Zero Carbon Act for New Zealand: Revisiting Stepping stones to Paris and beyond, Parliamentary Commissioner for the Environment.

“Having defined realistic long-term community water quality outcomes (for a holistic approach air needs to be included) it will then be necessary to have in place mechanisms that allow simple land use changes. Hence the need for a single integrated water and land policy. Good ongoing science is imperative to ensure new land use options don't create different problems.” Interviewee, professional service sector

More full cost accounting would require inclusion of biodiversity measures, GHG emissions, accelerated erosion, bacterial and phosphorous discharges. Other effects on temperature, oxygenation, ecosystem health and natural character are also required. Multi-factorial analyses that can identify intensification based on the effects on values for freshwater will become more important over time.

At the same time, the pursuit of sustainability in a value chain means operating to a wide set of values that often translates into performance standards, or conversely in limits (environmental, social, cultural).⁴³ Products that are sourced sustainably i.e. do not damage the environment, people or animals, are fresh and nutritious and possibly sourced locally are a focus for millennials and generation Z⁴⁴ – the future consumers of New Zealand products. The commerce mantra of ‘price, benefit, value’ has become ‘price, benefit, **values**, where values include fair trade, animal welfare, healthy soil, human rights, no environmental impact, climate and birds friendly and so on.

There is a need to connect what happens on the land and the performance achieved into the broader sustainable development context. Private sector and policy makers are missing the tools to make more holistic decisions and set limits for continuous improvement instead of minimum performance and be able to communicate their performance to the market. Focusing on the connection between farming – food - environment – health or the soil health – human health interface are areas of growth and transformative innovation that the Challenge could target.

The Challenge is well positioned to develop new knowledge and tools in this area.

“Good ongoing science is imperative to ensure new land use options don't create different problems”.
Interviewee

Finding #22 The (environmental) limits set in New Zealand context (and specifically freshwater limits) do not translate easily into credentials in the value chain.

This is directly linked to the finding above. In the case studies for this Think Piece and from scanning other catchments in New Zealand, it is apparent that the environmental outcome or performance achieved in terms of sustainable land use is not easily communicable to consumers and markets. The Taupo Beef is an exception to this as the business was able to receive a water quality endorsement from WRC⁴⁵ which was helpful for the producer in the market.

There is an opportunity and need to explore mechanism to better align rules and regulations with market demand for sustainability and reduce transaction costs for land owners. The Challenge can focus more strategically on this, including with a view to on-farm sustainability assessments that are consistent to regional regulations/limits setting but also meet supply chain requirements and certification.

⁴³ It should be noted that interviewees have pointed out that product quality in traditional sense still needs to be upheld in order to access/demand premiums related to sustainability in value chain.

⁴⁴ See for example the Nielsen *Global Health and Wellness Report 2015* or Colmar Brunton' *Better Futures Report 2017*.

⁴⁵ This may not have been possible if the producer was not based in a catchment operating under a nutrient cap and trade; likewise, there is no certainty that such arrangement can be applied in other catchments since this was a localised solution.

“Industry needs to be open and regularly report to the community on the impacts of their activity”
Interviewee, environmental NGOs

Question 3

In what ways might a Te Ao Māori perspective inform this discussion? Does Māori land ownership in a kaitiakitanga framework change the way limit-setting policy might impact on land use practice?

Context

As already discussed earlier in this report, Te Ao Māori view of the environment delivers a number of insights for a limit-setting policy:

- Māori values are interconnected, so as well as requiring kaitiakitanga, or guardianship of the land, there is also a need for rangatiratanga, or the appropriate authority to care for the land.
- Knowledge of interconnections, interdependencies, and the resultant cascading impact of actions on an ecosystem.
- Long-term intergenerational perspective that restricts the short-term financial gain focus.

Finding #23 The inter-generational perspective and the holistic & systems thinking of Te Ao Māori perspective offer insights into change and transition to sustainable land use over long horizons

A thread throughout interviews and case study analysis is that a Te Ao Māori perspective cuts across silos and introduces an inter-generational and systems’ perspective to increasing the mauri of the land and water. Existing challenges notwithstanding (see the next finding), a broader positioning (all four well-beings) and long-term outlook offers insights and inspiration for transition pathways for sustainable land use for New Zealand as a whole.

There is opportunity for the Challenge to develop and test systems and tools that can operationalise this view of the world at catchment and farm level.

Finding #24 The Māori land ownership in a kaitiakitanga framework can change the way limit-setting policy might impact on land use practice

The case studies in this think piece show that it is possible to change land use practice when Maori accumulate human, social, and financial capital, and when value chain opportunities are developed and aligned with Maori values and environmental ethics. However, this is not generally the case around New Zealand and learnings and insights from examples like Miraka can help with understanding how barriers can be overcome and new models developed.

There is an opportunity for the Challenge to explore more not just how value is captured in the value chain (and motivates sustainable land use) but also how to develop new value chains that recognise, develop and capture values for Maori owned land, enabling broader development strategies not driven by capital gain alone. Linked to this aspect, because of the fact that Maori owned land cannot be used as collateral for financing (since it cannot be sold in case the venture fails), investors are lending to Maori trusts on the basis of strong cash flows, robust management and capability. This unique constraint that Maori land owners are faced with gives rise to different business and value

chain models that require better examination and replication. A good example of a Maori incorporation that has overcome constraints presented by Maori land ownership is Miraka, which is explored below.

Miraka

- Miraka is a dairy processor with values founded on the cultural beliefs of its owners. It is owned by Māori supplier-shareholders, meaning that they have the relevant authority over most of the supply chain.
- As Miraka explain “These values guide our business decisions and underpin the interconnected relationships we have with each other and with the natural world that sustains and nourishes our well-being”.⁴⁶
- Miraka is a signatory to the Sustainable Dairying: Water Accord, they use renewable geothermal energy and compost waste products from the drying process.
- Miraka incentivise their supplying farmers to achieving higher environmental outcomes.⁴⁷
- Miraka has been praised for both its focus on sustainability and its capacity to add premium to its product.⁴⁸

Unlike Maori land owners, post-settlement iwi possess land that is not constrained by the same regulations. Such entities, as outlined previously, possess significant social, economic, political, and financial capital, and attempt to operate their commercial land use activities within a Kaitiaki framework.

An example of this is Ngai Tahu Farming, which is outlined below:

Ngāi Tahu Farming

- Ngāi Tahu Farming (NTF) is a subsidiary of Ngāi Tahu Holdings Corporation (NTHC) and operates 5,000ha of irrigated dairying land in the region.⁴⁹
- NTF operates in Ngāi Tahu’s takiwā (traditional area) and therefore has a degree of authority regarding the RMA, as well as a several roles regarding Te Waihora.
- NTF explains “As a Ngāi Tahu company, we understand that it is our responsibility to care for the lands, plants, and animals impacted by our activities. We believe ‘if we look after them, they, in turn, will look after us’”.⁵⁰
- NTF operates using a quadruple bottom line: economic, social and environmental and cultural.⁵¹

⁴⁶ <https://www.miraka.co.nz/who-are-we-.html>

⁴⁷ <https://www.nbr.co.nz/article/dairy-company-miraka-offers-20c-bonus-suppliers-under-farming-excellence-scheme-b-182764>

⁴⁸ <https://www.radionz.co.nz/national/programmes/ninetoonoon/audio/2018666011/the-new-biological-economy-sustainability-economy-and-adding-value-to-primary-industry-commodities>

⁴⁹ <https://mahi.ngaitahu.iwi.nz/business-groups/ngai-tahu-farming>

⁵⁰ <https://ngaitahufarming.co.nz/land/>

⁵¹ <https://www.stuff.co.nz/business/farming/77761067/ngai-tahu-looks-beyond-the-horizon>

- As well as the ECan required Overseer programme, NTF have also set up soil moisture metres and a nitrogen monitoring system on their farms to ensure minimal environmental impact.⁵²
- Mana whenua working parties have also made NTF following certain rules including: no palm kernel extract, no dead-cow holes, water use must be optimised and each farm must forge sustainability.⁵³
- NTF has won awards for the sustainability of its operations.⁵⁴

Finding #25 Māori greatly differ in their ability to apply their perspective and views regarding resource management in practice

A number of post settlement iwi and mature Māori land incorporations possess significant asset bases and political influence within their regions based upon Treaty of Waitangi co-governing arrangements. However, there are also many smaller and pre-settlement, or early settlement, hapu and iwi, and Māori landowners, that are addressing ongoing economic and institutional impacts of colonisation. Such groups may possess few assets and often lack the capacity and capability to engage and respond to broader land governance considerations. Consequently, Māori may be considered to exist on a spectrum between those that possess strong financial, social, human, and political capital, through to those that lack these capitals, but may be strong in their cultural capital.

Tribal and Māori land owning organisations that tend to have low levels of capital are confronted with the following constraints:

- Access to investment capital and management decision processes that allow for the involvement of multiple owners. In some cases, land returned under Treaty Settlement requires significant investment to achieve a high value use.
- The un-resolved aspect of rights to access and use water. This technically alienates the land from the owners, in respect to exercise of kaitiakitanga and rangatiratanga.
- Significant resource management related obstacles for development proposals⁵⁵; resulting in many Māori agri-businesses looking outside historical development opportunities to establish low impact, high value returns.
- These developments do rely on continued revenue from existing operations and there is a strong focus on strengthening the returns from these existing operations. This is causing considerable changes in the way Māori owned land is managed.
- One significant gap is in the provision of sound and independent advice regarding natural resource allocation processes and how best to exercise manawhenua. Another relates to advisory and extension services that can chart a path to conversion from lower to higher value production systems.

Finding #26 The wider economic, investment and institutional framework in which iwi operates puts pressure on exercising kaitiakitanga and manawhenua

⁵² Chalmers, H. (2014, October 30) Ngāi Tahu Farming replaces forestry with 14,000 cows at Eyrewell. *Stuff*. Retrieved from <https://www.stuff.co.nz/business/farming/108049548/ngai-tahu-farming-replaces-forestry-with-14000-cows-at-eyrewell>

⁵³ Rural News Group. (2016). Standards set high and obtained. *Rural News Group*. Retrieved from <https://www.ruralnewsgroup.co.nz/rural-news/rural-management/standards-set-high-and-obtained>

⁵⁴ https://ngaitahu.iwi.nz/our_stories/ngai-tahu-farming-wins-water-quality-award/

⁵⁵ Considerable constraints can exist for example due to the presence of outstanding landscape or natural feature designations and / or water quantity and quality constraints.

Land use outcomes more broadly, including the ability to exercise kaitiakitanga and manawhenua, are influenced and limited by the complexities of the policy setting and the nexus of interests between central government economic planning policies (e.g. irrigation infrastructure, export growth targets), private investment policies, and the farming systems approach of bank managers and farm consultants. Interventions that may cause industry to fail (lose economic opportunity) are therefore to be avoided.

The challenge could contribute to addressing this by exploring feasibility analyses to transition and 'de-risk' the wholesale shift to higher-value sustainable production across different industries for public and private investors.

"Every day of the week I'd attach the rights to water to land ... and often when we need water, the Council is simply telling us there is no water. if we forget what colour or culture we are, as a kiwi I believe we should be putting water on our most productive land ... not being able to get water for development is a technical alienation of land". Interviewee, iwi

Finding #27 Knowledge and capacity issues slow the uptake of development opportunities within environmental, social and cultural limits.

There is no doubt that the capital exists to encourage growth in Māori agribusiness. However, there are significant structural and capacity issues that slow uptake of development opportunities – particularly for Maori land owners and smaller iwi that do not have the appropriate capability or resources to invest in developing such capability.

One significant gap in operationalising Te Ao Māori view of the world is lack of knowledge, tools and sound advice regarding natural capital management, including natural resource allocation processes and how best to exercise manawhenua at relevant scale. This is a challenge that applies for non-Māori as well but it is more stringent for iwi because of the tension to uphold environmental values as per iwi members demand versus the expectation to return a profit. Another relates to the availability of trusted expert advisory services that can chart a path to conversion from lower to higher value production systems that align with Maori values and aspirations.

To address this, the Challenge could pursue much broader partnerships with iwi (specifically with individual land owners, farmers and farm advisers, and small-medium sized enterprises who have limited resources and capability/capacity), resourcing and supporting their participation in science design, implementation and application.

3 NEW RESEARCH QUESTIONS AND OPPORTUNITIES FOR THE CHALLENGE

In making the recommendations below, the aim is to provide some new ideas for research that address the longer-term shifts required in agriculture (food and fibre) to achieve the environmental expectations of New Zealanders with a commensurate development of high value chains – while also providing some answers to the more immediate knowledge needs of stakeholders.

Interviews demonstrated there are many potential beneficiaries of research outcomes that are not being fully engaged by the Challenge, with indirect but significant influence on land use. This includes the investment and finance sector and tourism, and some of the recommendations recognise their needs and influence.

The last area of recommendations is about the opportunities for the Challenge to focus more on the uptake of research and the synergies to other National Science Challenges – recognising that the challenges in agriculture and food system are extremely complex and requires a search for solutions developed from a systems-thinking perspective.

The capability currently available to the Challenge was not considered when making these recommendations. It is assumed that if new capability is needed, the Challenge can secure it. Many of the recommendations are interconnected.

At this point there are no platforms in New Zealand that address agriculture and the food system – this is the opportunity for the Challenge to take!

OLW theory of change: new positioning

The current ToC is that “the value chain holds the key to driving shifts to land uses and land use practices that will achieve sustainable outcomes”.

Recognising the need to focus on the wider agriculture and food system, we suggest consideration be given to broadening the current goal of the challenge from: “To enhance primary sector production and productivity while maintaining and improving our land and water quality for future generations.” along the lines of: “To transform our food and farming and build resilient landscapes for future generations”.

Such an approach recognises that the value chain concept is undergoing transformation into a value network or web that can underpin the transformation of the food and farming systems to build resilient landscapes for future generations.

New Research Questions

How can transformation in food and farming, and the related societal outcomes and impacts, can be generated more efficiently and effectively?

What possible models exist for expressing rights and interests to freshwater use in a manner that reflects Te Ao Māori and allows for continued innovation in land development?

Given that the public and private sectors are developing natural resource accounting systems; what are the standards and criteria to assess their acceptability for allocating natural resources? What

criteria should investors and water managers use to identify freshwater and climate change related risk?

How can the reputation of the “value chain” proposition be protected from poor regulatory performance by other businesses?

How can collaboration between public and private science providers be incentivised?

What indicators can be used to determine the naturalness of ecosystem health of farm systems or to describe healthy and functioning biodiversity in farming landscapes? How can this be applied to the RMA 1991 and the regulatory systems and processes?

What would be the implications and options for land use change in New Zealand as result of potential diet changes? What new investment in knowledge, innovation and infrastructure is needed to respond to changing food demands?

How can the investment and finance sector support adaptation to climate change, build resilience and achieve additional benefits for people and environment?

How can agri-business and tourism sectors, as vital parts of the economy, continue to improve the value proposition for New Zealand without resource conflict?

What is the potential of food economies and localized food production and consumption to accelerate transition to low-input – high value primary sector?

What incentives within a value chain could address the equitable transfer of economic value from those parts of the chain that add-value to those parts that cause significant environmental impact?

Research recommendations

Foresight research: planning for 2050

Recommendation #1 Exploring 2050 ‘baseline’ for land and water – taking a food system perspective
Current research and science agendas have short timeframes and seek outcomes a few years ahead, reflective of government, business and investment cycles.

However, there are a number of exceptions: the Zero Carbon Bill which aims for a carbon neutral New Zealand by 2050 through a bipartisan support; some of the iwi trusts have now put in place environmental plans that go 100 or even 1000 years out.⁵⁶ The Crown is also investing into an overarching goal – forests are rid of the devastating impacts of stoats, rats and possums by 2050.⁵⁷

The suggestion is to set up a 2050 research working group that can look across research disciplines and science challenges, societal landscape and megatrends to develop a new vision for food and farming in New Zealand – with the express purpose to sell this vision to farmers and communicate transition to the “2050 baseline” or plausible 2050 futures - where New Zealand wants to be (linked to health and wellbeing, resilience, living in harmony with nature etc).

⁵⁶ <http://www.ngatikuri.iwi.nz/wp-content/uploads/2018/11/NKTB-2018-Annual-Report.pdf>

⁵⁷ Predator Free 2050 Ltd, a charity to direct Crown investment into an overarching goal – forests rid of the devastating impacts of stoats, rats and possums by 2050.

This is an effort in deep thinking and dealing with uncertainty, imagination and communication – to tell a story about a future that is desirable and achievable. This is about taking New Zealand farmers and land owners on a journey into the future that is achievable if we start making changes now.

Recommendation #2 **New Zealand response to megatrends and transition in a disruptive world**

Pressure on agriculture and food, and natural assets management will be driven by a range of global megatrends such as emerging technologies, shift in diets, automation, urbanisation and factory production of food.

There is a need to explore and build scenarios on the impact of these trends on land use and land condition, and assess the implications for farming and well-being. Collaborations with the other National Science Challenges (see recommendations under Enhancing the Impact of the Challenge) and government agency support would be necessary.

Knowledge gaps and implementation toolbox

Recommendation #3 **The water, carbon and land use nexus**

The interface between land use and water limits (quantity, availability), and climate mitigation and adaptation are an area of immediate interest and was highlighted by most stakeholders consulted for this think piece. The current focus in the Challenge (“The implications of climate change for water quality contaminant delivery”) is insufficient in the face of tremendous upcoming regulatory pressure in New Zealand as well as overseas to reduce emissions, including the impact of climate on land use and food production, social inferences and other issues.

There needs to be a research co-design process with the goal to better connect research on implementing the NPS FW and the upcoming Zero Carbon Bill at a minimum, and potentially focusing on the proposed NPS for Biodiversity too.

Specific issues that can be explored include:

- Assessments and (decision-making) tools at farm and catchment level regarding water limits (quantity, allocation) and GHG emissions dynamic. This includes assessment of proposed GMPs for freshwater improvements from a GHG emissions and carbon sequestration perspective, including with a view to alternative tools to Overseer application.⁵⁸
- Spatial catchment models and scenarios for water and carbon systems with a view to assess changes, impacts and implications of policy.
- Assess the trade-offs and potential for burden shifting between water and carbon outcomes from land use to other sectors, or between regions or catchments.

Recommendation #4 **Natural Capital: connecting nature with wellbeing**

Natural capital and natural resource accounting are concepts used in policy with increasing frequency as resources become scarce and well-being is affected. At the catchment scale, many regions have started to explore and implement natural capital accounting systems to develop scenarios for policy making (outcomes, implementation) and investment. There is specific interest in relation to allocation quality and quantity under NPS FW as well as the Zero Carbon Bill. Targeted research is still needed in relation to:

- Decision support tools and methodologies at different scale (spatial, temporal & farm, catchment, region) and their connection to New Zealand’s systems of economic-environmental analysis to understand conditions and trends. This can include development of

⁵⁸ See the recently published independent review about Overseer’s fitness for purpose in a regulatory context: <https://www.pce.parliament.nz/media/196493/overseer-and-regulatory-oversight-final-report-web.pdf>, accessed on 14 December 2018.

natural capital indicators and metrics (linked to the Challenge’s “Creating a biosphere data commons for NZ where data are held across multiple institutions with common objectives and interests”).

- Modelling and testing of methods and tools with a view to getting dynamic feedback to decrease in knowledge gaps and to assist with timely intervention for improved environmental and economic outcomes, including:
 - Assessment of risks and benefits to priority sector (agriculture, forestry etc).
 - Guidance for investment decisions by public and private sector.
 - Exploring the potential for nature-based solutions at catchment scale (for example improved water storage, water quality and biodiversity and resilience to climate change of flood protection, drainage and irrigation infrastructure).
 - To guide risk-based regulatory intervention and performance management for potential investors, industry and business.
- Objectives and limits setting, monitoring, reporting and compliance for NPS FW but also central government investments like PGF, Freshwater Fund and future policies.
- The link between freshwater and climate related objectives and limit setting; and monitoring, reporting and compliance for evaluating implementation of the NPS FW and guiding central government investments such as Provincial Growth Fund or the Freshwater Fund and infrastructure development funding.
- Defining “intensification”, including guidance is required on what constitutes a breach of natural resource limits. Reductionist approaches focussing on a single attribute (for example nitrogen) can be a poor proxy for intensification. There is significant work to be done to assess multi-dimension footprints within their spatial location to establish whether an activity can maintain or improve natural resource objectives. In many respects this relates directly to a sound and scientifically valid definition of “intensification”.

Recommendation #5 Economic instruments for water, carbon and land use nexus

The need for greater use of appropriate and innovative economic instruments to assist with transition to, and ‘de-risking’ the shift to higher-value sustainable production across different industries is of interest to public and private stakeholders. below are some suggestions that the Challenge may consider:

- Explore market-based mechanisms for bundled services (water provision and storage, purification, flood control, carbon sequestration) based on risk where either the ‘polluter pays’ or ‘beneficiary pays’ approach. Exploration should consider how funding can be collected and distributed and what economies exist at differing collection points.
- Explore payments for ecosystem services (erosion control or water purification, biodiversity) in the context of urban – rural interface.
- Explore incentives schemes for farmers to deliver joint carbon and water outcomes.
- Explore and evaluate green bonds or other funding mechanism to help channel investment to accelerate sustainable land use outcomes, including policy (water, carbon) implementation.

Recommendation #6 Understanding externalities in food and fibre production

The Challenge could develop and apply a comprehensive evaluation framework (see for instance TEEBAgri-food) to understand the hidden costs and benefits of food and fibre production and consumption in New Zealand, knowledge gaps and uncertainties. A focus on externalities direct linkages with research requirements to determine the true value of regenerative agriculture and

natural capital – and it is also a pre-condition to more accurately generate and share value in value chains.

The results would support engagement with industry and government in order to:

- Strengthen the discipline of true cost accounting to enable industry and companies to comprehensively assess the true cost and value of their business and value chain
- Develop and test risk management tools for industry that reflect externalities from the farm gate to the consumer.
- Work on implementing true cost accounting with New Zealand exporters to be leaders or at least Fast Followers in this field.
- Support more consistent compliance and enforcement of environmental limits by regulatory authorities.

Further to this, the Challenge can build on externality insights to also assist with:

- Clarification of the rights and responsibilities for businesses in relation to biodiversity, climate change and freshwater .
- Examining how the regulatory functions of Councils could be most effectively implemented, ensuring that breaches and exceedances of environmental limits attract appropriate intervention.
- How well equipped is the Resource Management Act 1991 (and associated regulatory processes) to resolve this issue? Policy advisors and decision makers would benefit from a critical evaluation of alternative approaches to using the current legislative structure. It is also potentially useful to review the functions of the NZ EPA to see if there are reforms that could aid the implementation of national direction. Such reforms should also seek to support the efforts of regional and local government to manage environmental risk and how to share enforcement functions between central and local government to provide more consistency and greater capacity.

Unlocking the potential of regenerative agriculture for New Zealand farmers and consumers

Recommendation #7 Quantifying the value proposition of regenerative agriculture

Regenerative agriculture as a system of farming principles and practices that helps increase biodiversity, enhances ecosystem services like capture of carbon in soil, erosion control, pollination but also has health benefits of products represents a much more holistic framework for sustainable farm systems and agro-ecology. Regenerative agriculture as a system has not been comprehensively analysed by the New Zealand research community (from a bio-physical, social, cultural or economic perspective) despite interest from farmers and land owners and on the ground experiments in New Zealand. With the introduction of dung beetles, catchment groups are interested in monitoring the effects of this intervention on water quality as well as soil quality and nutrient cycling outcomes. There is need to understand the transformation over time, accounting for uncertainty, recognising deep uncertainty, and change our “value case” to being more holistic.

The Challenge has indicated in its strategy for 2019-onwards on the intention to set up a new research project (or programme) to “Quantifying the environmental, economic, social and cultural benefits of regenerative agriculture”.

It is important that this project is set up as a co-inquiry with groups and individuals that have an interest and want to be engaged in progressing this area, including health and nutrition

researchers/stakeholder (“one health”) – beyond currently identified priority stakeholders. International collaboration (especially US, where piloting of a regenerative organic standard is ongoing – see reference earlier in the report)) should be thought to build on existing knowledge. Because of the alignment between regenerative agriculture with Te Ao Māori, there is strong interest from, and involvement of iwi/maori trusts is critical.

Recommendation #8 Soil health – human health connection

Healthy soils contribute to a range of ecosystem functions like water and air quality, plant and animal productivity, biodiversity and habitat and also human health. Within the ‘one-health’ approach, there is strong interest across stakeholders and farmers to improve the understanding of the connections between soil health (and the farming practices that promote it) and human health. Such connections may occur through the impact of land management and crop and livestock production on the one hand and the parameters in food processing and production nutrition quality, food safety and the human microbiome.

The Challenge can make an important contribution to public good research and interdisciplinary collaboration by exploring a research agenda focused on the soil health – human health nexus and the farming and land management practices that that deliver dual outcomes.

Recommendation #9 Pathways to markets and consumers

The need to address the challenges of (regenerative) agricultural research and extension notwithstanding⁵⁹, exploring pathways to markets and consumers is an important area to examine and explore to facilitate the capture of value from farmer to consumer.

Current value chain set ups in New Zealand – particularly for sectors like dairy – means that products grown in specific conditions do not have pathways to markets and end up going in the joint product pools. Research is needed to explore alternative points to market (including a focus on New Zealand consumers to capture health benefits at home), the credence attributes and how to communicate them, including the possibility of premiums. Synergies with the development of the food movement in New Zealand should be thought as a way to explore value chain development. See recommendations under ‘Generating investable propositions for sustainable land use’ or ‘More sharing of value, better environmental outcomes’ for potential synergies.

Generating investable propositions for sustainable land use through impact investment

New Zealand farmers and landowners need to earn their licence to operate by decreasing impacts on water and the ecosystem as well as reducing carbon emissions while also being faced with the challenge of biosecurity incursions. So far, meaningful change has been prevented, even when policy pressure increases, due to the high leverage at the farm level, concerns about capital gain and a lack of sufficient knowledge and skills to start the transformation towards sustainable land use and ecological regeneration.

Below are research recommendations linked to impact investment.

Recommendation #10 Leveraging productive catchments/landscapes to achieve transformation at scale

This represents stretch research on the current focus of the Challenge on Future Landscapes. In broad terms, the investment opportunities at catchment or landscape level are generated by deploying capital to transition existing farmland to regenerative land use that achieves superior environmental performance and resilience, reduced exposure to rising input costs and higher prices for production. The opportunity is to combine planned and existing biophysical research (linked to natural capital,

⁵⁹ Turner, J. *et al* (2014). Challenges to effective interaction in the New Zealand agricultural research and extension system: an innovation systems analysis. *Extension Farming Systems Journal* volume 9 number 1

ecosystem services) and targets and science on reduction of environmental loads with land use and value chain economics to create investable propositions for sustainable land use and transformation at scale.

Catchments (where environmental pressure is often quantified) and productive landscapes (where ecosystems and value chain meet), and the interface between water quality and carbon goals, present us with “hooks” for investment. The tourism sector and the potential of local food economies in selected regions in New Zealand with significant visitor numbers provide opportunity for building local economies through local food production and consumption (ANZ 2018). Short value chain linked to local food economies can be a solution in itself (for instance, fresh milk or meat), or this is a stepping stone towards a pathway to export markets (see representation below).

Fundamental data and knowledge that the Challenge is developing can be applied in this context (see suggestions in relation to research needs).

Generating investable propositions

Leveraging catchments/landscape and value chains to achieve transformation at scale

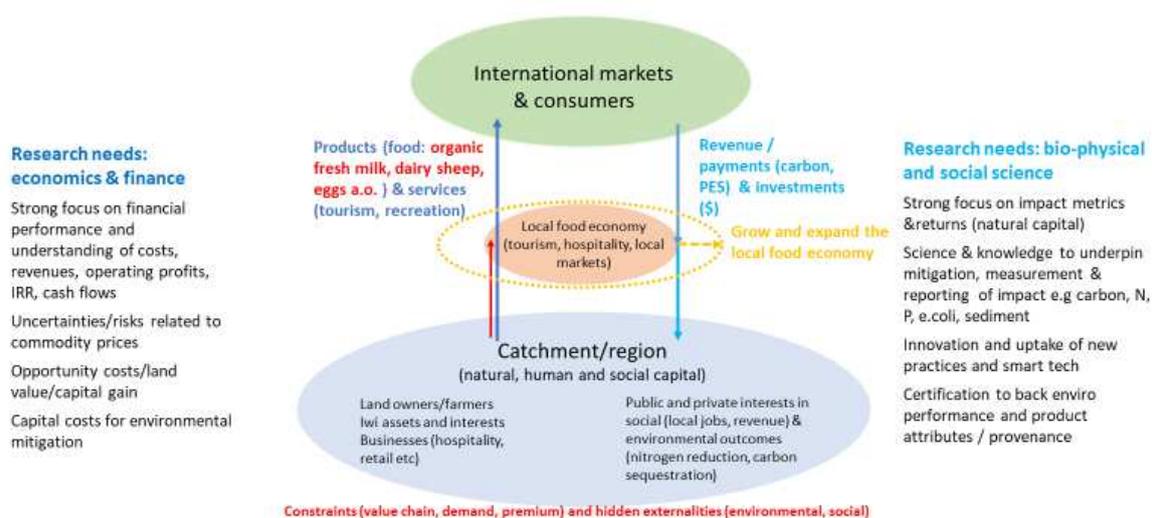


Figure 1: Generating investable propositions using catchments/landscapes as springboards (source: Envirostrat)

An example of investment proposition at scale is the Upper Waipā catchment where feasibility and due diligence work shows that significant environmental improvements can be achieved through targeted land use change combined with premiumization of pastoral production (in this case through conversion to organic production of dairy land). To bring this to scale, a hybrid bond is being proposed as an innovative investment opportunity to materially improve water quality in the Waipā and Waikato Rivers.⁶⁰ More details are included in the case study to this think piece.

Recommendation #11 New business and investment models to achieve ‘impact’

Linked to the research recommendation above as well as the ongoing work on Value Chains by the Challenge is the need to explore new business and investment models to attract appropriate investment in transformative change in food and farming in New Zealand. New business models are already emerging, especially by Māori Trusts that are by-passing traditional supply chains to bring products and services to the market. There are numerous entrepreneurs in New Zealand that want to generate shared value(s) but they do not have sufficient knowledge or insights into bio-physical pressures, land use economics. Radical transformation and innovation require using all drivers of entry to achieve change, including finance and investment.

⁶⁰ <https://waikatoriver.org.nz/wp-content/uploads/2018/11/Impact-Investment-Bonds.pdf>

Developing and testing of landscape level investment models and mixed land use enterprise, based on sound ecological-economic analysis, is a strong opportunity for the Challenge to demonstrate the value of, and generate uptake of research.

More sharing of value, better environmental outcomes

For OLW, improving access of New Zealand's food and fibre products to high margin market segments could achieve better environmental outcomes if increased value can be captured and shared by producers. These high margin market segments are defined by product and process standards⁶¹. However, although attaining many of these standards requires coordination along a value chain, the production end of the chain often imparts environmental impacts that are disproportionate to the associated added value⁶². Here, determining how value should be shared equitably poses a major dilemma for such a value chain. More so for the production end of the chain, where a lower proportion of value is added relative to the R&D, branding, distribution, marketing and retail functions⁶³. For primary sector food and fibre chains, these intangible assets are becoming more valuable than the tangible assets of land, water and stock⁶⁴. At the same time, the "license to operate" requirement for the New Zealand primary sector will increasingly require a proportion of the value captured by producers to be 'shared' by investing in environmental and social impacts in New Zealand.

Recommendation #12 Gap analysis of product and process standard

Research priorities need to consider a gap analysis of the product and process standards required by high margin export market segments for a given food and fibre chain against the environmental impact of that same food and fibre chain on New Zealand's land and water resources. Some of the regulators, NGO's and Iwi interviewed during the Think Piece felt these offshore market standards were being used by value chains as a proxy for good environmental practices. However, without analysis, these practices may fall short of reducing environmental impacts in the New Zealand context. In this case, if used for promotional activities, these standards could be viewed as misleading consumers⁶⁵. This would build on the work undertaken in the "Matrix" project that sought to identify, then compare the economic, social, environmental and cultural drivers between New Zealand and off-shore markets⁶⁶. The proposed new work would be more explicate about the good management practices required to achieve reduced environmental impacts from a given food and fibre value chain on New Zealand's land and water resources. Consideration should be given to a full-cost environmental accounting approach

⁶¹ Kaplinsky, Raphael (2010). The role of standards in global value chains and their impact on economic and social upgrading. World Bank, 20pp.

⁶² Clift, R. and Wright, L., 2000. Relationships between environmental impacts and added value along the supply chain. *Technological Forecasting and Social Change*, 65(3), pp.281-295.

⁶³ Aggarwal, S., 2017. Smile curve and its linkages with global value chains. *Journal of Economics Bibliography*, 4(3), pp.278-286.

⁶⁴ Vorley, B., 2001. The chains of agriculture: sustainability and the restructuring of agri-food markets. Proceeding of the IIED World Summit, 20pp.

⁶⁵ McEachern, M.G. and Schroeder, M.J., 2004. Integrating the voice of the consumer within the value chain: a focus on value-based labelling communications in the fresh-meat sector. *Journal of Consumer Marketing*, 21(7), pp.497-509.

⁶⁶ Saunders *et al*, 2016. Driving Better Programme Investment and Accelerating Challenge Impact Through a Prioritisation Matrix of International and National Perspectives. Our Land and Water National Science Challenge, 79pp.

when assessing the impacts of the current value chain⁶⁷. Although challenging, the approach can provide critical insights for land use managers and stakeholders in the application of these methods, including opportunities to negotiate from a more informed position regarding sustainable practices⁶⁸.

Recommendation #13 Creating competitive advantage by raising the bar on overseas standards

In relation to environmental impacts, there is value in integrating New Zealand's major food and fibre chains into global input output models that are based on the agricultural land and freshwater use that is embodied in global value chains⁶⁹. Such an approach enables benchmarking, as well as identifies opportunities to create 'plus' standards that meet as well as exceed the current high value market segment standards. Again, some of the regulators, NGO's and Iwi interviewed during the think piece, including some of the industry interviewees, felt offshore market standards could be improved on to give New Zealand food and value chains a verifiable competitive advantage.

Recommendation #14 Value creation and distribution in value chain

Thirdly, there is a need for research on better understanding how value is created and shared within value chains. In some cases, the act of sharing information between value chain participants creates additional value⁷⁰. This research also needs to include a fuller accounting of costs, as well as how these costs can equitably be communicated and shared alongside the value-added components (see earlier recommendation). To date, OLW has provided strong evidence that as a value chain becomes more collaborative, the greater the value can be captured from desirable credence attributes associated with the production systems^{71,72}. However, without balancing this increase in value capture and sharing against the full-cost environmental accounting data, it is not clear if the value chain is in a surplus or deficit regarding the economic resources available to offset its environmental impacts. Deficit is more likely if those parts of the chain associated with the greatest environmental impact have a limited ability to share value from the broader chain.

Recommendation #15 Environmental resource constraints in value chains

Based on Figure 4, there is a need to understand the historic, current and future states of New Zealand's major food and fibre chains in relation to the degree of environmental resource constraint they are operating under, as well as the degree of their value chain integration. This dynamic optimisation of ecosystem service value chains is linked to the Natural Capital recommendation and would build on the current OLW project on "Integrating Value Chains" that is using case studies to determine how integrated various value chains are using criteria derived from the academic literature.

⁶⁷ Epstein, M.J., 2018. *Making sustainability work: Best practices in managing and measuring corporate social, environmental and economic impacts*. Routledge.

⁶⁸ Herbohn, K., 2005. A full cost environmental accounting experiment. *Accounting, Organizations and Society*, 30(6), pp.519-536.

⁶⁹ Chen, B., Han, M.Y., Peng, K., Zhou, S.L., Shao, L., Wu, X.F., Wei, W.D., Liu, S.Y., Li, Z., Li, J.S. and Chen, G.Q., 2018. Global land-water nexus: agricultural land and freshwater use embodied in worldwide supply chains. *Science of the Total Environment*, 613, pp.931-943.

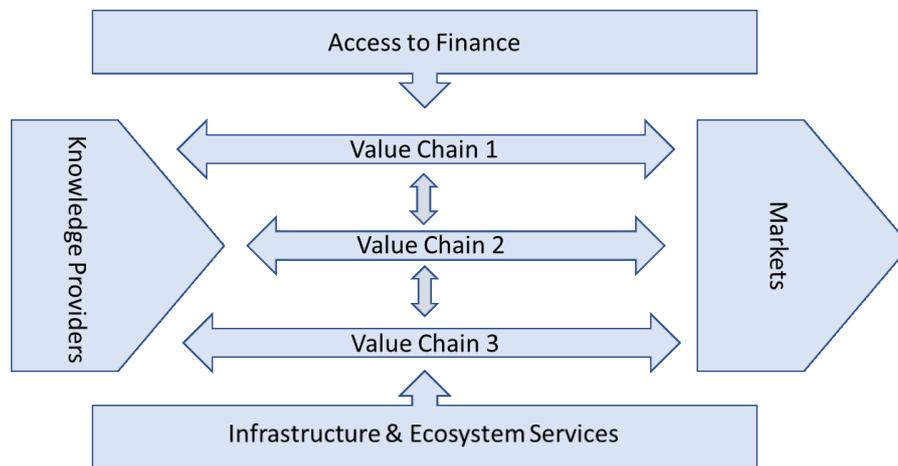
⁷⁰ Lee, H.L., So, K.C. and Tang, C.S., 2000. The value of information sharing in a two-level supply chain. *Management science*, 46(5), pp.626-643.

⁷¹ Saunders, Caroline M., Paul C. Dalziel, Mark MJ Wilson, Tiffany McIntyre, Hilton Collier, William H. Kaye-Blake, Alistair Mowat, Tava Olsen, and John D. Reid. "How value chains can share value and incentivise land use practices: a white paper." (2016).

⁷² Lees, N.J. and Saunders, C.M., 2015. *Maximising Export Returns (MER): Communicating New Zealand's Credence Attributes to International Consumers*. Agricultural Economics Research Unit, 65pp.

Value chain analysis will be critical in the proposed research of the past, present and future states as the source and location of value-adding within a value chain changes over time⁷³. Such analysis is essential as participants within the value chain need to continually weigh up the risks and benefits of any changes or actions taken⁷⁴. In addition, the actions of these chain participants may also depend on their experiences in another situation, location or different value chain⁷⁵. Extending the analysis to consider this behaviour will be critical in a New Zealand context given the close geographic proximity of different value chains, a diversity of small catchments with different environmental issues and differing local government regulation, as well as differing market standards.

Given the challenges of ensuring enough value within a value chain is reaching those parts of the chain creating the greatest environmental impacts, the value chain research should also consider the role of value networks, often shortened to value nets or webs, as an alternative means of achieving OWL's statutory challenge. In other parts of the economy, value chains are evolving into value networks to be more agile in response to changing market or societal pressures⁷⁶. Value chain analysis methods are still critical to identifying where value can be created, including service providers supplying supporting functions to a chain or network⁷⁷. For OLW, value networks recognise the pivotal role of the knowledge provider in supporting a cluster of aligned value chains, flanked by funders and infrastructure providers (Figure 2)⁷⁸.



⁷³ Kaplinsky, R., 2004. Spreading the gains from globalization: what can be learned from value-chain analysis?. *Problems of Economic Transition*, 47(2), pp.74-115.

⁷⁴ Ponte, S. and Ewert, J., 2009. Which way is "up" in upgrading? Trajectories of change in the value chain for South African wine. *World Development*, 37(10), pp.1637-1650.

⁷⁵ Villamayor-Tomas, S., Grundmann, P., Epstein, G., Evans, T. and Kimmich, C., 2015. The water-energy-food security nexus through the lenses of the value chain and the Institutional Analysis and Development frameworks. *Water Alternatives*, 8(1), pp.735-755.

⁷⁶ Allee, V., 2000. Reconfiguring the value network. *Journal of Business strategy*, 21(4), pp.36-39.

⁷⁷ Whitlock, D.D., Daigger, G.T. and McCoy, N., 2007. The future of sustainable water management: using a value chain analysis to achieve a zero waste society. *Proceedings of the Water Environment Federation*, 2007(16), pp.2672-2691.

⁷⁸ Jan-Maarten De Vet & John Huw Edwards & Matteo Bocci, 2017. "[Blue Growth and Smart Specialisation: How to catch maritime growth through 'Value Nets'](#)," [JRC Working Papers JRC100975](#), Joint Research Centre (Seville site).

Figure 2. A value network based on interconnected value chains, enterprises and enabling services (adapted from de Vet et al. 2016)⁷⁹

The value network concept separates the values of the network itself, such as the value of collaboration, from values “in” the network, such as credence values associated with a product or service⁸⁰. A network with the values “of” maintaining and improving high country land and water quality could seek out the knowledge providers needed to support the land use practices consistent with those values while at the same time creating value added products and services from values generated “in” the network.

Recommendation #16 Tools as enablers of sustainable value chains

Initially, sustainable intensification of New Zealand’s land and water resources has been the primary means of capturing the value associated with our food and fibre products. However, achieving sustainable intensification of New Zealand’s land and water resources continues to require land users and regulators having access to new tools and/or existing tools that are more available, effective or are more accessible. Traditionally, genetic improvement of productivity, resilience and quality traits of food and fibre products has been a major tool for enabling intensification⁸¹. Combined with precision application of inputs and demonstrated need, this has provided much of the sustainable intensification for food and fibre chains. Such approaches have enabled increased production with more efficient use of inputs, and lowered cost of production per unit of product. Research on understanding the potential for further sustainable intensification is needed, including the role of disruptive production systems, such as clean meat⁸².

To be more effective, a whole of value chain approach needs to be taken to determine where best tools should be developed and deployed, including the collaborations needed to effect further change in sustainable intensification. For example, to account for food and fibre wastage between production and end-use, additional land and water resources are required to ensure enough product is available meet market demands⁸³. Reducing these losses at each point in the chain requires significant coordination between chain participants as well as inputs from knowledge providers⁸⁴. Losses may occur due to factors up or downstream of where the losses are manifest. For example, preharvest factors affecting post-harvest losses or changes in market demand causing oversupply. Using this approach, producers can recover more of the value that would otherwise be lost with product wastage.

⁷⁹ Jan-Maarten De Vet & John Huw Edwards & Matteo Bocci, 2017. "Blue Growth and Smart Specialisation: How to catch maritime growth through 'Value Nets'," JRC Working Papers JRC100975, Joint Research Centre (Seville site).

⁸⁰ Block, D.R., Thompson, M., Euken, J., Liquori, T., Fear, F. and Baldwin, S., 2008. Engagement for transformation: Value webs for local food system development. *Agriculture and Human values*, 25(3), pp.379-388.

⁸¹ Chartres, C.J. and Noble, A., 2015. Sustainable intensification: overcoming land and water constraints on food production. *Food security*, 7(2), pp.235-245.

⁸² Specht, E.A., Welch, D.R., Clayton, E.M.R. and Lagally, C.D., 2018. Opportunities for applying biomedical production and manufacturing methods to the development of the clean meat industry. *Biochemical Engineering Journal*, 132, pp.161-168.

⁸³ Sun, S.K., Lu, Y.J., Gao, H., Jiang, T.T., Du, X.Y., Shen, T.X., Wu, P.T. and Wang, Y.B., 2018. Impacts of food wastage on water resources and environment in China. *Journal of Cleaner Production*, 185, pp.732-739.

⁸⁴ Ma, L., Qin, W., Garnett, T. and Zhang, F., 2015. Review on drivers, trends and emerging issues of the food wastage in China. *Frontiers of Agricultural Science and Engineering*.

Enhancing the impact of the Challenge

Recommendation #17 Collaboration and coordination: across National Sciences challenges, and at different scale

Having already identified the need to take a systems approach and wider the research lenses to do with agriculture and food system, this recommendation is about forging collaboration and transdisciplinary research with specific National Science challenges or other research platforms/organisations. The challenges and externalities of agriculture and the food system in New Zealand (and around the world) are complex and they require transdisciplinary co-inquiry to be able to assess linkages and interdependencies as well as achieve transformation. Externalities (which are both positive and negative) in the food system are spread across three areas that normally are addressed in silos (and are covered by the other National Science Challenges):

- People, Health & Nutrition (food sovereignty, farmer wellbeing, antibiotic resistance, diabetes, obesity, child under-nutrition) – see also the recommendation on Soil health - human health connection
- Ecosystem and environment (water, soils, carbon emissions, natural hazards)
- Agri-food system (technology, infrastructure, jobs, finance etc)

It is recommended that a co-inquiry process starts as part of existing engagement with relevant National Science Challenges, and possibly collaboration is secured with a view to a true cost accounting study or social capital assessment. The aim of this recommendation is not to define the research but rather highlight the importance of joint co-inquiry in pursuit of more holistic frameworks for change and transition.

Recommendation #18 Creating co-innovation spaces in which researchers and stakeholders especially farmers) work together

Farmers, landowners or rural consultants involved in the food and farming value chain are rarely involved in research projects that they have the possibility to shape or be involved in the design from the start through to assessment of outcomes. The Challenge is already focused on engagement with end user with a view to inform the research agenda. Many of such end users have themselves research capability and plans, and the resources to engage in science processes.

This recommendation is about creating a space where farmers themselves can test and experiment (a new practice, technology or product) or develop totally new approaches to environmental mitigation through collaboration and networking with researchers, other farmers and growers, rural consultants and farm advisors, entrepreneurs and even their investment advisors⁸⁵. This should not be industry constraint since solutions at catchment level depend on cross collaboration between dairy farmers and foresters and food manufacturers etc.

The Challenge could set up a research project fund on farmer (eco)innovation, which is nimble (not like an MPI investment tool) and innovation is pursued through collaboration and researcher support. This can be linked to any of the areas of research that the Challenge is pursuing, like novel farming systems or regenerative agriculture. Resourcing and supporting their participation in science is a direct way to remove barriers to engagement and seek more tailored solutions.

Recommendation #19 Mainstreaming the Challenge's research outcomes

Linked to the recommendation above, the current fluid context for agri-businesses (volatility and uncertainty in export markets, increasing regulatory pressure from environmental limits, climate

⁸⁵ Boyce, W., Srinivasan, M.S., Turner, J., Percy, H. and Fielke, S., 2018. Combining a cognitive framework and a co-innovation research strategy to address water use efficiency. *Rural Extension and Innovation Systems Journal*, 14(1), p.137.

impacts) appears to create a new environment in which farmers, landowners, agri-food manufacturers and investors are interested to understand, access and apply science and research. More specifically, in a form that would help them better manage their risks and identify innovation that could be applied to sustainable land use (not just in terms of good management practices but also diversification of land use). This has been a theme throughout the interviews where non-traditional research users like banking or consultants have expressed an interest for new research knowledge and tools in areas like natural capital, soils, biodiversity, water quality/availability - carbon. Rural consultants, specifically, appear to be a significant conduit for knowledge sharing (when and if they have it) for both farmers and banking and investment.

This interest in science and research presents an opportunity for the Challenge to think more tactically and strategically how to use dialogue and engagement to co-create knowledge for innovation in sustainable land use and 'translate' research in a way that it is applicable and easy to understand to maximise uptake. The ability to listen and interpret the ideas and needs of non-traditional research users and to communicate biophysical research and the implications in terms economics and finance (farm operational costs and profitability, revenue, cash flows, value chains) will be a key success factor. This will require not just a programme to 'push' the research out but the use of 'go to' researchers/ knowledge brokers / translator that know what science is available and where but also able to listen to the needs of end users in terms of application and innovation.

Recommendation #20 Building enduring partnerships with Maori

It is important to develop strong partnerships across the spectrum of Maori involved in the water and land sectors - including Whanau Trusts farming 100ha, runanga and marae committees with kaitiaki responsibilities, through to post-settlement iwi with large corporate land holdings. Each has unique circumstances, interests, perspectives, and capacity to engage. The process of building long-term engaging partnerships with Maori is well researched and understood. Generally speaking, it involves ensuring that Maori are not the research subjects but intimately involved in the co-creation of knowledge. Achieving this goal requires that Maori are resourced to participate successfully and that the benefits from the research accrue to the groups that are involved. This is typically referred to as Kaupapa Maori research.

When applied to the Our Land and Water Science challenge, it involves developing long-term relationships and corresponding investments with innovative, open, or leading Maori entities involved in the agricultural, forestry, and horticultural industries (across different enterprise scales) and Maori governing entities (at various scales) responsible for the resource management of land and water. Careful, open and transparent processes need to be used for selecting groups for which research investment is to be applied to ensure that the rich and diverse context of Maori land and water interests are captured.

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ANNEX 1 OLW positioning

OLW Conceptual Framework

The way land and water resources are used and managed will be transformed through three drivers based on achieving greater value in global markets, innovative resilient land and water use and building collaborative capacity. These drivers, along with research to connect them, form the three themes that the Challenge research addresses⁸⁶. The Challenge envisages a future where catchments contain mosaics of land uses that are more resilient, healthy and prosperous than today⁸⁷. In this future, all New Zealanders would share the economic, environmental, social and cultural value derived from a state of land and water resources that is aligned with their expectations.

In Australia, where the geographic scale and climate is more diverse, a similar Soil and Water challenge is located under Australia's Science and Research Priorities.⁸⁸ To inform better decision making, the focus is on building capacity for improved accuracy and precision in predicting change in Australia's critical soil and water assets. Effort will be placed on developing science capabilities and infrastructure in critical and emerging areas relating to soil and water. Also, the development of tools for primary producers to integrate and understand the data and information on soil and water is a future priority.

Comparing and contrasting land/soil and water challenges in both countries has highlighted that OLW is building science in value chain and collaborative capacity of society alongside the science of biophysical systems to enhance production and productivity while maintaining and improving land and water quality. In contrast, Australia is more heavily weighted to building the science base for understanding the biophysical environment in order to provide the knowledge and tools that enable decision makers to make more informed decisions that relate to soil and water management as well as use.

To put the OLW framework into context, resources are more limited and funders, as well as their constituents, have required greater clarity on how primary sector-based export growth can be achieved concurrently with the maintenance and enhancement of land and water resources. The Australian challenge is less explicit about who or how soil and water issues will be addressed. Ensuring soil and water-based decision makers are as well informed as possible about the current and future state of soil and water resources, including how they function, enables a wide range of options on the management, maintenance and enhancement of land and water resources to be considered.

A conceptual model for the OLW approach is shown in Figure 3. The OLW approach can also be reconceptualised around the market and societal pressures leading to structural change at the farm and industry scales⁸⁹ (Figure 4). Historically, market demand has been strong for food and fibre commodities that have been sourced for export from production sites when environmental resources were less constrained (A). Intensification and expansion of production has impacted on environmental resources to a level that has limited further production or led to societal pressures that have regulated production within environmental limits (A -> B). Where regulation costs affect the competitiveness or constrains the supply of the food and fibre commodities, production realigns to market signals for higher value and more differentiated products (B -> C). Reinvestment of improved margins in the implementation of audited good management practices and new technologies relieves, in part, environmental resource constraints and societal pressures (C -> D). This state can also be attained by competitive market pressures, such as over production, causing some food and fibre commodity

⁸⁶ <http://www.ourlandandwater.nz/>

⁸⁷ <http://www.ourlandandwater.nz/assets/Uploads/OLW-Strategy-2019-2024-final-MBIE-030718.pdf>

⁸⁸ science.gov.au

⁸⁹ Gali, J., Tate, C. and O'Sullivan, M., 2000. Structural Analysis of Agriculture: A Methodological Perspective. In *2000 Conference (44th), January 23-25, 2000, Sydney, Australia* (No. 123650). Australian Agricultural and Resource Economics Society.

chains, that are less constrained by environmental resources, to realign production into higher value and more differentiated products (A -> D). Expansion of a more integrated food and fibre value chain may see production depleting environmental resources or relocating production to areas under environmental resource constraints (D -> C).

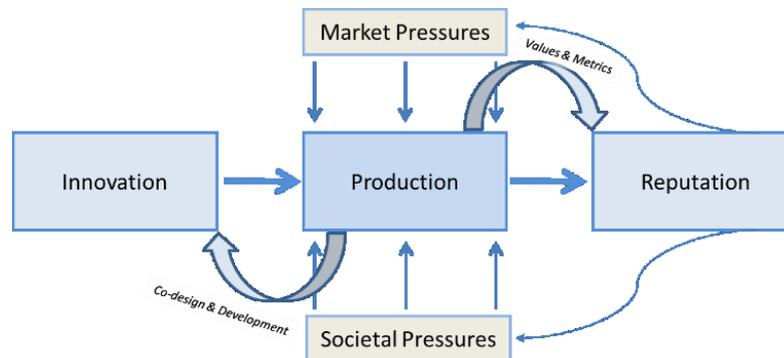


Figure 3. Transforming production systems through innovation builds reputation with markets and society
Adapted from Kaplinsky, 2010 ⁹⁰

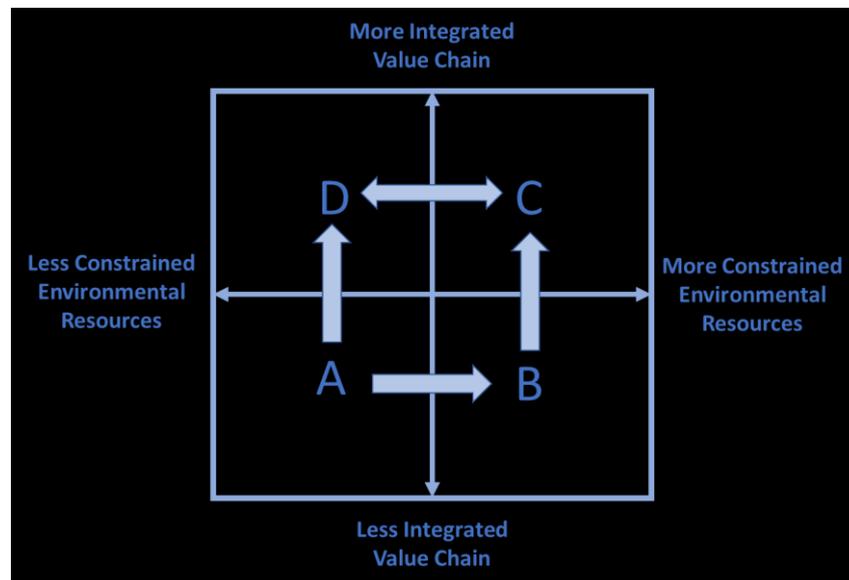


Figure 4. Representation of structural change of food and fibre chains at different stages of environmental resource constraints and value chain integration (adapted from Gali et al., 2000) ⁹¹.

As shown in Figure 4, food and fibre chains can become more value chain oriented and integrated as a consequent of market pressures, such as oversupply, as well as societal pressures in response to acceptable environmental limits being exceeded. In either case, an increasing cost of production relative to market returns facilitates the emergence of more integrated food and fibre value chains seeking higher returns. Also, attaining a societal ‘licence to operate’ becomes a competitive advantage

⁹⁰ Kaplinsky, R., 2010. The role of standards in global value chains. The World Bank, 20pp.
http://oro.open.ac.uk/22235/2/Kaplinsky_WB_report.pdf

⁹¹ Gali, J., Tate, C. and O’Sullivan, M., 2000. Structural Analysis of Agriculture: A Methodological Perspective. In *2000 Conference (44th), January 23-25, 2000, Sydney, Australia* (No. 123650). Australian Agricultural and Resource Economics Society.

for food and fibre chains sourcing supply from production sites where environmental resources have become more constrained⁹².

Internationally competitive firms are characterised by having the capacity to improve and innovate continually in a way that shifts constraints rather than being reliant on having the largest scale or cheapest inputs⁹³. Hence, structural changes in the food and fibre chains in quadrant A, who often have attained large scale and access to cheap inputs, can enhance competitiveness as these chains innovate in response to stricter environmental regulation. (Figure 2). Technological modernisation and/or shift from a production to a customer/consumer orientation enable these chains to move from A -> D and A -> C via B, when exposed to a change in market demand and or environmental resource constraints.

Within the Challenge, the science programmes were designed to underpin the transitioning of primary sector (food and fibre chains) so that production and productivity could be enhanced, and land and water quality could be maintained and improved for future generations. Earlier research has shown, that for transformation to occur there will need to be a shift in how the practices of science and policy making, as well as the practices using and managing land and water, are understood and thought about⁹⁴. Moreover, science is deeply implicated in transformation given the dependency of the other practices on knowledge. The OWL science programme is a collaborative effort that has been guided by a shared vision of the future based on an understanding of the pressures and drivers of change. Outputs of these science programmes are being used by a broad range stakeholder, including public and private sector policy making organisations, land and water users and managers as well as the wider society. For example, regulators, industry and NGO's alike have had a strong interest in understanding the current and future states of land and water quality under different land use options. Location of a given chain within its transitional pathway, as well as the unique characteristics of the chain, also determine what aspects of OLW's science programmes are being utilised at any given time.

However, achieving the desired transition of ongoing enhanced economic returns while land and water resources are maintained and improved is very dependent of several factors. In particular, the proportion of economic returns that are reinvested in our land and water resources, as well as how efficiently those resources are targeted to where the needs are most critical. Therefore, the Challenge considers that how land and water resources are used and managed will be transformed through three drivers based on achieving greater value in global markets; innovative resilient land and water use and building collaborative capacity. In short, a synergistic cycle of achieving of superior economic returns sustained by fit for purpose land and water use options implemented, managed and regulated through collaborative processes.

Value chain considerations

The Challenge has identified the importance of global value chains (GVCs) in capturing and sharing value back to the New Zealand producers⁹⁵. Governance in global value chains is complex, reflects the fragmentation of production and involves interactions amongst a wide set of players and decision

⁹² Moffat, K., Lacey, J., Zhang, A. and Leipold, S., 2016. The social licence to operate: a critical review. *Forestry: An International Journal of Forest Research*, 89(5), pp.477-488.

⁹³ Porter, M.E. and Van der Linde, C., 1995. Toward a new conception of the environment-competitiveness relationship. *Journal of economic perspectives*, 9(4), pp.97-118.

⁹⁴ Duncan, R., Robson-Williams, M., Nicholas, G., Turner, J., Smith, R. and Diprose, D., 2018. Transformation Is 'Experienced, Not Delivered': Insights from Grounding the Discourse in Practice to Inform Policy and Theory. *Sustainability*, 10(9), p.3177.

⁹⁵ <http://www.ourlandandwater.nz/assets/Uploads/OLW-Strategy-2019-2024-final-MBIE-030718.pdf>

makers with diverse agendas and sphere of influence. influence⁹⁶. Figure 5 aims to illustrate a simplified depiction of global value chains by three main spheres of influence: New Zealand (production and supply angle), global traders and processors, and export markets (brands and end consumer angle).

Whereas maximising export revenue remains a goal for New Zealand, the opportunity for distribution of profits and risks in these value chains continues to be a challenge in the context of fragmentation and pressure for New Zealand to be price competitive. At the same time, there is a need to address externalities⁹⁷ (in New Zealand and across the value chain) and responding to consumer requirements (environmental impacts, animal welfare, fair trade, carbon). In 2017, goods accounted for almost 70% of total New Zealand exports (which are concentrated in the primary industries) and there is a recent increase in trade in services due to a higher share of services export as result of strong tourism⁹⁸. To the extent that trade in value-added is a benchmark for performance in GVCs, New Zealand has mixed results according to OECD-WTO Trade in Value Added (TiVA) database: the country is below OECD average for exports of domestic value added share (49.3% vs the OECD average of 61.5%) but performing above OECD average for the services content of total exports (57.4% vs OECD average of 54.3%).

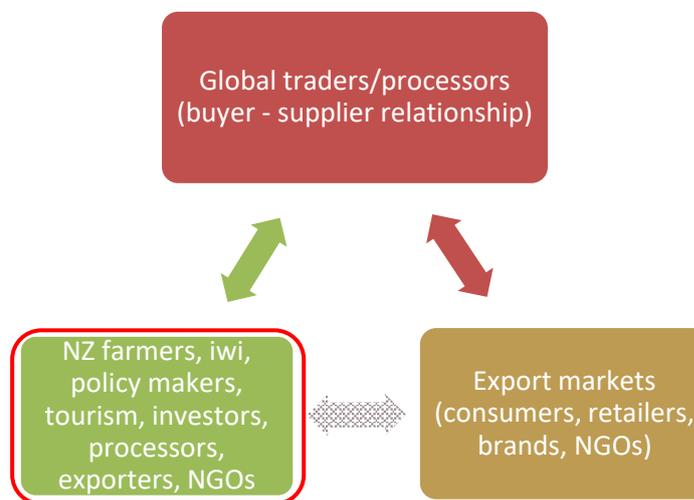


Figure 5: Illustration of key relationships in global value chain and the Challenge' focus and capacity to influence (----). Depiction by authors.

The Challenge's capability and focus, and the NZ policy frameworks, can contribute to and have direct influence over the New Zealand context for production. This involves a wide range of actors seeking different outcomes and values (regional policy and rules, NGOs, iwi others). The other focus area is the global value chain (global traders and end-consumers), where the opportunity to exercise influence (through knowledge, tools or policy) is conditioned by the type of value chain and how collaborative it behaves⁹⁹. This requires greater understanding of how value chains work and equally important in the case of novel and high value products, how new value chains can emerge and what

⁹⁶ Knoll, H.O. and Jastram, S.M., 2018. A pragmatist perspective on sustainable global value chain governance—the case of Dr. Bronner's. *Society and Business Review*.

⁹⁷ Externalities is defined as *a positive or negative consequence of an economic activity or transaction that affects other parties without this being reflected in the price of the goods or services transacted* (TEEB 2018).

⁹⁸ <https://treasury.govt.nz/publications/staff-insight/mei-special-topic-new%20zealands-goods-and-services-trade-flows>

⁹⁹ Saunders, C.M., Dalziel, P.C., Wilson, M.M., McIntyre, T., Collier, H., Kaye-Blake, W.H., Mowat, A., Olsen, T. and Reid, J.D., 2016. How value chains can share value and incentivise land use practices: a white paper.

policies can enable the greatest benefits and reduce the risks. In the value chain context, such policies include trade, investment and innovation.

To the extent that innovation and investment are areas that can be influenced the most when looking at the New Zealand sphere of influence (where can New Zealand intervene) and the focus of the Challenge, these were given specific attention in this think piece, including in the selection of individuals and organisations that were approached for insights.

Exploring synergies and alignment between New Zealand policy interventions to address sustainability (including regional policy, rules and regulations, investment in New Zealand production and land use, production and assurance standards) and private policies in value chains (supply chain requirements and the end-consumer expectations) is an area that the Challenge can make a significant contribution to.

“The most efficient means of capitalising on NZ efforts to meet pending regulatory changes at home is to ensure that there is as much alignment as possible between the needs of the consumers in the market (as signposted by supply requirements from major F&A companies like McDonald’s), the needs of the local community (manifested through regulations on water or carbon), and the investments made by the sector.” Interviewee

The theory of change

By operating at the nexus between agriculture and the environment, the Challenge is arguably focusing on one of the most complex issues, not just for New Zealand but globally, to shift food and agriculture towards a sustainable and resilient path. New Zealand is producing more food and fiber than ever before. Transformative solutions are required to address critical challenges on land and in consumer markets. These challenges include nutrient leaching and sedimentation, climate change and biodiversity loss, as well as food security and shifts in diets e.g. growth of plant-based diets in developed economies. The agenda for change is far reaching and puts the spotlight on the eco-agro-food system as a critical platform for change (TEEB 2018).

The current ‘Theory of Change’ (ToC) that OLW Challenge applies is that:

“the value chain holds the key to driving shifts to land uses and land use practices that will achieve sustainable outcomes”

Generally, a ToC aims to identify the processes by which interventions (in this case research workstreams) can reach their planned outcome. The OLW’s ToC places a great focus on value chain and assumes that consumers will reward producers for sustainable methods/systems of production and that the prospect of better capturing current or potential value by producers will continually reinforce behaviors and choices that lead to better environmental performance. As shown in Figure 4, path dependency can influence how a primary sector food and fiber chain can become a more integrated value chain that is more responsive to market signals.

With an export oriented primary sector, the need to focus on consumer and market requirements is well understood and presumably has been the on-going *modus operandi* for New Zealand farmers, producers and exporters already. This has enabled the tremendous growth in the revenue value of primary sector exports, currently at an all-time high of NZ\$42 billion.

The question is then why such economic growth has not led to a step increase in sustainable land use practices and environmental performance to date? Furthermore, whether the current ToC or the pre-conditions on which it is based is sufficient *vis a vis* the objective of the challenge to “enhance primary sector production and productivity while maintaining and improving our land and water quality for

future generations". The Challenge recognise that *"As a nation, we capture and share only a small fraction of what our high-quality produce is sold for overseas."*¹⁰⁰

However, we cannot assume that increasing New Zealand's capture and share of this value generated will translate into an increased uptake of sustainable land use practices and environmental performance if history is a guide.

Is the objective to enhance production and productivity enough and appropriate in order to maintain and enhance environmental outcomes? Can sustainable outcomes be achieved without considering and costing all environmental and social externalities across value chain, from producer to consumer?

'The current dialogue does not talk about food production systems and the fact that the environmental cost of food is not built into the price consumers pay. If the dialogue continues on its current path any change in food producer behaviour or in land use will merely be seen as a prerequisite to market access rather than a pathway to gaining more value.' Interviewee

And as important, is the Challenge objective itself fit for the future. For example, be able to capture market and consumer trends as well as concerns such as food security, diet and nutrition changes. Also, can the challenge objective provide for diversification of land use and resilience at scale, or explore new investment and value chain models to deliver to the market?

The Challenge has identified preconditions for this ToC (linked to value chain) and we are proposing that at a minimum, other preconditions and uncertainties need to be identified and examined for the OLW to be successful in delivering radical transformation. These include:

- Externalities of agriculture, and specifically of food system, as well as risks across the entire value chain are identified, including understanding the linkages to human health, diet and nutrition, equity and ethics.
- All points of entry for driving change in value chain are being considered (for instance better regulation and certification, demand for food quality, diet, nutrition and health, investment).
- Governance in the value chain is anticipatory to enable better alignment between key actors and influencers along the entire value chain. For example, alignment between NZ rules and regulations, investment and chain audit requirements for sustainability.
- Power relations and consumer-orientation in food and fibre chains that enables shared responsibility and allows for innovation and entrepreneurship.
- The role of fit-for-purpose technology and its accessibility, as well as end-user up-skilling and rate of technology uptake.

Where these preconditions are not considered by the Challenge, their conversion into research questions and focus is necessary in order to achieve the Challenge objectives. This has been captured as a finding in this Think Piece (section 3).

Given the new OLW strategy envisages a future where catchments contain a mosaic of land uses that are more resilient, healthy and prosperous than today¹⁰¹, there is scope to consider other ToC's that are targeted at similar outcomes. For example, multifunctional agriculture (MFA) which jointly produces agricultural products and ecological or tourism related services from land and water resources using a ToC that develops new economic options through agroecological partnerships

¹⁰⁰ <http://www.ourlandandwater.nz/assets/Uploads/OLW-Strategy-2019-2024-final-MBIE-030718.pdf>

¹⁰¹ same as above

generating the knowledge and being supported by synergistic societal policies to exploit these opportunities¹⁰².

Such a ToC has enterprises operating within a value chain as an agroecological sub-system interacting with a supersystem of public opinion and public policy with the whole system is informed by knowledge generation processes. Such a framework, where collaboration between business and stakeholders and government are implicit, will lead to more effective sustainability outcomes than a more economic centric value chain approach¹⁰³. For an enterprise operating in this framework, they are likely to undergo transformation from an economic value focus to a shared value focus that expands their total pool of economic and social value¹⁰⁴.

Seeking solutions by positioning OLW in the wider research agenda for agriculture and food system

Because the challenges in agriculture and food system are complex, transformation at scale in New Zealand requires systems thinking and deep understanding of the tangible and intangible links between all capitals (natural, human, social and manufactured capital), and the dependencies and impacts of food and farming.

TEEB for agriculture and food (TEEB AgriFood) is the first holistic evaluation framework that adopts a systems' approach in seeking "truly sustainable and equitable solutions to the agri-food challenges we face". TEEBAgriFood evaluation framework was developed as a result of a decade of work by UN and organisations looking at the economics of ecosystems and biodiversity (TEEB) which surmised that irrespective of the environment, socio-economic and cultural context in which an agri-food system is situated, there are always positive and negative externalities and impacts across the entire value chain. The purpose of TEEBAgriFood is to promote a decision-making environment in which the positive impacts flourish and the negatives are mitigated by understanding the capital stocks and value flows (see Figure 6).

Because of the obvious synergy between what OLW is trying to achieve and that of TEEBAgriFood, the highlights in red in Figure 6 are aimed to provide a high-level perspective on where the perceived focus of the Challenge is *vis a vis* TEEBAgriFood framework.

The Challenge is only focusing on some of the dimensions captured in the valuation framework. The gaps offer opportunities for the Challenge in terms of:

- future research areas to address, and
- more strategically pursue joint research and make better use of outcomes from the other National Science Challenges.

¹⁰² Jordan, N. and Warner, K.D., 2010. Enhancing the multifunctionality of US agriculture. *BioScience*, 60(1), pp.60-66.

¹⁰³ Barnett, Michael L. and Henriques, Irene and Husted Corregan, Bryan, Governing the Void between Stakeholder Management and Sustainability (January 17, 2018). M. L. Barnett, I. Henriques & B. Husted. Governing the Void between Stakeholder Management and Sustainability. *Advances in Strategic Management*. Edited by: S. Dorobantu, R. Aguilera, J. Luo, & F. Milliken (2018 Forthcoming).

¹⁰⁴ Porter, M.E. and Kramer, M.R., 2018. 16 Creating Shared Value. *Managing Sustainable Business: An Executive Education Case and Textbook*, p.327.

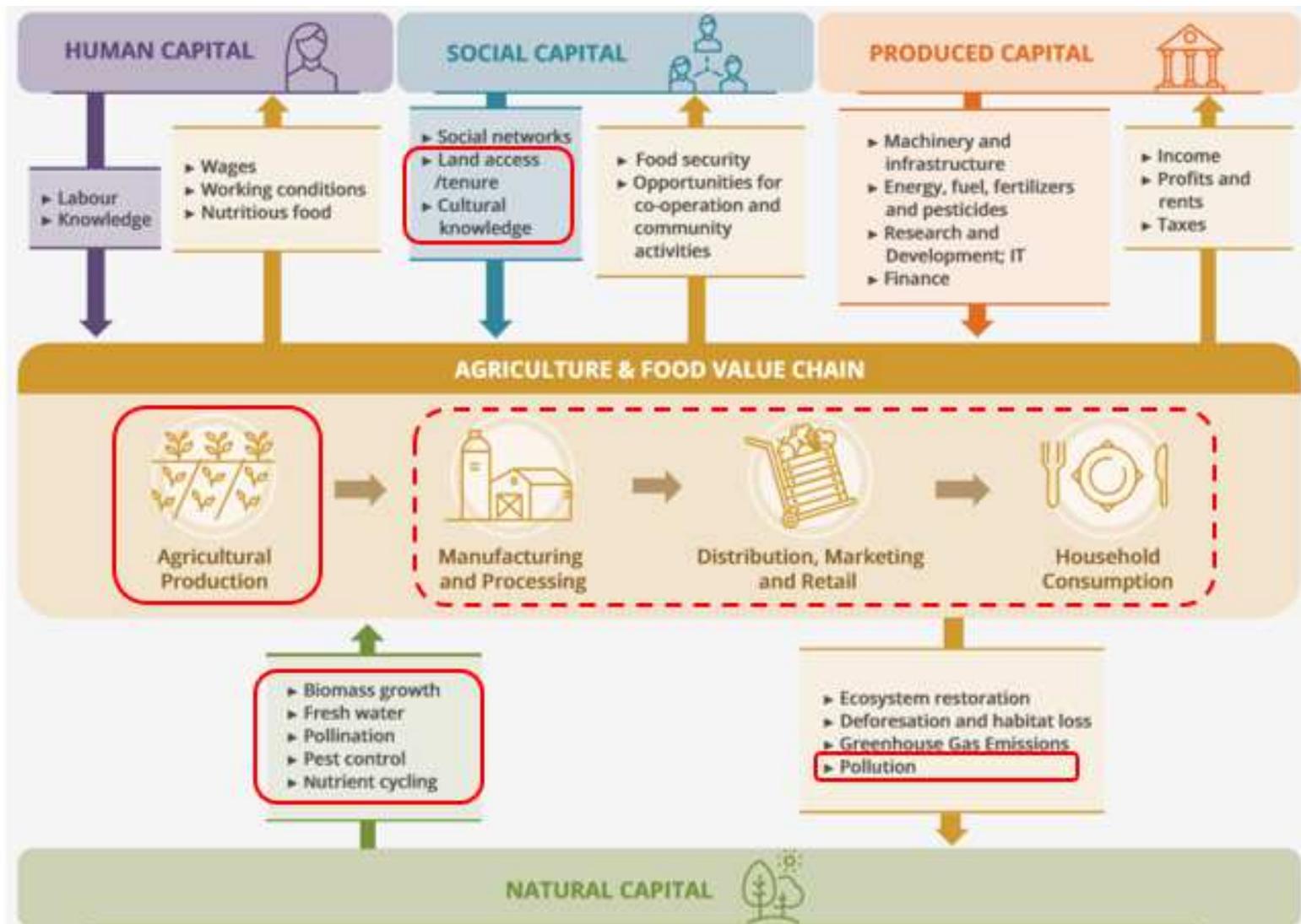


Figure 6: Capital stocks and value flows in eco-agri-food systems, TEEBAgriFood Evaluation Framework (Source: TEEB 2018). Red marking (—) suggests the areas that the Challenge is perceived to focus on the most (authors' representation)

ANNEX 2 The context for change in New Zealand: a snapshot

This section includes a snapshot of current issues and aspects as identified through desktop reviews and stakeholder interviews and conversations for preparing this piece. It helps provide context for the questions explored and the recommendations for research, recognizing that the Challenge is focused on the future uptake of tools and methods to promote transition pathways and increase the shared value (economic, environmental, social and cultural) from our land and freshwater resources.

Pushing environmental limits

Agriculture and food production have been key to our economic growth but also main drivers for environmental and ecosystem change in New Zealand. Primary sector exports have reached NZ\$42 billion this year and there is a continuing effort to seek export growth and enhance (on-farm) productivity.¹⁰⁵ Tourism, which like agri-food is highly dependent on natural assets, has passed NZ\$35 billion revenue and it has a target to grow to \$41 billion by 2025 (TIA 2018).

There are over 12 million hectares of land in primary production (pasture, forestry, cropping, horticulture) and lending to NZ agri-business has reached \$41.1b in 2017.¹⁰⁶ Dairy land area has increased by about 40% since late 90s and even though the median price per hectare paid for dairy farms has decreased in the past year,¹⁰⁷ it remains one of the highly desirable assets in the primary sector.

The economic importance of the sector is, however, matched by its impact on the environment and natural resources: agriculture has fundamentally altered our landscapes and catchments, and production and productivity increases have come with environmental trade-offs (greenhouse gas, emissions, water quality, soil and biodiversity loss). Agricultural intensification and urban expansion has led to a loss of 70,000 ha indigenous cover between 1996 and 2012, and 190 million tonnes of valuable soil is lost through erosion every year.¹⁰⁸ The concentration of nitrate-nitrogen increased at 55% of monitored river sites between 1994 and 2013 and climate change is projected to decrease water flows and the availability of water in much of New Zealand – annual rainfall is expected to decrease in the east and north (thus limiting the ability to use dilution to improve water quality).¹⁰⁹

For many agribusinesses, freshwater and climate change challenges are not the most immediate concerns. Customer satisfaction, recovering costs of capital, managing food safety / quality and labour are more urgent priorities. While regulatory pressure from Councils can be strong driver, often the first influencers are the customers, the banks and lending institutions. Managing freshwater, biodiversity and climate change risks are difficult, particularly if a systematic framework for managing risk has not been established at the planning phase of a new business venture.

Overall, the bio-capacity of New Zealand is on a continuous decline even if our ecological footprint stays the same. This poses an ongoing risk to primary production as the bio-capacity to buffer declines while the risks from climate change and natural hazards increase, as shown in Figure 7.

¹⁰⁵ Ministry for Primary Industries (2018). Situation and Outlook for Primary Industries, June 2018.

¹⁰⁶ New Zealand Treasury.

¹⁰⁷ <https://www.stuff.co.nz/business/farming/107317409/higher-dairy-payout-not-enough-to-halt-falling-farm-prices>

¹⁰⁸ Ministry for the Environment & Stats NZ (2018). *New Zealand's Environmental Reporting Series: Our land 2018*.

¹⁰⁹ Ministry for the Environment & Stats NZ (2017). *New Zealand's Environmental Reporting Series: Our freshwater 2017*.

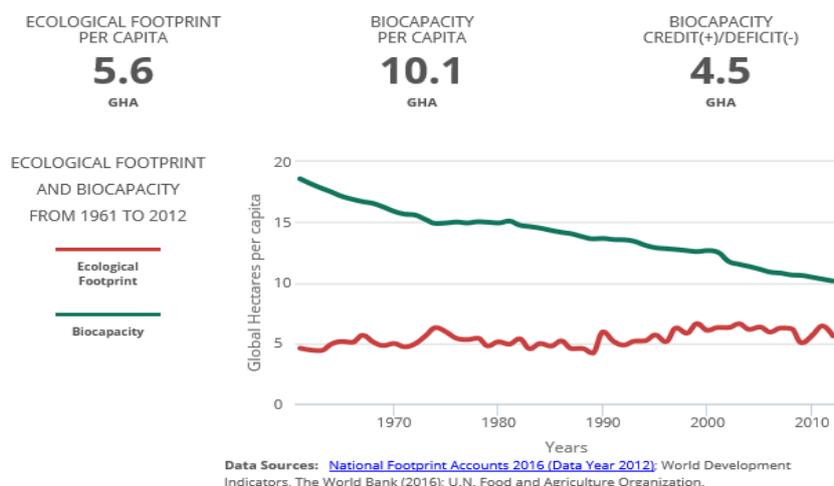


Figure 7: New Zealand’s ecological footprint: 2016 update. Source: Global Footprint Network.

Combined with high financial leverage at farm levels, land owners may not have easy access to finance for mitigation or adaptation.

In the 2017 environmental performance assessment, OECD states that “*New Zealand’s growth model has started to show its environmental limits, with increased GHG emissions, freshwater contamination and threats to biodiversity*” and recommends that GHG emissions from agriculture and especially dairy are addressed with priority (OECD 2017).

Where primary sector producers have not advanced up the value chain as expected, the economic resources they have available to invest in mitigating these risks is constrained and increases their dependency on the public sector to assist in mitigating and adapting to these risks. Global shifts in the food system and pressure from consumer markets can compound these risks unless there is determination and innovation capability to turn these challenges into opportunities for transformation across farming and food production – while also having sufficient surpluses to invest in carbon reduction, mitigation and regeneration.

International commitments

New Zealand is party to global agreements that are also changing the policy agenda domestically and are relevant in terms of the new knowledge and tools that the Challenge (and other National Science Challenges) can develop in support of meeting these commitments. Two of these agreements are particularly important: the Paris Agreement on Climate Change and the 2030 Agenda for Sustainable Development.

Both require ambitious actions and implementation in areas like water and climate. Here, solutions in food and energy production are being considered as critical conditions for success (TEEB 2018). Without radical and swift transformation to the way we produce and consume food, the well-being and prosperity of New Zealand and all other countries is at risk in a “business as usual” scenario.

The Agenda 2030 include 17 Sustainable Development Goals (SDGs) and associated targets with the ultimate aim to end poverty, protect the planet and ensure that all people enjoy peace and prosperity (United Nations, 2015). Mobilization by New Zealand to deliver the Agenda 2030 has been relatively limited but expected to improve as result of the change in policy setting associated the incoming

government in 2017 and SDGs being part of the Confidence and Supply Agreement for the governing coalition (Flood et al. 2018). To describe the SDGs's relative importance, a prioritisation ('wedding cake') was developed which underscores the importance of ecological goals in relation to societal and economic goals and specifically with a view to food and agriculture (Figure 8).



Figure 8: The SDG 'wedding cake'. Source EAT 2016

This representation counters the current paradigm for development and the sectorial approach where social, economic, and ecological development are addressed in separately. This new approach aligns with the Government's Living Standards Framework which brings an intergenerational well-being approach to the stewardship of the public finance system. It is also consistent with a Te Ao Māori world view rather than the historic focus on economic development through maximising productivity without adequate consideration of environmental and social externalities.

Government policy priorities

Freshwater policy, climate change and biodiversity are high on the coalition government agenda. Central government initiatives combined with the regional council policy and planning, are encouraging New Zealand land owners and primary sector to change. While incoming governments have often been highly critical of previous government's efforts to manage freshwater and climate related challenges, there is more focus on cross party agreements to achieving timely changes to public policy. They are motivated to provide greater political stability over time to establish clear and enduring strategic direction on natural resource challenges (see the section on Zero Carbon Bill).

A clear and strategic direction for climate change, freshwater and biodiversity is needed to ensure a consistent approach and linkages. Some of the aspects that emerged in discussions for the Think Piece which require attention and give opportunity for the Challenge to contribute include:

- A refresh of the funding criteria for public investment in business and infrastructure.
- Targeted support for innovation in primary production systems with the proven potential to reduce environmental risk.

- Development of natural capital accounting approaches and criteria for emissions, discharges and water quantity at regional and local scales. What cannot be measured; cannot be managed.¹¹⁰
- Coordination of current funding capacity to upgrade infrastructure and the capacity of regional and local Councils critical to manage freshwater and climate change risks.
- Legislative reform to clarify the rights and interests of iwi and others in freshwater, with emphasis on clarity in the “maintain or improve” direction provided by the Resource Management Act; and an investigation of how first in first served access to water impacts on businesses seeking to undertake new activities.
- Clarification of the rights and responsibilities for businesses in relation to biodiversity, climate change and freshwater; including firm advice on how decisions will be made on applications that are likely to exceed a natural resource limit.¹¹¹
- Coordination of natural resource tax mechanisms at the national, regional and local level.
- Review of how existing tools such as the national planning template and Ministerial powers, could be used to coordinate national, regional and local growth strategies in line with current Government intentions to arrest and remediate the decline in natural resource quality and availability. The Wāipa river catchment case study is an example of the impacts of coordination when the Treaty related legislation establishing the Vision and Strategy for the Waikato River has been incorporated into regional and district plans across the Waikato region.
- Assessments into the sustainability of irrigation infrastructure, flooding and drainage networks at the national scale and assessment of the impending risks to that infrastructure from climate change and the opportunity for nature-based infrastructure (opportunity for collaboration with the Resilience Challenge).

Continuing freshwater policy implementation and reform and a renewed focus on biodiversity policy

The Land and Water Forum made a step change by breaking through inertia in the development of a National Policy Statement (NPS) on Freshwater Management. The approaches adopted by regional councils to give effect to NPSFM vary considerably. The NPSFM was amended in 2017 to include a national target of making 90 percent of New Zealand’s rivers and lakes swimmable by 2040 (MfE 2018). The cost for implementation can be around \$135 million per year, much of it as on-farm investment. The position on the role of ‘Good Management Practice’, development of capacity to address freshwater management and the funding of freshwater infrastructure and science has also changed over time. The case study examples prepared for this Think Piece cover different contexts and approaches to managing freshwater risk in three catchments around the country – including the constraints and structural issues that need addressing.

As part of the freshwater agenda for the next two years, the government set up a task force that will provide advice on how to achieve the freshwater objectives:

- Stop further degradation and loss

¹¹⁰ For a description of what “natural resource accounting framework” means see pp 27 – 30 of the Fourth Report of the Land and Water Forum: <http://landandwater.org.nz/includes/download.aspx?ID=141905>

¹¹¹ Significant guidance is needed on what constitutes a breach of natural resource limits. A reductionist approach focussed on one attribute of contamination alone is often a poor proxy for intensification. There is significant work to be done to assess multiparametric discharge footprints in their spatial location to establish whether an activity can maintain or improve water quality. In many respects this relates directly to a sound and scientifically valid definition of “intensification”.

- Reverse past damage
- Address water allocation issues

MfE indicated that the government will be looking at other legal instruments, including the introduction of a new National Environmental Standard for nutrient management. Resolving iwi rights and interests is also a focus for the Crown. Because of the connection to “Planting One Billion Trees”, there are expectations of synergies with climate mitigation and adaptation, though there is no expressed scope to link the issues.

A draft National Policy Statement for Indigenous Biodiversity has also been released for public consultation and its final form is expected to lead to rules and regulations that regional councils will put in place – with likely implications for land use and land management.¹¹²

In addition to this, the Treasury, Ministry of Health and the Department of Internal Affairs has been reviewing the provision of infrastructure for Freshwater Management across wastewater, water supply and stormwater management, recognising critical shortages in the ability of Councils to fund upgrades, including flood protection and drainage infrastructure. These are directly linked to land use and management and climate adaptation, including public and private investments.

Internationally, The UNESCO World Water Assessment Programme (see box below) is a global programme looking at freshwater and climate risks, including the role of nature-based infrastructure to freshwater management.

UNESCO World Water Assessment Programme (UNESCO WWAP)¹¹³

New Zealand not alone in facing critical challenges to biodiversity, water management and changing climate. The United Nations has been conducting detailed and comprehensive work on water and land through the UNESCO WWAP. Two elements to this Programme provide some fundamental guidance to countries about future freshwater and climate change challenges. The fourth report focusses on managing water under uncertainty and risk:¹¹⁴

“It presents the case that, in today’s world, a ‘business-as-usual’ approach to water management is tantamount to blind neglect of the ecosystems that sustain life and well-being. Past attitudes – which in many cases were of an expectation of governments to manage water as a ‘sector’ while decision-makers in other true sectors (food, energy, health and others) paid little attention to how their actions affected the water cycle (and other users) – have created a disconnect between policies and actions, and the role of managing both their consequences ... Perhaps the most troubling aspect of this assessment is that the rate of change now seen across the water cycle leaves water experts somewhat perplexed; history is no longer a reliable means of predicting future water demand and availability. In admitting that current understanding of the various pressures being placed on the water cycle is akin to islands of knowledge in a vast sea of unknowns, the WWDR4 also sets a challenge for all water users and the full spectrum of leaders and decision-makers to invest in building and sharing knowledge about how their actions affect water quality, quantity, distribution and use.”

The report highlights the fundamental need to have better feedback and coordination of environmental data and information to support decisions and investment. This includes provision for better monitoring and enforcement of minimum standards that is carried out at the appropriate

¹¹² www.mfe.govt.nz/more/biodiversity/national-policy-statement-biodiversity/about-national-policy-statement, accessed on 29 October 2018.

¹¹³ <http://www.unesco.org/new/en/natural-sciences/environment/water/wwap/about/>

¹¹⁴ <http://unesdoc.unesco.org/images/0021/002156/215644e.pdf>

level. Reporting of actions and good practice undertaken is crucial feedback to the market, the public and the regulator.

The second element of the UN Programme worth considering is the recently released report on nature-based solutions (NBS) for water¹¹⁵. NBSs recognise that substantive changes have occurred in waterbodies worldwide. These changes have degraded freshwater and reduced resilience to climate change impacts. Nature based solutions seek to restore ecosystem function at the catchment scale, through coordinated catchment management planning:

“Currently, water management remains heavily dominated by traditional, human-built (i.e. ‘grey’) infrastructure and the enormous potential for NBS remains under-utilized. NBS include green infrastructure that can substitute, augment or work in parallel with grey infrastructure in a cost-effective manner. The goal is to find the most appropriate blend of green and grey investments to maximize benefits and system efficiency while minimizing costs and trade-offs.”

While the UNESCO programme is focussed on climate change and water challenges, the solutions they point to involve management of natural systems in ways that promote ecosystem health and a systemic approach to the resilience of natural capital. Often this change has required a change in the reliance on flood protections systems and drainage networks, and an increase in the presence of wetlands and forests to increase resilience to flooding and drought extremes.

This s recommended a closer look be taken at the relevance of this international work to New Zealand.

Zero Carbon Bill and transition to a low carbon economy

The Zero Carbon Bill is expected to be introduced as a bi-partisan legislative initiative that would require New Zealand to be carbon neutral by 2050. Whereas options and approaches are still being considered, for example if agriculture will be included in the Emissions Trading Scheme (ETS) or whether methane will be targeted for reduction, it is largely expected that the bill will lead to an increase in carbon price and therefore costs will occur to the economy and households (MfE 2018). Land use decisions that take into account the emissions implications of that use are an important area of focus with significant knowledge gaps and opportunity for research – particularly linked to competitiveness and innovation (Vivid Economics, 2018 and NZIER, 2018).

The Productivity Commission report into pathways to transition to a low-emissions economy suggest that one of the shifts that needs to happen is making changes to the structure and methods of agricultural production – which will include “diversification of land use towards more horticulture and cropping, and greater adoption of low-emissions practices on farms.” (NZPC 2018).

There are many uncertainties and assumptions being made about the options and pathways that New Zealand can take towards a low carbon economy, especially how far to target agriculture sector given the mitigation technologies available at the moment.

The interface water-carbon and the role and implications for land use suggest a great opportunity for research inquiry and innovative solutions that the Challenge can explore in connection to its value chain focus.

Well-being, resilience and natural capital

Wrapped around the challenges on freshwater management and low-carbon transition is the well-being dimension and its close and fundamental linkage to New Zealand’s natural capital and biodiversity. The siloed nature of much of New Zealand’s risk management means that insufficient

¹¹⁵ <http://www.unesco.org/new/en/natural-sciences/environment/water/wwap/wwdr/2018-nature-based-solutions/>

attention is paid to the interconnectedness nature of risk factors and the Treasury is leading work to further develop the Living Standards Framework in order to consider the collective impact of policies on intergenerational wellbeing. Indicators for intergenerational wellbeing that are being considered are based around the four capitals: natural, human, social, and physical and financial. This represents a significant shift from focus on economic growth to the wider concept of wellbeing and resilience. papers have been published on the value of human, social and natural capital.

Investment by public and private sector

With increased awareness about resource scarcity, risk from bio-security and natural hazards, environmental constraints and climate change, the public and private sector are starting to explore the management of these risks for investments or purposely make available investments and finance that address specific environmental and social outcomes.

Investment and market requirements are likely to have a significant influence on the way business responds to these risks and may prove to be a stronger change agent than regulatory initiatives in New Zealand in the short term. Concerns in the market have already led to slight decrease in the price of dairy farms. Land owners have more difficulty in accessing capital in this constraint environment which has led to a high number of dairy farms for sale on the market - similarly to the number at the top of financial crisis in 2008/9.

Obtaining finance for new ventures is often a critical obstacle for business. Banks and lending institutions have not traditionally factored the risks of freshwater policy and climate change into finance. But they are becoming concerned at the risks to investment capital; particularly when freshwater and climate change risks have the potential to shift the value of land. Banks are seeking to establish lending criteria for managing freshwater and climate change risk; and are currently establishing methods to undertake environmental due diligence on businesses seeking finance.

“Farmers and land owners have difficulty with preparing business and investment cases reflective of the new constraint environment in which they operate – beyond rules and regulations. Responding to market shifts, transitioning to high value, low carbon food and fiber requires new knowledge and farm tools (including measurement and certification), and capability to connect and agility to innovate”
Interviewee.

On the other hand, increased government focus on improving the management of natural resources and addressing the country’s freshwater, marine and conservation challenges, including the aspiration for New Zealand to become predator free, is helping to channel significant public money to deal with these issues. This year, a \$100 million Green Investment Fund was set up which is expected to stimulate \$1 billion of private investment in high-value, low-carbon industries and clean technology. Additional funding for sustainable natural resource management and rural development is available from MBIE and MPI through initiatives like the Provincial Growth Fund and the Billion Tree Fund. MPI has launched a refreshed fund – SFF (Sustainable Food and Fiber) Futures - which combines the previous PGP and SFF.

The tools and knowledge that OLC Challenge and the other National Science Challenge develop can be adopted by the financial sector and investors if there is more collaboration and responsiveness to provide the financial service sector what it needs – including advice on managing climate change and freshwater related risk.

In our view, greater demands will emerge from customers for strong environmental performance. While this paper has focussed on climate change and water related policy, there is an increasing likelihood that the biodiversity impacts will be a “fast follower” in regulatory terms. This is evident

from the increasing focus on biodiversity; with the recently announced discussion document for a biodiversity NPS and current indications from Government to progress work in this area.

Markets and consumers

Agricultural market advantage is likely to change over time for New Zealand. Increasingly global food technology is providing new products to market. These products may rival New Zealand's reputation for affordable commodities with good nutritional value, strong food safety credentials and well-established supply chains. Many of these products may also compete with or better our environmental performance as well. One of our key advantages is likely to be how *natural* our products are.

Interviewees consulted while preparing this paper raise a key point regarding New Zealand's market advantage. New Zealand has comparative advantage in terms of the state of our natural ecosystems. This is not because development has been sympathetic to these values. Mainly it is because New Zealand has not had as much cumulative development as many other parts of the developed world. Another of our other key foreign exchange earners (tourism) also trades on our "natural" brand.

Any brand seeking to develop strong environmental credentials is vulnerable to the ability of the business to change practices in response to lower than expected environmental performance. If New Zealand is to incentivise businesses to adopt sound environmental management systems, there must be strong incentives or penalties related to good or bad environmental performance. The consequences of enforcement of environmental standards need to be a tangible driver for New Zealand businesses.

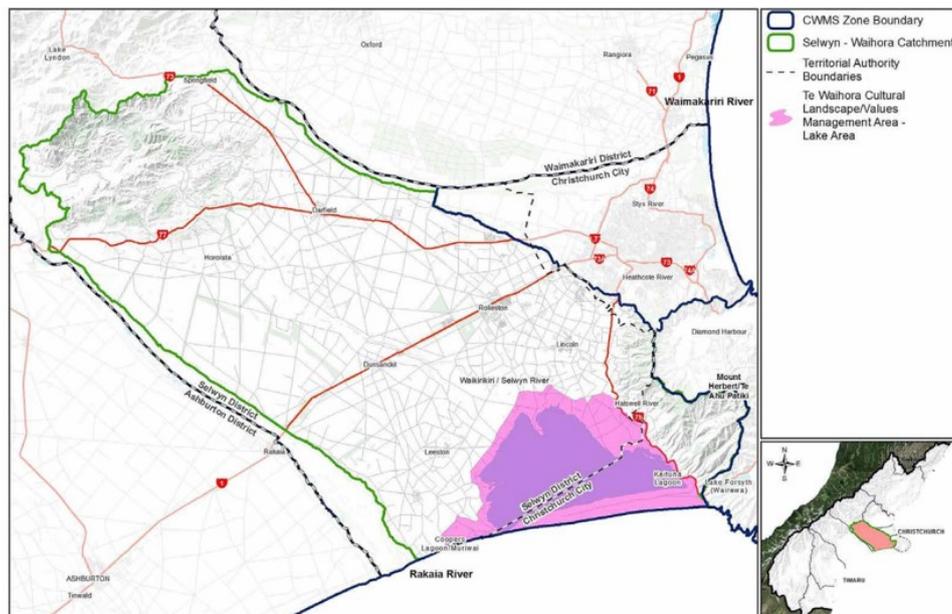
A high degree of "naturalness" is not currently a core value for many businesses. Public policy agencies and political institutions have not always provided clear and consistent direction to investors about risks to investment that are related to freshwater, biodiversity and climate change issues. The policy of private organisations will not respond to public policy direction quickly, without a strong regulatory driver setting the bottom lines and standards expected. The public policy environment is not currently providing that direction consistently. This section of the paper explores some of the key changes to public policy that could drive rapid change in the behaviour of business. It also provides some views on key research topics that could help to establish an evidence base for change in public policy. Some systemic change is required at all levels of government if the objectives of the Challenge are to be realised. The current Government agenda has reform on the horizon with legislative amendment proposed for the 2019 calendar; particularly in the areas of climate change and freshwater regulation.

ANNEX 3 The case studies

Te Waihora Catchment, Canterbury

Constraints to policy interventions encouraging sustainable land use

Te Waihora Lake is a taonga of deep significance to Ngāi Tahu.ⁱⁱ Ngāi Tahu's approach to governance and management of the lake and catchment is a holistic 'mountains to the sea' (ki uta ki tai) focus driven by fundamental components of their worldview: whakapapa (humans are related to nature and all of nature including humans is interconnected); mauri (everything has an essential life force that can be decreased or increased through interactions); rangatiratanga (the right authority needs to guide the interactions); and kaitiakitanga (humans have a duty to look after nature).ⁱⁱⁱ These concepts create an ethic of care for the whole ecosystem by the properly constituted authority because the mauri of the land and water is important as there is an ethical duty *and* because it has long term beneficial outcomes. The Ngāi Tahu focus is on setting limits on use of ecosystem services to ensure long term sustainable use.



Ngāi Tahu Farming (NTF) has made an attempt to put these values into practice. While NTF's dairying operations are not in the catchment, it has 5000ha of irrigated farmland in the wider Canterbury region, including 2000ha of dairying in the neighbouring Waimakariri District.^{iv} The Holdings Corporation move to dairying farming was opposed by many of the iwi, and TRONT worked hard to ensure its operations were sustainable, including running trials and consulting iwi members.^v NTF is guided by these Ngāi Tahu concepts, as a "Ngāi Tahu company, we understand that it is our responsibility to care for the lands, plants, and animals impacted by our activities. We believe 'if we look after them, they, in turn, will look after us'".^{vi} NTF operates using a quadruple bottom line that measures economic, social and environmental and cultural outcomes and has a focus on intergenerational outcomes.^{vii} Mana whenua working parties comprised of representatives of the local hapū have also made NTF follow sustainability-oriented rules including no palm kernel extract, no dead-cow holes, optimised water use and stricter than regulated nitrogen leaching levels.^{viii} As well as the ECan required Overseer programme, NTF have also set up soil moisture metres and a nitrogen monitoring system in conjunction with Lincoln University on their farms to

ensure minimal environmental impact.^{ix} NTF has won the ECan Water Quality Award for these efforts.^x

Despite the approach and insights that Ngāi Tahu brings to land management on their own dairy operations, their influence on land use within the Te Waihora catchment has been limited.^{xi} The current structures that underpin the governance and management of the catchment have incentivised intensive, irrigated dairy resulting in negative environmental impacts with long-term implications for Te Waihora. The structure is comprised of numerous laws, regulations and plans and multiple actors with different jurisdictions, mandates and agendas.^{xii} The lake and catchment are often governed and managed as separate rather than connected entities but their interlinked nature mean effectively governing and managing the former demands influence over the latter.^{xiii} The contemporary institutional framework and the current form of land use this framework has created are both significant constraints on change towards sustainable high value land use.

Intensification of land use

The existing institutional framework has encouraged land use to move from dryland pastoral farming to irrigated dairy. Economic analysis demonstrates that intensive irrigated dairy farming in Canterbury is one of the most profitable, lowest risk operations in the farming sector.^{xiv}

Irrigation increases gross revenue from around \$1,200 per hectare for a dryland farm to \$7,500 per hectare for an irrigated dairy farm.^{xv} As a consequence banks have pursued lending policies with an emphasis on the intensive dairy model.^{xvi} This has been supported by successive central governments that have supported 'intensification through irrigation' in Canterbury. Likewise regional government through ECan initially facilitated irrigation and dairy conversion during the 1990s. However in doing so it over-allocating groundwater abstraction consents.^{xvii} As a consequence Central Plains Water (CPW)^{xviii} was set up by ECan, CCC and SDC to provide farms with access to river water.^{xix} Eventually, with growing environmental pressures, ECan reduced the number of consents to abstract water. In 2009 the central government replaced the elected councillors of ECan with appointed commissioners.^{xx} ECan went from processing 29% of resource consents in 2007/2008 to 92% in the first year commissioners took over, including consenting the CPW scheme.^{xxi} Created under the commissioners watch, the Selwyn Waihora Water Zone (SWWC) Zone Implementation Plan (ZIP) incentivises farmers to join CPW.^{xxii} Irrigated dairy in the Waihora catchment became cemented as the most profitable and reliable form of agriculture. However, with the large dairy processors Fonterra and Synlait operating as price-takers dependent upon international commodity cycles, there is continual pressure on farmers to increase production to remain profitable.

The overall institutional framework has seen dairy herd numbers in Canterbury increase by 500%, within a national trend of 68.9%, and dairy farms covering three times the area they did in the mid-nineties.^{xxiii} The intensification through irrigation has generated a significant economic boom, Selwyn is one of the fast growing districts in the country. The CPW scheme is worth roughly \$322,500,000 per annum to the economy versus \$51,600,000 left unirrigated.^{xxiv} Furthermore, irrigation has greatly increased the value of land with dryland worth \$17,500 - \$27,500/ha and CPW land worth \$35,500 - \$38,000/ha.^{xxv} Dairy, particularly the intensive model that involves significant inputs including irrigation, feed and nutrients to get maximum per hectare output, is adding hundreds of millions to the Canterbury economy every year and increasing farmers' capital gains.

This economic growth comes at a heavy environmental price. Canterbury's freshwater quality is some of the lowest in the country with the region experiencing the highest increase in nitrogen, a major dairy pollutant, in New Zealand.^{xxvi} Te Waihora is one of the most polluted lakes in the country.^{xxvii} ECan estimate every dairy farm in Selwyn would need to be shut down for lake to meet national water quality standards and consequently asked for lake to be excluded from the standards.^{xxviii} CPW has been framed as having a positive impact on freshwater quality, CPW claims it will take 70 years for the scheme to have a positive impact on the lake, with nitrogen leaching

rates increasing for the next 30 years.^{xxxix} Freshwater ecologists questions the modelling that CPW claims are based on and believe nitrogen leaching thresholds are already too high.^{xxx}

One of the key issues antithetical to the value chain lens is the complexity of the institutional framework. The legislative/ regulatory/planned framework includes the RMA and the National Policy Statement for Freshwater Management, the Canterbury Water Management Strategy (CWMS) and the Canterbury Land and Water Regional Plan, the CWMS ZIPs, the Joint Management Plan (JMP) and a Water Conservation Order (WCO).^{xxxxi} There is no single agreed upon delineation of the 'catchment' within the wider framework and consequently the lake and catchment are often governed and managed independently by the various actors.^{xxxii} The legislated actors involved in the lake and catchment include: ECan, CCC, SDC, DoC, MfE, MPI, Ngāi Tahu (in the form of TRONT and the Te Waihora Management Board), and the SWWZ Committee.^{xxxiii} The lake itself is split jurisdictionally between the CCC and SDC, while Ngāi Tahu owns the lakebed and DoC manages the lake margins, ECan oversees resource management in the lake and catchment with SWWZ exercising delegated authority from ECan. A number of these actors have also been criticised for either being compromised, conflicted or incapable of conducting their mandated roles.^{xxxiv}

The other the key issue antithetical to the value chain lens is the capital investments made within the institutional framework, including water storage and irrigation infrastructure, industry processing facilities, and farm infrastructure (sheds, fencing, etc.). The CPW scheme has cost \$450 million with farmers spending another \$187 million in on-farm irrigation infrastructure and roughly another \$1 billion in other conversion costs, including stock, sheds, fencing etc.^{xxxv} It is consequently estimated that the Waihora catchment has had \$1.6 billion in dairy infrastructure installed. There has also been industry investment in processing facilities of at least \$1.3 billion and there are also considerable support services across the region.^{xxxvi} CPW and individual farmers are highly leveraged, CPW has \$260 million finance from ANZ and Westpac and \$75 million from Crown Irrigation Investment.^{xxxvii} ANZ and Westpac have taken control of CPW operating consents as a condition for funding the project.^{xxxviii} CPW water charges are \$34,400,000 per annum, with \$25,800,000 of this servicing CPW debt.^{xxxix} The average dairy farmer in Canterbury has an equity to total asset ratio of only 33%, one of the highest in the dairy sector.^{xl} Issues regarding CPW and connections to local and national government have also been raised.^{xli}

Because of this capital investment Te Waihora catchment presents limited options for dramatic land use change. The investment in intensive dairy infrastructure is such that any shift to a sustainable land use that would permit the taonga Te Waihora and its tributaries to recover would cause farms in the catchment to fail, and investors to suffer. The wide -spread perception is that the system is 'too big to fail'. Despite Ngai Tahu's emphasis on maintaining the mauri of Te Waihora, managing whole catchments, and the development of environmentally award-winning farms, there is criticism of Ngai Tahu (both internally and externally) for its corporate investments in intensive dairy within Canterbury. Although Ngai Tahu's investments are not in the Te Waihora catchment, arguably additional intensive dairy is likely to lead to decreases in water quality and as such may be considered wrong from Ngai Tahu's own moral perspective. Nonetheless, Ngai Tahu are also a people recovering from the impacts of colonisation and can argue that it should not be excluded from economic opportunity within its own tribal area because institutions beyond its control have prioritised economic values over environmental.

However, one potential option to address the underlying environmental problems in the Waihora catchment is organic dairy, which maintains income by gaining premiums and reduces inputs of the intensive model whilst utilising the existing irrigation infrastructure. NZ already has good international reputation that it can capitalise on when marketing organic dairy. Organic dairy adds value, with recent Fonterra prices five times conventional prices.^{xlii} There is increasing international demand, and a lack of supply, for organic dairy.^{xliii} The ability to add a premium to the product reduces the required number of stock per hectare which would reduce the environmental impacts and stock on organic dairy farms also output less nitrogen.^{xliiv} Converting to organic takes three years

and farmers require financial, social and human capital.^{xlv} Policies would need to ameliorate these three areas, offering some form of monetary support via taxation or subsidies politically and processor premiums during conversion, as well as encouraging both horizontal and vertical learning, e.g. facilitating inter-farmer dialogue and providing consulting/mentoring. Another constraint is processing facilities and logistics to these organic facilities, which could be solved by concentrating organic conversion in a specific area.^{xlvi} The Ngāi Tahu cultural landscape/values management (CL/VM) area in the Selwyn Waihora Water Zone would serve as a good area for any policy focus as it is already under more stringent environmental regulations.

Ngāi Tahu possesses culturally unique insights regarding the management of the Te Waihora catchment, which it attempts to put into practice through its own governance responsibilities and commercial farming activities. However, it has limited influence over land use within the catchment. The current institutional framework has incentivised intensive, irrigated dairy which has seen billions of dollars invested into dairy infrastructure. The capital investment represents a significant constraint to land use change which is exacerbated by the framework's lack of a singular actor and mechanism through which significant change could be effected and the vested interests in maintaining the income from this dairy model. One possible change would be to organic dairy as this utilises the infrastructure but reduces environmental impacts. Ngāi Tahu approaches also offer insights into how limit setting can be both framed and put into practice.

Upper Waipā River Catchment

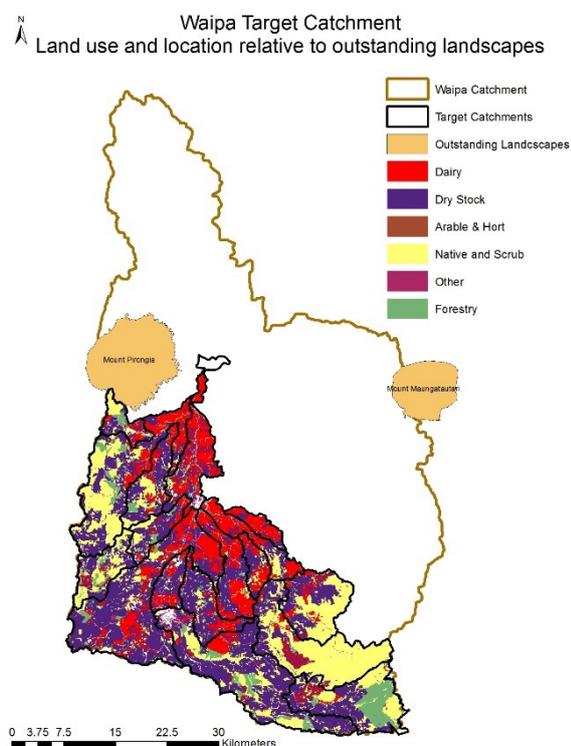
Combining long-term Vision & Strategy with impact investment

Context and approach

The Vision and Strategy for the Waikato River and Waipā River Catchment was adopted by the Government in 2008 as part of Treaty Settlement legislation.¹¹⁶ It has the status of a National Policy Statement and it gives effect to the National Policy Statement for Freshwater Management. The regional council (WRC) has a legal requirement to give effect to both of these.

The experience with integrated catchment management in Wāipa (and across Waikato) has been used as a spring-board to pursue multiple outcomes across the four well-beings: environmental, social, cultural and economic.

Healthy Rivers/Wai Ora is the Proposed Waikato Regional Plan Change 1 aimed at protecting the environment and ecosystem for future generations. The plan was developed in coordination and collaboration



¹¹⁶ <https://waikatoriver.org.nz/wp-content/uploads/2011/07/Vision-and-Strategy.pdf>

with iwi and key stakeholders and seeks to reduce the amount of contaminants entering into the Waikato and Waipā catchments to achieve the Vision and Strategy/Te Ture Whaimana o Te Awa o Waikato of making the **river swimmable and viable for food collection along the entire length of the river.**

The Waikato River Authority is a Crown / Iwi organisation established in 2010 to oversee the Vision & Strategy for the improved health and wellbeing of the Waikato River and Waipā River. In addition, WRA oversees the Waikato River Clean-up Trust (WRCuT) to support and coordinate the restoration efforts of community and iwi. The Crown allocated \$220 million over 30 years to support the clean-up and restoration activities of the rivers in addition to other funding provided to river restoration activities by central and local government organisations, non-government organisations, iwi, private landowners and others.

To maximise opportunities to realise the Vision & Strategy (and by extension the NPS FW), WRA spearheaded efforts together with WRC and Dairy NZ to develop a Restoration Strategy. A wide range of activities and project opportunities have been identified in six areas:

- Erosion and sedimentation
- Water quality
- Biodiversity
- Fish
- Access and recreation
- Cultural values.

To give effect to the strategy, all stakeholders need to contribute and play a role – iwi, land owners, urban and businesses, communities, NGOs. Funding is available from WRC and WR; however, more investment and finance needs to be accessed to deliver the strategy and achieve the Vision.

History of Wāipa

The Waipā River has deep cultural significance to the Maniapoto river iwi. The responsibility to exercise kaitiakitanga led to the the Te Mana o Te Awa o Waipā (Nga Wai o Maniapoto (Wāipa River) Act 2012). The Ngā Wai o Maniapoto (Waipā River) Act 2012 was enacted with the purpose to restore and maintain the quality and integrity of the waters that flow into and form part of the Waipā River for present and future generations and the care and protection of te mana tuku iho o Waiwaia.

The upper Waipā River catchment covers over 300,000 ha of primarily pastoral farmland and residential areas associated to small townships including Ngaruawahia, Pirongia, Te Awamutu, Otorohanga, and Te Kuiti. The catchment has gone through significant transformation since the middle of 19 century – involving large scale conversion of forested areas into pasture and the drainage of wetlands that has weakened the integrity of the river ecosystem.

Ongoing development pressures and associated degradation of the Waipā River catchment has resulted in the decline of its rich fisheries and other food sources which had sustained the people of Maniapoto and their ability to meet their obligations of manaakitanga (e.g., Cunningham 2014). Remnants of the original landscape are scattered through the catchment and include indigenous vegetation, the peat lakes and wetlands which provided key habitat for native species and important ecosystem services. This habitat is critical to many plant, native fish, invertebrate, and bird species, and provide important ecosystem services such as nutrient removal, flood mitigation, and trapping

sediment. The restoration of river water quality, which is significantly compromised by the existing pastoral land use¹¹⁷, is very important.

Waikato and Wāipa River total environmental loads per annum

Catchment	Area (ha)	N leach (kg)	P Loss (kg)	Sediment (tonnes)	E Coli (peta)
Waikato River total	1,095,065	11,800,136	857,488	981,948	1,653
Waipā catchment total	309,332	4,143,495	287,077	394,073	438
% Waikato total	28%	35%	33%	40%	27%
Upper Waipā study area total	130,351	1,685,561	163,937	228,568	151
% Waipā catchment total	42%	41%	57%	58%	34%

Source: MOTU 2017

Waipā Catchment Plan (WCP) 2014-2034

The Waipā Catchment Plan has been developed in collaboration with the Waipā Zone Liaison Subcommittee (which includes a number of farmers) and representatives of iwi, government agencies and industry. WCP outlines a 20-year plan to support the restoration and protection of the health and wellbeing of the Wāipa River (and the Waikato River).

The plan implementation is led by the WRC's Integrated Catchment Management directorate in partnership with Wāipa and Waikato river iwi and catchment stakeholders, and actively involves the wider community. It is intended to guide Waikato Regional Council, Waipā river iwi, communities and other stakeholders in the implementation of integrated catchment management activities within the Waipā River catchment.

The plan includes:

- The 20-year goals for the catchment.
- Strategies to achieve the goals.
- Implementation actions for the strategies, focusing on priority catchments for action.
- The funding strategy for implementation activities.

The WCP contributes to the Vision and Strategy for the Waikato River, and WRC' Strategic Directions and the objectives, policies and methods including the Regional Policy Statement (RPS)¹¹⁸ and the Waikato Regional Plan (WRP).

The WCP will complement any future changes to the WRP including Healthy Rivers Plan Change 1.

The Maniapoto Iwi Environmental Management Plan

¹¹⁷ Waikato River Independent Scoping Study. NIWA 2011

¹¹⁸ <https://www.waikatoregion.govt.nz/assets/WRC/Council/Policy-and-Plans/RPS-Regional-Policy-Statement/WaikatoRegionalPolicyStatement2016.pdf>, accessed on 28 October 2018

The 2016 Maniapoto Iwi Environmental Management Plan¹¹⁹ describes the aspirations, intent and priorities for achieving a safe and healthy environment. The key objectives of the plan are to provide a Maniapoto-wide strategy to enhance and sustain the exercise of kaitiakitanga over the natural environment within Maniapoto, and to support the leadership of marae, hapū and regional management committees at the forefront of exercising kaitiakitanga in the Waipā River catchment (Maniapoto Māori Trust Board 2007).

The knowledge provided by Maniapoto whānau during this project has been summarised in the following section under the four principles of the 2016 Maniapoto Iwi Environmental Management Plan, namely¹²⁰:

- Rangatiratanga – The principle that Maniapoto will facilitate informed and effective decision making on matters within the Maniapoto rohe;
- Kaitiakitanga – The principle of responsible guardianship to maintain and enhance a safe and healthy environment for the present and for generations to come;
- Kotahitanga – The principle that Maniapoto will work constructively with others to achieve a safe and healthy environment for future generations; and
- Tūmanako – The principle that Maniapoto will strive for a safe and healthy environment and a sustainable environmental future for future generations.

Impact Investment as opportunity for Vision and Strategy delivery

To support and accelerate the implementation of the Restoration Strategy and Healthy River plan change, and realise the Vision and Strategy, the Waikato River Authority has spearheaded work to explore the development \$100 million investment bond as a pathway to access capital and transform farms in the catchment to regenerative organic operations. Targeted change of farm systems throughout the catchment could rapidly accelerate the environmental targets sought under the Healthy River plan change.

That assessment process identified hotspots within the catchment where the load of sediment, E. coli and nutrient were high. A conversion to organic farming is a viable land use model to help expedite the implementation of Vision and Strategy and give effect to HRPC while also maintaining economic outcomes.

When converted, an estimated 40-45 per cent reductions in main water contaminants - E. coli, phosphorous, nitrogen and sediment – as well as identical reduction in greenhouse gas emissions is envisaged.

The project evolved out of the plan change process when the WRA sought ways to restore and protect the Waikato and Waipā River catchment. An information memorandum outlining the investment has just been released by the WRA. The project included the Maniapoto Māori Trust.

If it finds investor support, the project would be the first large scale environmental impact investment project of its type launched in New Zealand.¹²¹

Analysis of process & drivers and relevance to OLW

¹¹⁹ <https://www.maniapoto.iwi.nz/ko-ta-maniapoto-mahere-taiao-maniapoto-environmental-management-plan/>, accessed on 23 November 2018.

¹²⁰ <https://www.waikatoregion.govt.nz/assets/WRC/Council/Policy-and-Plans/HR/S32/Part-A/Tipa-G-et-al-2014.-Maniapoto-priorities-for-the-restoration-of-the-Waipā-River-Catchment.-NIWA-client-report-no.-WEL2015-3-prepared-for-Maniapoto-Trust-Board.pdf>, accessed on 28 October 2018.

¹²¹ <https://www.stuff.co.nz/waikato-times/business/108738626/waikato-river-authority-unveil-investment-plan-to-clean-up-waipā-catchment>

Below is a brief overview/analysis of the most important elements from a catchment management and environmental outcome perspective.

Public policy drivers

Public policy drivers (specifically NPS for FW) combined with statutory requirements as result of settlement process i.e giving effect to the Vision and Strategy, have created a synergic context to pursue joint outcomes and benefits (environmental, social, cultural), including sustainable land use. This is reflected in the Regional Policy Statement¹²²

Private sector drivers (supply chain requirement)

The intensification patterns (especially via shifts from dry stock to dairy land use) are a result of opportunity to capture value in the supply chain through higher revenue returns in dairy. Volatility in dairy pay-out and the pressure of HRPC have now tempered the intensification drive and some of the land owners are looking at other models for maintaining/improving returns while also reducing environmental footprint.

Land-use focus (land use change and value add outcomes)

All land uses are covered as part of catchment planning. Dairy land use is used as benchmark for the nitrogen reference point and in setting limits.

This aspect is not addressed as part of the processes to reduce environmental load; however, the economic implications of water quality limits have been considered as part of the economic impact study for NPS. A value-add approach presents a better alternative for exploring land use and water limits – which is partly what Maniapoto tried to do with their work on opportunities for under-developed maori land.

Process (collaborative, sectoral integration¹²³ etc)

All processes have followed a collaborative approach, underpinned by technical and science support for good decision making. The focus on water (and to a lesser extent land use) are a reflection of the importance of NPS FW in driving policy and planning processes at regional, district and catchment level.

Limits setting approaches

Waikato Regional Council uses Nitrogen Reference Point information from dairy farms to determine the 75th percentile nitrogen leaching value (kilograms of nitrogen leached per hectare/ per year in each Freshwater Management Unit (FMU)), using the values provided by dairy farming properties and enterprises. All farming activities whose NRP is above 75% percentile not just dairy farming activities, will be required to reduce their discharges to the 75th percentile, by July 2026.

The NRP approach is used instead of the more common grandparenting approach in order to avoid locking in pre-existing levels of nitrogen, including¹²⁴:

- prevent any increase in nitrogen loads over the next 10 years,
- quantify existing nitrogen loads to help inform future policy, and
- require the highest NRPs to come down to the 75th percentile.

Overview of tools applied

¹²² <https://www.waikatoregion.govt.nz/assets/WRC/Council/Policy-and-Plans/RPS-Regional-Policy-Statement/4686-RPS-summary-document-WR.pdf>

¹²³ Sectoral integration could go beyond water and land use to consider carbon/energy.

¹²⁴ <https://www.waikatoregion.govt.nz/council/policy-and-plans/plans-under-development/healthy-rivers-plan-for-change/infosheets/nitrogen-reference-points/>

A range of tools are being deployed concurrently or in sequence vis a vis water and land use:

Rules and regulations linked to NPS¹²⁵

- Nitrogen reference point and limit setting based on percentile
- Water allocation
- Farm Environment Plans
 - prepared by certified consultants
 - distinguish between farms that belong to a Certified Industry Scheme or not
- Land use change (greater than 4.1 ha): expansion of non-complying activities that require resource consent:

Current land use	Future land use
Woody vegetation	Pastoral farming
Any livestock grazing and/or arable cropping	Dairy farming
Any land use	Commercial vegetable growing

Incentives

- Financial assistance: non-reimbursable grants from WRC and/or WRA for projects and activities related to the Restoration Strategy, Strategy & Vision
- Rate rebates for Significant Natural Areas.

Te Ao Māori considerations

The Maniapoto Māori Trust Board is the iwi authority for Maniapoto. Consultation and collaboration with Maniapoto is weaved throughout planning and policy processes. The approach that Maniapoto was strategic to achieve maximum influence through clarity around aspirations and goals, outcomes, inclusion in statutory processes and finance allocation:

- develop The Maniapoto Iwi Environmental Management Plan that includes the aspirations, values, outcomes that whanau is seeking (updated in 2016)
- The Ngā Wai o Maniapoto (Waipā River) Act 2012 was enacted with the purpose to restore and maintain the quality and integrity of the waters that flow into and form part of the Waipā River for present and future generations
- Joint Management Agreement between Ngati Maniapoto and Waikato District Council, Wāipa District Council, Waitomo District Council, Otorohanga District Council and the Waikato Regional Council signed the
- Maniapoto aspirations and goals included in RPS, Restoration Strategy, Healthy River Plan change thus ensuring a level of operationalisation and access to funding.

Linkages to investment/new business models

There is a strong linkage between Wāipa catchment objectives and the investment made available by WRA, WRC and other organisations. Maniapoto has also been active in seeking opportunities to develop Māori land within the values set by the iwi. In addition, they have supported impact investment as a pathway to access capital to help with Vision and Strategy but potentially also create business opportunities. development of value chains and new business models (including in the context of diverse, mixed farm enterprise and re-localisation of value chains).

Funding committed to restoration activities in Wāipa catchment in the past 3 years has totalled approximately \$8.6M (\$3M WRC, \$3M WRA and \$2.6M landowners).¹²⁶ The investment is significant but small to the estimated total budget for the strategy \$340 million.

Conclusion

The Upper Wāipa Catchment was selected as a case study due to the coordinated, long term approach and the strategic combination of statutory processes and obligations, with finance and investment to pursue the Vision and Strategy for the river and people.

This is a unique process in New Zealand and the focus on restoration, local indigenous biodiversity and cultural values also means that the catchment is in a good position to respond to upcoming policies linked to carbon and biodiversity.

Whereas the Waikato River Authority and Waikato Regional Council both measure the progress in terms of people and ecosystem health, there seems to be an opportunity to provide for more responsibility and accountability at catchment level, beyond setting policy frameworks and strategies. Devolved accountability can be an area of research for the Challenge. Likewise, the process for limits setting, while avoiding a grandparenting approach, it needs inquiry in terms of delivering nutrient reduction outcomes. Lack of capability and access to knowledge about sustainable land use and policy context as well as difficulty in accessing capital for development of Māori free hold land are continuing challenges for Maniapoto.

Waipaoa Catchment, Gisborne District

Constraints to policy interventions encouraging sustainable land use

Background

The Gisborne district is governed by a unitary authority that has the Regional and District Council functions combined. The district is dominated by steep hill country on raised seafloor sediments. The hill country still retains significant indigenous land cover; largely as a result of inaccessibility and slope factors. Forestry and pastoral farming (sheep and beef) are the historically predominant economic activities in the hill country.

The most productive lands of the Gisborne district are found within the Poverty Bay Flats; some 11,000 ha of extremely deep silts laid down by historical flooding events in the Waipaoa River. The marine sediments provide a particularly fertile soil. The flatland is dominated by horticultural and arable production with major crops including wine grapes, squash, broccoli, lettuce, citrus, kiwifruit, corn, maize and apples.

Land in the hill country of the Waipaoa catchment is dominated by Māori agribusiness with nearly 50,000 ha managed by 2 Māori Trusts responsible for administering land on behalf of a mix of iwi (Te Aitanga-a-Māhaki, Rongowhakaata, Ngāi Tāmanuhiri and Te Aitanga-a-Hauiti). Some iwi still await progress of claims and settlement under Treaty of Waitangi legislation. There is some dispute over land ownership and/or control and there are many potential owners and managers. There is significant Māori land holding on the Waipaoa / Poverty Bay flats as well. Much of this land is leased on either a long-term or short-term basis.

Flood protection networks on the Waipaoa flats provides the opportunity to invest in high value crops with some security. The Gisborne climate provides the warmest summer mean temperature

¹²⁶ Personal communication, WRC Integrated Catchment Management group.

in New Zealand, giving an early-season market advantage to Gisborne. Rainfall is on average 1050 mm annually¹²⁷, and the region experiences tropical cyclones that can bring intense rainfall in short time periods.

Cyclone Bola, (March 1988) was the most significant such event in recent history. It followed extensions of the flood protection network commenced in 1987 following protracted negotiations.¹²⁸ Cyclone Bola overwhelmed the recently completed network destroying farmland and crops and wreaking havoc on the hill country, particularly in established pine plantations (many funded by government assistance) on shallow sedimentary soil.

Some of the slips caused (such as the Tarndale slip) are still influencing water quality in the Waipaoa today, and will for years to come. Cyclone Bola resulted in \$111 million worth of government assistance that was spent mostly on road repairs, flood protection and economic development. Emergency water facilities were built on the banks of the Waipaoa River to provide the city of Gisborne with water should such an event re-occur. Cyclone Bola was the catalyst for a major plan change limiting the extent of forestry planting and harvesting on some lands within the catchment. This year prosecutions of forestry companies have been launched¹²⁹ following another event where widespread damage caused by discharges of forestry slash in Tolaga Bay.

More recently the government has announced a major assistance package to Gisborne through the Provincial Growth Fund¹³⁰ to improve economic performance.

Water quality and quantity in the Waipaoa catchment

The quality of fresh water is most significantly influenced by elevated sediment discharges. Suspended sediment discharge changed from 2.3 ± 4.5 to 14.9 ± 8.7 Mt yr⁻¹ during the Anthropocene, increasing by 140% after Polynesian arrival, by 350% after European colonization, and by 660% after the catchment headwaters were deforested.¹³¹ Compared to this influence the impact of fertiliser use and bacterial discharge from livestock and human sources has been relatively low, although there are some problems with these contaminants in subcatchments of the river system such as the Taraheru subcatchment.

A Plant and Food report modelling nutrient loss in Gisborne cropping systems¹³² revealed some of the lowest nutrient loss figures estimated for horticultural cropping systems in New Zealand. These estimates are influenced significantly by climate and the nature of soil deposited in the Poverty Bay Flats; with a recent report suggesting attenuation of leached nitrogen may be as high as 90%¹³³. There is still research required to confirm this, but recent testing¹³⁴ conducted to assess the viability of aquifer recharge identified high methane gas discharges indicative of anaerobic conditions.

¹²⁷ Niwa climate data

¹²⁸ <http://gisborneherald.co.nz/localnews/3270255-135/looking-back-at-devastating-cyclone-bola>

¹²⁹ <https://www.stuff.co.nz/business/farming/109025916/prosecutions-over-flood-triggered-logging-debris-on-east-coast>

¹³⁰ https://www.nzherald.co.nz/nz/news/article.cfm?c_id=1&objectid=12121050

¹³¹ Modeling suspended sediment discharge from the Waipaoa River system, New Zealand: The last 3000 years. A. J. Kettner B. Gomez J. P. M. Syvitski 12 July 2007.

¹³² Land Management Practices and Nutrient Losses from Farms on the Poverty Bay Flats Gentile R, Green S, Mason K, van den Dijssel C, Johnstone P, Clothier B. August 2014

¹³³ Waipaoa River Catchment Modelling Gisborne District Council and Horticulture New Zealand SOURCE Modelling Report 2 | Final 15 August 2016

¹³⁴ <https://www.gdc.govt.nz/assets/Files/Major-projects/Manager-Aquifer-Recharge/Initial-injection-test-June-2017.pdf>

Water quantity is a significant limitation for establishment of high value production systems on the Poverty Bay Flats.¹³⁵ No reliable surface water allocation remains in the catchment and a waiting list of applications is in force. Groundwater allocation is currently estimated to be approximately six times current actual use and a clawback process has been established under the NPS Freshwater. This is as a result of established groundwater decline in major aquifers including the Makauri and Matokitoki aquifers confirmed in 2012 by GNS.¹³⁶

Māori agribusiness developments have been hampered by the availability of water. Less than 3000 of a potential 11000 hectares of the Flats are currently irrigated.¹³⁷ Some recent applications by Māori agribusinesses have been turned down and others have had to implement localised surface water storage at considerable cost to ensure reliable water is available.

Other agribusiness investments of note that are under threat include Leaderbrand Produce Ltd; a major supplier of high value vegetable crops with a dominant position in the domestic supply of salads and broccoli to the domestic market as well as a range of export vegetable crops. The existing consent arrangements and overall shortage of water availability not only limit opportunities for growth but also threaten existing investment in high value production systems. The effects on the Gisborne community have been calculated and are of extreme concern. Since the 2012 GNS report options to enhance water availability have been sought. Managed aquifer recharge is being trialled and is a contentious issue for the Gisborne community. Some iwi support recharge and some oppose it. Despite the opposition consents have been granted for trials, but an operative solution to water shortages is still some way off. Major impediments include a lack of sound environmental baseline data and tools to model groundwater flows to illustrate the impact of future scenarios on water quality and quantity. A significant body of research has been completed in the last 9 years, but the tools to assist the community to evaluate potential futures are not completed. There is also a significant piece of work to be completed on the cultural impacts of different water futures.

Regional Planning Processes

In 2009 Gisborne District Council began planning for a freshwater plan. The Council at that stage was the only council in the country not to have a targeted freshwater plan. Water management was governed by some existing provisions in the general plan and consent to take and use water renewed as a controlled activity¹³⁸ with a 5-year term. Concerned about the potential costs of conflict in developing a freshwater plan, Gisborne District Council established a collaborative process with stakeholders and partners; The Freshwater Advisory Group.¹³⁹

The group was formed as a Committee in Council with the 1st meeting held on 8 December 2010. Subsequent meetings occur through to March 2015 averaging one meeting every 2 months. At the conclusion of the collaborative process a draft proposed Freshwater plan was issued for public comment. After public comments were received the plan was notified in October 2015 with hearings leading to a decision by Commissioners in 2017. The decisions version of the plan was appealed to the Environment Court by a range of parties. Court assisted mediations in 2018 have resolved many appeal points; the forestry sections of the plan are still under appeal and may be pursued to Environment Court hearings.

¹³⁵ Regional Economic Impacts of the Makauri Managed Aquifer Recharge Scheme, Gisborne 29 June 2017. Market Economics, Ayers, M.J., McDonald, G.M.

¹³⁶ White, P.A., Moreau-Fournier, M., Tschritter, C., Murphy, P. 2012. Groundwater in the Poverty Bay Flats, GNS Science Consultancy Report 2012/106. 67p.

¹³⁷ An assessment of the economic value of irrigation on the Poverty Bay Flats Prepared for: Gisborne District Council and Horticulture New Zealand Prepared by: The AgriBusiness Group February 2012.

¹³⁸ Controlled activity status allows a council to indicate matters of control within the consent, but not to decline the renewal of the consent.

¹³⁹ <https://www.gdc.govt.nz/freshwater-advisory-group/>

Over the same period; Council supported by other parties (in particular the horticulture industry) continue to progress research into managed aquifer recharge; to determine the viability of taking surface water in the winter from the Waipaoa River and injecting groundwater systems (the Makauri Aquifer) to stabilise aquifer decline and potentially provide additional water for irrigation of land and other uses in the summer months when water is scarce.

An initial consent was granted to the Gisborne District Council in 2017 despite significant opposition from the Rongowhakaata Iwi Trust over concerns about impacts on the aquifer and iwi rights and interests in freshwater. The consent was granted for a two-year trial. An extension of the pilot has also recently been granted consent, again with continued opposition from Rongowhakaata Iwi Trust.¹⁴⁰

Current situation

The following outcomes have resulted from the freshwater planning processes:

1. Clawback of paper over allocation has commenced on the latest round of groundwater consent renewals. Some parties are considering challenge the clawback process.
2. While scientific experts were able to agree the status of freshwater objectives for quality and quantity, the general conclusion was that freshwater quality limits could not be established with the current tools available; meaning there is still significant work to be undertaken to meet the requirements of the Freshwater NPS 2017. Impediments include changes in the monitoring methodology of Council over time; lack of a functioning groundwater model to connect land and freshwater outcomes; and a lack of resolution over iwi rights and interests in freshwater.
3. While significant progress has been made to improve land management regulations to protect water quality, the absence of hard limits is a partial obstacle to regulatory enforcement. Further plan changes will be required.
4. The plan change has resulted in a limited opportunity to progress a functioning recharge scheme for the aquifers; although the bar for success is very high; with a successful application requiring demonstration of positive social, economic environmental and cultural benefits. Any functioning scheme would still require a noncomplying¹⁴¹ activity consent process.

Conclusion

It has taken over 10 years to partially implement the NPS for freshwater. Investment of time and resources has been significant. A major challenge will be integration of climate change policy in the prediction of climate change impacts on infrastructure and investment.

While significant consensus has been established on a number of issues there are still legitimate concerns regarding iwi rights and interests in freshwater; and the potential for appeals regarding the forestry sections of the plan. A greater emphasis on communication of very complex issues is required.

The Gisborne region and the Gisborne District Council have undertaken a highly complex process in good faith with limited resources compared to other councils; and the shortage has only partially been offset by external funding from central government in recognition of the economic situation in the region. The Gisborne District Council is now faced with implementation of catchment

¹⁴⁰ <https://www.gdc.govt.nz/managed-aquifer-recharge-trial/>

¹⁴¹ A noncomplying activity consent process requires the application to demonstrate that effects are less than minor if the application is to be granted.

management plans for the rest of the region; alongside a future process to complete implementation of the NPS for freshwater management prior to 2025.

ANNEX 4 Continuous improvement approach

This is an example of continuous improvement approach used in industry in Japan. A focus on continuous improvement present an alternative to limit setting implications and practices at farm level.

The Top Runner Programme, Japan Continuous improvement in regulatory setting

Japan's Top Runner Programme, introduced in 1999, is a set of energy efficiency standards for energy intensive products, such as home appliances and motor vehicles. As of 2014, the programme involved 23 product categories. The programme now is also used as a key tool for climate change policy. Products are included due to either their high energy or widespread use or their substantial scope for improving energy efficiency. Energy efficiency targets are set to be achieved within a given number of years on the basis of the most efficient model on the market (the 'Top Runner'). This sets off the continuous improvement approach which Japan has famously applied as a management principle. An adaptation for farming is possible, using nutrient leaching or carbon sequestration as parameters for performance.

Description

Japan's Top Runner programme is an on-going regulatory scheme designed to stimulate the continuous improvement of the use-phase energy efficiency of products within selected segments of markets for household and office appliances, vehicles, etc.

Through its design, the Top Runner programme undergoes recurring revisions, allowing its scope to be continuously modified. In iterative cycles, it introduces product-specific energy performance requirements, where the basis for the adoption of standards is pre-defined as the use-phase energy performance of the best technology available on the market at the time of revision. Exact standard levels, however, along with appropriate target years, are agreed on in extensive consultative processes involving several stakeholder groups. Thereafter, when promulgated by the regulator, the targets become mandatory for all manufacturers and importers in Japan (except for very small actors).

Japan's Top Runner programme demonstrates the benefits that can be accrued within a framework that commits stakeholders through involvement in common target setting (very similar to a collaborate freshwater process). It is modular and iterative and it lends itself well to monitoring and evaluation efforts, which can easily be incorporated into the common, overarching framework. Which indicators to monitor and to evaluate against depends on the programme's explicit objectives and on the ambitions of the regulator.

ⁱ Stats NZ, Retrieved from http://archive.stats.govt.nz/browse_for_stats/businesses/business_finance/dairy-farming-article.aspx

ⁱⁱ Bennion, T. (2018). The end of the beginning for Te Waihora? *Te Karaka 79*. Retrieved from https://ngaitahu.iwi.nz/our_stories/he-whakaaro-the-end-of-the-beginning-for-te-waihora/

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- ⁱⁱⁱ Joint Management Plan (JMP). (2005). *Te Waihora Joint Management Plan: Mahere Tukutahi o Te Waihora*. Christchurch: TRONT/DoC.
- ^{iv} <https://mahi.ngaitahu.iwi.nz/business-groups/ngai-tahu-farming>; <https://ngaitahu.iwi.nz/investment/ngai-tahu-farming-2/>
- ^v RNZ. (2011, November 10). Ngai Tahu defends dairy farming plans. *RNZ*. Retrieved from <https://www.radionz.co.nz/news/te-manu-korihi/90575/ngai-tahu-defends-dairy-farming-plans>
- ^{vi} <https://ngaitahufarming.co.nz/land/>
- ^{vii} Stuff. (2016, March 10). Ngai Tahu looks beyond the horizon. *Stuff*. Retrieved from <https://www.stuff.co.nz/business/farming/77761067/ngai-tahu-looks-beyond-the-horizon>
- ^{viii} Rural News Group. (2016). Standards set high and obtained. *Rural News Group*. Retrieved from <https://www.ruralnewsgroup.co.nz/rural-news/rural-management/standards-set-high-and-obtained>; <https://ngaitahuproperty.co.nz/news/ngai-tahu-farming-and-lincoln-university-partner-for-best-dairy-farm-practices/>
- ^{ix} Chalmers, H. (2014, October 30) Ngāi Tahu Farming replaces forestry with 14,000 cows at Eyrewell. *Stuff*. Retrieved from <https://www.stuff.co.nz/business/farming/108049548/ngai-tahu-farming-replaces-forestry-with-14000-cows-at-eyrewell>; https://ngaitahu.iwi.nz/our_stories/ngai-tahu-farming-lincoln-university-announce-partnership/
- ^x ECan. (2014, March 25). Ngāi Tahu Farming dairy farm wins Canterbury regional award. *Scoop*. Retrieved from <http://www.scoop.co.nz/stories/BU1403/S00822/ngai-tahu-farming-dairy-farm-wins-canterbury-regional-award.htm>
- ^{xi} Harris, R. C. (2015). *The changing face of co-governance in New Zealand—how are Ngāi Tahu and Ngāi Tūhoe promoting the interests of their people through power-sharing arrangements in resource management?* Master's thesis, University of Canterbury, Christchurch; OAG; Waihora Ellesmere Trust (WET). (2015). *Assessment of the cultural health of Te Waihora*. Retrieved from <http://www.wet.org.nz/wp-content/uploads/2015/10/2015-Te-Waihora-Cultural-Health-Report.pdf>
- ^{xii} Rennie, H., & Lomax, A. J. (2010). Acronyms, acronyms everywhere... Water players and programmes in the Selwyn/Christchurch area. *Lincoln Planning Review* 2 (1): 11-14.
- ^{xiii} McCrone, J. (2017, September 9). Can Canterbury afford to wait for ECan's water improvement strategy to work? *Stuff*. Retrieved from <https://www.stuff.co.nz/the-press/96610426/Can-Canterbury-afford-to-wait-for-ECans-water-improvement-strategy-to-work>
- ^{xiv} SDC, <https://www.selwyn.govt.nz/news-And-events/news/selwyn-growth-a-continuing-success-story>; Dairy Investment Fund Limited (2010). Financial performance of dairy farms by region. Retrieved from <https://www.tdb.co.nz/wp-content/uploads/2016/05/011010-DairyFarm-FinancialPerformance.pdf>
- ^{xv} Ivamy; Based on \$7500 x 43,000ha versus \$1,200 x 43,000ha. It is acknowledged that not all the CPW is used for dairy but for ease of calculation it is treated as such.
- ^{xvi} Ivamy, D. (2009). *Mapping the environmental footprint of the Central Plains Water irrigation scheme*. Master's thesis, Massey University, Palmerston North; Pangborn, M. C. (2012). *Growth and innovation in the Canterbury dairy industry*. Doctoral dissertation, Lincoln University, Canterbury; Wynyard.
- ^{xvii} Burton, R. J., & Wilson, G. A. (2012). The rejuvenation of productivist agriculture: the case for 'cooperative neo-productivism'. In *Rethinking agricultural policy regimes: food security, climate change and the future resilience of global agriculture* (pp. 51-72). Emerald Group Publishing Limited; Eppel, E. (2015). Canterbury water management strategy: 'A better way'? *Policy Quarterly*, 11(4); McCrone 2017; Wynyard, M. (2016). *The price of milk: Primitive accumulation and the New Zealand dairy industry 1814-2014*. Doctoral dissertation, University of Auckland, Auckland.
- ^{xviii} While there is both a CPW trust and a CPW company, CPWT and CPWL, here the term CPW will be used for simplicity.
- ^{xix} Fulton, T. (2015, September 29). Central Plains Water trustees gave banks security in return for financing. *Stuff*. Retrieved from <https://www.stuff.co.nz/business/72415795/central-plains-water-trustees-gave-banks-security-in-return-for-financing>
- ^{xx} Wynyard.

^{xxi} Wynyard.

^{xxii} Boone, S., & Fragaszy, S. (2018). Emerging Scarcity and Emerging Commons: Water Management Groups and Groundwater Governance in Aotearoa New Zealand. *Water Alternatives*, 11(3), 795-823; Hardy, A. (2018, October 1). The value of water: Differentials in water supply options should be taken into consideration with land valuations. *New Zealand Dairy Exporter*, 103–104; Rennie, H. (2014). The Selwyn Waihora catchment: A triumph for collaborative management? *Resource Management Journal* 3: 31-35.

^{xxiii} Ivamy; Eppel.

^{xxiv} Ivamy; Based on \$7500 x 43,000ha versus \$1,200 x 43,000ha. It is acknowledged that not all the CPW is used for dairy but for ease of calculation it is treated as such.

^{xxv} Colliers International. (2018, October). Dairy property market review. Retrieved from <https://www.colliers.co.nz/~ /media/new%20zealand%20website/files/research/rural%20and%20agribusiness/2018%20colliers%20canterbury%20dairy%20property%20market%20report%20spreads.ashx/> The report provides the average price per hectare, total value is taken from \$36,750 x 43,000ha.

^{xxvi} Radio New Zealand. (2017, April 18). Water fools? - Worry in Waihora. *RNZ*. Retrieved from <https://www.radionz.co.nz/programmes/water-fools/story/201840731/water-fools-worry-in-waihora>

^{xxvii} Bennion, T. (2018). The end of the beginning for Te Waihora? *Te Karaka* 79. Retrieved from https://ngaitahu.iwi.nz/our_stories/he-whakaaro-the-end-of-the-beginning-for-te-waihora/

^{xxviii} Mitchell.

^{xxix} Hutching, C. (2017b, April 6). Irrigation move supports environmental limits. *Stuff*. Retrieved from <https://www.stuff.co.nz/the-press/business/102886903/irrigation-move-supports-environmental-limits;>

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^{xxx} Hutching 2017b.

^{xxxi} Rennie & Lomax.

^{xxxii} Chittock, D. K. (2016). *The management of Lake Ellesmere/Te Waihora: An assessment of the integration of co-governance and community agreements into a nested, statutory management plan* (Doctoral dissertation, Lincoln University).

^{xxxiii} Rennie & Lomax.

^{xxxiv} McCrone, J. (2015, May 23). The deal to Clean Lake Ellesmere. *The Press*. Retrieved from <https://www.stuff.co.nz/the-press/business/68674419/lake-ellesmere-cleanup-deal-explained>; Memon, P. A., Kirk, N. A., & Selsky, J. W. (2011). Limits to ecological modernisation as a framework for sustainable fresh water governance. *Land use Policy*, 28(3), 534-541; Office of the Auditor General (OAG). (2016). *Principles for effectively co-governing natural resources*. Wellington: OAG. Retrieved from <https://www.oag.govt.nz/2016/co-governance/docs/co-governance-amended.pdf>; Rennie, H. G. (2015). A failed attempt at collaborative water planning: Selwyn Waihora Variation. *Lincoln Planning Review*, 7 (1-2): 23-27; Rodgers, M. (2014, September 8). Canterbury's water still declining. *The Press*. Retrieved from Factiva.

^{xxxv} Chalmers, H. (2018, July 10). Canterbury irrigation scheme on target. *Stuff*. Retrieved from <https://www.stuff.co.nz/business/farming/105336592/canterbury-irrigation-scheme-on-target>; the \$1 billion is based on the assumption that all the land in the scheme has been converted to dairy, which is not correct but no reliable figures exist to show what percentage of the land has been converted. This figure is taken from a recent scoping paper for Hawkes Bay Regional Council, <https://www.hbrc.govt.nz/assets/Document-Library/RWSS-Documents/Case-Study-Ashley-Farm.pdf>, where the cost of conversion (excluding irrigation and Fonterra shares) if land use was changed is between \$4,106,000 and \$6,509,500 (median cost \$5,307,750) per farm, divided by mean farm size in report of 240ha times the 43,000ha of the scheme = \$950,971,875.

^{xxxvi} Fonterra has over a billion dollars invested in infrastructure in the region, with a \$500 million drying facility and \$150 million cheese plant at Darfield, which is in the catchment. Synlait has a plant in Dunsandel, in the catchment zone, they have spent \$240 million on. Westland has a \$40 million plant in Rolleston, also in the catchment.^{xxxvi} A new \$15 million production facility is being built by Keytone Dairy, also in Rolleston. Jamestrong has a \$13 million packaging plant in Christchurch.

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^{xxxix} Chalmers, H. (2018a, July 10). Canterbury irrigation scheme on target. *Stuff*. Retrieved from <https://www.stuff.co.nz/business/farming/105336592/canterbury-irrigation-scheme-on-target> Chalmers estimates farmers are paying \$800 per hectare in water charges, with \$600 servicing debt over the next 40 years. $\$800 \times 43,000\text{ha} = \$ 34,400,000$, $\$600 \times 43,000\text{ha} \$25,800,000$.

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