OUR LAND AND WATER | Toitū te Whenua, Toiora te Wai | National SCIENCE Challenges | SCION forests · products · innovation | Plant & Food RESEARCH RANGAHAU AHUMĀRA KAI | agresearch | LANDCARE RESEARCH MANAAKI WHENUA

CO-INNOVATION LEADS TO HIGH IMPACT INDICATORS

Our Land & Water National Science Challenge

Indicators Think-Piece

Authors: Loretta Garrett (Scion), Anne-Gaelle Ausseil (Landcare Research), Tracy Williams (Plant & Food Research), Estelle Dominati (AgResearch) and John Dymond (Landcare Research)

Contents outline

Contributors: The following individuals and organisations have joined us in the spirit of co-innovation and generously contributed time and expertise to this project.

Name	Organisation
Bruce Thorrold	Our Land and Water Theme Leader, Dairy NZ
John Quinn and Chris Tanner	Our Land and Water Theme Leader, NIWA
Ken Taylor	Director, Our Land and Water
Tim Payn	Scion
Tim Barnard	Scion
Peter Clinton	Scion
Mike Beare	Plant & Food Research
Garth Harmsworth	Landcare Research
Jon Manhire	Agribusiness Group, Lincoln University
Henrik Moller	University of Otago
Mereana Wilson	Ministry for the Environment
Deborah Burgess	Ministry for the Environment
Clare Bear	Ministry for Primary Industries
Kate McNutt	Department of Conservation
Dave West	Department of Conservation
Elaine Wright	Department of Conservation
Meredith McKay	Department of Conservation
Kirsty Johnston	Environment Canterbury
Haydon Jones	Waikato Regional Council
Geoff Ridley	Beef + Lamb NZ
Iain Maxwell	Hawke's Bay Regional Council
Charlotte Rutherford	Fonterra

1. THE CHALLENGE WITH INDICATORS

'Enhancing primary sector production and productivity while maintaining and improving our land and water quality for future generations' is the mission of New Zealand's Our Land & Water National Science Challenge. New Zealand land use is dominated by primary production sectors, and competing pressures are increasing between the economic, environmental, social, and cultural values or drivers that stakeholders express. These values may be expressed through various mechanisms, including their preferences, opinions or consumer patterns in relation to New Zealand Inc., food safety, biodiversity, soil quality, etc. These values or drivers are often in tension due to the diversity of perspectives held by stakeholders.

To guide its investments and activities and inform future evaluations of its performance, the Challenge commissioned a Think-Piece to address the question:

`What is the ***most appropriate suite of land and water indicators*** *to show progress in meeting domestic and international drivers and commitments and achieve the Challenge Mission?'*

The proposal for this Think-Piece was required to present a central hypothesis for testing. In addressing the question posed by the Challenge the research team adopted the hypothesis: *`That co-innovation leads to high impact indicators'* because the Challenge has already made a clear commitment to deliver its outcomes using co-innovation approaches. These approaches involve stakeholders in design and implementation processes to help ensure results are representative, usable and deliver impact. The team reviewed existing indicator initiatives, assessed current approaches to the design and use of indicator sets, and explored the contribution that co-innovation might make to the outcomes the Challenge is committed to. Finally, we have recommended topics for further discussion with stakeholders in order to guide future work that might contribute to the design of land and water indicators that can be used to show progress towards agreed outcomes identified by the Challenge.

2. WHAT IS CO-INNOVATION AND WHY DO WE THINK IT MIGHT BE USEFUL?

Co-innovation is a systemic approach to facilitating practice change and innovation when addressing complex challenges. Taking a systemic approach means considering as a whole the wider system in which a problem is situated. It requires interactions with a broad range of stakeholders to draw on multiple perspectives and sources of experience and knowledge.

Our Land & Water has developed a Monitoring & Evaluation plan that will enable progress made towards the delivery of the Challenge's mission to be monitored and managed across seven performance areas required by the Ministry of Business, Innovation and Employment (MBIE). Performance Area 1 is `Delivery of the Challenge objective' and it seeks to answer the question: To what extent has progress been made towards achievement of the Challenge objective? That plan confirms a number of indicators that the Challenge's executive and Board as well as MBIE will use to evaluate the Challenge's progress towards delivering its objective and outcomes. The Challenge has also stated its commitment to using co-innovation approaches to ensure close engagement with stakeholders throughout the design and the delivery of Challenge-directed activities to increase prospects for achieving Challenge outcomes. Indeed, the Challenge's outcomes, impacts, and activities were developed through co-innovation processes that engaged diverse stakeholders in land and water in discussion on problems, gaps in knowledge, and the types of research needed to advance land and water management in New Zealand.

Knowledge of the theory and practice of co-innovation in the New Zealand context is being developed by the MBIE-funded `Primary Innovation' programme. The Primary Innovation research team has concluded that co-innovation has much to contribute to the resolution of complex and highly contested problems compared with more traditional linear approaches to engaging with stakeholders over research outputs, such as technology transfer models (Figure 1). The development and application of land and water indicators sits at the complex problem end of this spectrum. Potentially significant changes may arise for land users and other stakeholders as a result of the implementation of indicator data and monitoring to inform land and water use decision making.

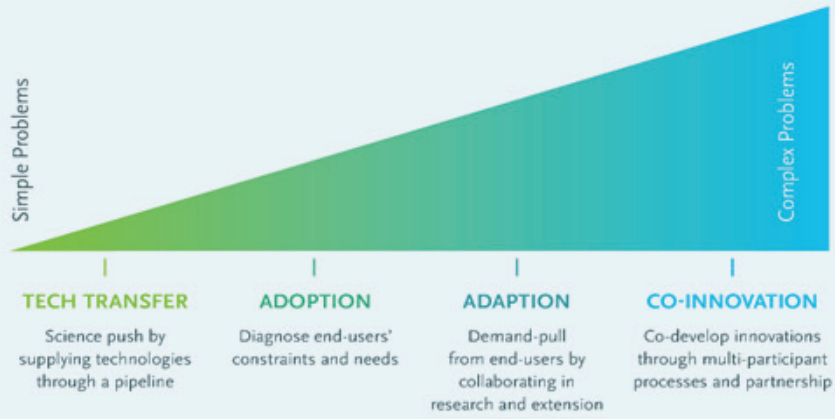

Figure 1: Co-innovation in context (www.beyondresults.co.nz/PrimaryInnovation/Pages/Theory.aspx).

3. "WALKING THE TALK" USING A CO-INNOVATION APPROACH

As a co-innovation project, and to test the hypothesis that co-innovation leads to high impact indicators, the research team made a commitment to engage with people involved in indicator development. This engagement was practised throughout the project to inform our thinking and enhance our outputs and their impact. Over 3 months, from July to September 2016, the working group gathered data and interacted with a range of researchers, programme managers and stakeholders involved in land and water indicator development and use. Four main integrated steps were undertaken (Figure 2):

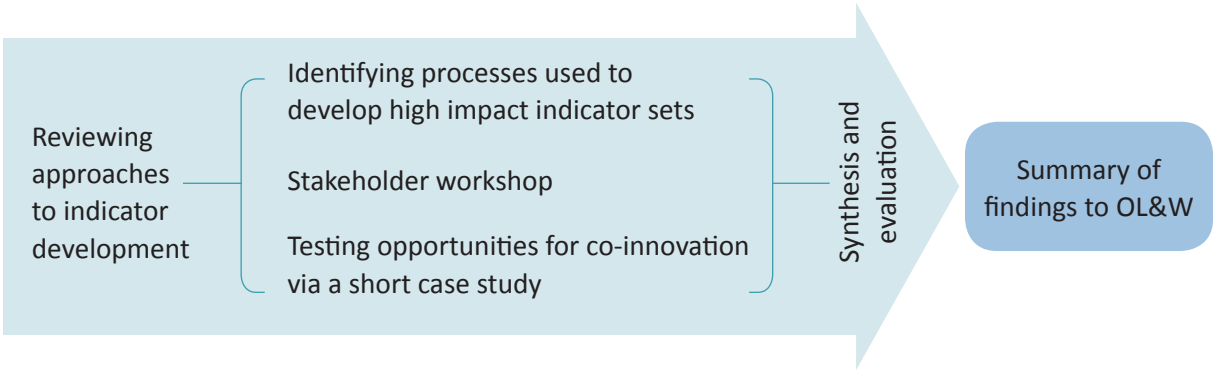

Figure 2: Co-innovation process used to assess the development of high impact indicators. 1) Selecting examples of New Zealand and New Zealand-relevant land and water indicator sets and interviewing key people involved and/or reviewing key publications; 2) Engaging with stakeholders in a workshop to support data gathering and analysis; 3) Identifying processes used to develop high impact indicator sets and evaluating the contribution that co-innovation had made; and 4) Undertaking a short case study using the Waiapu Catchment research and indicators that were developed to work towards a desired state for the catchment to test our assumptions about the contribution of co-innovation (Porou et al., 2012; Warmenhoven et al., 2014).

This approach enabled conclusions to be drawn about processes used in New Zealand to identify, develop and apply indicators. The workshop was held over video conference link on 22 August at five locations within New Zealand and included the project team plus attendees from the Ministry for Primary Industries, the Ministry for the Environment, regional councils, industry bodies, and research organisations. Workshop participants also discussed the role of the National Science Challenge in advancing indicator programmes and their use. A list of interviews and reviews undertaken and workshop participants are shown in the Appendix.

4. WHAT ARE INDICATORS AND WHAT ARE THEY USED FOR?

4.1 Definition

Indicators provide specific information on the state or condition of something that can be measured through time. Indicators are frequently generated in response to a problem that requires action to address. They are designed to generate information about how well actions or interventions are progressing and the impact they are having in terms of addressing problems being targeted. An indicator captures essential qualitative or quantitative information about current states and can be compared to a target point. Over time, indicators enable changes to be tracked, identifying trends.

4.2 Creating a common language

Indicator sets may be used to build a much richer picture of a pressure, state or impact – in a manner similar to the way in which individual pixels contribute to a picture. This can be extremely valuable in building a common understanding or language between stakeholders and partners of what is important and what should be taken into account in policy or management decisions. For example, The Montreal Process Criteria and Indicators for the Conservation and Management of Temperate and Boreal Forests[1] were developed by 12 participating countries (including New Zealand) as a way of creating a shared understanding of the key elements of sustainable forest management, thereby establishing a platform for future international collaboration.

At a local level, indicators that reflect the values of communities and stakeholders and embrace their livelihoods or local context are more likely to create a base for effective partnership in decision making than those that are developed independently by agencies. Failure to embrace or reflect locally held values in the design of indicators may on occasions constitute a risk to the decision-making process as ultimately all environmental decisions occur in a socio-political setting (Slootweg, 2001).

Any change in condition (e.g. environmental, social, political or cultural) can affect the livelihoods of people by threatening what they value. When changes are negative, tensions between values may arise. Capturing the complex and multi-dimensional relationships between the environment and human values through indicators is challenging. Adopting a holistic view that recognises these interconnections can enable more meaningful indicators to be identified and reduce unintended effects of decision making.

[1] http://www.montrealprocess.org/

5. EVALUATING THE NEW ZEALAND EXPERIENCE WITH LAND AND WATER INDICATORS

5.1 New Zealand land and water indicators – a work in progress

Co-ordination of effort across the environment/land and water space in New Zealand is still clearly a "work in progress" compared with some of the well-established indicator programmes in health, education, and social services. These sectors have well-established indicators to monitor and targets to report, enabling effort across different levels of the system to be relatively well aligned with the delivery of agreed outcomes for New Zealanders (e.g. New Zealand Health System Targets http://www.health.govt.nz/new-zealand-health-system/health-targets).

Our review has confirmed that previous work on land and water indicators in New Zealand has had diverse goals, target audiences, a variety of values considered, the extent to which efforts have moved beyond monitoring and reporting to evaluation, time scales, physical scales, conceptual frameworks used, extent of engagement, resources deployed, data management activities, and ultimately, impact. In particular, frameworks typically have been of the pressure-state-response (PSR) format and have relied heavily on science to inform discussion about current states, limits, and trends. This has led to many different indicator sets and frameworks for assessing the performance of primary production systems at multiple scales across multiple dimensions and sectors. Their stated purpose is to guide decision making, but relatively few do.

5.2 A good practice approach to designing indicators

We identified key areas to address in developing land and water indicators based on good practice guidelines (Figure 3). The following section provides examples from our review and stakeholder interactions in relation to this process.

Figure 3: Process for developing indicators (derived from Good Practice Guidelines, 2009).

1. Establish a purpose to address the problem

The purpose of measuring indicators is to track progress towards an agreed goal. Recognising the importance of goal setting is of key importance so that divergence in prioritisation may be overcome through a shared understanding of the importance of integrated action across a range of issues. The indicator programmes we reviewed had developed their own goals as there were no overarching national end goals to focus effort towards. We also found there was uncertainty in linking between the different indicator sets across domains, industries and scales. For example, linkages between land and water indicators are unclear or missing when looking at a single outcome such as water quality.

We identified three main scales at which indicators have been developed:

- At **national and regional scales**, indicator development tends to be *policy-driven* and designed to enable monitoring and reporting,
- At the **sectoral scale**, indicator development tends to be *compliance and/or market-driven* with a focus on demonstrating the sustainability of industry practices and evaluating effects and risks,
- At **catchment/community scale**, land and water indicator development tends to be *value-driven*, dealing with local issues such as water quality, biodiversity, environmental pests and land degradation, building Māori capacity, and integrating Matāuranga Māori with Western science.

2. Design the framework to represent land and water values

Pressures on land and water resources can impact both positively and negatively on a range of environmental, economic, social and cultural values. All changes or impacts on land and water are ultimately social impacts due to the complex and multi-dimensional relationship between the environment and human values. Understanding why people behave in a certain way in the linked socio-ecological system is extremely difficult. It is particularly difficult to identify why patterns are occurring and what might be done to encourage change for a better outcome.

For example, causal frameworks like the pressure-state-impact framework have been used (e.g. Environment Aotearoa) with indicators developed in each domain (land and water separately). However, the links between land and water indicators in each domain and the connection with people are missing, making it difficult to identify how they relate to each other, as well as their wider effects on the environmental, economic, and social outcomes.

Criteria for good indicators include credibility, relevance, and legitimacy (Ash 2009). The review revealed difficulties in reaching these three essential criteria for various reasons. First, what is valued needs to be agreed on by stakeholders, including acceptance that some values may be non-negotiable. Also, understanding tensions between private land ownership and common resources such as air and water is essential. Finally, communication must be timely to build understanding and a shared language.

Scientists, policy makers, and industry stakeholders we consulted with agreed that indicators are about values and the performance of a system towards multiple outcomes simultaneously and that reflecting values in the process of setting indicators is essential (Alrøe et al. 2016). The development of indicators in a way that enables a clear understanding of what values are held, what may be negotiated in trade-offs, and what is non-negotiable is a significant science and policy challenge to address.

3. Select and apply indicators to story tell

A number of those we consulted identified difficulty in understanding the linkages between indicators and articulating the story of what change is actually happening and where it comes from. This is related to how the information about the system and its functioning is captured by the indicator set. This, in turn, is followed by how the data is synthesised, analysed, and communicated to lead to better decision making.

Greater understanding of the problem and where it comes from occurs when indicator sets measure a range of values linked to land and water and different levels of the system. This can help with understanding the complexity of the interaction within the biophysical environment and between human values. Measuring only the biophysical aspects of the environment may show a problem but not show what is driving the problem, making finding a solution difficult.

4. Interpret and communicate indicators across scales and land uses

The most appropriate process for developing indicator sets for multiple reporting scales and land use is not clear from previous practice. There is debate as to whether an indicator and metric used at the local scale can be merged with other data and reported at the national level. There is concern that the information may be taken out of context and used in a way for which it was not designed. Moving across scales and land uses is made more challenging by the diversity of indicator approaches, the presence or absence of targets, and their relationship with agreed goals.

5. Maintain and review indicators

Stakeholders with whom we engaged recognised that the plethora of indicators that have emerged to monitor land and water has created complexity and confusion. It has also created significant cost across the system to collect data to populate and maintain as well as review indicators.

Everyone consulted acknowledged the need for a more connected conversation rather than the commissioning of further programmes to develop indicators. They also acknowledged that, long-term, sourcing monitoring data was a key issue. Data gathering was limited due to a lack of ongoing funding. Working with data and service providers was seen as important to integrated well-equipped data systems.

6. HOW CAN CO-INNOVATION LEAD TO HIGH IMPACT INDICATORS?

6.1 Evidence of co-innovation in land and water indicator development

Co-innovation is evident to varying degrees in the development of a number of New Zealand land and water indicator programmes. We found that at each stage in the best practice process of indicator development co-innovation could have played an important part, if it was not already a contributing factor to the success. Often, co-innovation has been part of a wider process even if it is not an explicit guiding principle. We found that co-innovation was a critical element of projects that were either case study specific (e.g. Waiapu Catchment – see section below, INVEST projects, INFERR) or related to a targeted group or topic (e.g. sector-based indicators from the Sustainable Dashboard or Montreal Process). In these examples co-innovation helped scope the goal and reach agreement on the values and indicators on which to focus. Prioritising indicators to focus on will also rely on linking with other Challenge projects, for example, the Challenge's Matrix programme, which identifies national and international market drivers.

Other examples of the application of co-innovation are evident in strategy and policy development for freshwater and natural resources. For example, the Canterbury Water Management Strategy, which included the development of targets and indicators, as well as the collaborative work plan on the National Policy Statement on Freshwater with the Freshwater Iwi Leader Group and the Land and Water Forum.

Some programmes used co-innovation to a lesser extent than the previous examples, and consulted mainly with the scientific community (e.g. Land Monitoring Forum, DOC biodiversity indicators). In top-down approaches, in-house or targeted experts

developed indicators, e.g. at a national scale (e.g. Environment Aotearoa) or international scale (e.g. Intergovernmental Platform for Biodiversity and Ecosystem Services).

Reviews and interviews undertaken by the research team informed an analysis of the potential benefits and limitations of co-innovation (Table 1) in relation to land and water indicators. Key processes involved in developing land and water indicators (outlined previously in Figure 3) are identified, and the contribution of co-innovation to each of these processes, including any limitations, is noted. This information will inform efforts to improve best practice for indicator development using co-innovation.

Table 1: Essential processes in indicator frameworks and identifying the potential contribution of co-innovation theory and practice

Processes in indicator development	Element	Benefits of co-innovation to essential element	Limitations of co-innovation to essential element	Other considerations
Establish a purpose to address the problem	Identifying the problem	Provide a view on complexity of the problem and its multiple facets	The problem may be ill-defined or biased depending whether the stakeholder group has been well identified	
	Setting a goal	Provide a clear goal and agree on values and a measure of success (target end state)	If the co-innovation involves too many audiences and goals, it may be challenging to get consensus	Involves collectively addressing trade-offs and risks for stakeholders May lack a regional or national perspective, depending on the range of stakeholders involved
	Identifying key stakeholders	Ensure stakeholders are involved early and an appropriate range of perspectives are identified		Important in ensuring all interests are represented to avoid the process being derailed
	Planning for and delivering impact	Relationship building between stakeholders for a shared goal, leading to shared ownership of the solution Strong collaborative process with capability building Stakeholder endorsement and sense of ownership Raising awareness for taking action and behavioural changes Generation of solutions between stakeholders, including highlighting trade-offs to be negotiated	Strong leadership may be needed to ensure progress is made	Change in mind set is a slow process Ongoing support needed from stakeholders
Design framework	Identifying interactions between land and water and people (i.e. taking a holistic approach)	Improved understanding of values and linkages between indicators across the land:water:people interface Helps to build a picture of the system and it's functioning		Can identify areas where more knowledge (e.g. science) is required
	Considering scaling and inconsistencies between regional/ national-scale indicators	Reconcile and understand community, regional and national drivers; data underpinning indicators and targets Relationship building between communities for shared understanding of national drivers and values		If selecting standard units of measure for national consistency of data – can mean that very few indicators can be sufficiently developed/ populated for use

Design framework	Linking to diverse views and established frameworks	Integrated and holistic approach across sectors and ecosystems helps consider synergies and trade-offs Triggers a conversation on values and enables non-negotiable values to be identified Helps in finding a common language	Co-innovation is a slow process so it needs to be iterative to keep everyone on board with early wins acknowledged	
Select and apply indicators	Considering a range of values	Creates an inclusive forum for all values to be shared and considered Understanding values that cannot be traded-off / non-negotiable	Too many indicators can lead to unclear progress towards a goal	
	Building confidence in indicators	Increase credibility by communicating between stakeholders	Co-innovation may lead to indicators that are not sufficiently evidence-based with scientifically robust indicators	Science may not have advanced enough in some parts of the system
	Planning for data	Consensus on standardised methods (for reliability, credibility, consistency) or understanding that data is different and representing the area and stakeholder values Generation of targets upon which to measure indicators against Help in understanding where to focus efforts		A designed data infrastructure is required for transparency (e.g. open-source national repository access, authoritative sources), reliability (record limitations, uncertainties), credibility (authoritative sources, data storage for future use) and robustness
	Showing transferability	Define indicators that can be scaled up (sufficiently broad)	Difficulties in scaling up due to focus on science details Local issues can lead to missed opportunities for greater environmental benefits	
Interpret and communicate	Negotiating trade-offs	Engaged stakeholders recognise, understand and accept trade-offs Work together to reconcile tensions between bottom-up and top-down processes Results and effects are shared in real-time, avoiding delays in communication from more linear technology transfer approaches	System-level changes may be necessary to address the implications of trade-offs	
Maintain and review	Planning for long-term monitoring	Consensus on achievable indicators that can be measured simply and cheaply, as well as data management, storage and access		Planning for long-term monitoring

6.2 Co-innovation case study – the Waiapu Catchment

The following case study illustrates ways in which co-innovation can be applied to enhance the identification of indicators at a catchment level to address an erosion problem. In the Waiapu, iwi worked with central and local Government agencies to identify shared outcomes that reflected what was valued in the catchment. These were expressed as quantitative and qualitative indicators, which were refined into a measurable set. Italicised text draws connections between events in the Waiapu and the benefits of co-innovation identified by the Think-Piece research team.

Healthy land, healthy rivers, healthy people describes the desired outcomes shared by the Waiapu Catchment Restoration Partnership between Te Runanganui o Ngāti Porou, Ministry for Primary Industries, and Gisborne District Council[2] formed in April 2014. The Waiapu Catchment has suffered severe erosion and the environment, land and water is currently in a current degraded state. The degraded environmental state has flowed through to the people with a current low-socio-economic profile. The Partnership was formed with the understanding that the land, water, and people were closely linked and part of the restoration of the Catchment over a 100-year timeframe. The long timeframe acknowledged the complex and inter-generational process of restoring the Catchment.

Indicator development

The desired shared outcomes for the Waiapu Catchment were expressed through indicators (Porou et al. 2012; Warmenhoven et al. 2014). The indicators were guided by understanding Ngāti Porou's aspirational or desired state for the catchment (*clear purpose set*). The development of the indicators was Ngāti Porou-focused (*majority of the population in the catchment*) and co-innovation was critical between the Ngāti Porou Consultative Group and leading Ngāti Porou researcher through a series of hui (*co-innovation with key partners*). A total of 96 indicators were developed. Many of the indicators were detailed and specific, relying on experiences and qualitative data as limited quantitative data were available to populate them (*indicators used as a discussion point to set shared outcomes).* The indicator development was supported by a larger research programme pulling together many years of research on biophysical and social impacts of erosion (*supported by past research*). The indicators served as a valuable starting point for discussion between a wider range of partners with shared interest in the Waiapu Catchment (*including key agency partners in shared outcome discussions*). The indicators were also used as evidence in the Waiapu Catchment Restoration Partnership to support desired share outcomes for the Waiapu Catchment (*clear, shared outcomes set between partners*).

The indicators were further refined with minimal co-innovation and placed into a livelihoods assessment framework to describe the social, economic and biophysical trends through the use of capital groups (Figure 4) (Warmenhoven et al. 2014) (*refinement of indicators to enable measurement*). A total of 25 indicators were developed, which were guided by the Montréal Process (2009) monitoring framework and research findings of qualitative livelihoods assessment interviews across the community (*indicator refinement part of a larger community resilience research programme*). The result (Figure 4) showed where existing community strength and weaknesses were needed to design effective interventions (*direction on where to focus investment*). Long-term monitoring of the indicators will show progress towards the desired shared outcomes for the Waiapu Catchment (*progress monitoring*).

Lessons

The Waiapu Catchment Restoration Partnership has been built on co-innovation, resulting in shared outcomes expressed in indicators. The journey of developing the indicators started with a kōrero, sharing values of Ngāti Porou with a key Ngāti Porou researcher (*trusting relationship*) and covered all values held by the group (***interconnectedness of values – mountain to sea***). The Ngāti Porou Consultative Group, which was already formed, enabled the kōrero to represent the wider values held by Ngāti Porou (*infrastructure for co-innovation already in place*). This early co-innovation set a solid foundation to start discussions with a wider set of partners on shared outcomes (*building relationships*).

The early co-innovation in describing shared outcomes underpinned The Waiapu Catchment Restoration Partnership (*high impact, 100-year plan; all partners part of the solution*). Using this solid foundation the following refinement of the indicators required minimal co-innovation with partners (*partner values were already well described and shared*). The indicator development journey was embedded in larger research programmes (*support from a larger research programme in indicator development*), relied on community and partners' willingness to participate (*shared goals; contribution of their time and values*), and was supported by government funding (*priority setting for improved environmental restoration whilst securing enhanced well-being for all the people*).

[2] Restoring the Waiapu Catchment Flyer – Te Runanga o Ngati Porou, Gisborne District Council and the Ministry for Primary Industries. http://www.mpi.govt.nz/Default.aspx?TabId=126&id=2232

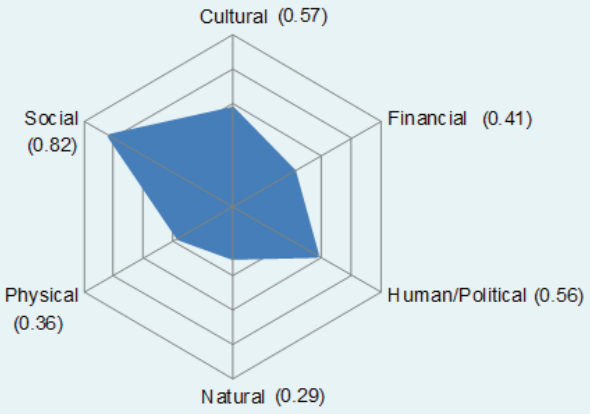

Figure 4: Quantification of capitals using aggregated indicators for the current state of the Waiapu Catchment. Values shown are measured against a target of a desired state for the catchment.

6.3 The sweet spot for co-innovation to contribute to high impact indicators

Figure 5: Co-innovation enables values held by stakeholders to be made explicit, including the desired states (or targets or outcomes) for what is valued, leading to the identification of indicators and necessary trade-offs to reflect progress towards desired states over time.

Our review suggests that co-innovation has been used to develop indicators in some New Zealand case study or community-based initiatives where programmes are value driven. There is less evidence of co-innovation in top-down approaches, at national scale, where programmes are goal driven (Figure 5). The absence of explicit discussion of values across these scales remains a point of tension that needs to be addressed if higher impact land and water indicators are to be developed for New Zealand and New Zealanders.

Our analysis suggests that co-innovation has much to contribute in three main areas that help define a sweet spot for its application:

Exposing shared goals and tensions between stakeholder groups

We observed that indicator programmes used a) top-down 'goal-driven', b) bottom-up 'values-driven' or c) sectoral compliance or `market-driven' approaches that were disconnected. Meeting in the middle is critical to be able to scale indicators up, down, and across land uses.

Co-innovation can help support values-driven, bottom-up approaches and identify opportunities for action research (solution driven) to address points of conflict (between values and drivers) with top-down and sectoral compliance or market-driven approaches. Indicators may not be immediately identified through the co-innovation process, but values can be along with their links to the environment. Values held by stakeholders may be better considered and connected across scales (communities, sectors, regional and national) by taking a holistic or landscape approach and including the role of people.

Improving understanding of the relationship between human values and the environment

Co-innovation can help understand and value multiple benefits that landscapes provide across the environmental, economic, social and cultural dimensions of sustainability. Research questions could be formulated to address points of conflict between the goals of enhancing primary production while maintaining and improving land and water quality. By extending PSR frameworks to a DPSIR framework (EEA 2007) with 'values/driving forces' (economic sectors, human activities) through 'pressures' (emissions, waste) to 'states' (physical, chemical and biological) and 'impacts' on ecosystems, human health and functions, eventually leading to political 'responses' (prioritisation, target setting, policy review) the values held by consumers (both domestic and international), communities and producers could be identified along the value chain. This creates opportunities for win-win solutions through added-value "green" products derived from the land and generating improved environmental outcomes for New Zealand. These concepts are being explored in the Challenge's Matrix programme.

Building collaborative capacity

Co-innovation can help the development of high impact indicators by better engaging stakeholders and creating a sense of ownership. This can build collaborative capacity among land and water stakeholders, increasing commitment to long-term sustainability outcomes for New Zealand.

7. WHAT IS THE OPPORTUNITY FOR THE OUR LAND & WATER NATIONAL SCIENCE CHALLENGE TO MAKE A DIFFERENCE TO LAND AND WATER INDICATORS IN NEW ZEALAND?

This Think-Piece has tested the hypothesis, `That co-innovation leads to high impact indicators' to gather evidence to inform a discussion on `What is the most appropriate suite of land and water indicators to show progress in meeting domestic and international drivers and commitments and achieve the Challenge Mission?'

The following four topics are important components that will need to be explored in the Our Land & Water workshop discussions, which involve a broad range of stakeholders in land and water indicators for New Zealand. This will set the direction for future work to develop suitable indicators for the Challenge.

7.1 Engaging in a broader discussion about what is important

It is our assessment that indicator frameworks in New Zealand have largely adopted a PSR approach. This approach has focused effort largely on using science and science-based models to diagnose both the impacts of land and water use and management as well as the effects of any changes in use on land and water resources.

To address the limitations of this approach to date we recommend discussion on extending the PSR framework to a DPSIR framework to include ***values/drivers*** as well as ***Impacts***. This will enable those involved in indicator development processes to engage in a broader discussion about what is important (values), what end states (targets or outcomes) are desirable, what is non-negotiable, and what solutions may be appropriate. The approach will also allow indicators to illustrate the impact of changes on land management and responses of land managers to those changes, which will result in a feedback loop to decision making about land management.

This broader discussion needs to include dialogue on what is at stake, including issues such as impacts on licence to operate, continued economic growth, opportunities foregone and implications for future generations, and the response of land managers to indications of these potential impacts. The process of indicator development, and the ownership of those indicators, may be as important as the quality of the final indicators themselves. Table 1 is a resource to support discussion on the identification of important items in designing indicators.

Our research suggests co-innovation has a significant contribution to make to creating and sustaining these discussions throughout the indicator development process, especially in identifying values/drivers, impacts and responses. Co-innovation can support the design and application of indicators that are more likely to inform the evaluation of the sustainability of New Zealand's land and water resources. Increased engagement with stakeholders (across catchment, regional, national, and international scales) about what it is that they value and what drives their interactions with the environment (e.g. use, consumption or appreciation) will inform indicator development. The flow-on effect will be an increased likelihood of impact from the application of indicators as priorities, trade-offs, non-negotiables, and impacts will be more explicitly negotiated.

7.2 Developing a co-innovation tool kit for best practice

Stakeholders with whom we engaged suggested a co-innovation tool kit would be of particular value in providing guidance on how to apply co-innovation theory and practice consistently to the development and implementation of land and water indicators. We recommend discussion on developing a tool kit that summarises co-innovation theory and practice that will enable best practice to develop in the New Zealand context and build collaborative capacity. This will ensure the application of co-innovation leads to robust defensible and credible indicators (see Table 1).

Components of the tool kit need to include guidelines on how to communicate the analysis of indicators through building a narrative (or story) for an issue. This would include how to communicate technical indicators so as to be culturally relevant for community groups. In addition, the tool kit could include case studies outlining the New Zealand experience with these processes.

7.3 Building a more integrated indicator system using the wealth of existing indicator knowledge

We recommend discussion on the use of co-innovation to connect and build on existing knowledge of indicators. This will increase the connectivity and links between different indicator sets, and thereby their applicability and credibility, and also build a more integrated indicator system for New Zealand. Co-innovation could also support the development of a common set of indicators at a sufficiently

high level to be applicable across the primary sector and at a range of scales, linking different types of indicators across the DPSIR framework and making these links easier to inform from different sources.

For example, swimmability may be a value (and desired target or outcome) held by stakeholders in relation to a wide range of water bodies. This value could be expressed through a high-level indicator of water quality. Indicators on pressure, states, and impacts can use a range of qualitative and quantitative measurements that have high credibility and reflect the values held by diverse stakeholders. In this way, it becomes possible to assess the swimmability of New Zealand's water bodies across regions irrespective of the range of indicators used or the choice of data to populate them.

7.4 Exploring indicator priorities to reflect changing values and drivers

We recommend discussions on the identification of land and water indicators that reflect national and international market drivers and the Challenge Mission. These drivers have been identified through the Challenge's Matrix project. For example, the environmental driver of 'sustainable supply' is ranked as medium in domestic markets and ranges from low to high in international markets. Continued measurement of these drivers is required because they may change over time as individual drivers change domestically and internationally.

ACKNOWLEDGMENTS

We thank the Our Land & Water National Science Challenge for funding this work. A special thanks to Christine Harper (Landcare Research) for supporting the research team.

APPENDIX

List of key references, resources and documents reviewed, contributors and workshop participants

References

Advisory Committee on Official Statistics 2009. Good practice guidelines for the development and reporting of indicators. Wellington: Statistics New Zealand.

Ash N et al. eds 2010. Ecosystems and human well-being. A manual for assessment practitioners. Washington, DC: Island Press. 288 p.

European Environment Agency (EEA) 2007. Halting the loss of biodiversity by 2010: proposal for a first set of indicators to monitor progress in Europe, EEA Technical Report no. 11/2007, European Environment Agency, Copenhagen.

Groot Koerkamp PWG, Bos AP 2008. Designing complex and sustainable agricultural production systems: an integrated and reflexive approach for the case of table egg production in the Netherlands. NJAS – Wageningen Journal of Life Sciences 55: 113–138.

Nederlof S, Wongtschowski M, van der Lee F eds 2011. Putting heads together: agricultural innovation platforms in practice. The Netherlands: KIT publishers.

Porou T, Barnard, T, Fitzgerald, G, Moore D, Barry L, Garrett L Harrison D 2012. Benchmarking, scope assessment, & critical evaluation – social, cultural, & economic aspects of erosion for Ngāti Porou & a desired state for the Waiapu catchment Waiapu River Catchment Study: Final Report. Scion Confidential Client Report No. 15201. Rotorua, New Zealand: Scion. Pp. 192–259.

Slootweg R, Vanclay F, van Schooten M 2001. Function evaluation as a framework for the integration of social and environmental impact assessment. Impact Assessment and Project Appraisal, volume 19, no. 1, March 2001. Guildford, UK: Beech Tree Publishing. Pp. 19–28.

Warmenhoven T, Pohatu P, Garrett L, Porou T, Harrison D 2014. Climate change and community resilience in the Waiapu Catchment. Report prepared for MPI, June 2014.

Key resources and documents reviewed

Title	Reference
Research Initiatives	
The New Zealand Sustainability Dashboard	Interviewed: Jon Manhire and Henrik Moller http://www.nzdashboard.org.nz/
InVEST: Natural capital project	Reviewed: www.naturalcapitalproject.org
Investment Framework for Environmental Resources (INFFER)	Reviewed: http://www.inffer.com.au/ Pannell DJ, Roberts AM, Park G, Alexander J, Curatolo A, Marsh SP 2012. Integrated assessment of public investment in land-use change to protect environmental assets in Australia. Land Use Policy 29(2): 377–387. doi:http://dx.doi.org/10.1016/j.landusepol.2011.08.002 Roberts AM, Pannell DJ, Doole G, Vigiak O 2012. Agricultural land management strategies to reduce phosphorus loads in the Gippsland Lakes, Australia. Agricultural Systems 106(1): 11–22. doi:http://dx.doi.org/10.1016/j.agsy.2011.10.009
Australian Murray-Darling Basin (MDB) – ecosystem services assessment	Reviewed: CSIRO. (2012). Assessment of the ecological and economic benefits of environmental water in the Murray-Darling Basin. CSIRO water for healthy country national research flagship, Australia. MacDonald H, Bark R, Coggan A 2014. Is ecosystem service research used by decision-makers? A case study of the Murray-Darling Basin, Australia. Landscape Ecology 29(8): 1447–1460. doi:10.1007/s10980-014-0021-3
SEQ: South East Queensland ecosystem services framework	Reviewed: Maynard S, James D, Davidson A 2010. The development of an ecosystem services framework for South East Queensland. Environmental Management 45: 881–895, DOI 10.1007/s00267-010-9428-z http://www.ecosystemservicesseq.com.au/about-the-framework.html https://conference.ifas.ufl.edu/aces08/presentations/RP4-5/Tuesday/pm/0200%20S%20Maynard%20.pdf
Land and Soil monitoring indicators Regional Councils - Land indicators programme	Interviewed: Matthew Taylor (Waikato Regional Council) Taylor MD, Kim ND, Hill RB, Chapman R 2010. A review of soil quality indicators and five key issues after 12 yr soil quality monitoring in the Waikato region. Soil Use and Management 26: 212–224. http://www.massey.ac.nz/~flrc/workshops/15/Manuscripts/Paper_Drewry_2015.pdf https://www.nlrc.org.nz/__data/assets/pdf_file/0018/100386/EMAR_land_soil_workshop.pdf Mackay A, Dominati E, Taylor M 2013. Soil quality indicators: the next generation. Report prepared for Land Monitoring Forum of regional councils. Client report number: RE500/2012/025.
Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES)	Reviewed: http://www.ipbes.net/
"Freshwater ecosystem services project- Phase 1" of Waikato Regional Council	Reviewed: Dominati EJ 2016. Review of Freshwater Ecosystem Services Project, AgResearch Report prepared for Waikato Regional Council, RE500/2016/048.

Programmes – primary sector / environment and others	
EMaR Land domain - LAWA	Interviewed: Haydon Jones (WRC) Jones H, Drewry J, Burton A, Burgess D, Wyatt J 2015. Knowing our land – a review of land and soil state of the environment monitoring and reporting in New Zealand. Scoping report of the Environmental Monitoring and Reporting (EMaR) Land project. Unpublished report.
Stats NZ – variety of indicators NZ progress Indicators	http://www.stats.govt.nz/browse_for_stats/snapshots-of-nz/Measuring-NZ-progress-sustainable-dev-%20approach/key-findings-2010.aspx
Environment Aotearoa – MfE and Stats NZ	Reviewed: http://www.mfe.govt.nz/publications/environmental-reporting/environment-aotearoa-2015
The Montréal Process: Criteria and Indicators for the Conservation and Management or Temperate and Boreal Forests	Interviewed: Tim Barnard (Scion) http://www.montrealprocess.org/ Montréal-Process 2009. Criteria and Indicators for the Conservation and Sustainable Management of Temperate and Boreal Forests. 4th edn. 49 p. *ISBN 978-0-9825274-0-3.* *http://www.montrealprocess.org/documents/publications/general/2009p_4.pdf*
Fonterra/Dairy NZ – sustainable dairying water accord	Reviewed: http://www.fonterra.com/cn/en/Sustainability/Environment/Water/Clean+Streams+Accord http://www.dairynz.co.nz/media/3286407/sustainable-dairying-water-accord-2015.pdf http://www.dairynz.co.nz/media/4113400/Water_Accord_2_years_report_WEB.pdf
Beef + Lamb NZ- Land and Environment Plan (LEP) toolkit	Reviewed: http://www.beeflambnz.com/farm/environment/land-and-environment-planning-toolkit/

Workshop Participants

Name	Organisation
Chris Tanner	Our Land and Water Theme Leader, NIWA
Mike Scarsbrook	Dairy NZ
Geoff Ridley	Beef + Lamb NZ
Victoria Lamb	Beef + Lamb NZ
Kirsty Johnston	Environment Canterbury
Haydon Jones	Waikato Regional Council / Land Monitoring Forum
Deborah Burgess	Environmental Monitoring and Reporting, MfE
Steven Cox	International Policy, MPI
Levente (Levi) Timar	Motu

APPENDIX II GLOSSARY

Activities: The things undertaken in an intervention, project or programme.

Attribution: The assertion that certain events or conditions were, to some extent, caused or influenced by other events or conditions. This means a reasonable [causal] connection can be made between a specific outcome and the actions and outputs of a government policy, programme, or initiative (EPA).

Co-innovation: a systemic approach to facilitating practice change and innovation when addressing complex challenges. Taking a systemic approach means considering as a whole, the wider system in which a problem is situated. It requires interactions with a broad range of stakeholders to draw on multiple perspectives and sources of experience and knowledge.

Impact: Often associated with the ultimate outcome or benefit of an intervention at a system-wide level.

Indicator: A variable that measures a phenomenon of interest to the evaluator. The phenomenon can be an input, an output, an outcome, a characteristic, or an attribute (World Bank). Note – [an indicator can be either] a quantitative or qualitative factor or variable that provides a simple and reliable means to measure achievement, and to reflect the changes connected to an intervention (OECD-DAC).

Inputs: Resources that go into an initiative, programme or project. Resources can include, for example, time, legislation, organisational values, and funding.

Livelihood: Can be held by an individual or community and describes the means by which an individual or community secure the necessities of life.

Monitoring: Periodic collection and reporting of data to track progress over time.

Outcome(s) (benefit(s): An outcome is the intended result of initiatives on individuals, groups, agencies or systems. Outcomes are often classified as short, medium or long term to indicate interdependencies of short and intermediate term outcomes. There may be unintended outcomes (positive and negative) arising from implementation of initiatives, and both intended and unintended outcomes should be captured through evaluation mechanisms.

Outputs: Quantification or evidence of the things we produce/deliver – tangible deliverables or activities/products or services produced within given specifications, e.g. the number of training programmes delivered per quarter.

Stakeholders: Agencies, organisations, groups, or individuals who have a direct or indirect interest in the [programme] or its evaluation (OECD-DAC).

Values: Underpin individual and community livelihoods or the means by which an individual or community secure the necessities of life. Values describe the social, economic, cultural and spiritual needs for a secure livelihood.