


Integrated Decision Support Systems Workshop:

Summary and Recommendations





Landcare Research
Manaaki Whenua

Integrated Decision Support Systems Workshop: Summary and Recommendations

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Summary

Project and Client

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- Hawke's Bay Regional Council.

Objectives

- Review the state of integrated decision support systems (iDSS) in New Zealand
- Outline council needs for integrated decision support systems to support integrated policy, planning, and resource management
- Summarise council needs
- Prioritise 3–5 Envirolink projects for transfer among all interested councils.

Methods

- Undertake a stock take of integrated decision support systems in New Zealand
- Convene a workshop of council staff, researchers, and other interested parties to overview the state of integrated decision support systems, explore needs and opportunities for regional councils to use those systems, and identify council priorities for future funding, especially future Envirolink projects
- Synthesise the finding of the stock take and workshop and recommend 3–5 projects for future Envirolink funding.

Results

- Integrated Decision Support Systems Stock Take
    - Stock take included twenty-two systems
    - System foci: biodiversity (2), biosecurity (2), economics (3), integrated (10), land use (1), nutrient management (2), risk management (1), water resources (4)
    - Integrated decision support systems covered integrated land management, environment–economy interactions, catchment land-use impacts on water quality, integrated catchment management, land-use change impacts on greenhouse gases, water quality values in urban areas
    - Only two integrated qualitative systems addressed all four 4 well-beings (cultural, economic, environmental, social).
- Workshop
    - One-day workshop held in Wellington on 15 September 2010
    - Attendance from seven regional councils (including 2 unitary authorities) and seven other organisations
    - Highlights: overview of decisions support systems, report back on Regional Council Policy Special Interest Group, identification of council policy research needs, presentations on three case studies, identification of useful criteria for integrated decision support systems, potential value added of integrated decision support systems to council processes and functions, and next steps.

Conclusions

Many (integrated) decision support systems are in development and, in some cases, in use throughout New Zealand. These systems could provide substantial benefits to end-users in achieving desired outcomes by helping to:

1. Characterise and explore the consequences of different actions on future long-term well-being, e.g., desired cultural, economic, environmental, and social outcomes
2. Identify and understand trade-offs among the four outcomes
3. Outline potential policies, strategies, plans and actions and explore how they would help contribute to desired outcomes
4. Discuss and deliberate the range of possible outcomes resulting from different policies, strategies, and plans, including how they relate to the values and needs of different stakeholders and interest groups
5. Prioritise policies, strategies, plans and actions to be undertaken by different parties to help achieve desired outcomes.

There are a number of barriers that restrict the uptake and use of iDSS. Overcoming those barriers would need to be focus of further tool development projects.

Recommendations

- Short-term: suggested Envirolink-funded projects (type of project)
    - Decision Support System Directory (Tool) – expand the directory of decision support systems started in this project and make it web-based
    - Enhanced Deliberation Processes (Tool) – develop and disseminate education and training materials
    - Joint Science-Policy Research Workshop (Medium Advice Grant) – convene a 2-day workshop among researchers, end-users and other interested parties to discuss, agree and publish recommendations for more coordinated approaches to decision support system development within New Zealand
    - New Zealand Scenario Network (Tool) – develop a framework for establishing a network where interested parties can share knowledge and information on scenarios with an aim to reducing duplication of effort in scenario development and helping foster more consistency of approach
    - Overcoming Barriers (Tool) – organise and run a series of workshops to identify council policy staff about systems approaches, systematically identify barriers to adoption of decision support systems, and develop methods to reduce or overcome those barriers.
- Long-term: Coordinated Integrated Decision Support System Development
    - Move towards a more coordinated approach, as strongly signalled by workshop participants
    - Commission a review of existing initiatives to determine
        - How well they address current needs
        - Identify gaps
        - Recommend how the initiatives can be aligned to bring broader benefits and greater efficiencies by using via collaboration approaches.

1 Introduction

Across New Zealand many projects have developed or are developing a range of methods, applications, and tools to help with policy development, planning, and resource management. Examples of such projects include: Creating Futures (Waikato), Sustainable Pathways (Auckland and Wellington), Old Problems-New Solutions (Canterbury), integrated catchment management (Tasman), Pastoral 21 (Bay of Plenty), Building Capacity (national), Catchment Land Use for Environmental Sustainability (CLUES, national) or Vital Sites (national, but focused currently on the Conservation Estate).

Knowledge of the various methods, applications and tools is currently fragmented and difficult to access. In addition there is no coordinated approach for sharing and/or transferring them among councils across the country. Substantial individual investment would be required by any one council to uptake the tools, and often that investment is beyond the means of any one particular council.

Regional councils, unitary authorities, and city/district councils would substantially benefit from transfer of the knowledge, methods, and tools being developed by different projects focused in other regions or areas of New Zealand. A coordinated and shared approach will help maximise the opportunity for sharing the benefits among many councils of emerging advanced integrated decision support tools and lead to higher efficiencies in the use of limited research funds.

Hawke's Bay Regional Council and Landcare Research have therefore collaborated to develop the proposal leading to this Envirolink Medium Advice Grant funded project. The project aims to help overcome some of the barriers to the transfer of knowledge and, eventually, the sharing of methods, applications and tools for the benefit of all councils and their constituents, i.e. potentially everyone in New Zealand.

2 Background

As required by the Resource Management Act and the Local Government Act, councils have the statutory obligation to oversee and monitor the sustainable use of natural resources under their jurisdiction in an integrated and sustainable manner. This includes understanding the state (past, present, and future) of resources under current and likely uses, designing policy to manage those resources sustainably, and formulating plans to carry out the various policy objectives, including evaluating various activities and their effects on natural resources.

There are a number of emerging integrated decision support systems (e.g., deliberation matrices, participatory modelling, integrated spatial decision supports systems, agent-based modelling, integrated catchment management) that could assist councils in undertaking sustainable, integrated management of natural resources. In theory the systems can be used in an integrated manner to analyse policies and plans from different perspectives (i.e. from global trade to sub-catchment scale water quality, local communities, regional economy, etc.). Such systems allow for the development, testing, and deliberation of various scenarios and strategies that would allow councils and their stakeholders to explore future trajectories and evaluate the consequences of different strategies for the full suite of cultural, economic, environmental, and social issues facing councils. This in turn will help councils prioritise which actions to take to help achieve desired outcomes and objectives identified by statutory planning documents such as regional policy statements, long-term council community plans, regional plans, pest management strategies, coastal management strategies, etc., and contribute to meeting goals and objectives of various non-statutory strategies and guidelines, such as regional or sub-regional economic growth strategies or spatial plans.

In practice, however, the successful application of the advanced integrated decision support systems requires at minimum

- Specialised knowledge
- Robust data
- Appropriate capabilities and skills.

Some of the knowledge, data and capabilities reside with the research community, while some resides with councils. To realise the benefits of some integrated decision support systems, councils must invest in upskilling staff and collecting new or enhanced data, sometimes under great uncertainty, i.e. will the investment pay dividends, that can be difficult to justify to councillors.

While some councils have participated in development and application of various advanced decision support systems and benefited from the knowledge gained and applications undertaken, the knowledge and benefits from the various systems developed to date would likely benefit more than the original council involved. A good example would be the CLUES project, which has been successfully made available to all councils.

Broader transfer and uptake of advanced integrated support systems is hampered by:

1. Lack of broader knowledge of such systems – what they are, what issues they address, what benefits they could provide

2. Adequate funding to facilitate transfer and maintain/upkeep both the systems themselves and the skills and capacity to use them.

Some systems (e.g., new deliberation methods) could quite readily be transferred and applied, whereas other tools (e.g., integrated spatially-explicit decision support systems) will require more substantial investment and capacity building to insure effective transfer and uptake.

3 Objectives

The objectives of the Envirolink Advanced Integrated Decision Support Systems workshop were to

- Review the state of play with regard to such systems in New Zealand
- Outline council needs for advanced integrated decision support systems to support integrated policy, planning, and resource management.

Based on the review, prepare a short report that will

- Summarise council needs
- Prioritise 3–5 systems for transfer among all interested councils

- Outline pathways, including funding opportunities such as Envirolink tools projects, for implementing transfer of the prioritised systems.

The desired outcome will be the implementation of the priority systems within councils over the next several years. As before, the timing of delivery will vary according to the specific system, but we anticipate that at least one or possibly two could be operational across all regional councils within 2 years, subject to availability of funding. We recognise that this approach carries the risk that none of the systems will be implemented. However not undertaking a more coordinated approach carries a much higher risk of non-transfer given the costs and complexities involved. Indeed without a coordinated approach it is almost certain that many of the promising systems that have been or are being developed will only benefit those councils with enough resources to embed them and maintain them within their organisations.

4 Methods

The project consisted of three main activities:

- Undertake a stock take of integrated decision support systems in New Zealand
- Convene a workshop of council staff, researchers, and other interested parties to overview the state of play of integrated decision support systems, explore needs and opportunities for regional councils to use those systems, and identify council priorities for future funding, especially future Envirolink Tools projects
- Synthesise the finding of the stock take and workshop and develop a list of recommended projects for Envirolink Tools funding or other potential funding pathways.

The stock take consisted of an informal solicitation of major research organisations (Crown Research Institutes, universities, non-governmental research organizations) asking each to provide short descriptions of relevant integrated decisions support systems that they have developed or are developing. Note this was not a formal survey. Therefore the results are not exhaustive and could be augmented if additional time and resources were made available.

A one-day workshop was held in Wellington on 15 September 2010 to correspond with a regional council Policy Special Interest Group (Policy SIG) meeting already scheduled for 14–15 September 2010.

Appendix 1 contains the announcement for the workshop.

5 Results

5.1 Integrated Decision Support System Stock Take

The stock take included contributions from several organisations about twenty-two (22) decision support systems covering a range of topics ranging from biodiversity to water resources management (Table 1). Of the 22 reported decision support systems, ten (10) were classified as "integrated" because their coverage included more than one topic (Table 2). Specifically, they attempted to integrate various cultural, economic, environmental and social outcomes (Table 3).

Table 1 List of decision support systems included in the stock take organised by focus

Focus	*Number*	*Decision Support System*
Biodiversity	2	Threatened Environments, Vital Sites
Biosecurity	1	Vertebrate Pest Control
Economic	3	Forecaster, Forest Calculators, N-Trader
Integrated	10	ACRES, ARDEEM, CLUES, Deliberation Matrix, Future Scenarios, IDEAS, LURNZ, Octopus Planning Cities for Water Values, Octopus, WISE
Land Use	1	Geomaster
Nutrient Management	2	Overseer, SPASMO
Risk Management	1	Riskscape
Water Resources	4	AquiferSim, C-Calm, ROTAN, WATYIELD

Table 2 Coverage of topics of the 10 integrated decision support systems

Integrated Decision Support System	*Coverage*
ACRES	Integrated Land Management
ARDEEM	Auckland Environment-Economy Model
CLUES	Catchment Land Use Impacts (N, P, Bugs)
Deliberation Matrix	Broad & Adaptable
Future Scenarios	Broad & Adaptable
IDEAS	Integrated Catchment Management
LURNZ	Land Use Change Impacts (GHG Emphasis)
Planning Cities for Water Values	Water Quality Values in Urban Areas
Octopus	Land Use Optimisation for Multiple Objectives
WISE	Integrated Spatial DSS

Table 3 Outcomes considered by the integrated decision support systems. Tick marks = outcome considered as part of the systems. Blanks = outcome not considered as part of the system. ? = status unknown

	Cultural	*Economic*	*Environmental*	*Social*
ACRES		✓	✓	
ARDEEM		✓	✓	?
CLUES		✓	✓	✓
Deliberation Matrix	✓	✓	✓	✓
Future Scenarios	✓	✓	✓	✓
IDEAS	✓	✓	✓	✓
LURNZ		✓	✓	?
Planning Cities for Water Values*	?	?	?	?
Octopus		✓	✓	
WISE		✓	✓	✓

*This programme was under active development; therefore the suite of outcomes to be included remained under investigation.

Of the 10 integrated decision support systems, two were primarily qualitative: the Deliberation Matrix (AgResearch) and Future Scenarios (Landcare Research). The Deliberation Matrix aims to help a group of stakeholders understand a particular issue or problem through a qualitative assessment of the problem including articulation of important values, an understanding of the broader system, and assessment of strategies to address the issue in question. Future Scenarios is a tool to help users explore and gain capabilities in formulating and exploring a range of possible futures. Being qualitative, they are also the most flexible and adaptable and can cover the widest range of outcomes.

The remaining eight integrated decision support systems were predominately quantitative. While quite diverse, they had a number of themes in common such as land-use/land-cover change, economics, demographics, and water resources. LURNZ and CLUES are both national, while the remainder are regional or catchment-based in extent.

The eight quantitative integrated decision-support systems operate using a variety of technological frameworks including geographic information systems (ArcGIS), mathematical programming environments (Matlab), systems modeling software (VENSIM), and open-source (Java). This diversity is both a strength and weakness: a strength because the systems collectively are not reliant or beholden to one technology or platform; a weakness because it can hamper further adaptation and integration, especially if a council or organisation does not have the software and/or capabilities to operate a particular system.

Finally, the eight integrated systems are currently either paper-based (e.g., Future Scenarios) or stand-alone applications. None of them are currently web-based, although note that the Vertebrate Pest Control DSS is web-based.

Appendix 2 contains a brief description of each of the 22 systems included in the stock take.

5.2 Workshop

5.2.1 Summary

A one-day workshop was held in Wellington on 15 September 2010. Staff from several councils, research organisations, and the Envirolink fund coordinator (morning only) attended (Table 4).

Table 4 List of organisations with staff attending the workshop

Councils	*Other Organisations*
Bay of Plenty RC	AgResearch
Gisborne DC	Alchemists Ltd
Greater Wellington RC	Envirolink
Hawke's Bay RC	Manaaki Wheuna Landcare Research
Northland RC	Motu Economic and Public Policy Research
Otago RC	NIWA
Tasman DC	Scion

The workshop was organised as follows:

- Welcome & Introduction
- Overview of decision support systems
- Brief report back from the Regional Council Policy Special Interest Group
- Session – Council needs for decision support systems
- Case Studies (LURNZ, CLUES, Creating Futures)
- Session – Criteria making integrated decision support systems useful to councils
- Session – Potential value added of integrated decision support systems to councils
- Next steps.

5.2.2 Welcome

Helen Codlin of Hawke's Bay Regional Council (HBRC) welcomed everyone to the meeting, explaining that HBRC had sponsored this research as they were faced with a plethora of plan changes and were starting work towards a Hawke's Bay 2050 plan. Integrated decision support systems would help councils address the increasingly complex decisions involving the management of land, water and other natural resources as HBRC move beyond the Resource Management Act as a basis for decision-making. Helen noted that councils were likely to shift focus back to catchments for future policy development, planning, and resource management.

5.2.3 Overview of decision support systems

Daniel Rutledge (Landcare Research) gave a representation on decision support systems to help set the stage for the rest of the day. The presentation included a summary of systems currently in development or in use in New Zealand based on the stock take summarised in the preceding section.

During the presentation workshop participants discussed what constitutes a "decision support system" and, by extension, an "integrated decision support system." The general characteristics that define a decision support system the emerged were:

- Sufficient scope and complexity
- Targeted towards specific resource issues or policy/planning challenges
- Usually, but not always, a software programme
- Oriented towards public, and not private, issues.

The above criteria were neither exhaustive nor mandatory. The consensus leaned toward a decision support system being a broad concept. While such a system should exhibit the attributes listed to some degree, the definition is flexible such that different systems can meet a variety of organisational needs.

Further discussion ensued about what constitutes an "integrated decision support system." In this case opinions varied more widely. The consensus leaned towards any system that considers more than one issue or outcome, without necessarily specifying a threshold above which a system can be considered "integrated." A simple rule of thumb could be any system that considers two or more outcomes is "integrated."

Regardless of the definition or criteria used to define a (integrated) decision support system, participants agreed that compiling and maintaining a directory of systems and keeping council staff aware of their development would be of value over the long term.

5.2.4 Policy Special Interest Group – Report Back

Regional councils, in cooperation with the Envirolink fund, developed a coordinated research strategy that outlined goals, objectives, roles and responsibilities regarding regional councils' needs for research and development.[1] The regional councils, also in collaboration with Envirolink, are currently reviewing and updating their strategy. At the August 2010 Policy Special Interest Group meeting, members reviewed and discussed an updated list of research priorities. The following is a list of key points and current research priorities that emerged from that meeting:

1. *Valuing Resource Services* – research effort into understanding public and community values across all domains

[1] Research for the Environment: A Research, Science & Technology Strategy for Regional Councils. Available at: http://www.envirolink.govt.nz/PageFiles/29/researchfortheenvironmentmar09.pdf

2. *Policy Effectiveness* – improved understanding and measurement of the success and effectiveness of public policy across the four well-beings (cultural, economic, environmental, social)

3. *Settlement Development and Patterns* – capture the dimensions of urban settlement across the four well-beings including impacts and requirements of form, footprints, and networks and the implications of different uses of space

4. *Hazard Risk Assessment and Management* – integrated approach to grapple with exposure to multiple risks in urban settings

5. *Cumulative Effects* – what are the critical thresholds, what stresses or pressures increase risk and what margins should be allowed in the RMA planning process? Note this links to #1.

5.2.5 Session – Council needs for decision support systems

Following the Policy SIG report back, workshop participants undertook a session to outline council needs for decision support systems. The session proceeded in four stages:

1. Collective brainstorm to identify various needs
2. Clustering of needs into a smaller set of themes to be addressed in more detail
3. Further elaboration of themes by small groups
4. Report back.

Based on the results of the brainstorm session, workshop participants agreed four primary themes for further exploration in small groups:

- Communication and Engagement (Group 1)
- Organisation (Group 1)
- National to Regional Policy & Planning (Group 2)
- Regional to Catchment Policy & Planning (Group 3).

Communication and Engagement Needs (Group 1)

Group 1 discussed and identified needs for communication/engagement and organisational needs. Communication and organisational needs clustered into 8 broad topics:

1. What are the trade-offs of community wants
2. Understanding values and managing expectations
3. Managing conflicting and competing needs, including NIMBYism (Not In My Back Yard)
4. Personalising the issue and the solutions and making them relevant
5. Helping communities understand the financial impacts of needs, such as playgrounds
6. What is the most appropriate and relevant way to communicate with and engage an audience
    a. Suite of facilitation skills
    b. Back to first principles

   c. Process orientated
   d. Making it real
7. Simulation games
8. How do you apply values to different elements.

Organisation Needs (Group 1)

Group 1 also identified help with prioritising activities as a key council need. The prioritisation must occur in concert with alignment to council strategies and plans as well as helping meet community outcomes. A key element would involve understanding the fiscal implications of different activities across various organisations contributing to the delivery of desired outcomes.

National to Regional Policy & Planning (Group 2)

Group 2 discussed and outlined the needs of councils in terms of national- to regional-scale policy and planning needs. They identified twelve key needs, several of which had several aspects (Table 5).

Table 5 National- to regional-scale council policy and planning needs

National- to Regional-scale Needs	
1. Define and prioritise policy and planning – what are the issues and problems? a. Current (including historic) b. Emerging c. Potential 2. What are the interrelationships among resources? a. Drivers b. Limits & constraints from resources system information c. Risks & conflicts between different resource values 3. What are policy options? 4. What are the implications of various policy options? 5. How to evaluate policy options under different criteria? a. Effectiveness across the 4 well-beings b. Efficiency c. Sustainability 6. Social equity	7. Priority setting 8. Scope of regional resources and their inter-relationships 9. National directions and frameworks for 4 well-beings 10. Resource information and characterisation a. Natural b. Infrastructure spatial & temporal fluxes c. Built d. Social 11. Pressures and drivers a. Economic b. Social / demographic c. Technological d. Natural risks and fluxes to stocks e. Global and national 12. Community goals and outcomes 13. Threats and opportunities – short-term versus long-term

Regional to Catchment Policy & Planning (Group 3)

Group 3 discussed and outlined the needs of councils in terms of regional- to catchment-scale policy and planning needs. They identified sixteen (16) key needs, several of which had several aspects (Table 6).

Table 6 Regional- to catchment-scale council policy and planning needs

Regional- to Catchment-Scale Needs	
1. Good technical information (types and inputs) a. Hazards b. Use & quality c. Land use 2. Defensibility – DSS developers need to avoid the "black box" syndrome, e.g., Overseer 3. Data organisation 4. Decision Support Systems a. Logical link between action → effect → intervention b. What is the threshold for stream water quality? 5. Allocation and cumulative effects 6. Ability to retrieve data *7.* Pressures for land-use change	8. Understanding what is currently in the catchment 9. Values a. People b. Infrastructure 10. Environmental bottom lines, critical thresholds, and allocation frameworks 11. Long-term effects 12. Cumulative impacts of decision 13. Storm water impacts and implications for infrastructure 14. Broad scale versus local decisions 15. Assessing different expectations and values to determine priority & trade-offs 16. Tangible evidence to convince people where difficult to visualise, e.g., climate change

5.2.6 Case Studies

Three cases studies of integrated decision support systems were presented:

- Land Use for Rural New Zealand (LURNZ)
- Catchment Land Use for Environmental Sustainability (CLUES)
- Creating Futures.

Appendix 2 contains copies of all three presentations and a presentation on an urban storm water spatial decision support system under development by NIWA that was not given at the workshop.

5.2.7 Session – Integrated decision support system criteria

Following the session outlining council needs, the groups discussed and identified the desirable criteria that integrated decision support systems should possess. Table 7 lists the collective criteria that emerged in a report-back session following the individual group discussions. Criteria are listed in alphabetical order.

Table 7 Desirable criteria for integrated decision support systems.

CRITERIA		
Accessible	Forward thinking and believable	Need to explain why the model comes up with the results it does
Accommodate information gaps	Good interface required for individuals to use it	Organisational open environment
Affordable	Identify best intervention with systems results	Persuasive
Answers the right question	Improve confidence in decisions	Plan for a period of consolidation
Avoid scope creep	Is the effort around the model(s) with highest priorities?	Practical application
Bang-for-buck	Integrated	Political understanding (easy to understand for politicians)
Be clear about the spatial scale at which it operates	Legally defensible	Problem definition – effort here rather than jumping to solution
Clear expression of values	Limitations are clear	Self funding (not free)
Clear problem definition	Local flexibility; not generic assumptions when local is different from national knowledge	Scientifically robust
Cope with uncertainty	Longevity (software support, institutional support)	Transparent assumptions
Clear understanding of intended purpose (will evolve)	Management system (cluster of organisations) needs to be able to use it - not just individual policy developers	Portability (process, lessons learned, principles)
Collect data – know why they are required	Model comparability	Repeatable
Council maintain control of model use to minimise risk of users walking away	Needs to be supported: data / research / maintain multiple outputs	Stakeholder credibility
Dialogue among users, stakeholders, and researchers		Training to interpret results
Easy to understand		Transferable
Every 7 years need to look at new software		Update easily and quickly
Flexible		Use across scales (national, regional, local)
		Validated

5.2.8 Session – Value Added to Councils

In the final session, the groups outlined what activities they currently undertake with regards to the three themes and then identified how integrated decision support systems could add value to those activities or, in some cases, transform them (Table 8).

Table 8 Current activities of regional councils and the potential added value that could be provided by better access to and use of integrated decision support systems

	CURRENT ACTIVITIES	POTENTIAL VALUE ADDED
Community Engagement and Organisation	Traditional methods: workshops, road shows, discussion documents Way we consult with community/iwi across many planning processes Ambivalence out in the community, 80-90% already involved Communication needs to be updated more with the times	What do we want the future to look like? (Scenarios, simulations) Integrating information from the community across the different processes: strategic planning for *all* community engagement How to engage the silent majority, e.g., social networking Discuss the tensions up front and early on New ways of engaging communities
National- to Catchment-Scale	In absence of information on natural resources, decisions become political Still looking 5–10 years ahead (traditional mode) Some councils are doing futures planning No nation view or approach; lack of integration across councils – disjointed Additional foresight scanning is needed Make decisions on resource constraint/supply Need dynamic system rules; models that continue to make decisions as time changes impact supply)	More overt, robust decision-making Improve robustness of planning assumptions before looking into areas of concern Help to change paradigm from now to future Need to develop tools for future scenario exploration Horizons scanning – communicating the art of the plausible to councils Want to be able to use potential uses for tools Allows the ability to resolve the tensions between supply and demand Linking across scales and consequences
Regional- to Catchment-Scale	Not able to integrate, e.g., land use for irrigation allocation Simulation models to look at individual resources without looking at the interrelationships among resources Limited methodologies Predictive sense, uncertainty and confidence in question	Scale of Deliberation Matrix process credible, acceptable process to come to a decision Integrating models and evaluating trade-offs Change that could occur – future looking, anticipate change Implications – effects of decisions across resources (systematic approaches) Future consequences of policy Across spatial scales

5.2.9 Session – Barriers to adoption

It was recognized that these systems have to be implemented within existing organizational structures and culture and that, to be effective, alignment of systems and behaviours would have to occur. Workshop participants therefore designed the question "What are the barriers to effective uptake of these systems within our organization?" to identify the factors that will need to be addressed. Overall participants identified 12 major barriers that hinder adoption:

- Affordability – too costly to develop and maintain, especially on an individual basis and for small councils
- Awareness and knowledge – do not know what systems exist or how could be used and the benefits
- Capacity and capability – to learn about and subsequently operate systems
- Complexity – of individual systems and the suite of (sometimes competing) systems available for potential use
- Cost effectiveness – affordability of tools and cost/benefit compared with existing methods used
- Cultural – difficult to change ingrained methods and procedures
- Data availability – does not exist, hard to obtain, difficult to update
- Infrastructure – lack of hardware or software needed to run the system
- Silos – lack of integration remains prevalent
- Scepticism – mistrust of results or bad experiences in the past
- Support – lack of central government support and overall coordination/collaboration.

5.2.10 Next Steps

The final session of the workshop involved a synthesis of the findings from the day into a set of conclusions and key messages. Each participant was asked to contribute. Their responses are summarized below. They are listed below in alphabetical order to avoid implying any ranking or priority.

Key concluding messages:

- Barriers between science and policy need to be broken down
- Be specific about the policy questions that a system will address
- CRIs may have more discretion on funding with the move to core purpose funding and could support specific aspects of work once current contracts are complete and the new funding regime in place
- Current useable models need to be used as researchers need them to be tested, and projects that use 2 models will help understand the models / outputs better
- Good to have providers and users meeting together

- Heartening to have workshops such as this
- How to continue the conversation
- IT issues within and among regional councils must be addressed as well for broader benefits to be realized
- Lack of a research working group that melds Regional Councils, TAs and CRIs
- Long-term thinking (50–100 years) and strategies for how to do it
- Long-term thinking requires us to learn how to plan long-term and increase competency around this. Tools will follow.
- Lots of funding moving to CRIs and they focus on biophysical
- Look for funding to continue the Creating Futures programme
- Maintain a directory of systems and expand descriptions to include detail of how it works, what it does (and limitations) and when it should be used, practical examples etc.
- Models used to support decisions and not just data
- Need a forum where developers, suppliers and consumers of DSS can converse
- Need another workshop to tease out 5 key research issues
- Need for an interactive connection between developers and councils
- Need to convince powers-that-be of value of the systems
- Need to go to funders with specific policy questions (there is funding for science but not for policy) and integrate these with the science. This includes strong messaging to research selection panels. CRIs tend to do the geophysical work then tag on the social or economic work as consultancy – it needs to be there at the start.
- No research working group that crosses research organisations currently exists
- Opportunity to develop a further workshop to work through the issues raised in the SIG and include key people from FRST and central government.
- Patience is required as system development can take a long time
- Regional council research strategy can help focus future work
- Remember models are "support" – you still need to collect data
- Research funding process of decision support system development must change, which will require advocacy by councils so that needs are met
- Research funding and design process for Environmental DSS needs effective advocacy
- Science-policy conversations are useful

- Second generation systems will be cheaper, so we need to encourage use as they evolve
- Substantial focus on the environment issues, much less on cultural, economic, and social issues
- Use Envirolink to transfer what we already have.

6 Conclusions

Many (integrated) decision support systems are in development and, in some cases, in use throughout New Zealand. These systems potentially could provide substantial benefits that would help articulate and achieve desired outcomes through:

1. characterising and exploring future long-term well-being under different scenarios based on assumptions about drivers, pressures, and constraints
2. stretching the time horizon for policy and planning from 5–10 years to 50–100 years
3. understanding cumulative effects, hazards, risks, and trade-offs relative to different values and opinions
4. identifying potential policies, strategies, plans and actions and evaluating their potential effectiveness
5. communicating and educating everyone about the potential options and their consequences
6. discussing and deliberating different options
7. prioritising policies, strategies, plans and actions and their associated costs to be undertaken by different parties.

Integrated decision support systems would fill an especially critical gap by helping organisations, particularly councils, address multiple outcomes simultaneously.

Another key message was the need for on-going dialogue and interaction among policy makers and researchers. This includes both within (research-research, policy-policy) and between (research-policy) interactions. Many examples already exist of good relationships between particular institutions or persons. However transfer and uptake of benefits beyond those smaller circles remains problematic. A broader and more systematic approach would benefit both researchers and councils by more efficiently targeting limited resources, reducing duplication of effort, and building a network of people who can support one another by sharing knowledge and experiences.

7 Recommendations

The main finding of the workshop was a clear and urgent requirement to develop a more coherent, enduring, and collaborative approach involving researchers, policy makers, and stakeholders regarding the formulation, development, delivery, and uptake of decision support systems, integrated or otherwise, across New Zealand. This approach should also focus on reducing the identified barriers to the uptake and use of these tools.

Several major initiatives already exist at national and regional scales that address various elements discussed at the workshop. Therefore the time is ripe for developing a more coherent and coordinated approach. To that end we outline both short-term and long term recommendations that can start to foster a more coordinated approach.

7.1 Short-Term – Priorities for Future Envirolink Funding

The short-term recommendations encompass a set of five potential Envirolink projects that would yield benefits most rapidly (Table 9). The projects focus on metadata (data about data), identification and prioritisation of additional policy research questions as suggested in the workshop, and transfer (and perhaps enhancement) of the knowledge, methods, and tools from the two qualitative integrated decision support systems reviewed: the deliberation matrix and the integrated qualitative scenarios. The recommendations fulfill the project objective to identify and prioritise 3–5 projects for future Envirolink funding.

7.2 Long-Term – Coordinated Integrated Decision Support System Development

In addition to identifying a set of priority projects for future investment and transfer, the workshop also highlighted a strong preference for the development and dissemination of more integrated decision support systems. In that sense, “more” can mean both increasing the number of systems available for use and increasing the complexity of those systems in terms of the issues and/or well-beings they address. In wanting more, participants recognised that no single system can encompass all needs or meet all criteria. Nonetheless there is a demand for more comprehensive systems that address multiple issues and outcomes in more detail and complexity, work across scales, yet are understandable, accessible, and robust.

All workshop participants shared the view that developing and delivering integrated decision support systems will require moving from the historic solitary and fragmented approach to a more coordinated and collaborative one. As alluded to above, a number of current initiatives already provide elements of what would be required in terms of governance, funding, infrastructure, policy, etc. (Table 10). Therefore moving towards a more coordinated approach does not have to start from scratch, but instead can involve aligning the various initiatives to achieve the desired goals. This will not necessarily be straightforward, especially as it will require balancing the desire for more collaboration and cooperation against a healthy competitiveness that drives new and innovative ideas in research, policy and planning.

Nonetheless, a first simple step would involve a review that examines the existing initiatives and 1) determines how well they address current needs, 2) identifies gaps regarding decision support system development, and 3) recommends how they might be aligned to bring broader benefits and greater efficiencies. For example, to what degree will the Environmental Domain Plan address critical data needs across a number of scales? How better can Regional Council Special Interest Groups interact with research organizations in a coordinated manner? In many cases, we suspect that these existing initiatives collectively provide the solid foundation that is needed, i.e. we can avoid re-inventing the wheel. In other cases, we suspect unmet needs will become apparent that will require further investigation.

Table 9 Recommended short-term projects for future Envirolink funding

Name	*Purpose*	*Envirolink Funding*
Decision Support System Directory	Expand the directory started in this project including increasing both the number of systems listed and the information available about each system	Tool (already has preliminary approval)
Enhanced Deliberation Processes	Develop and disseminate education and training materials collating the deliberation matrix process; run a series of workshops demonstrating these materials to upskill interested organizations in these new processes	Tool
Joint Science-Policy Research Priorities Workshop	Convene a 2-day workshop to discuss, agree and outline a joint research strategy targeting five key policy questions	Medium Advice Grant
New Zealand Scenario Network	Develop a framework for establishing a network where interested parties can share knowledge and information on scenarios with an aim to reducing duplication of effort in scenario development and helping foster more consistency of approach.	Tool
Overcoming Barriers	Organise and run a series of workshops to identify council policy staff about systems approaches, systematically identify barriers to adoption of decision support systems, and develop methods to reduce or overcome those barriers.	Tool

In conclusion, the complexity and scope of what is both needed and desired (see Table 7) in the long term are beyond the capabilities of this project to address. However this project does provide a very strong signal that the current situation is neither desirable nor particularly smart. A better approach should be developed that will increase the use and application of existing integrated decision support systems and foster coordinated development and delivery of future integrated decision support systems for the benefit of all of New Zealand.

Table 10 Major initiatives that could contribute to a more coordinated approach to decision support system development (not exhaustive)

Scale	***Initiative***	***Lead Agency***	***Addresses***
National	CRI Core Purpose	CRIs	Collaboration, Funding
	Environmental Data Management Review	Ministry of Science and Innovation	Data Management
	Environmental Domain Plan Review	Statistics New Zealand	Framework
	KAREN Advanced Network	Ministry for Science and Innovation	Infrastructure
	Natural Heritage Management System Development	Department of Conservation	System Development and Data Management
	New Zealand Geospatial Strategy	LINZ Geospatial Office	Strategy
	NZGOAL (creative commons)	Ministry for Science and Innovation	Data Management
	Science Funding Reframing	Ministry for Science and Innovation	Collaboration and Funding
Regional	Auckland Council including explicit requirement for spatial planning	Auckland Council	Governance, Strategy, and Policy
	Regional Council Research Strategy Update	Regional Councils	Collaboration, |Funding
	Resource Management Act Amendments	Regional Councils	Governance
	Special Interest Groups (SIGs)	Regional Councils	Collaboration

8 Acknowledgements

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Appendix 1 Workshop Announcement

envirolink ...transferring scientific environmental knowledge to councils

Integrated Decision Support Systems Workshop

9:00am – 4:30pm, Wednesday, 15th September 2010
Turnbull House
11 Bowen St, Wellington

Landcare Research Ltd in conjunction with Hawke's Bay Regional Council is organising an Envirolink funded workshop to:

- Overview the opportunity for Regional Councils to use Integrated Decision Support Systems (iDSS)
- Review the current state of iDSS and their development in NZ
- Explore the needs and opportunities for Regional Councils to use these tools to support their work
- Identify priorities for future Envirolink Tools Projects.

Those who should attend are Regional Council policy and strategic planning staff.

Background

Regional Councils are involved in decision making processes, both internally for strategic planning, and externally with stakeholders and the community as part of policy development. These decisions are often complex and involve both spatial elements and interdependent interactions between environmental, economic, cultural and social elements. Such decision making processes can be informed and assisted by the use of integrated decision support systems or iDSSs.

There are a number of iDSSs available and others currently under development that could assist Regional Councils with their decision making processes. To utilise these tools Council staff need to understand how the tools work and where they can assist in their decision making processes. Also further development of these tools requires researchers to fully understand the needs of Councils in undertaking decision making, and where tools can add the most value.

See overleaf for a draft workshop agenda.

Please RSVP by Friday, 3 September to either

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HAWKE'S BAY REGIONAL COUNCIL

Landcare Research
Manaaki Whenua

Workshop Agenda

9:00 am	Welcome and coffee
9:15 am	Introductions and Workshop Purpose
9:30 am	Overview of Integrated Decision Support Systems
10:00 am	Report back from Policy SIG
10:15 am	Morning Tea
10:30 am	Facilitated discussion on regional council needs for decision support tools
12:00 pm	Lunch (provided)
12:30 pm	Case Studies o LURNZ – Suzie Kerr o CLUES – Reece Hill o Creating Futures – Daniel Rutledge, Liz Wedderburn, and Beat Huser
2:00pm	Workshop session to define criteria that an iDSS would need to meet to be useful for Council needs
3:15 pm	Afternoon Tea
3:30pm	Barriers to uptake of iDSS tools within Regional Councils
4:00pm	Where to next for development and use of iDSSs within New Zealand?
4:30 pm	Workshop closes

Appendix 2 Workshop Background Paper

Envirolink Advanced Integrated Decision Support Systems for Integrated Policy, Planning and Resource Management Workshop

Background Paper

Turnbull House
15 September 2010

Prepared by: Dr Daniel Rutledge, Landcare Research

Rationale

Regional councils, along with city/district councils throughout New Zealand, would potentially substantially benefit from the coordinated development, sharing, and transfer of knowledge, methods, and tools being developed to support integrated policy development, planning, and resource management. Currently knowledge of those methods and tools is fragmented and difficult to access. In addition there is no coordinated approach to transfer and maintenance/upkeep across the country. Substantial individual investment would be required by any one council to uptake and maintain individual tools, and often that investment is beyond the means of particular councils. A coordinated approach could help maximise the opportunity for the transfer and shared benefits among many councils of emerging advanced integrated decision support systems.

Objectives

The objectives of the Envirolink Advanced Integrated Decision Support Systems workshop are to

- Review the state of play with regard to such systems in New Zealand
- Outline council needs for advanced integrated decision support systems to support integrated policy, planning, and resource management

Based on the review a short report will be prepared that will

- summarise council needs
- prioritise 3-5 tools for transfer among all interested councils
- outline pathways, including funding opportunities such as Envirolink tools projects, for implementing transfer of the prioritised tools.

Background

Councils have to determine potential environmental policy effects in a comprehensive and integrated manner as required by both the Resource Management Act and Local Government Act. There are a number of emerging integrated decision support systems (iDSS) that could assist councils in undertaking sustainable, integrated management of natural resources.

In theory the systems can be used in an integrated manner to analyse policies and plans from different perspectives (i.e. from global trade to sub-catchment scale water quality, local communities, regional economy, etc). Such tools allow for the development, testing, and deliberation of various scenarios and strategies that allow councils and their stakeholders to explore future trajectories of development and evaluate the consequences of different strategies for the full suite of cultural, economic, environmental, and social issues facing councils. This in turn helps councils to prioritise which actions to take to help achieve desired outcomes and objectives identified by statutory planning documents such as Regional Policy Statements, Long-term Council Community Plans, Regional Plans, Pest Management Strategies, Coastal Management Strategies etc. as well as an emerging number of non-statutory strategies and guidelines.

In practice, however, the successful application of such tools requires specialised knowledge, some of which resides within the research community and some of which resides with councils. Often council capabilities must be developed to realise these benefits. To date, some councils have participated in the development and application of a number of advanced iDSS. The knowledge and results from those efforts could be transferred more broadly. The timing of the benefit will depend on the iDSS in question. Some (e.g., new deliberation methods) could quite readily be transferred and applied, whereas others (e.g., integrated spatially-explicit decision support systems) would require more substantial and on-going investment and capacity building to insure effective transfer, uptake, and longevity.

Key Considerations

The development of integrated decision support systems raises a number of important issues for consideration and discussion. Those questions are listed below grouped into 4 aspects of design, development and use. We will begin to address these questions as part of the workshop but recognise that they require on-going discussion and consideration into the future.

1. Development
    a. Can we identify a generic development model or does each iDSS require a customised approach?
    b. How has the research provider-end-user partnership approach fared in previous projects (e.g., CLUES, Creating Futures, Motueka ICM, etc.)? What lessons can we share?

2. Ownership and On-going Updates and Maintenance
    a. Who should "own" the resulting systems? Should systems funded with public research money be placed in the "creative commons" or owned by the developing organisation(s) (e.g., CRIs, universities, councils?)
    b. Who should be responsible for update and maintenance? If a shared responsibility, what institutional structures might be needed (new or modified)?
    c. How should on-going updates and maintenance be funded, especially regarding an iDSS shared amongst many councils?

3. Application
    a. Where is the boundary between service and direct use? How much do councils want the ability to run an iDSS in-house versus have it provided externally as a service?
    b. What are barriers to uptake within councils?
    c. Do council staff receive the necessary training to use and apply new systems? If not, what could be done to provide on-going training?
    d. What systems are councils using now? Why/why not?

Appendix 3 Decision Support System Directory

Compiled by: Daniel Rutledge, Landcare Research, Hamilton

Updated: 15 September 2010

List of IDSS

- ACRES: Land Use Decision Tool
- AquiferSim
- ARDEEM: Auckland Regional Dynamic Environmental-Economy Model
- C-CALM: Catchment Contaminant Annual Loads Model
- CLUES: Catchment Land Use for Environmental Sustainability
- Deliberation Matrix
- Forecaster: Maximising Forest Investment
- Forest Calculators - Radiata pine, Douglas fir, Cypresses, Redwood, Eucalyptus
- Future Scenarios
- Geomaster: Land Use Records in Space and Time
- IDEAS: Integrated Dynamic Environmental Assessment System
- LURNZ: Land Use in Rural New Zealand
- N-Trader
- Overseer©
- Planning New Zealand’s cities and settlements to sustain environmental, economic, social and cultural values of urban water bodies
- Octopus: Optimal Catchment Tradeoffs, Production, Utilities and Services
- Riskscape
- ROTAN: Rotorua and Taupo Nitrogen Model
- SPASMO: Soil Plant Atmosphere System Model
- Threatened Environments
- Vertebrate Pest Control DSS
- Vital Sites
- WATYIELD: Water Yield Prediction Tool
- WISE: Waikato Integrated Scenario Explorer

ACRES: Land Use Decision Tool

Organisations: SCION, AgResearch, MAF

ACRES is a DSS tool for assessing the financial and environmental benefits of integrated land management by providing:

- A strategic view of land management (30+yrs)
- Integration of multiple land uses at the paddock level
- Financial and environmental impacts
- Easy to use, web-based, map interface
- Access to information from many existing models

Land management decisions affect financial, social and environmental outcomes therefore land owners need to take a holistic view and to make informed strategic decisions. ACRES is currently in development by Scion and AgResearch with funding from the Ministry of Agriculture and Forestry.

AquiferSim

Organisations: Plant & Food Research, AgResearch, ESR, Aqualinc, Environment Canterbury, Lincoln Ventures, Landcare Research

Website: www.irap.org.nz

AquiferSim, is a regional-scale model of nitrate transport in groundwater, with a fast computational engine, linked to a GIS user interface.

AquiferSim works in tandem with another model under development by Lincoln Ventures, called FarmSim, which predicts the effect of different agricultural land uses at the root zone level, while AquiferSim looks at the cumulative effect on the groundwater as a whole.

AquiferSim is intended to assist regional councils to answer two main questions:

1. What are the long-term effects of land-use change (such as a conversion from sheep to dairy) on groundwater in various parts of a region?
2. How long will it take to achieve this long-term effect?

ARDEEM: Auckland Regional Dynamic Environmental-Economy Model

Organisations: Ecological Economics Research New Zealand, Market Economics, Auckland Regional Council

The Auckland Region Dynamic Environment-Economy Model (ARDEEM) is a systems dynamics model of Auckland Region's environment-economy interactions . ARDEEM builds on the static monetary and physical flow models developed by McDonald and Patterson (1999), McDonald, Le Heron and Patterson (1999) and McDonald (2004a, 2004b, 2005). The model is characterised by positive and negative non-linear feedbacks between its component modules. The purpose of the model is not to predict Auckland Region's economic future, but instead to highlight possible physical and economic consequences under various scenarios. A key reason for the adoption of a system dynamics modelling framework is that it allows a great deal of flexibility in setting the scenarios that may be investigated. The scenarios themselves are designed to capture not only the 'business as usual' situation, but also the dynamic physical and economic consequences resulting from more extreme change.

C-CALM: Catchment Contaminant Annual Loads Model

Organisation: NIWA

The Catchment Contaminant Annual Loads Model (C-CALM) is a GIS-based contaminant load model which operates at the sub-catchment scale. Contaminants modelled are total suspended solids (TSS) and particulate and dissolved zinc and copper. The model was developed by NIWA under sub-contract to Landcare Research as part of the FoRST funded Low Impact Urban Design and Development programme. C-CALM is intended to aid in the planning of stormwater treatment systems and has been developed to be easy to use with minimal set-up and run times and modest data requirements. C-CALM consists of a modelling interface backed by a query library of performance rules for a range of stormwater treatment options commonly found in NZ.

C-CALM is supplied as a tool-bar for ArcMap. Users are asked to supply the spatial data needed to run the model; the minimum data required are sub-catchment boundaries and a breakdown of land covers found in each sub-catchment. Users are then able to add treatment options to each sub-catchment; each treatment option is customised for catchment and device characteristics, and the contaminant sources, by filling in a treatment option window. Treatment options are aggregated, that is, rather than simulating every element in the drainage system, similar treatment devices are modelled as a single device with the same removal efficiency as the individual devices. Rudimentary treatment trains can be simulated by C-CALM with the caveat that C-CALM does not simulate surface flows or device hydraulics, so that the effects of storage and attenuation on treatment are not taken into account. Running the model generates a set of display map layers and a summary table which gives the annual load for each contaminant listed by sub-catchment.

CLUES: Catchment Land Use for Environmental Sustainability

Organisations: MAF, NIWA, AgResearch, Landcare Research, Plant & Food, Lincoln Ventures, Envirolink

Website: www.maf.govt.nz/mafnet/rural-nz/sustainable-resource-use/clues

CLUES models nitrogen and phosphorus loads in streams in specific locations under different land-use scenarios. Links to socio-economic models mean that the effects of a large-scale change in land-use, say from grazing livestock to viticulture, on local communities can also be predicted.

The CLUES project includes creating national maps of land use, soils, and pollution risk, plus extensive databases predicting nitrogen leaching for many combinations of crop, fertiliser, climate, and soils. Land-use types which can be analysed include arable, horticulture, forestry, and several sheep, beef, dairy, and deer farming variations.

The initial impetus for CLUES development came from MAF, who wanted 'what if' scenarios to be modelled at large scales. A number of existing modelling and mapping procedures, developed by various research organisations, have been amalgamated to produce CLUES.

Deliberation Matrix

Organisations: AgResearch; REEDS Universite de Versailles Saint-Quentin-en-Yvelines France

Policy agencies plan and develop policy while taking into account the four well beings identified in the Local Government Act. The detailed values associated with the well beings are developed through use of public consultation so that they will represent the views of the community. Exploring the consequences of potential policy across the four well beings is an integral part of policy development. The Deliberation process allows for the organisation of a dialogue between stakeholders on the consequences of a potential policy on their chosen value sets, integrated across the four well beings. This conversation can inform policy development in identifying the values of importance to a variety of stakeholders, the acceptability of the potential policy to stakeholders and it makes transparent the trade offs and win win's. The process allows for the mobilisation of information from a variety of sources including integrated decision support systems such as WISE and CLUES.

The six steps of the deliberation process are:

1. Identify the issue- What is the issue, at what scale does it occur, who is it an issue for, and why is it an issue?
2. Organise the issue- What are the options/strategies to address the issue, who are the stakeholders/actors impacted by the problem and or the strategies, what are the performance criteria by which the issue and proposed strategy can be assessed against?
3. Identify and mobilise tools for representation (e.g., maps, models of processes and systems).
4. Deliberate the consequences of the current system and any proposed strategy with regard to the identified stakeholders and the identified performance criteria.
5. The preparation, validation and communication of the results and recommendations
6. Return to step one (the deliberation process is iterative).

Forecaster: Maximising Forest Investment

Organisations: Scion, Future Forest Research

Forecaster is a software framework used to maximise tree crop returns based on predicted log product out-turns. It works by modelling the impacts of site, silviculture and genetics on tree growth, branching and wood properties. Forecaster is suitable for all plantation species. Currently it is used to:

- Support the correct scheduling of silvicultural operations such as pruning and thinning, and is especially useful for scheduling intensively pruned regimes.
- Develop yield tables to report the predicted volume availability by log grade at each age;
- Predicted CO2 sequestration for two rotations
- Compare easily the potential impacts of adopting different, sites genetics, and management regimes.

Forest Calculators - Radiata pine, Douglas fir, Cypresses, Redwood, Eucalyptus

Organisations: Scion, Future Forest Research

These are species based calculators that are easy to use with Excel like interfaces aimed at the farm forester. They primarily use a single page interface to predict the outcome of site and management regimes scenarios in terms of per hectare wood production as log grades, carbon dioxide sequestration, and give economic results from discounted cash flow. Carbon is calculated using the C-Change model.

Future Scenarios

Organisation: Landcare Research

Future Scenarios is a card-based “game” that allows users to explore different scenarios of the future. It comes in three editions: New Zealand, Biodiversity, and Urban. The game is suitable for between eight and 200 participants. The scenarios game engages participants quickly. First it connects them with common lifestyle experiences through ‘Recent Trend’ picture cards. Then it retains interest by prompting discussion and recording of change drivers and the uncertainties that they generate. One of the scenarios is then introduced and an imaginary group ‘visit’ is made to that possible future, with each participant role-playing a future resident of their grandchild’s generation. This is followed by reflection on routes taken to reach that future and its contrasts to the present day. If time allows, participants then repeat this in the same role in a contrasting scenario. Ideally all four scenarios are used to expose participants collectively to the full range of possible futures via reporting back on experiences and reactions.

To reflect the cumulative impact of long- and short-term change drivers, scenario game participants are subjected to ‘Wild Card’ events, as both good and bad surprises. They consider how resilient their scenario may be to these events. Participants are asked if, and how, the accumulation of trend drivers and wild card shocks could potentially overwhelm their imagined scenario?

Game players complete a feedback sheet as they progress. This includes questions about where they think New Zealand is heading in relation to these four scenarios, and where they would prefer themselves and their descendants to be in the future. From this, perceptions of current New Zealand trends away from a desired environmental sustainability and social cohesion were investigated.

The New Zealand version of the game is linked to a set of four future scenarios depicting life in New Zealand 50 years hence and a companion future scenarios game to introduce participants to using scenarios. The scenarios were developed in a series of workshops in 2004 attended by a selected group of independent thinkers from inside and outside New Zealand public bodies. Each scenario outlined the logical consequences resulting from various drivers of change.

The scenarios clustered around two axes: a vertical axis representing the extent of resource availability and ecosystem resilience in the future from “depleted” to “plenty” and a horizontal axis representing the extent of society’s focus on competitive individualism versus collaboration and social cohesion [sensu by Putnam (1995) and Fukuyama (1999)].

The four scenarios were: (A) ‘Fruits for a few’—a socially divided authoritarian society led by competent eco-technocrats; (B) ‘Independent Aotearoa2’—a generational value-base change towards social equity and participation; (C) ‘New Frontiers’—a projection of 2004’s then current technology adoption, business globalisation and growth trends; and (D) ‘No. 8 wire’—an economic collapse from this trend with resulting global disconnection and retreat into local improvisation. Although developed spontaneously and not based on others’ scenario sets, they offer a similar breadth of contrasting futures.

Geomaster: Land Use Records in Space and Time

Organisation: Scion

Geomaster is a forest and land information system, and is designed to record large quantities of information on where the land is and what is its use through time, e.g., forest areas, tree crop and stand treatment, and track any operation or event. GeoMaster interfaces with a GIS system and forms the basis for many forestry management functions. It can interface with business systems to be used for operational control

IDEAS: Integrated Dynamic Environmental Assessment System

Organisations: Landcare Research, Tasman District Council, Cawthron Institute, NIWA, IGNS, ENSIS, Otago, University

Website: icm.landcareresearch.co.nz

The purpose of IDEAS is to provide an Integrated Dynamic Environmental Assessment System within which modelling tools provide answers to real catchment questions about cumulative causes and effects of a mosaic of catchment developments. IDEAS is a strategic planning tool for testing “futures scenarios” involving a triple bottom-line approach, a collaborative learning development process, and assessment of cumulative effects in land and water management.

IDEAS needs to feed information into the dialogue between stakeholders so that a shared vision of the catchment can be generated. Stakeholders will need to know the present status of the catchment, in terms of environmental, economic, and social performance, and will also need to know how this changes with various catchment management scenarios.

A challenge in the development of tools for ICM is ensuring they are fully utilised beyond the development phase by stakeholders. To meet this challenge IDEAS has both a social and technical stream of work associated with development. The technical stream is concerned with the linking of models to come up with a technical package. The social stream uses a participatory approach to ensure stakeholder knowledge is incorporated into the technical stream, to set parameter thresholds and design scenarios, and to ensure users understand the inherent assumptions within the models used. The technical and social aspects together are called IDEAS.

Within the technical stream of work the biophysical models predict the flow of water, and associated sediment, carbon, nutrients, and pollutants, through the catchment and into the marine environment. Inputs to the models will be spatial data (land use is time dependent). Outputs from the models will be time-dependent digital maps of mass flows (water, carbon, nutrients, and pollutants). No one model is able to handle all of the processes of interest in the catchment, so we plan to use several models of what we judge to be the important processes and to link them.

The mass flows from biophysical models are linked into socio-economic models through biophysical coefficients. The socio-economic models comprise aspatial and spatial components. The aspatial component is called the Catchment Futures Model and is an economic input-output model coupled with a population growth model. It may be used in a temporal mode where yearly environmental and economic outcomes influence sector drivers for following years. The spatial component is Evoland. It models individual agents on the landscape and how policy, and environmental and economic outcomes influence individual land use and management decisions. It may be used to assess the influence of policy and education of actors on future land use patterns. Within IDEAS Evoland is predominantly used as a possible land-use scenario generator; allowing evaluation of policy and agent values on possible catchment futures. These are then used as the basis for biophysical model simulations within the catchment (e.g. SWAT) and in the coastal marine area which evaluate the environmental fluxes within possible land-use scenarios.

LURNZ: Land Use in Rural New Zealand

Lead organisations: Motu Economic and Public Policy Research; GNS-Science;

Contributing organisations: Scion; NIWA; AgResearch; Canterbury University School of Forestry

Website: www.motu.org.nz/research/group/land_use_in_rural_new_zealand_model

Land Use in Rural New Zealand (LURNZ) is a computer model that simulates land-use change at a fine spatial scale over the whole country. The model employs historical relationships between land-use and profitability as well as cross-sectional variation in land attributes to produce dynamic paths of rural land-use change and maps of rural land-use with an annual time step. LURNZ enables policy makers to empirically investigate and compare the potential impacts of various environmental policies that may affect land-use decisions. It can simulate any policy that can be expressed as a restriction on land use or a change in the effective price for a commodity produced from an existing land use. Its greenhouse gas module allows simulation of climate mitigation policies. LURNZ outputs include:

- national aggregates over time:
  - areas of land uses;
  - agricultural production;
  - animal numbers;
  - emissions;
- spatial maps:
  - land uses
  - emissions and removals,
  - greenhouse gas liabilities,
  - profitability
- marginal abatement cost curves

N-Trader

Organisations: Motu Economic and Public Policy Research, NIWA, and GNS-Science

Website: www.motu.org.nz/research/detail/nutrient_trading

N-TRADER is a spatial, stochastic, dynamic simulation model that simulates the effect of different aspects of nutrient trading (and potentially other nutrient management options) for the Lake Rotorua catchment. It is an optimisation model that combines the economics of land use (using LURNZ) and land management decision making (using UDDER and FARMAX), the functioning of temporal nutrient allowance markets and a model of nutrient flows (based on OVERSEER) and lags(based on ROTAN) and is based on the best available empirical information on the geophysical and economic conditions for this catchment. It produces prices/marginal costs of nitrogen reduction, impacts on sheep/beef and dairy profitability, and nutrient flows into the lake under different regulatory scenarios.

Overseer©

Organisations: MAF, FertResearch, AgResearch

Website: www.overseer.org.nz

OVERSEER® is an agricultural management tool which assists farmers and their advisers to examine nutrient use and movements within a farm to optimize production and environmental outcomes.

The computer model calculates and estimates the nutrient flows in a productive farming system and identifies risk for environmental impacts through nutrient loss, including run off and leaching, and greenhouse gas emissions.

Its current uses are in the development of on-farm nutrient budgets, whole-of-farm nutrient management plans and, through the use of additional proprietary software, the development of farm specific fertiliser recommendations. Because it calculates potential greenhouse gas emissions, it has a potential role to play in any future emissions trading scheme.

Planning New Zealand's cities and settlements to sustain environmental, economic, social and cultural values of urban water bodies

Organisation: NIWA

This FRST-funded research programme aims to help local government to plan the development of New Zealand's cities and settlements in a way which protects and enhances the services and values associated with urban water bodies. The research involves the development of a spatial decision-support system (SDSS) that allows the impacts of urban development scenarios on attributes such as water and sediment quality; ecosystem health; and cultural, amenity and recreation values to be investigated and compared. A sustainability indexing system is being developed to integrate the measurement of environmental, social, economic and cultural impacts and allow planners to consider these impacts holistically. The programme also includes the investigation of methods by which impacts on Māori values associated with urban water bodies can be measured and communicated. The research involves NIWA, the Cawthron Institute and Tipa Associates working alongside end-users at Auckland Regional Council, Environment Canterbury and Christchurch City Council.

Octopus: Optimal Catchment Tradeoffs, Production, Utilities and Services

Organisation: Scion

Octopus is an optimisation framework that takes outputs from multiple scenarios for land use and production systems and solves large combinatorial problems across space and time. This involves the integration of data from multiple sources and the application of mathematical algorithms that will find optimal solutions given multiple objectives and constraints.

For example, an objective may be a sustainable business over 50 years with an acceptable cash flow. Another objective may be an acceptable environmental impact. Another may be a minimum level of livestock numbers. This is achieved through land use options and management strategies. The key is property management as an investment in time and space

Riskscape

Organisations: NIWA, GNS

Website: riskscape.org.nz

Riskscape is a tool for analysing risks and impacts from multiple hazards.

The main goal is to develop and implement a decision-support tool that readily compares the likely consequences of multiple hazards on a region.

By quantifying the consequences across the same portfolio of communities and associated assets (buildings and infrastructure), RiskScape conveniently provides information to prioritize risk-reduction measures and a more informed response as an event unfolds.

A range of consequences (or risk) can be quantified, such as direct damage and replacement costs, casualties, number of people that may need evacuation or medical assistance and indirect effects such as disruption on transport and tourism. These impacts and losses can then be compared across several hazards.

The Regional RiskScape system is being developed so it is flexible enough to operate across an internet or intranet link or as a stand-alone station basis, although a web based system will usually be running in parallel.

ROTAN: Rotorua and Taupo Nitrogen Model

Organisations: NIWA, Motu Economic and Public Policy Research, Environment Bay of Plenty

A GIS-based, daily-weekly time step, conceptual land use-surface water-groundwater-nitrogen model to predict the effects of land use changes on nitrogen delivery to lakes like Rotorua and Taupo, especially the lags involved with groundwater.

SPASMO: Soil Plant Atmosphere System Model

Organisation: Plant & Food Research

SPASMO, which has been in continuous development for over 20 years, models the transport of water, micobes, and solutes through soils integrating variables such as climate, soil, water uptake by plants in relation to farm and orchard practices, and any other factors affecting environmental process and plant production.

SPASMO is currently used by six Regional Councils for allocation of irrigation water, and it has been used in a large number of jobs for other Regional Councils, commercial clients and other researchers. It has been used in many Environment Court, or Commissioner, hearings.

The SPASMO computer model considers water, solute (e.g. nitrogen and phosphorus), and microbial (e.g. viruses and bacteria) transport through a 1-dimensional soil profile. The soil water balance is calculated by considering the inputs (rainfall and irrigation) and losses (plant uptake, evaporation, runoff and drainage) of water from the soil profile. The model includes components to predict the carbon, nitrogen and phosphorus budget of the soil. These components allow for a calculation of plant growth and uptake of both N and P, various exchange and transformation processes that occur in the soil and aerial environment, recycling of nutrients and organic material to the soil biomass, and the addition of surface-applied fertilizer and/or effluent to the land. The filtering capacity of the soil with regard to micro-organisms is modelled using an attachment-detachment model with inactivation (i.e. die-off) of microbes.

SPASMO is currently used as an 'in house' code within Plant and Food Research. Models are tailored according to the individual needs of the end user. End users are councils at regional and district levels as well as consultants, and the model accounts for a range of on-farm and within-orchard practices. For example, consultants may use a SPASMO framework when analysing irrigation to determine the need to irrigate a given crop in the next week, month or period until harvesting, on a particular soil given the weather history at the site and the current weather-cycle conditions (such as whether or not a La Niña pattern is observed).

SPASMO incorporates data from several databases including weather and soil databases and from information such as material safety data sheets for pesticides which record the holding times in soils. Because a unique SPASMO simulation is created for individual client, and their farm and orchard practices, the data sources used are appropriate for the question and for the time period specified.

SPASMO is now being used as the software engine for online, real-time irrigation scheduling, and it has also been modified to act as a water footprint calculator for primary products.

Threatened Environments

Organisations: Landcare Research, Ministry for the Environment, Department of Conservation, Envirolink

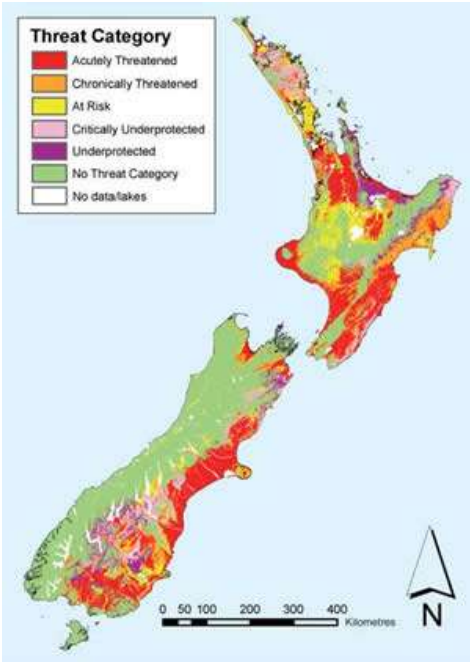
Website: www.landcareresearch.co.nz/databases/LENZ/downloads.asp

An interactive GIS tool is helping planners identify and set a value on New Zealand's threatened environments, which in turn can help protect our biodiversity.

Planners need quality advice to prioritise protection efforts in their day-to-day management of resource consent applications. New Zealand's coastal, lowland and montane environments have been substantially modified, with considerable loss of indigenous ecosystems. The remaining areas of indigenous vegetation may be highly modified and degraded, but nevertheless support disproportionate numbers of threatened species, habitats and ecosystems.

With clearance of indigenous cover ongoing, protection of those areas that are left becomes more important. The highest rates of loss occur in unprotected areas with the least remaining cover, which exacerbates biodiversity loss.

Landcare Research has produced a "Threatened Environments" tool for identifying environments with much reduced indigenous ecosystems. The tool was developed with end-users including DOC, MfE, Land Information New Zealand, regional councils and the QEII National Trust.



Threatened Environments is an add-on to LENZ (Land Environments of New Zealand), an MfE-funded software product by Landcare Research that combines information on land environments, land cover, protected areas and similar information at a range of scales, from national to local. Threatened Environments shows at a glance how much of any environment remains in native cover and how much is protected – key criteria in determining the significance of remaining indigenous vegetation. It also assigns environments to one of five categories ranging from acutely threatened to not threatened.

The tool can display loss and protection statistics for any area or point, assess priorities for protection and conservation management, and report on biodiversity achievements.

Vertebrate Pest Control DSS

Organisation: Landcare Research

Website: pestdss.landcareresearch.co.nz/

This DSS has been developed to assist a wide range of possible end-users in determining the most appropriate choices of control tools for a particular pest control programme. Presently the DSS covers five common pests.

Vertebrate pest control in New Zealand is necessary to protect native flora and fauna, and to protect people from the damage that pests cause to agriculture and property. Deciding how to control vertebrate pests has become increasingly complex over the last 20 years due to new knowledge of pest impacts and control, an increase in the range of products available for pest control, new legislative and safety requirements for pest control operations, increased public interest in the impacts and control of pests, diversification of the pest control industry, and reorganisation of the roles of some of the key participants.

The system considers all well-recognised environmental, social, and economic constraints that must be considered in selecting the most appropriate control options, given the description of key site parameters by the user. However, the tool is designed to support, not replace, decision-making by pest managers. This is because there is always the possibility that the DSS may not consider every operational constraint that applies to a particular pest control operation in a particular locality.

Control options are all linked to best-practice advice and supplier information. Additional components include a control-costing tool, and a generic means of prioritising planned control operations. The DSS is not a comprehensive planning tool for pest control operations. Links to additional planning tools are however given in the 'help' sections associated with various parts of the system.

Vital Sites

Organisations: Landcare Research, DOC

The Vital Sites model of biodiversity incorporates the current and natural distributions of biodiversity, pressures on biodiversity, and management effects that mitigate pressures. The effects of pressures on biodiversity are used to predict vulnerability and future biodiversity patterns. Management actions affect future biodiversity patterns by reducing pressures. Model procedures are used to produce the required outputs, including naturalness, significance and priority, as well as an ordered list of vital sites.

The model adopts the Lee et al. (2005) definition of ecological integrity (EI) as a high level goal for planning conservation work and reporting outcomes. EI has three components: 1) species occupancy, or the extent to which species inhabit their natural ranges; 2) environmental representation, or the extent to which all ecosystems remain; and 3) native dominance, reflecting the extent to which species composition, biomass and ecosystem processes are dominated by native species.

Our model separates ecological integrity into two strands. The first strand (the SO strand) addresses the species occupancy component of ecological integrity. The second strand (the ERND strand) combines the other two components of ecological integrity: environmental representation and native dominance (ERND). Calculations for the two strands follow similar and parallel paths, until the two are combined in the final calculations.

Input data for the model in this demonstration are spatial grids, including current and natural distributions of native species; distributions of pest and other pressures; an environmental classification; current and natural land cover; and expected loss of native cover. The format of inputs could be modified in future to use predefined sites as data, analysis and output units.

The model uses a biodiversity loss model (via a pressure-native species effects table) to estimate future biodiversity distributions and vulnerability, based on the distributions of pressures and the effects of pressures on biodiversity. A simple management-pressure model (via a management-pressure effects table) is used to estimate effects of management actions on pressures.

Procedures in the model estimate the significance of sites based on the current and natural distributions of native species (SO strand) and native ecosystems (ERND strand). A value function is used that relates the occupancy of species and the representation of environments to ecological integrity. The significance of a site is calculated as the marginal contribution of the site to national ecological integrity. The priority of a site for conservation considers both the significance of a site and the vulnerability of the biodiversity at the site. Highest priority sites are those where conservation action will avert the most loss to national ecological integrity. Significant and priority sites are identified in relation to species occupancy (SO), environmental representation and native dominance (ERND), and for SO and ERND combined. Vital sites are identified using a simple, iterative algorithm to estimate the best order in which to choose sites for intensive conservation management.

WATYIELD: Water Yield Prediction Tool

Organisations: Landcare Research, Tasman District Council

The WATYIELD Decision Support Tool is based around a water balance model developed by catchment staff at Landcare Research. The model can be used where there is a limited amount of data on the climate, soils, and vegetation of the catchment, and is similar to the approach widely used for computing crop water requirements. It runs in a Windows environment and uses Excel spreadsheet for input and output of data.

WATYIELD consists of:

- A user guide for the model including details of how to install the model and the background information required to run it
- An installation package for the model
- An input spreadsheet set up ready for running the model (as a dummy for future runs).

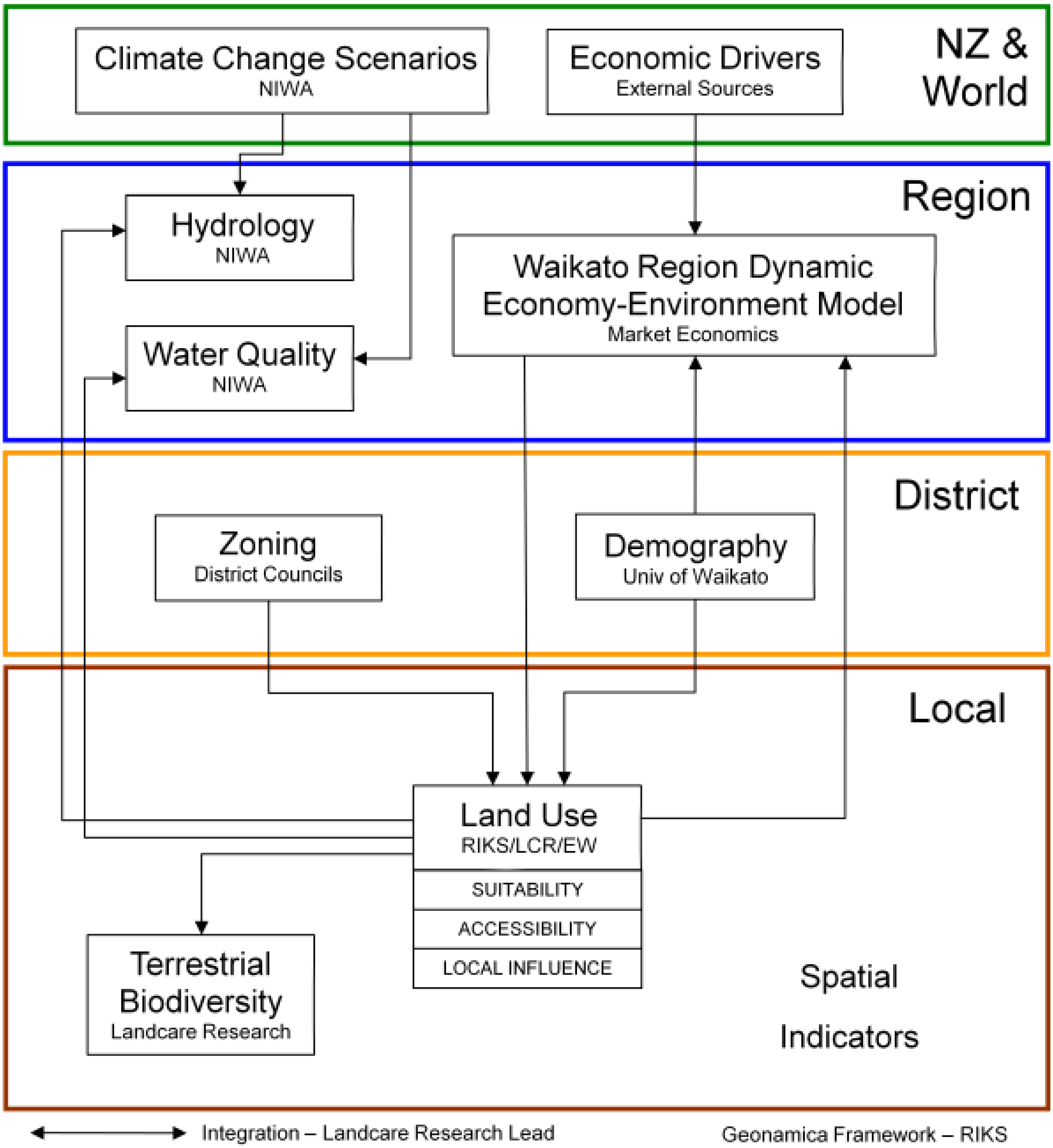
WATYIELD can be run on your own computer or evaluations of water yield changes can be carried out for you by Landcare Research staff.

WISE: Waikato Integrated Scenario Explorer

Organisations: Environment Waikato, Landcare Research, NIWA, AgResearch, University of Waikato, Research Institute for Knowledge Systems, Ecological Economics Research New Zealand, Market Economics

WISE is an Integrated Spatial Decision Support System (ISDSS) designed specifically for New Zealand, focusing on the Waikato region. It is developed as part of the Creating Futures project (www.creatingfutures.org.nz), a 4-year project (2006–2010) funded by the New Zealand Foundation for Research, Science, and Technology. The project brings together a regional council (Environment Waikato) and several research partners in New Zealand and from overseas to provide better knowledge, methods, and tools to support long-term integrated planning.

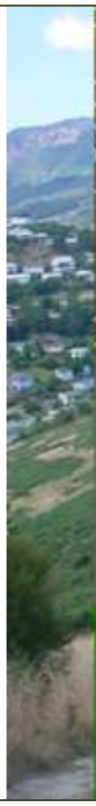
WISE uses knowledge, models, data, and parameters obtained from several central and local government agencies and research organizations, including the project partners. Its principal purpose is to support policy, planning and decision-making.



WISE Version 1.1 System Design

Appendix 4 Workshop Presentations

Landcare Research
Manaaki Whenua



Envirolink Workshop

Decision Support Systems Overview

Dr Daniel Rutledge
Manaaki Whenua Landcare Research – Hamilton

Wellington
15 September 2010

Purpose

- Brief Overview of Decision Support Systems
  - Definition
  - Characteristics
- Discussion: DSS vs. *Integrated* DSS
- Current State of Play with Regard to (i)DSS in New Zealand

What is a Decision Support System (DSS)?

- Helps to break it down
  - Decision – a choice amongst various alternatives
  - Support – provide help or assistance
  - System – a set of interacting components

iDSS Conclusions

- There are actually quite a few iDSS within New Zealand at various stages of development
- Coverage
  - Economic and environmental strongest
  - Social moderate
  - Cultural weakest (at this point)
- Extent of application ranges from national to paddock, with catchment being most common
- The qualitative iDSS (Deliberation Matrix and Future Scenarios) are most adaptable

DSS Characteristics

- Formalised
  - Knowledge & Information
  - Process
  - Interpretation
- Replicable
- Transferable
- Purpose for Application

Integrated DSS

- What makes a DSS integrated?
- Likely a matter of opinion and degree
- For my purposes, an integrated DSS is one that helps in making choices that involve >1 one aspect or dimension
  (Is 2 sufficient?)

DSS vs. iDSS

DSS
- Single aspect, objective or consideration
- Simpler
- Maximise/minimise

iDSS
- Multiple aspects, objectives or considerations
- More complex
- Weightings
- Trade-offs

iDSS: Yes or No?

- Financial programme for profit maximisation?
- Water quality model?
- Resource consent?
- Regional Policy Statement?

DSS: State of Play in NZ

- Informal survey of key developers and providers of DSS within New Zealand
- Not exhaustive
- Many others exist; would be good to capture them but would require more time & resources

DSS Directory

- 24 DSSs (as of 15 September 2010)
- Biased towards CRIs
- Mostly quantitative (i.e. computer models) but a few qualitative as well
- 10 (42%) are integrated (my assessment)

DSS Foci

Focus	Number	DSS
Biodiversity	2	Threatened Environments, Vital Sites
Biosecurity	1	Vertebrate Pest Control
Economic	3	Forecaster, Forest Calculators, N-Trader
Land Use	1	Geomaster
Nutrient Management	2	Overseer, SPASMO
Risk Management	1	Riskscape
Water Resources	4	AquiferSim, C-Calm, ROTAN, WATYIELD
Integrated	10	ACRES, ARDEEM, CLUES, Deliberation Matrix, Future Scenarios, IDEAS, LURNZ, Octopus Planning Cities for Water Values, Octopus, WISE

iDSS Coverage

	Coverage
ACRES	Integrated Land Management
ARDEEM	Auckland Environment-Economy Model
CLUES	Catchment Land Use Impacts (N, P, Bugs)
Deliberation Matrix	Broad & Adaptable
Future Scenarios	Broad & Adaptable
IDEAS	Integrated Catchment Management
LURNZ	Land Use Change Impacts (GHG Emphasis)
Planning Cities for Water Values	Water Quality Values in Urban Areas
Octopus	Land Use Optimisation for Multiple Objectives
WISE	Integrated Spatial DSS

iDSS & Well-Beings

	Cultural	Economic	Environmental	Social
ACRES		X	X	
ARDEEM		X	X	?
CLUES		X	X	X
Deliberation Matrix	X	X	X	X
Future Scenarios	X	X	X	X
IDEAS	X	X	X	X
LURNZ		X	X	?
Planning Cities for Water Values	?	?	?	?
Octopus		X	X	
WISE		X	X	X

iDSS Observations

- Form
  - 8 Quantitative
  - 2 Qualitative
- Most In Common
  - Land Use
  - Water Resources
  - Economics
  - Demographics
- Variable Technologies (GIS, Matlab, Java, VENSIM, etc.)
- Delivery Methods
  - Stand alone application seems most common
  - None web-based as far as I can tell

iDSS Conclusions

- There are actually quite a few iDSS within New Zealand at various stages of development
- Coverage
  - Economic and environmental strongest
  - Social moderate
  - Cultural weakest (at this point)
- Extent of application ranges from national to paddock, with catchment being most common
- The qualitative iDSS (Deliberation Matrix and Future Scenarios) are most adaptable

Integrated Decision Support Systems

LURNZ: Land Use in Rural New Zealand

N-Trader: Nutrient management in Rotorua

Suzi Kerr, Motu

15 September 2010, Envirolink workshop

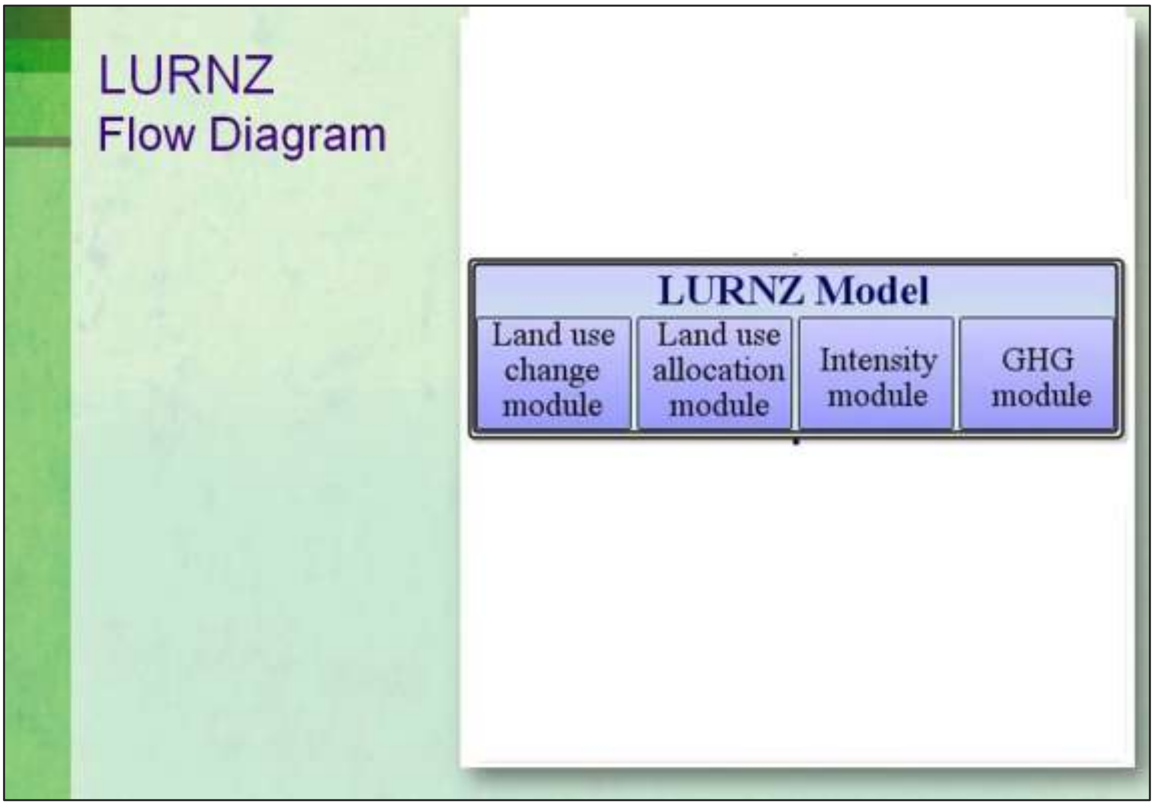
Funders and collaborators

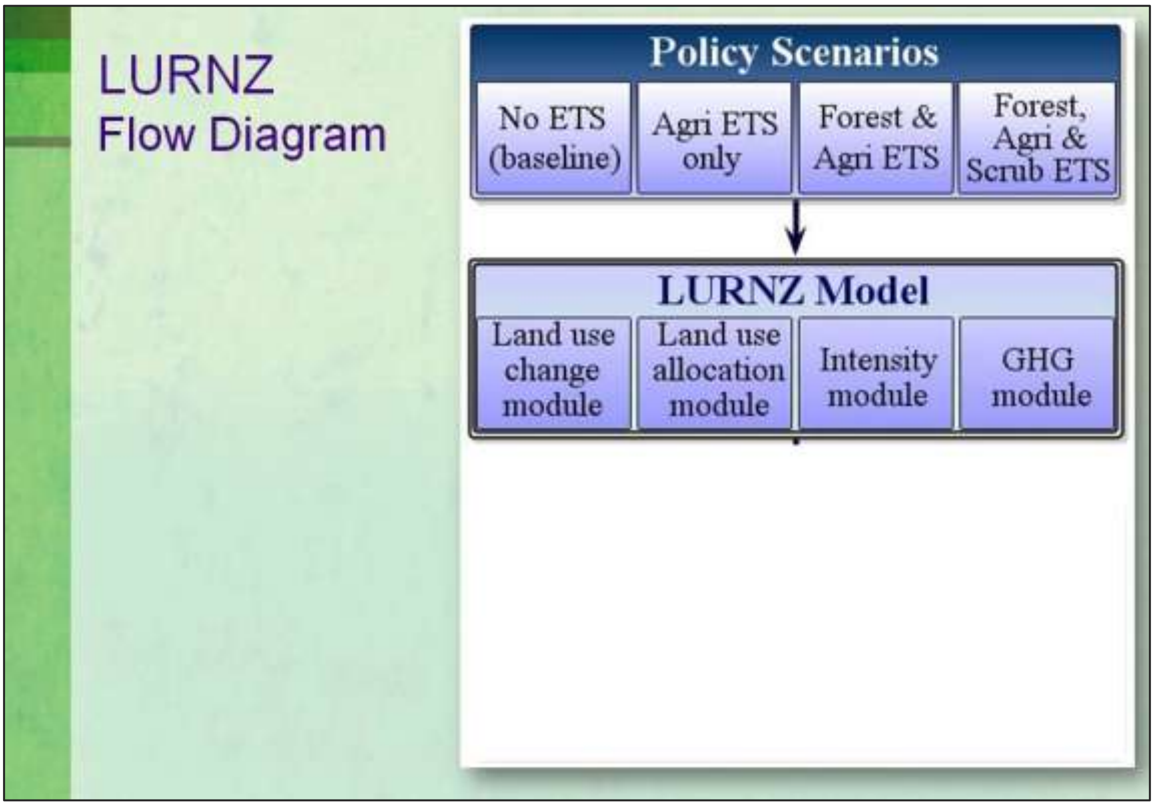
All funded by the Foundation for Research Science and Technology

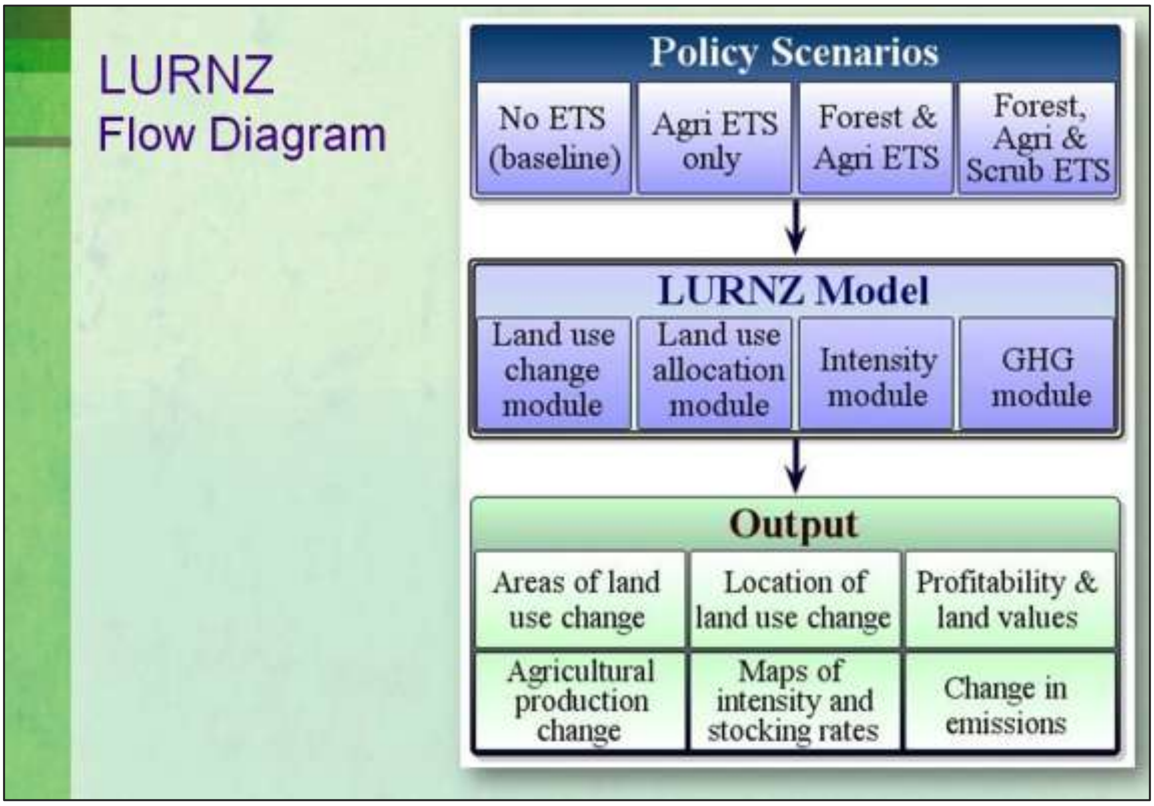
Collaborators include: NIWA, GNS-Science, Landcare Research, Scion, University of Canterbury, AgResearch…

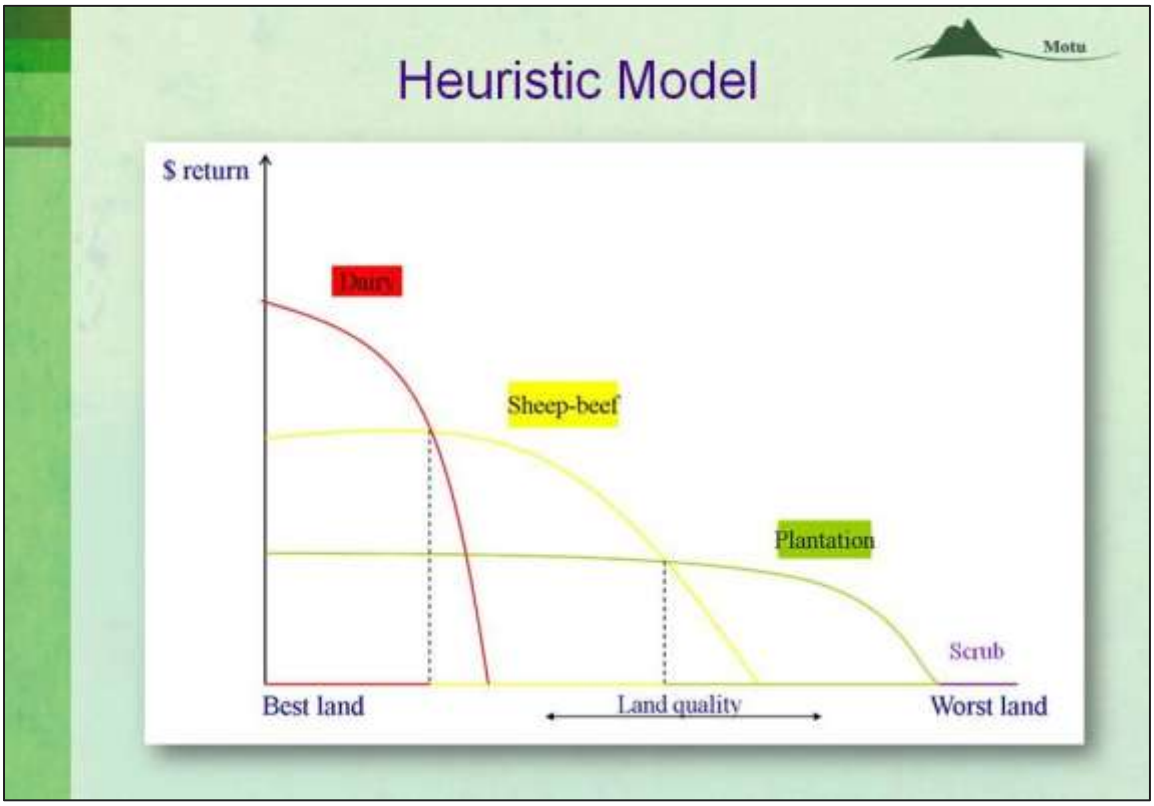
Models are developed alongside policy development processes.

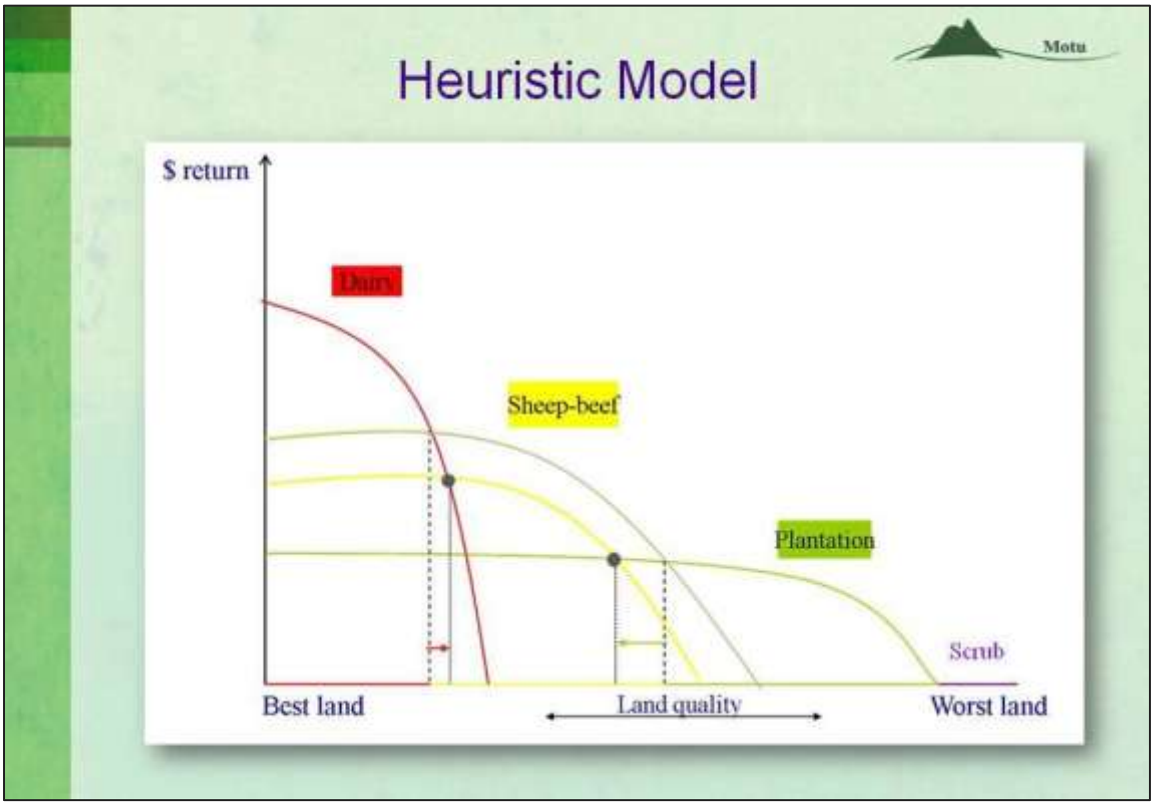

LURNZ Model Overview
• Scale
National, includes all of New Zealand
• Spatial resolution
Operates on a 25-hectare grid
• Scope
Four major rural sectors: dairy, sheep or beef, plantation forestry, scrub
• Dynamics
Dynamic, models gradual adjustment


LURNZ
Flow Diagram
LURNZ Model
Land use change module
Land use allocation module
Intensity module
GHG module


LURNZ
Flow Diagram
Policy Scenarios
No ETS (baseline)
Agri ETS only
Forest & Agri ETS
Forest, Agri & Scrub ETS
LURNZ Model
Land use change module
Land use allocation module
Intensity module
GHG module


LURNZ
Flow Diagram
Policy Scenarios
No ETS (baseline)
Agri ETS only
Forest & Agri ETS
Forest, Agri & Scrub ETS
LURNZ Model
Land use change module
Land use allocation module
Intensity module
GHG module
Output
Areas of land use change
Location of land use change
Profitability & land values
Agricultural production change
Maps of intensity and stocking rates
Change in emissions


Heuristic Model
Motu
$ return
Dairy
Sheep-beef
Plantation
Scrub
Best land
Land quality
Worst land


Heuristic Model
Motu
$ return
Dairy
Sheep-beef
Plantation
Scrub
Best land
Land quality
Worst land

Land-Use Change Module

- System of land-use share equations

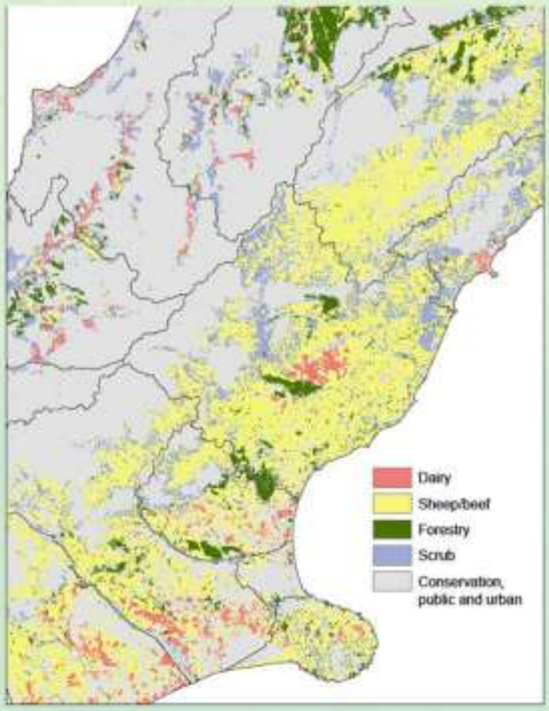
$$s_i = \alpha_i + \beta_i OL + \sum_j \gamma_{ij} \log p_j + \delta_{1i} r + \delta_{2i} time$$

- Estimated with cross-equation restrictions
- Able to simulate any policy that can be expressed as a commodity price or interest rate shock
- Simulations as far into the future as forecasts of exogenous variables

Land-Use Allocation Module

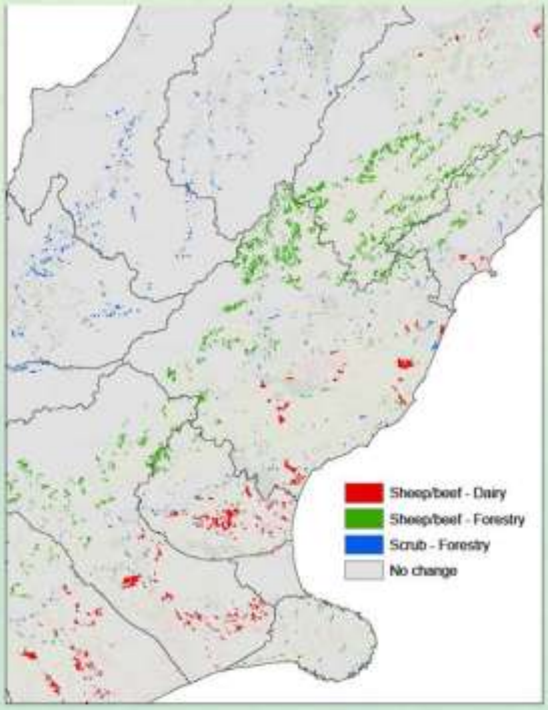
- A weighted ranking algorithm to allocate national land-use shares spatially
- Uses maps of geophysical and socio-economic land attributes to identify land likely to change use
- Characteristics used in ranking
  - geophysical limitations (LUC class, slope), existing land use in territorial authority, land use in neighbouring parcels, physical productivity

Base Year Map

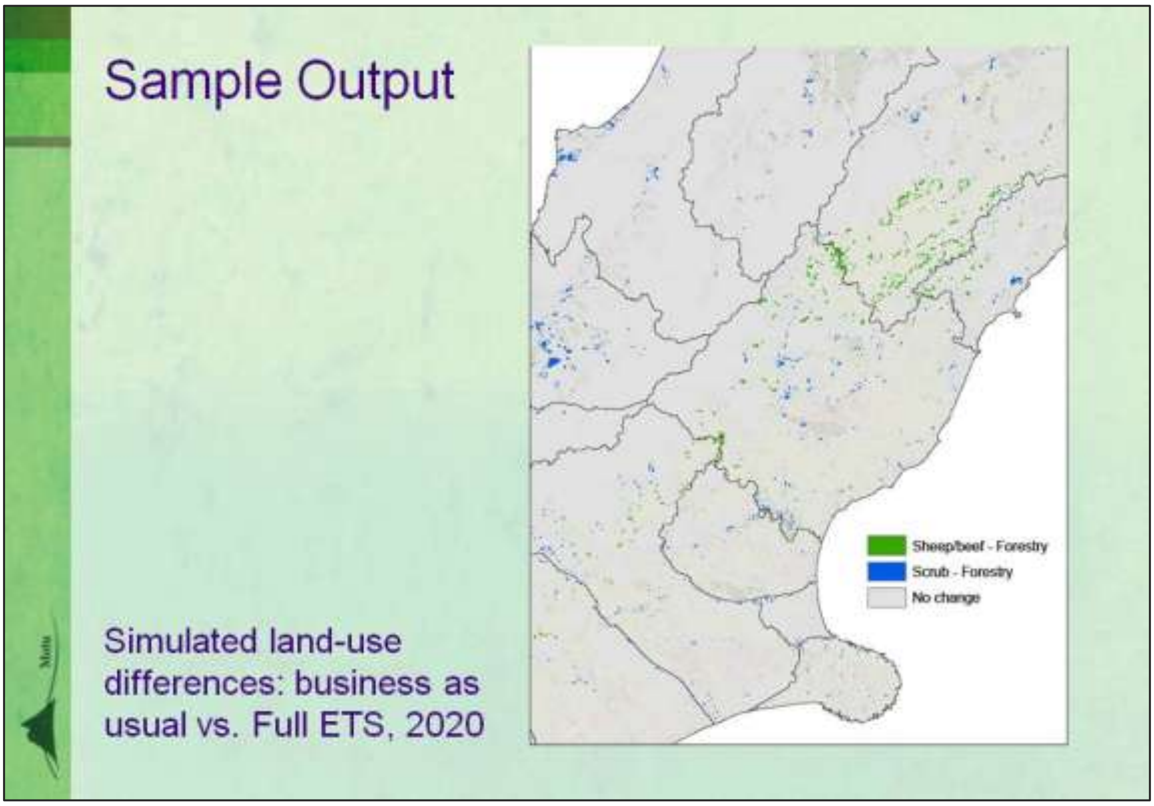


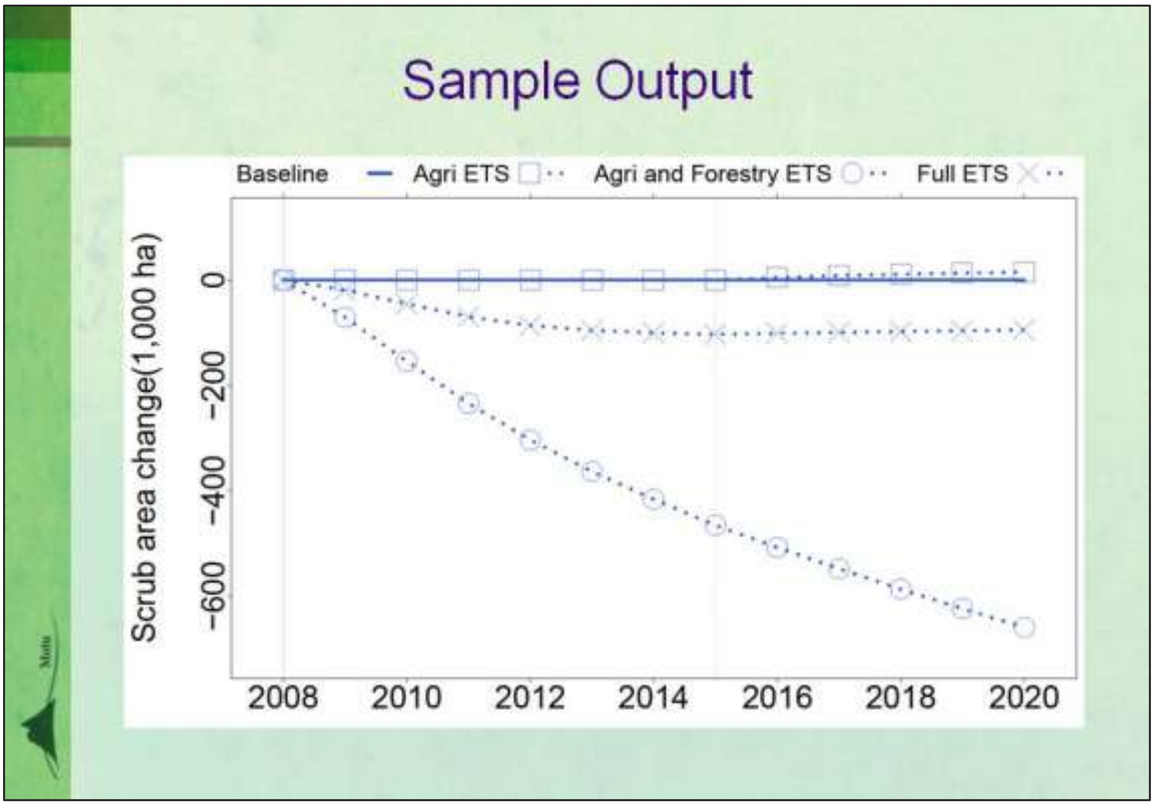
Land-use, 2008

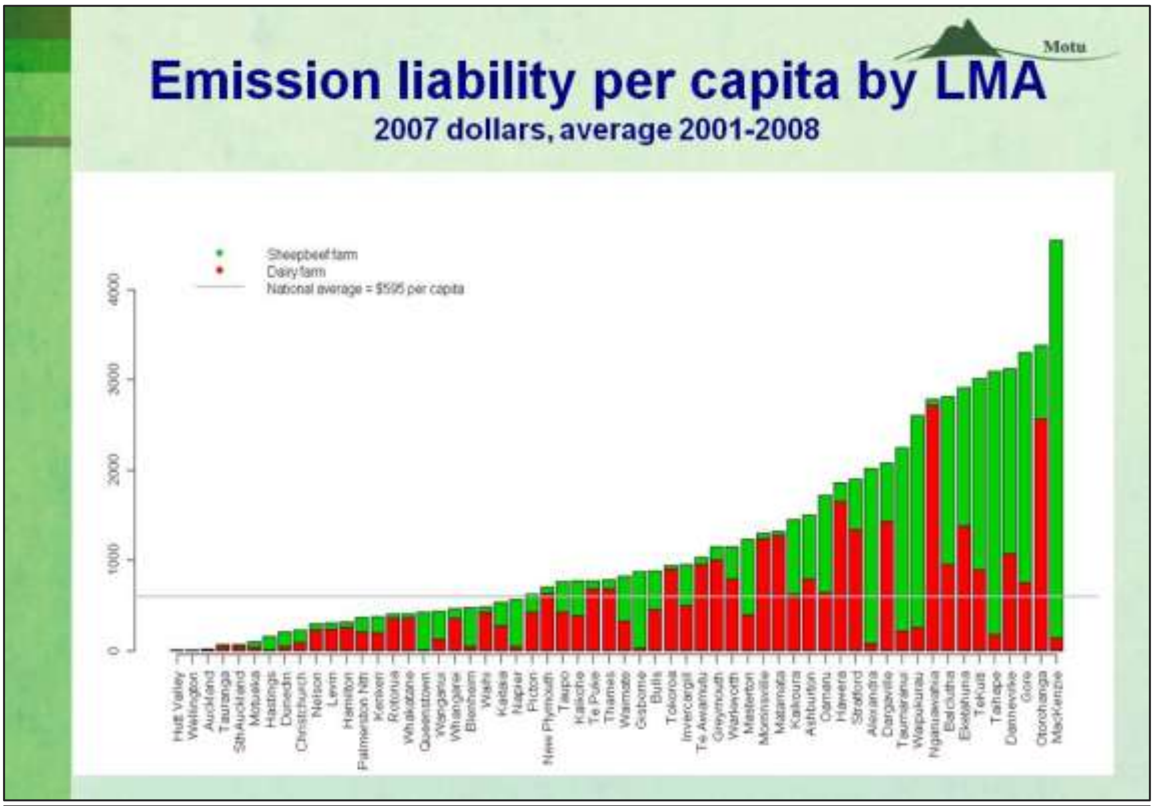
Sample Output

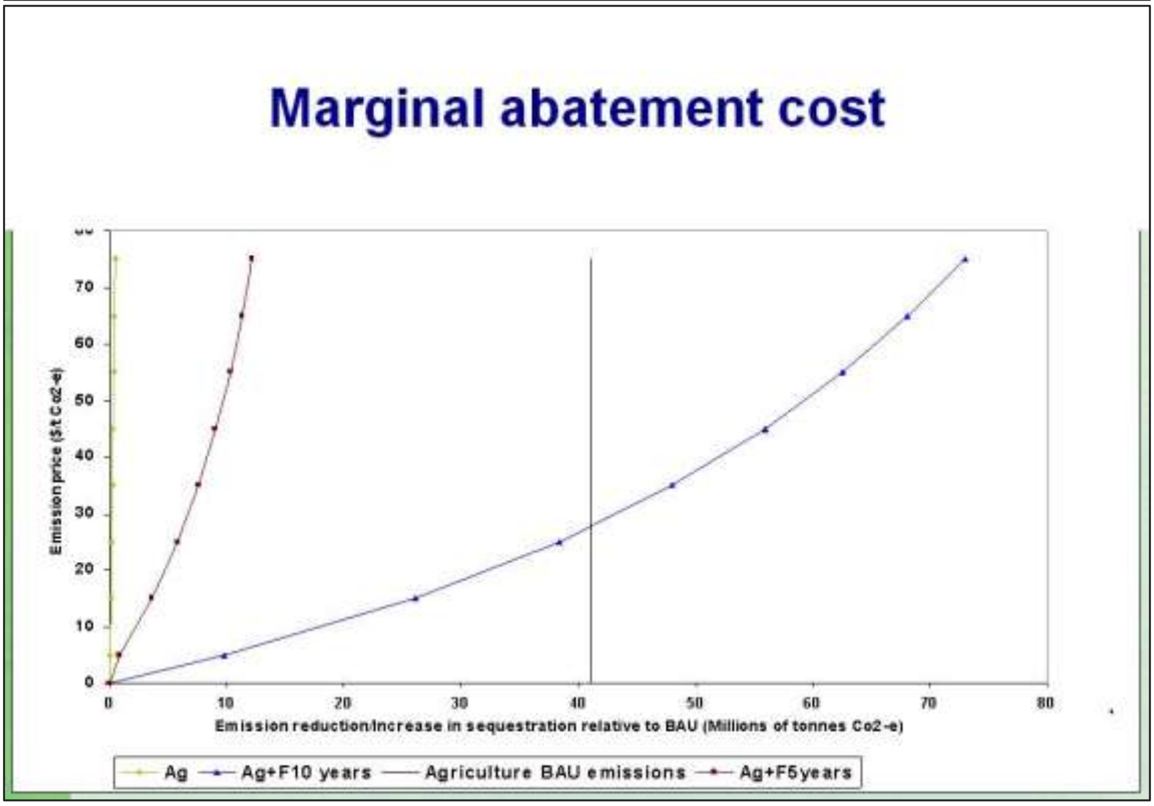


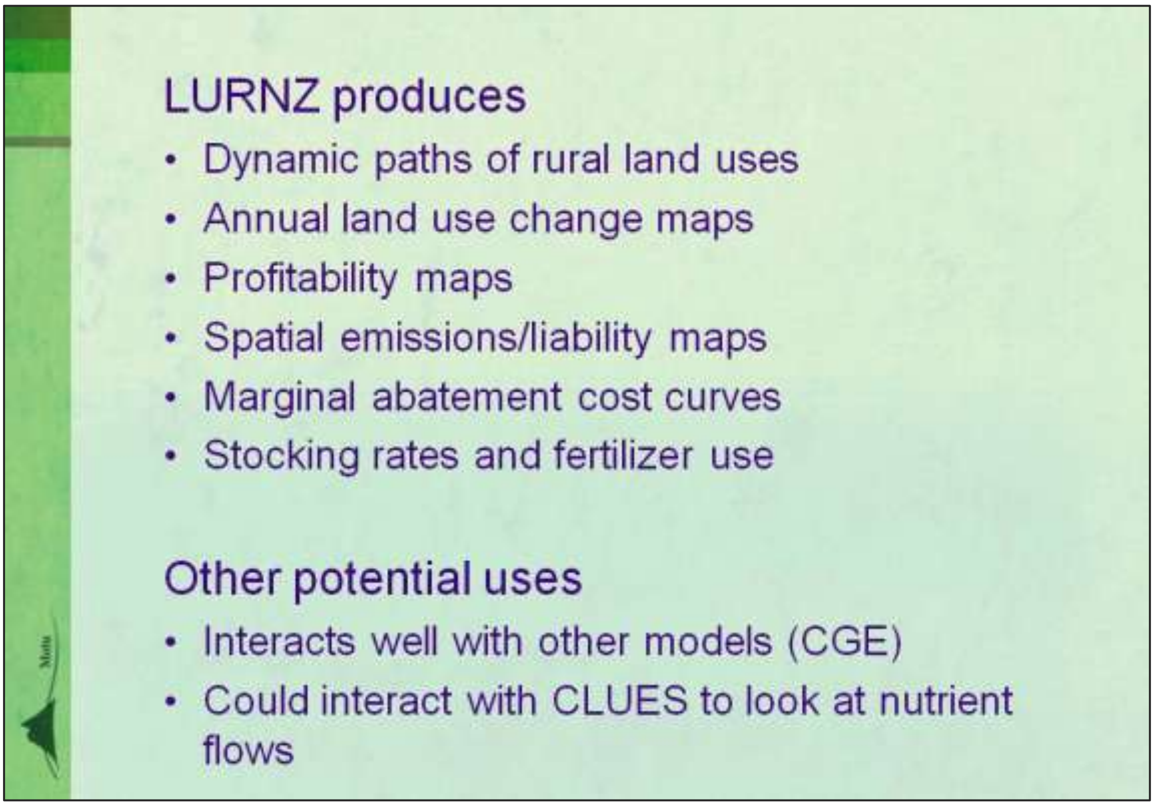
Simulated land-use conversions: business as usual scenario, 2020

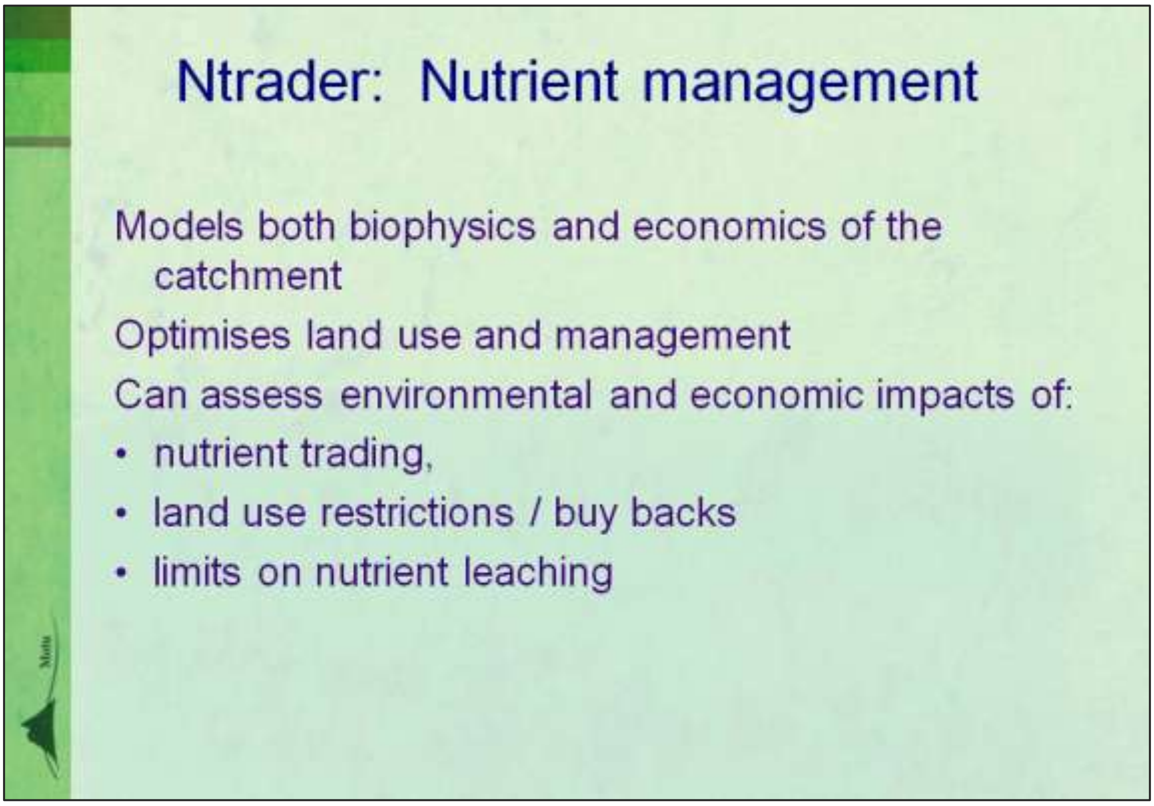

Sample Output
Simulated land-use differences: business as usual vs. Full ETS, 2020
Sheep/beef - Forestry
Scrub - Forestry
No change

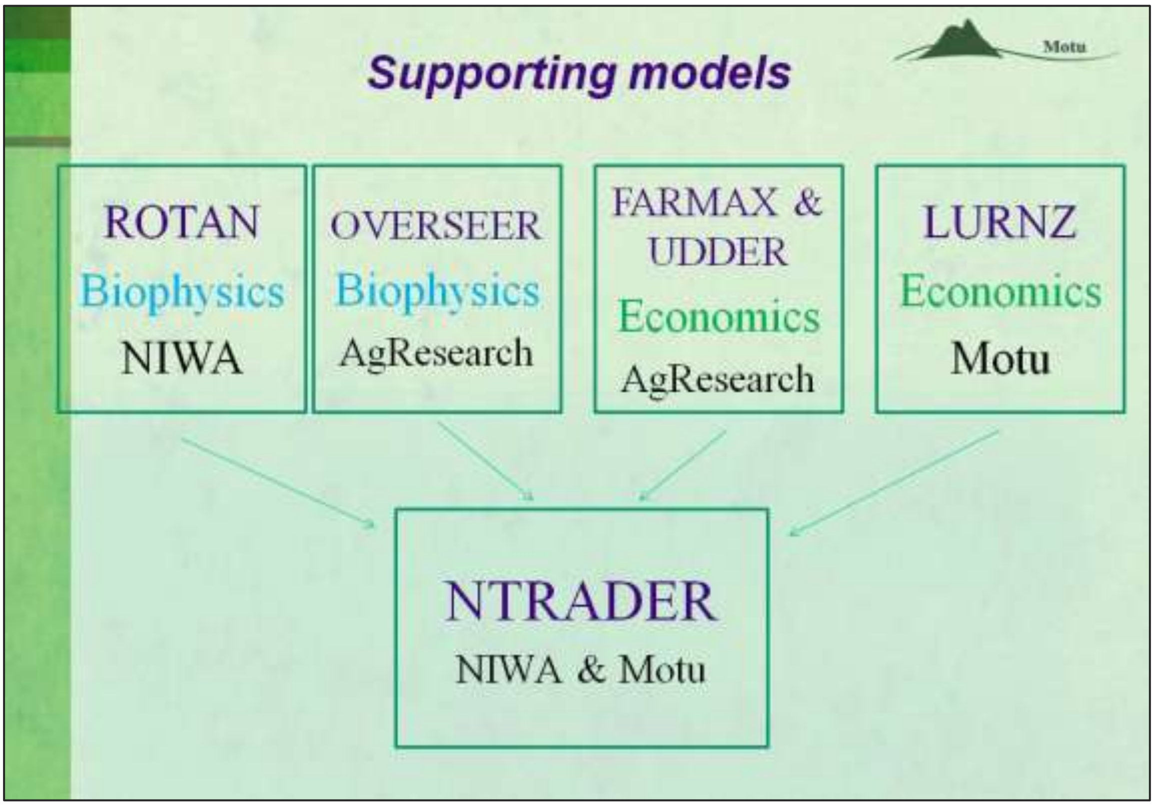

Sample Output
Baseline
Agri ETS
Agri and Forestry ETS
Full ETS
Scrub area change(1,000 ha)
0
-200
-400
-600
2008
2010
2012
2014
2016
2018
2020

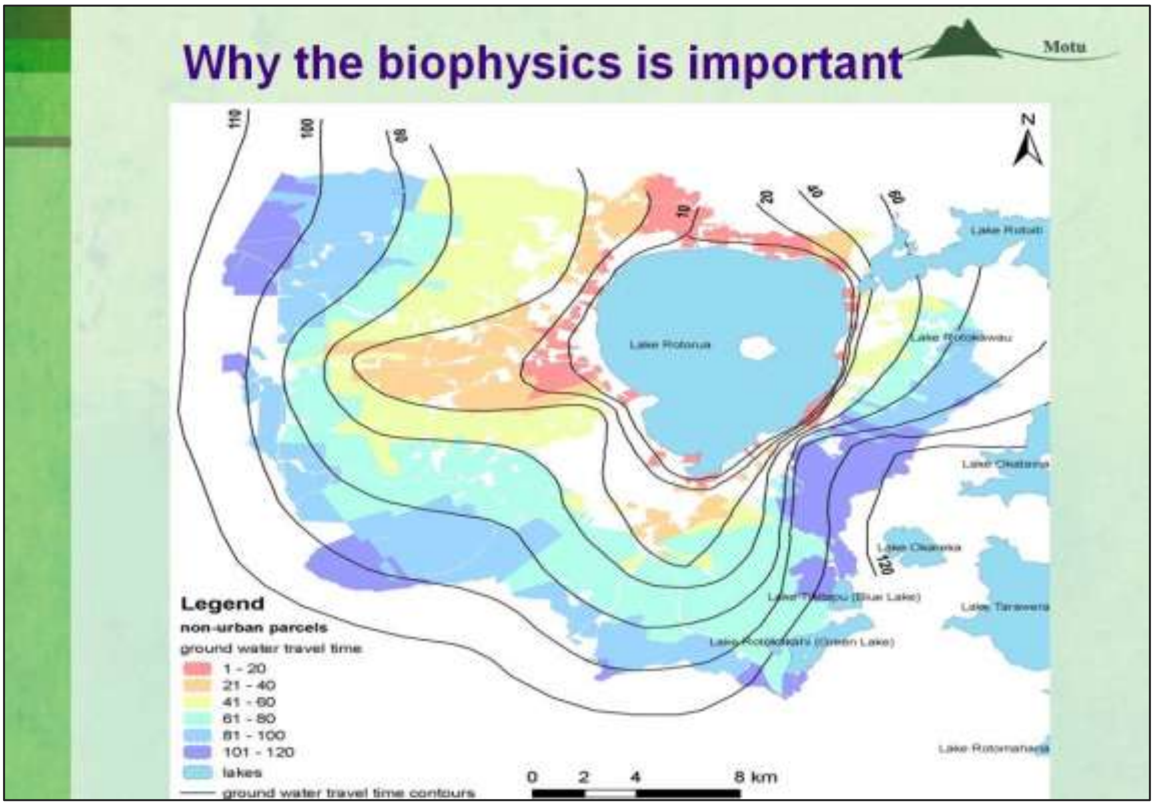

Motu
Emission liability per capita by LMA
2007 dollars, average 2001-2008
Sheepbeef farm
Dairy farm
National average = $595 per capita
0
1000
2000
3000
4000
Hutt Valley
Wellington
Auckland
Tauranga
Sth Auckland
Motueka
Hastings
Dunedin
Christchurch
Nelson
Levin
Hamilton
Palmerston Nth
Kerikeri
Rotorua
Whakatane
Queenstown
Wanganui
Whangarei
Blenheim
Waihi
Kaitaia
Napier
Picton
New Plymouth
Taupo
Kaikohe
Te Puke
Thames
Waimate
Gisborne
Bulls
Tokoroa
Invercargill
Te Awamutu
Greymouth
Warkworth
Masterton
Morrinsville
Matamata
Kaikoura
Ashburton
Oamaru
Hawera
Stratford
Alexandra
Dargaville
Taumarunui
Wapukurau
Ngaruawahia
Balclutha
Eketahuna
TeKuiti
Taihape
Dannevirke
Gore
Otorohanga
MacKenzie

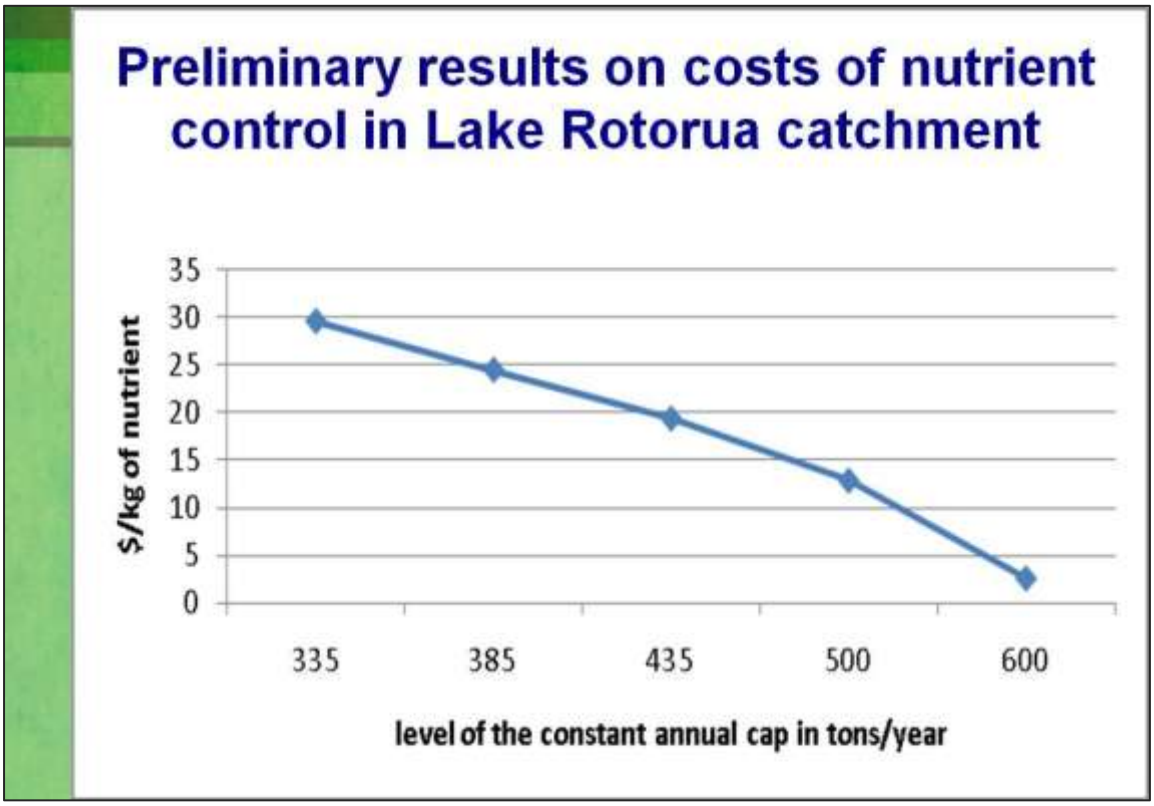

Marginal abatement cost
Emission price ($/t C o2-e)
0
10
20
30
40
50
60
70
0
10
20
30
40
50
60
70
80
Emission reduction/increase in sequestration relative to BAU (Millions of tonnes Co2-e)
Ag
Ag+F10 years
Agriculture BAU emissions
Ag+F5years


LURNZ produces
• Dynamic paths of rural land uses
• Annual land use change maps
• Profitability maps
• Spatial emissions/liability maps
• Marginal abatement cost curves
• Stocking rates and fertilizer use
Other potential uses
• Interacts well with other models (CGE)
• Could interact with CLUES to look at nutrient flows


Ntrader: Nutrient management
Models both biophysics and economics of the catchment
Optimises land use and management
Can assess environmental and economic impacts of:
• nutrient trading,
• land use restrictions / buy backs
• limits on nutrient leaching


Supporting models
Motu
ROTAN
Biophysics
NIWA
OVERSEER
Biophysics
AgResearch
FARMAX & UDDER
Economics
AgResearch
LURNZ
Economics
Motu
NTRADER
NIWA & Motu


Why the biophysics is important
Motu
N
110
100
90
10
20
40
60
120
Lake Rotorua
Legend
non-urban parcels
ground water travel time
1 - 20
21 - 40
41 - 60
61 - 80
81 - 100
101 - 120
lakes
ground water travel time contours
0
2
4
8 km


Preliminary results on costs of nutrient control in Lake Rotorua catchment
$/kg of nutrient
35
30
25
20
15
10
5
0
335
385
435
500
600
level of the constant annual cap in tons/year


Motu
www.motu.org.nz

NIWA
Taihoro Nukurangi

HortResearch

CLUES

Catchment Land Use
for Environmental Sustainability

Manaaki Whenua
Landcare Research

agresearch

AQUALINC
AQUALINC RESEARCH LIMITED

LINCOLN
ENVIRONMENTAL
RESEARCH

Harris Consulting

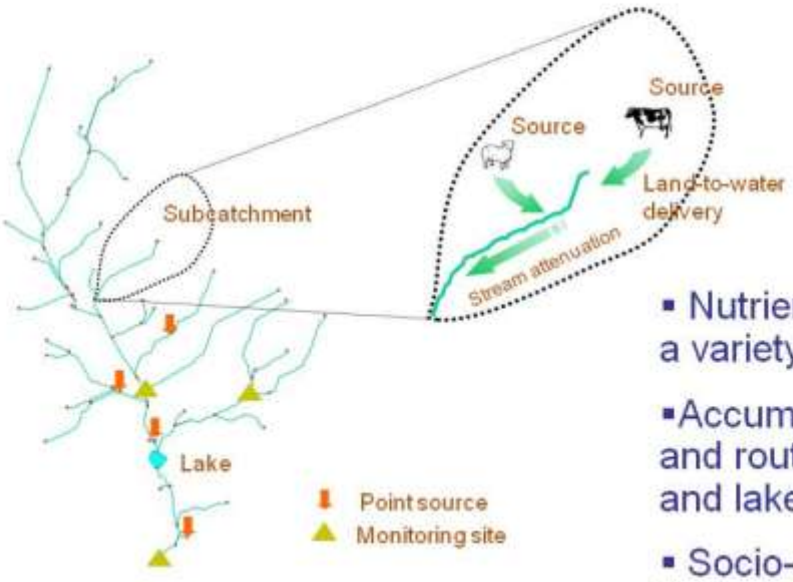
What is it?

- GIS-based catchment-scale model
- Predicts water quality and socio-economic indicators as a function of land use
- Free and ready to run for all of NZ
- Couples several models together
- Allows for land-use change, intensification, mitigation

What does it predict?

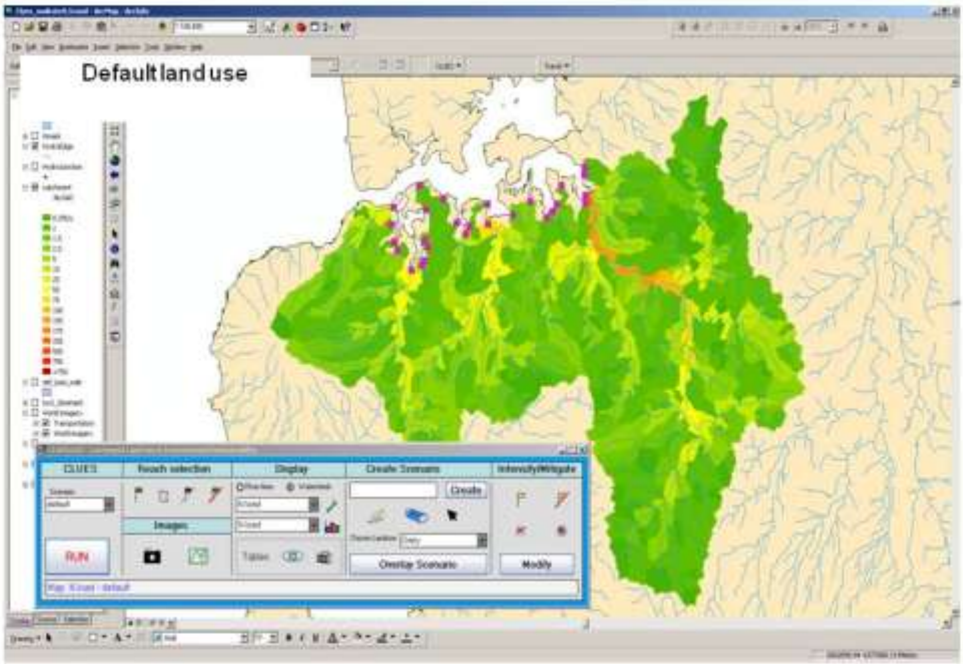
- Load of nutrients, E.Coli, and sediment sediment in streams
- Concentrations of nitrogen phosphorus
- Hot-spots of generation
- Socio-economic indicators
  - Employment
  - Enterprise revenue, surplus
  - Energy
  - GHG
  - Roading

CLUES model



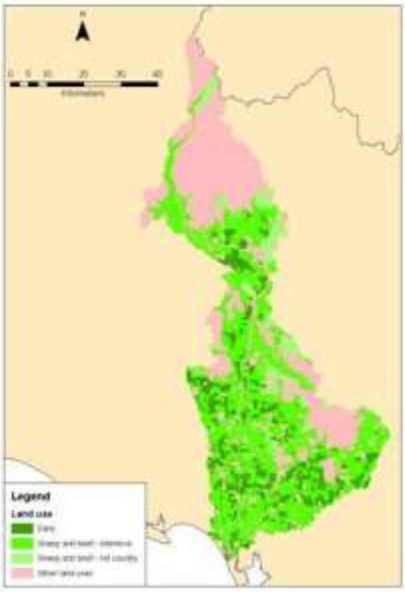
- Nutrient sources from a variety of models
- Accumulation, decay and routing in streams and lakes
- Socio-economic indicators

User friendly functionality

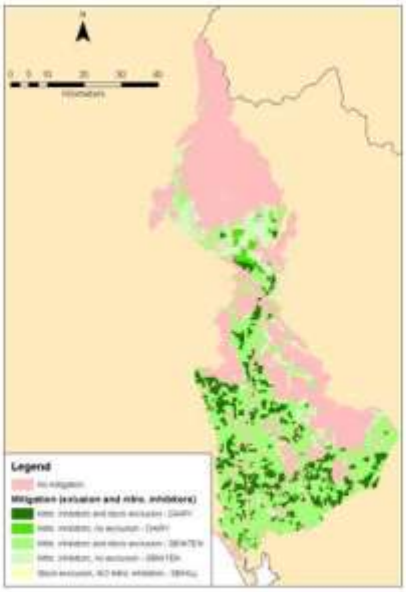


Oreti application

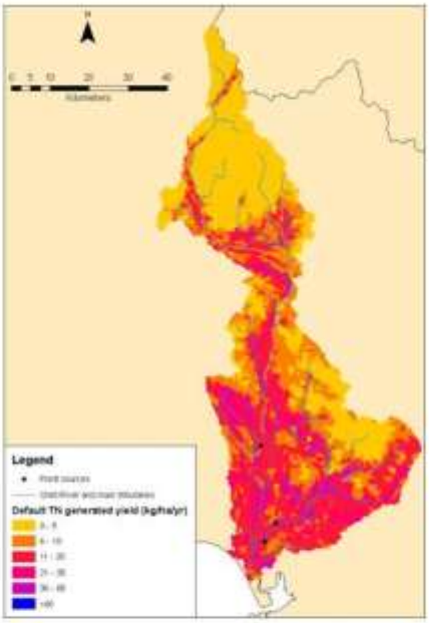
Current landuse



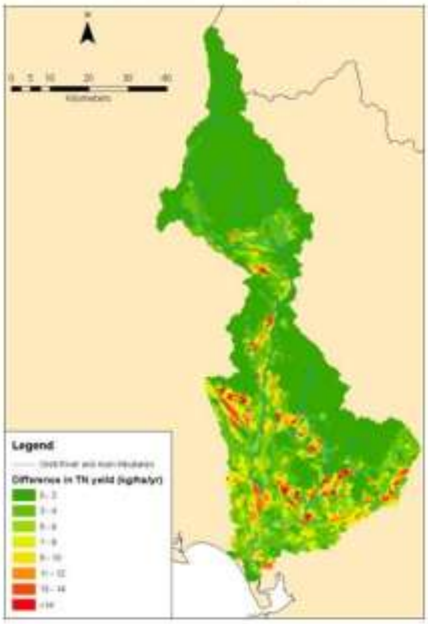
Nitrification inhibitors



Current yield



Nitrification inhibitors
Decrease in yield



Net reduction in N load

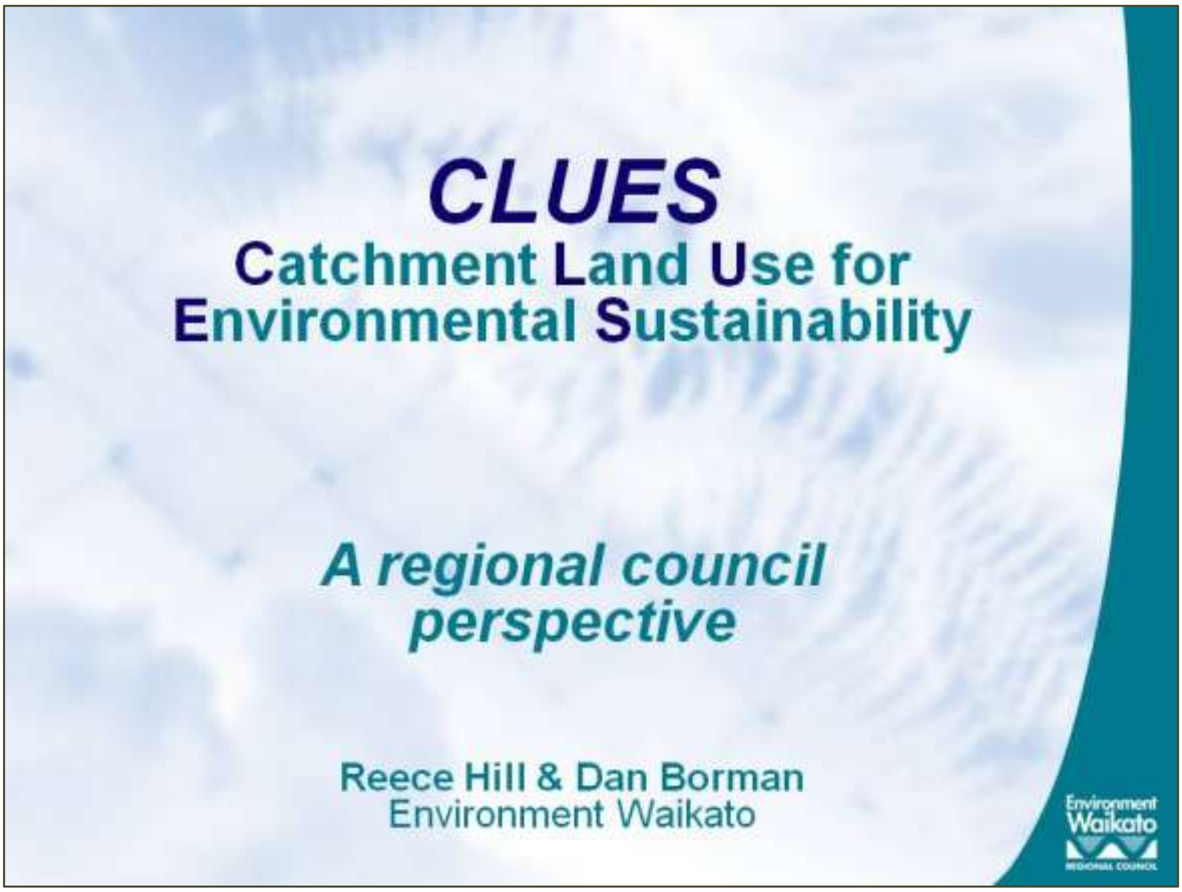
Current	5%
Stock exclusion	3%
Nitrification inhibitors	16%
Herd Shelters	10%
Wetlands	9%
Improved FDE management	2%

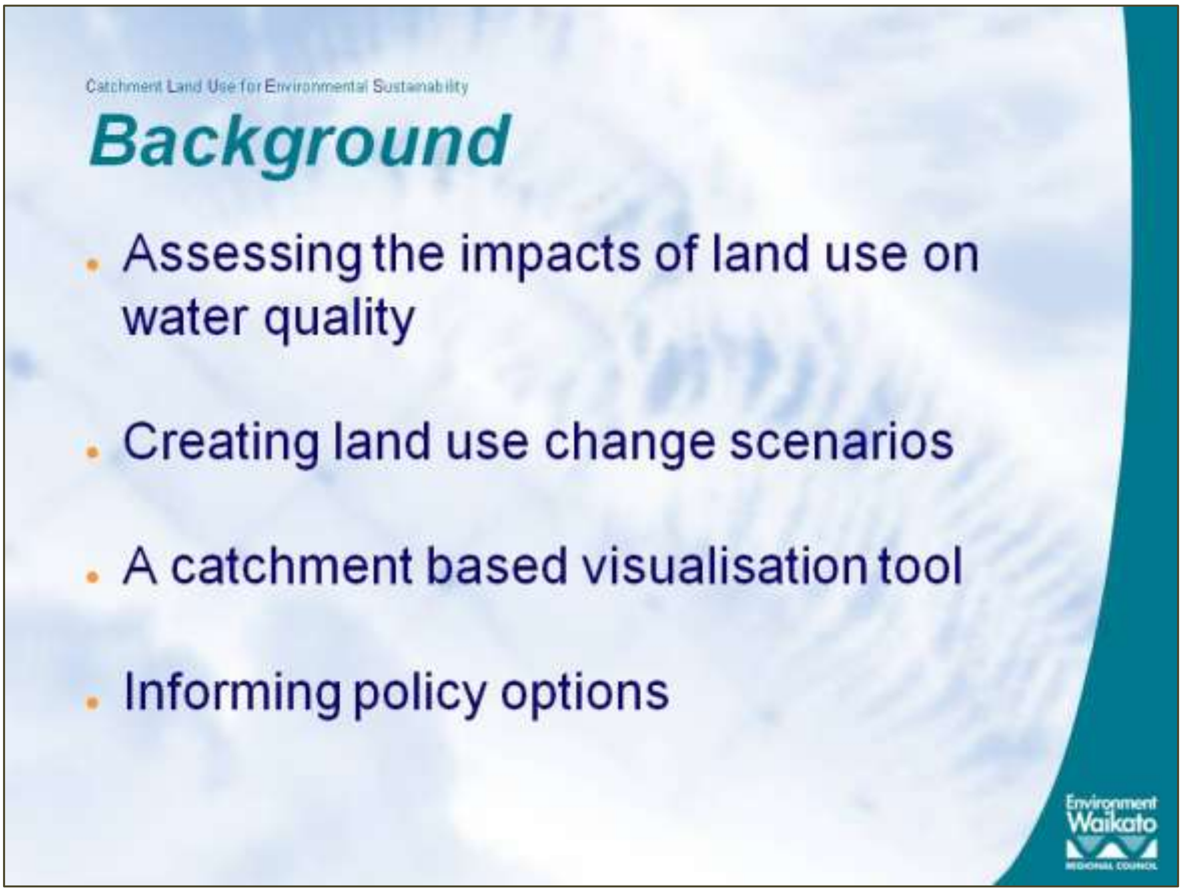
New Features

- Mitigation measures
- Scenarios management
- Import maps of stocking rates
- Updated socio-economic indicators:
  - economics (employment, profit, GDP)
  - transport use
  - energy
  - climate change

What's 'missing'

- Water management
- Groundwater
- Ecological impacts
- Cost of mitigation measures
- Link to farm scale


CLUES
Catchment Land Use for Environmental Sustainability
A regional council perspective
Reece Hill & Dan Borman
Environment Waikato
Environment Waikato


Catchment Land Use for Environmental Sustainability
Background
Assessing the impacts of land use on water quality
Creating land use change scenarios
A catchment based visualisation tool
Informing policy options
Environment Waikato

Catchment Land Use for Environmental Sustainability

Application

- at different scales
  - Waikato River Catchment
  - Sub-catchments (e.g. Upper Waikato)
- modelling the impacts of land use change
  - Pine to pasture conversion
- developing land use change scenarios
  - Afforestation of steep land
  - Matching land use with capability

Environment Waikato REGIONAL COUNCIL

Pine to pasture conversion

-land use change impacts on water quality in the upper Waikato Catchment?

Environment Waikato REGIONAL COUNCIL

Catchment Land Use for Environmental Sustainability

Waikato Catchment example

- *Using* CLUES 2002 land use
- Changes in N load following:

A. Soil conservation on LUC class 6e, 7 and 8

B. Matching land use to LUC

- *Dairy on LUC 1-4*
- *Intensive Sheep and Beef on LUC 5-6*
- *Pines on LUC 6e-7*
- *Shrub on LUC 8*

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Catchment Land Use for Environmental Sustainability

Land Use Capability (LUC)

↓ *Increasing limitations to use* ↓

LUC Class	Arable cropping suitability†	Pastoral grazing suitability	Production forestry suitability	General suitability
1	High	High	High	Multiple use land
2	↓	↓	↓	
3				
4	Low			
5				Pastoral or forestry land
6	Unsuitable			
7		Low	Low	
8		Unsuitable	Unsuitable	Conservation land

↓ *Decreasing versatility of use* ↓

Figure 2: Increasing limitations to use and decreasing versatility of use from LUC Class 1 to LUC Class 8 (modified from SCRCC 1974). † Includes vegetable cropping.

- ***LUC 6e, 7 and 8 on pasture = "at risk" land***

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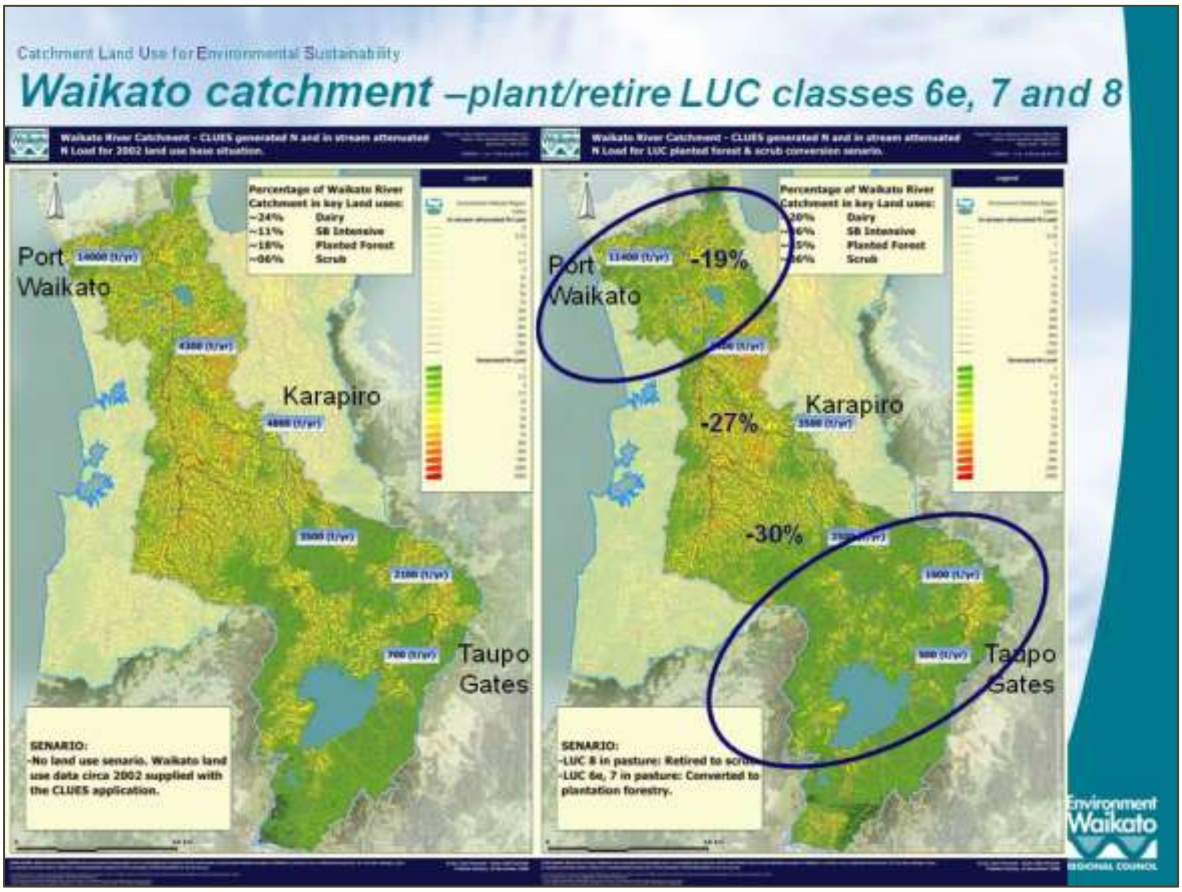
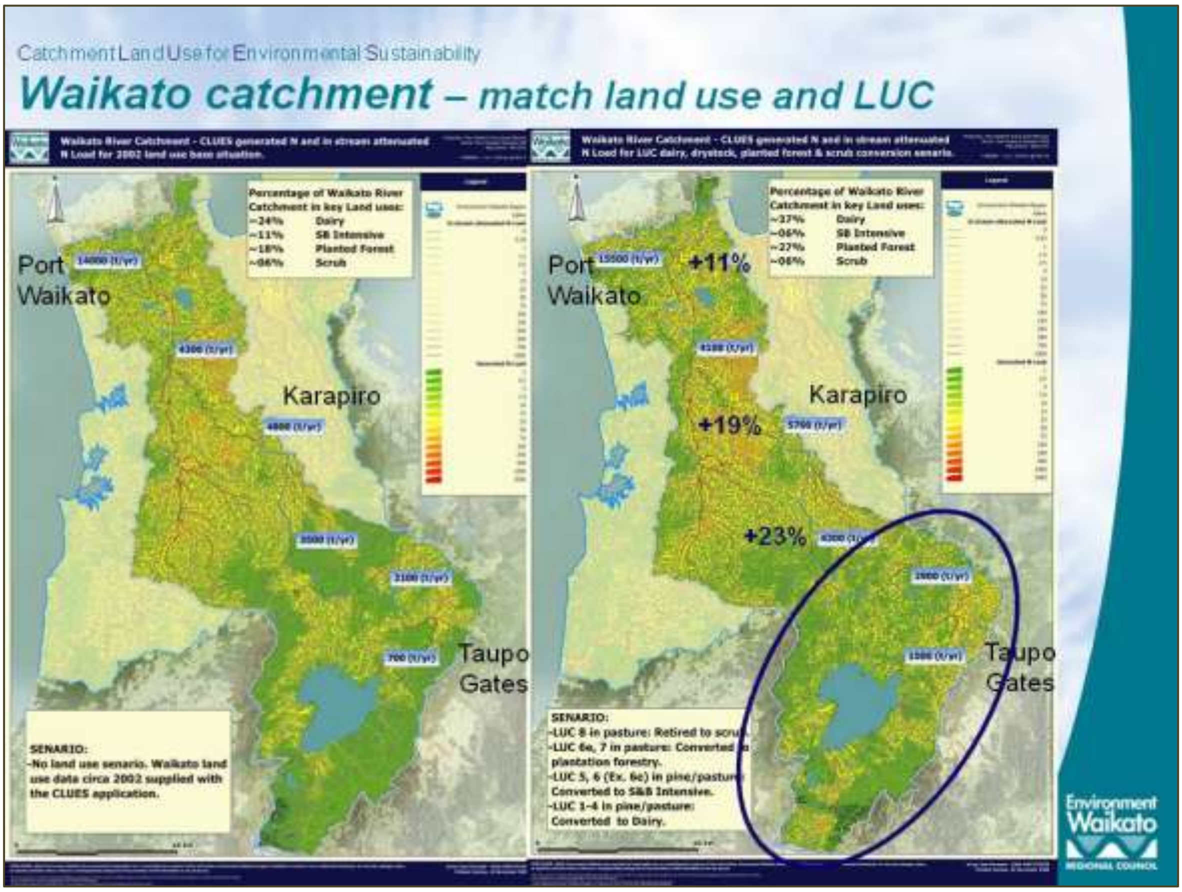
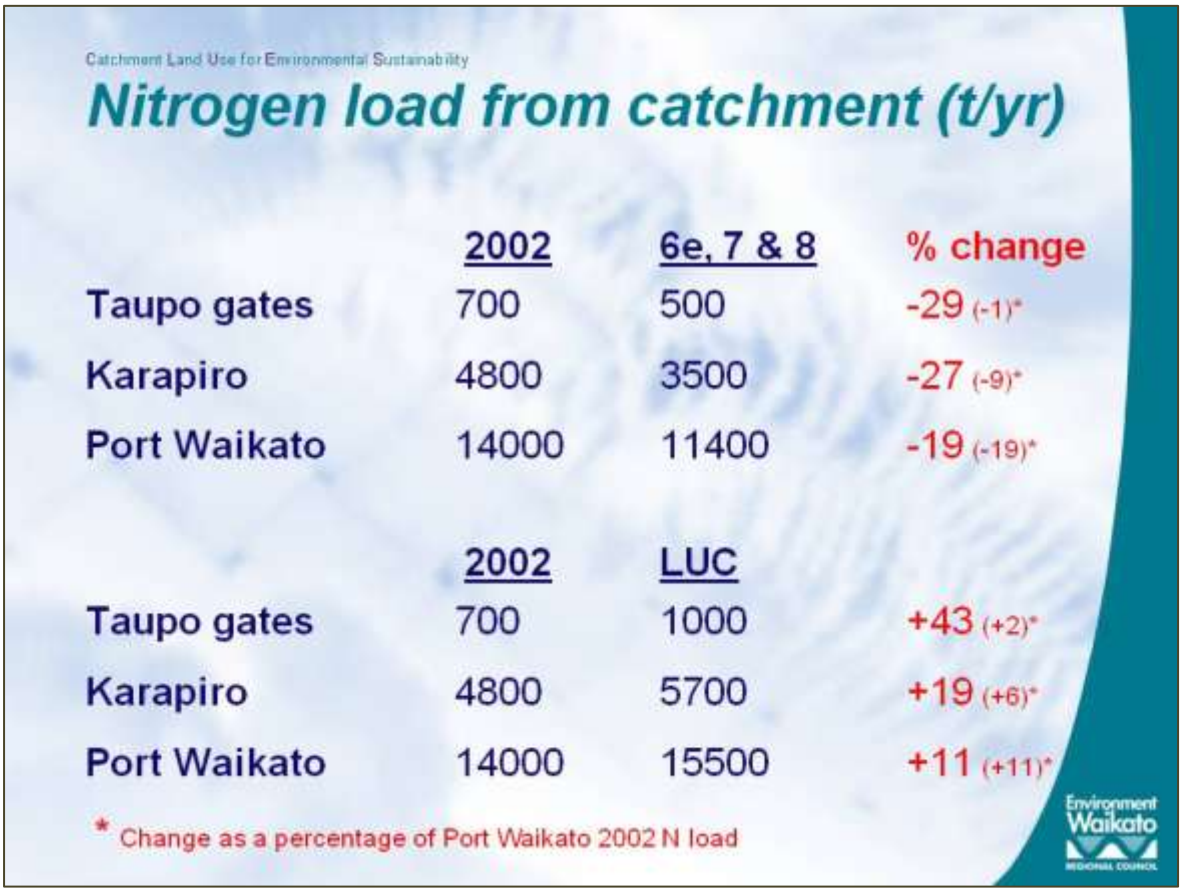
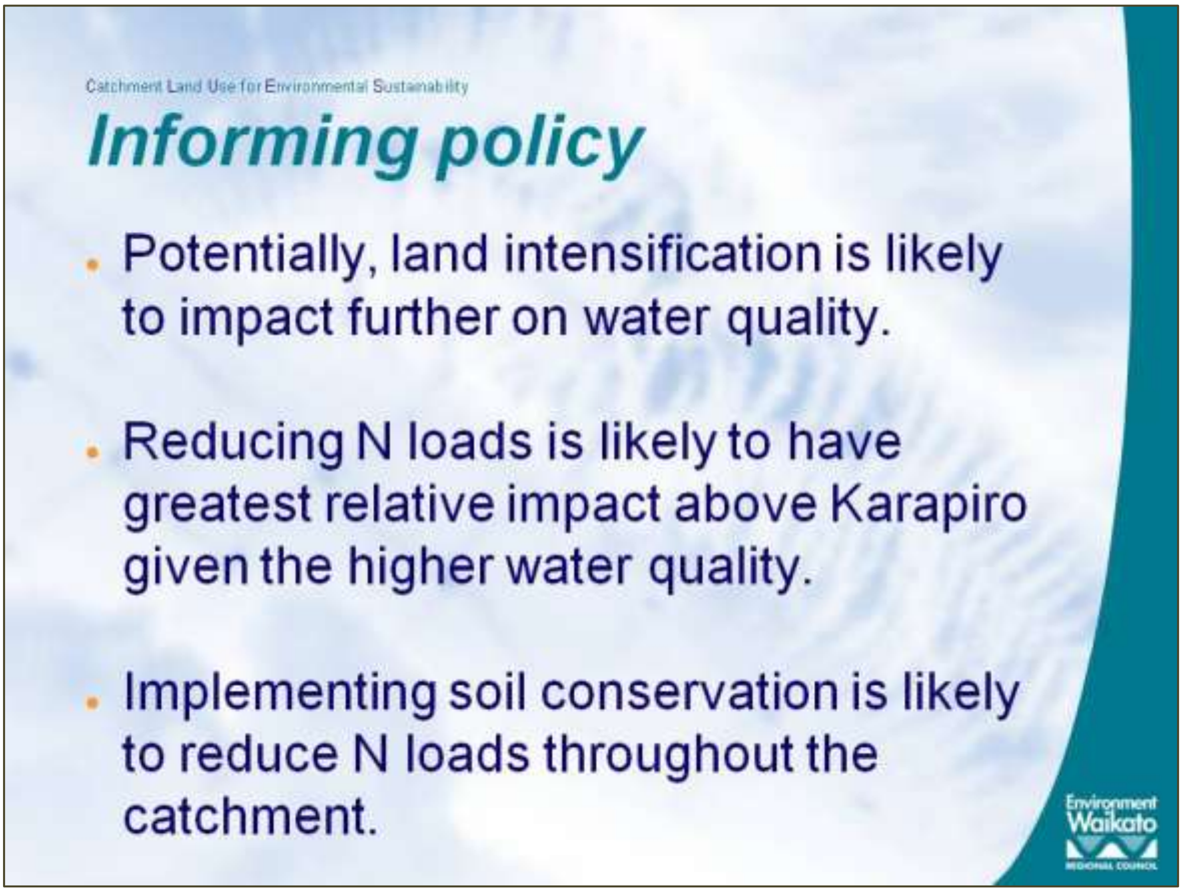
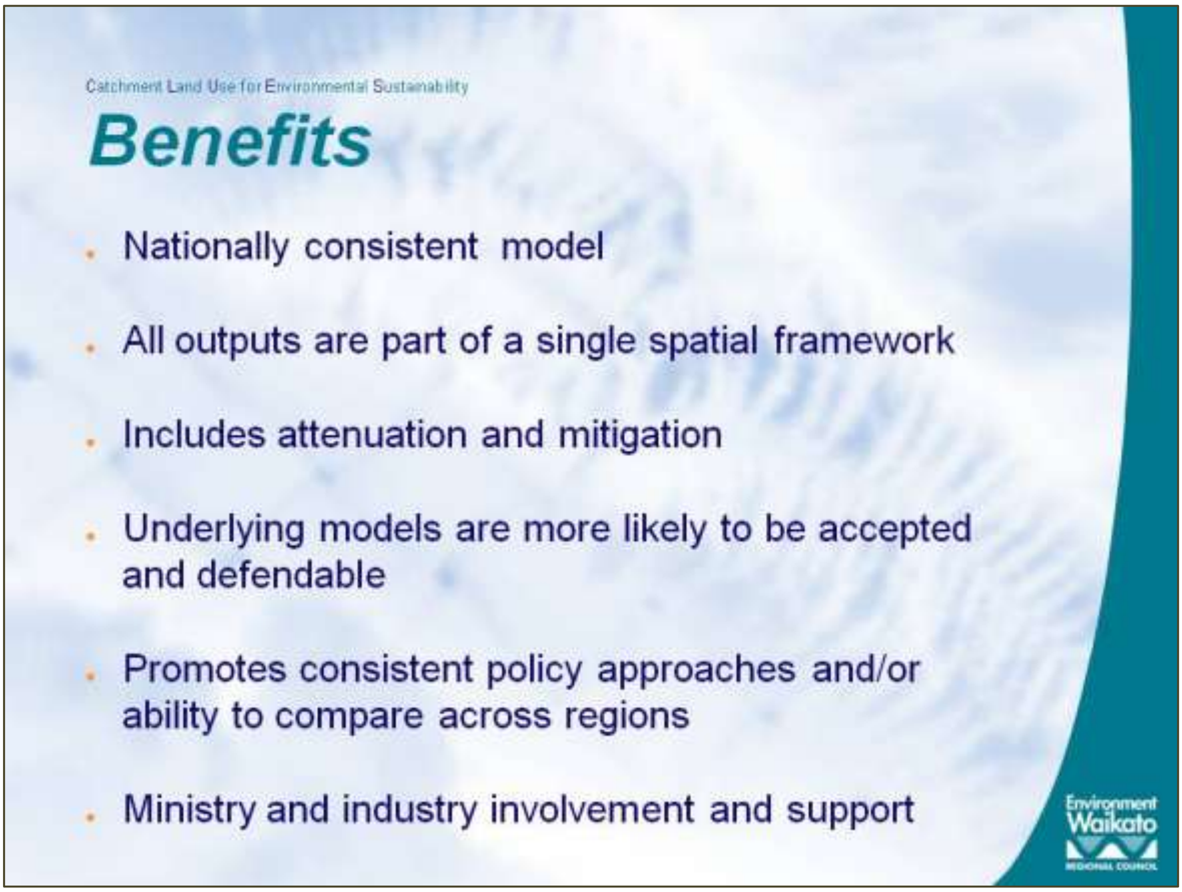

Catchment Land Use for Environmental Sustainability
Waikato catchment –plant/retire LUC classes 6e, 7 and 8
Waikato River Catchment - CLUES generated N and in stream attenuated N Load for 2002 land use base situation.
Waikato River Catchment - CLUES generated N and in stream attenuated N Load for LUC planted forest & scrub conversion senario.
Percentage of Waikato River Catchment in key Land uses:
~24% Dairy
~11% SB Intensive
~18% Planted Forest
~06% Scrub
Port Waikato
Karapiro
Taupo Gates
-19%
-27%
-30%
SENARIO:
-No land use senario. Waikato land use data circa 2002 supplied with the CLUES application.
SENARIO:
-LUC 8 in pasture: Retired to scrub
-LUC 6e, 7 in pasture: Converted to plantation forestry.
Environment Waikato
REGIONAL COUNCIL


Catchment Land Use for Environmental Sustainability
Waikato catchment – match land use and LUC
Waikato River Catchment - CLUES generated N and in stream attenuated N Load for 2002 land use base situation.
Waikato River Catchment - CLUES generated N and in stream attenuated N Load for LUC dairy, drystock, planted forest & scrub conversion senario.
Percentage of Waikato River Catchment in key Land uses:
~24% Dairy
~11% SB Intensive
~18% Planted Forest
~06% Scrub
Percentage of Waikato River Catchment in key Land uses:
~37% Dairy
~06% SB Intensive
~27% Planted Forest
~06% Scrub
Port Waikato
Karapiro
Taupo Gates
+11%
+19%
+23%
SENARIO:
-No land use senario. Waikato land use data circa 2002 supplied with the CLUES application.
SENARIO:
-LUC 8 in pasture: Retired to scrub
-LUC 6e, 7 in pasture: Converted to plantation forestry.
-LUC 5, 6 (Ex. 6e) in pine/pasture: Converted to S&B Intensive.
-LUC 1-4 in pine/pasture: Converted to Dairy.
Environment Waikato
REGIONAL COUNCIL

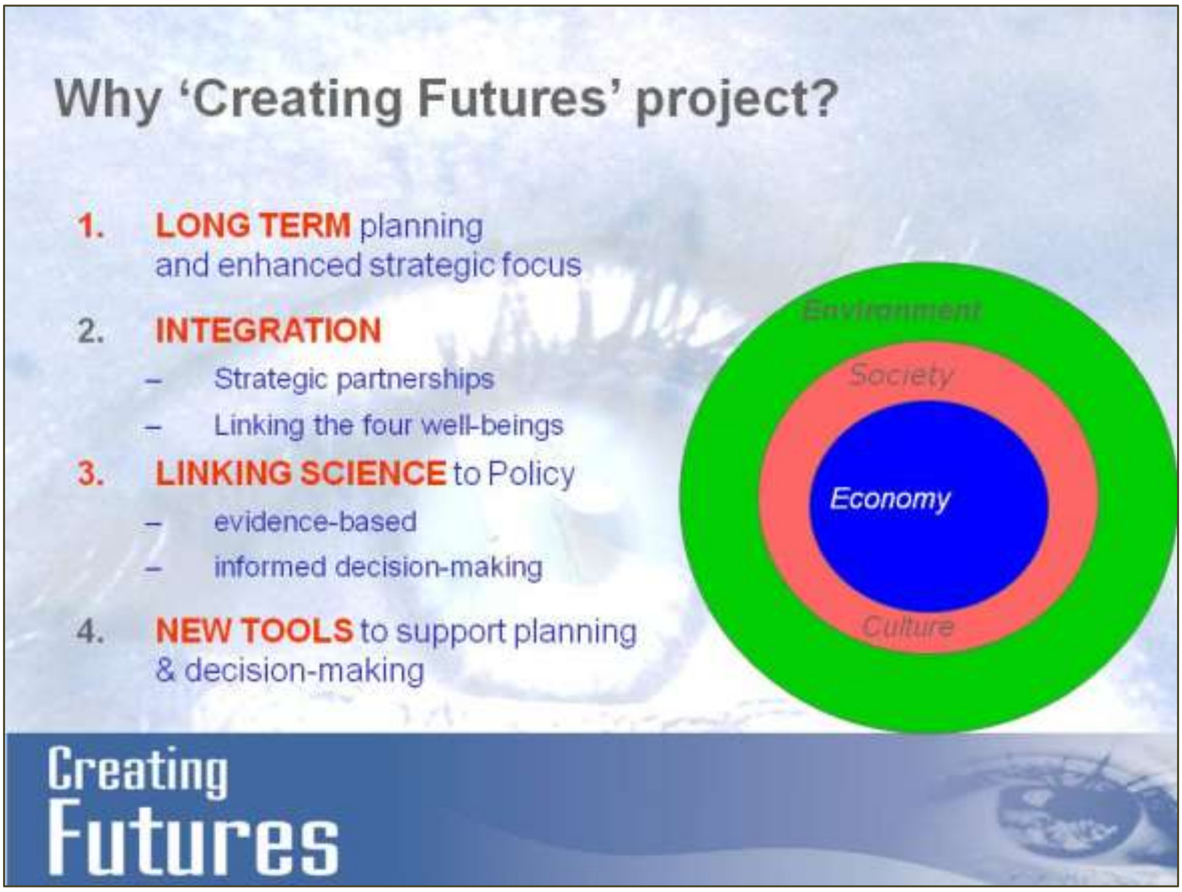

Catchment Land Use for Environmental Sustainability
Nitrogen load from catchment (t/yr)
2002
6e, 7 & 8
% change
Taupo gates 700 500 -29 (-1)*
Karapiro 4800 3500 -27 (-9)*
Port Waikato 14000 11400 -19 (-19)*
2002
LUC
Taupo gates 700 1000 +43 (+2)*
Karapiro 4800 5700 +19 (+6)*
Port Waikato 14000 15500 +11 (+11)*
* Change as a percentage of Port Waikato 2002 N load
Environment Waikato
REGIONAL COUNCIL

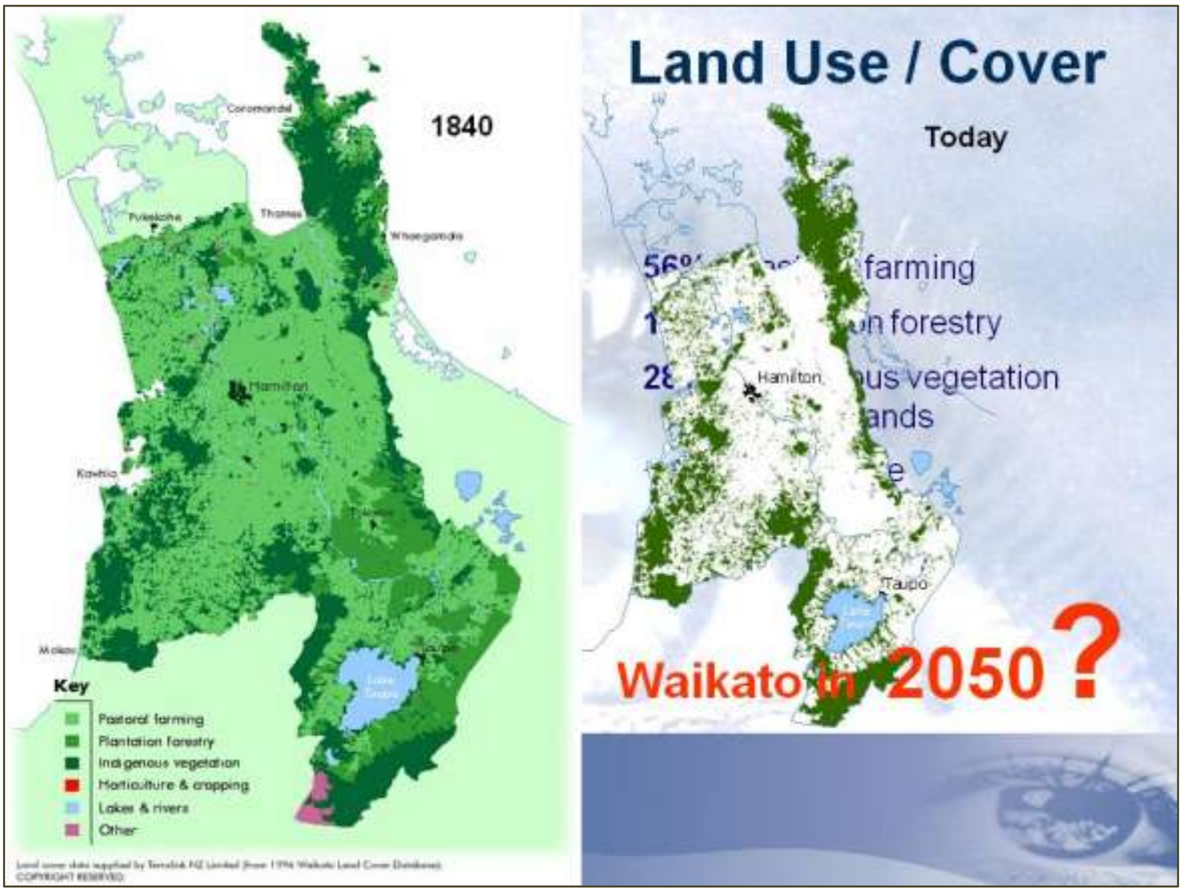

Catchment Land Use for Environmental Sustainability
Informing policy
Potentially, land intensification is likely to impact further on water quality.
Reducing N loads is likely to have greatest relative impact above Karapiro given the higher water quality.
Implementing soil conservation is likely to reduce N loads throughout the catchment.
Environment Waikato
REGIONAL COUNCIL


Catchment Land Use for Environmental Sustainability
Benefits
Nationally consistent model
All outputs are part of a single spatial framework
Includes attenuation and mitigation
Underlying models are more likely to be accepted and defendable
Promotes consistent policy approaches and/or ability to compare across regions
Ministry and industry involvement and support
Environment Waikato
REGIONAL COUNCIL


Catchment Land Use for Environmental Sustainability
Challenges
Comparison of models and approaches
Accurate land use data
Data updates
Developing useful scenarios
Environment Waikato
REGIONAL COUNCIL

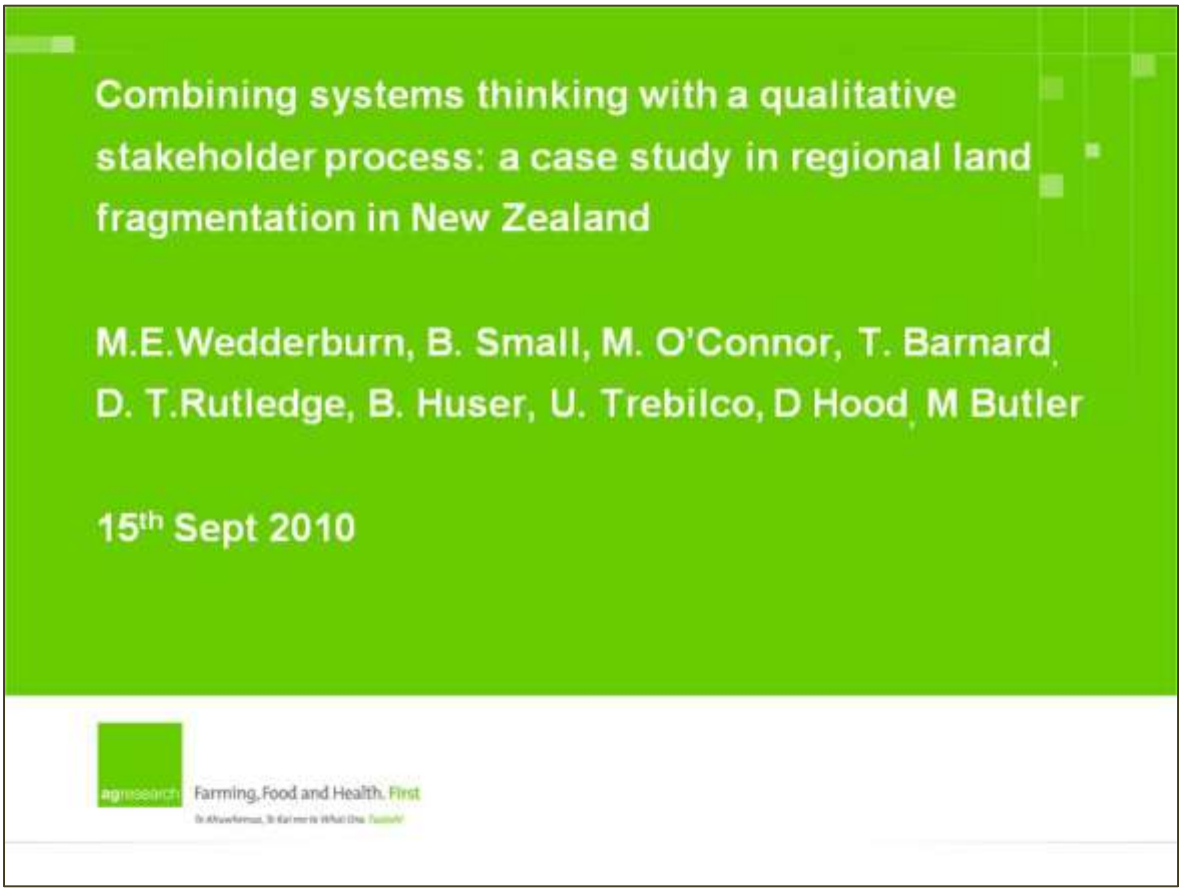

Creating Futures:
Tools for
Integrated
Planning
Wellington
Daniel Rutledge (LCR)
Liz Wedderburn (AgR)
Beat Huser (EW)
Auckland
Hamilton
- Waikato
Envirolink Workshop, Wellington, 15 September 2010


Why 'Creating Futures' project?
1. LONG TERM planning
and enhanced strategic focus
2. INTEGRATION
– Strategic partnerships
– Linking the four well-beings
3. LINKING SCIENCE to Policy
– evidence-based
– informed decision-making
4. NEW TOOLS to support planning
& decision-making
Environment
Society
Economy
Culture
Creating
Futures


Land Use / Cover
1840
Today
Coromandel
Thames
Hamilton
Taupo
Key
Pastoral farming
Plantation forestry
Indigenous vegetation
Horticulture & cropping
Lakes & rivers
Other
farming
forestry
vegetation
Waikato in 2050?


Project Aim
Develop and apply
planning and communication tools
to make informed choices for the future
Creating
Futures


Project Structure
Developing and applying planning tools to make informed choices for the future
Environment Waikato
REGIONAL COUNCIL
Advisory Group
EW, MfE, LGNZ, SNZ, MAF, EBOP, ARC, HCC
OBJECTIVE 1:
Improved communication & deliberation tools
agresearch
SCION
OBJECTIVE 2:
Spatial decision support system development
Landcare Research
Manaaki Whenua
NZCEE
NIWA
RIKS
WAIKATO
FOUNDATION FOR
RESEARCH
SCIENCE &
TECHNOLOGY
Creating
Futures

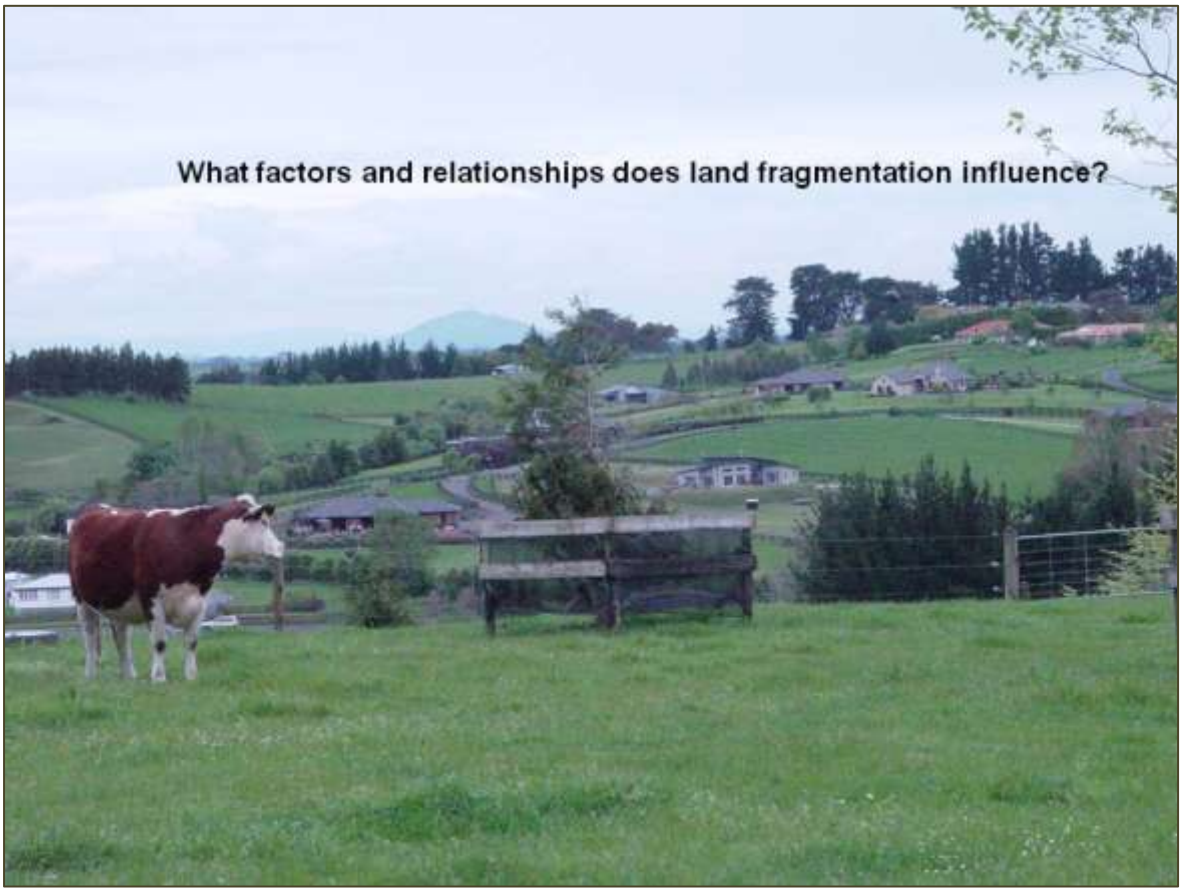

Combining systems thinking with a qualitative stakeholder process: a case study in regional land fragmentation in New Zealand
M.E.Wedderburn, B. Small, M. O'Connor, T. Barnard, D. T.Rutledge, B. Huser, U. Trebilco, D Hood, M Butler
15th Sept 2010
agresearch
Farming, Food and Health. First

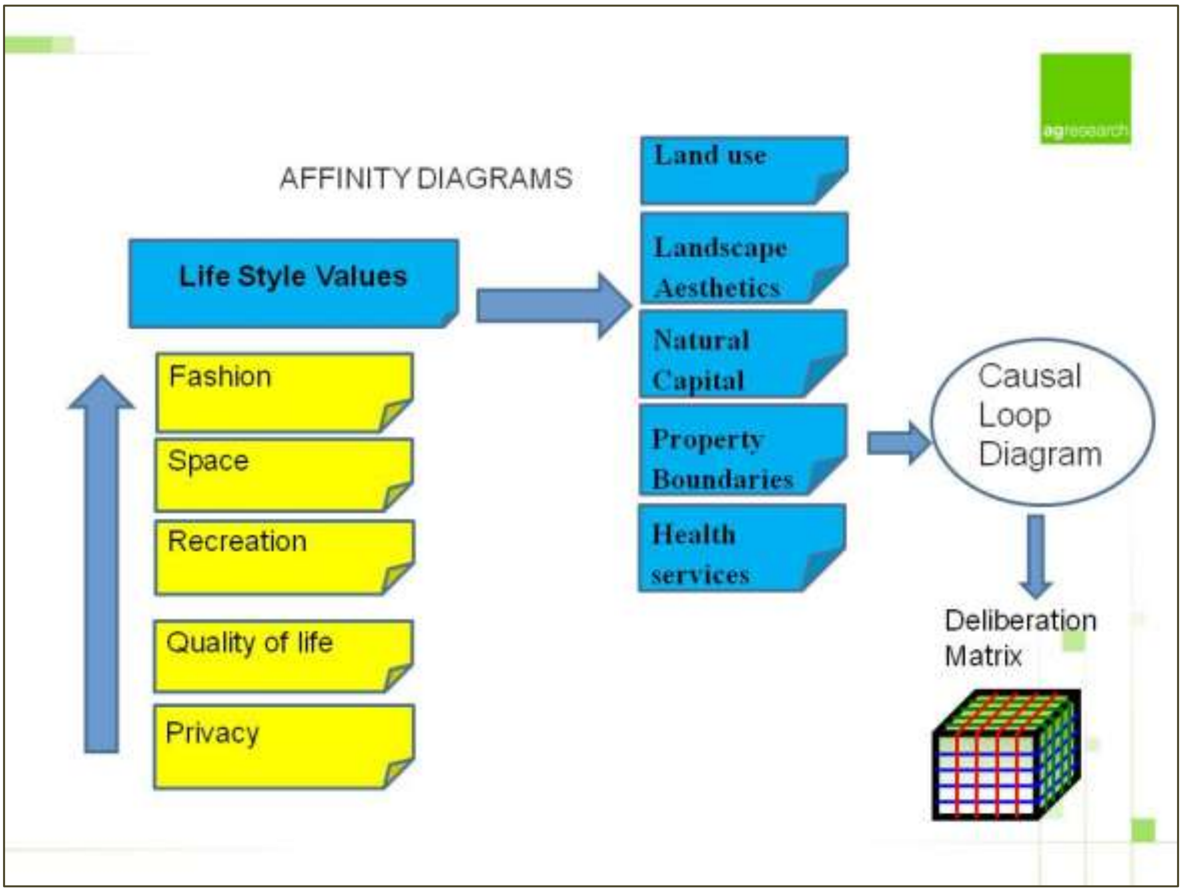

• Context
• A Sustainable development approach
• The Case
Issue
Processes and tools
Results
Principles

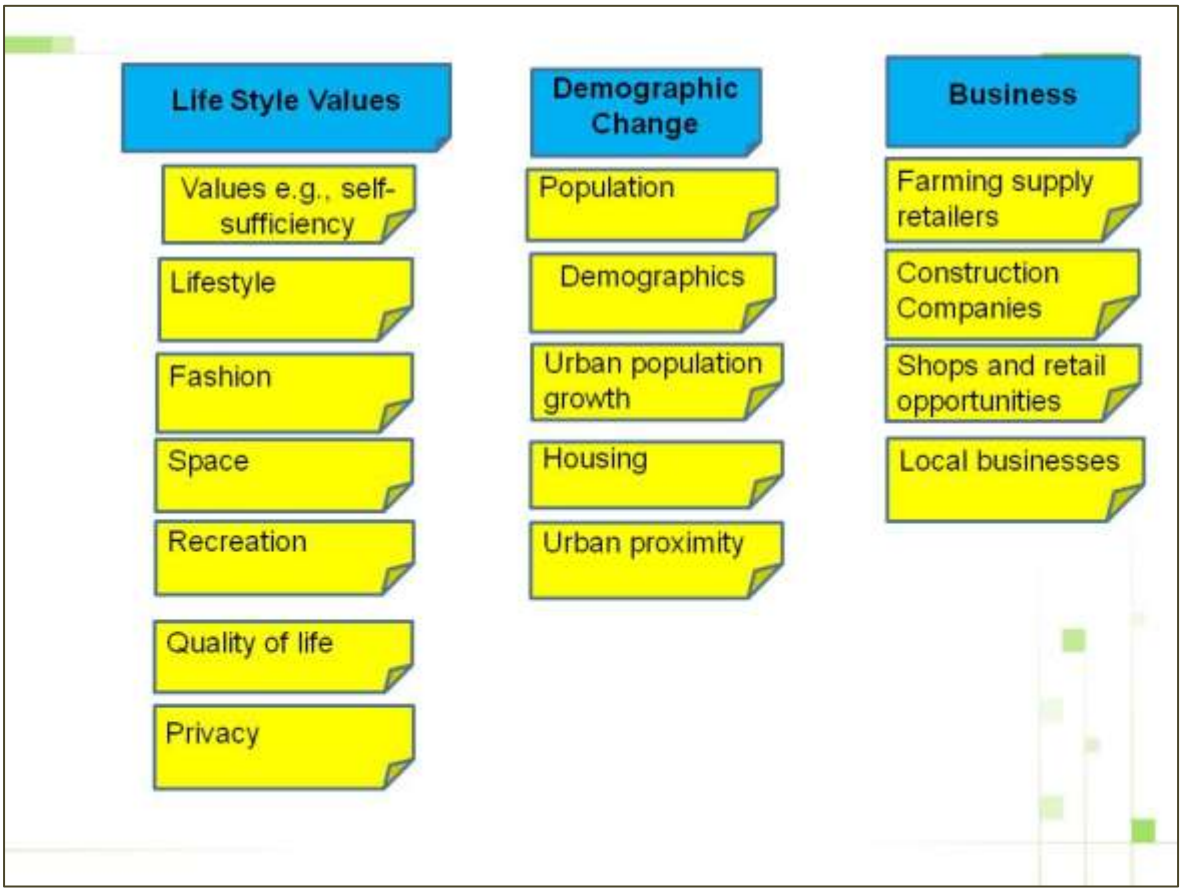

Sustainability of What, Why and for Whom?
A community conversation
Cultural
Social
Quality of Life
Economic
Environmental
Source
Creating Futures
2007

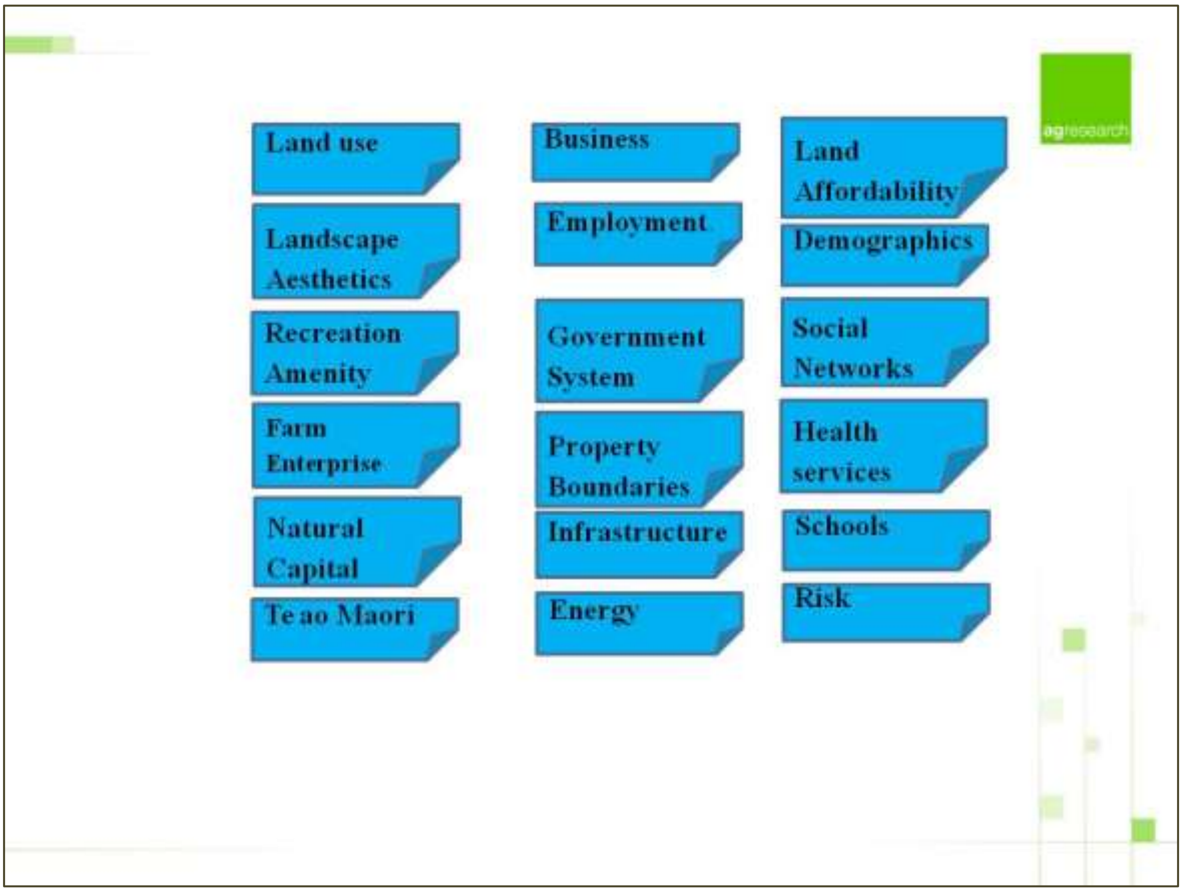
Integrated assessment linking system methodologies with a deliberative tool to enable collective learning: Issue Land Fragmentation

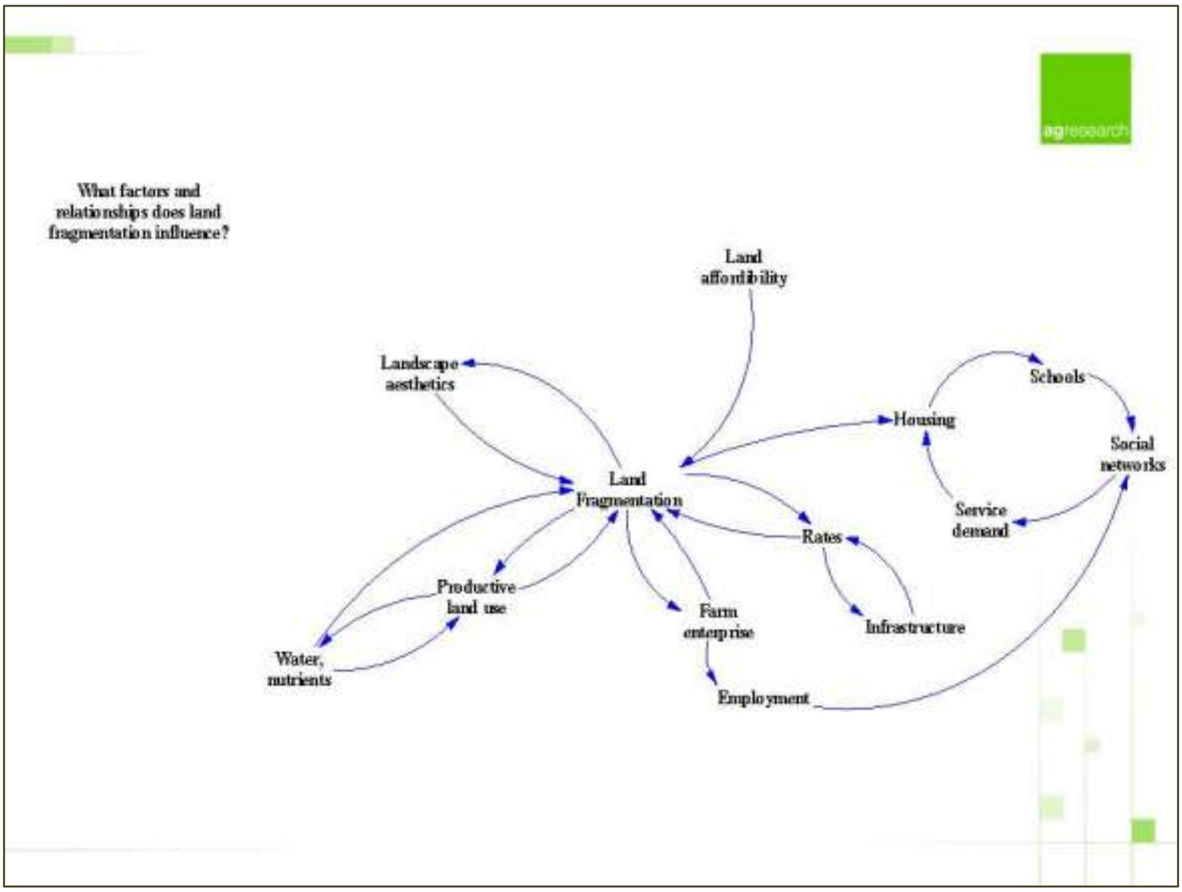
Systems Approach
- Develop a shared understanding
- Collectively learn about the impact of fragmentation on a range of outcomes
- Identify where we would lever the system to achieve improved outcomes
- Evaluate system performance and impact of strategies, policies and scenarios
- Identify data required to enable evaluation of strategies to address fragmentation

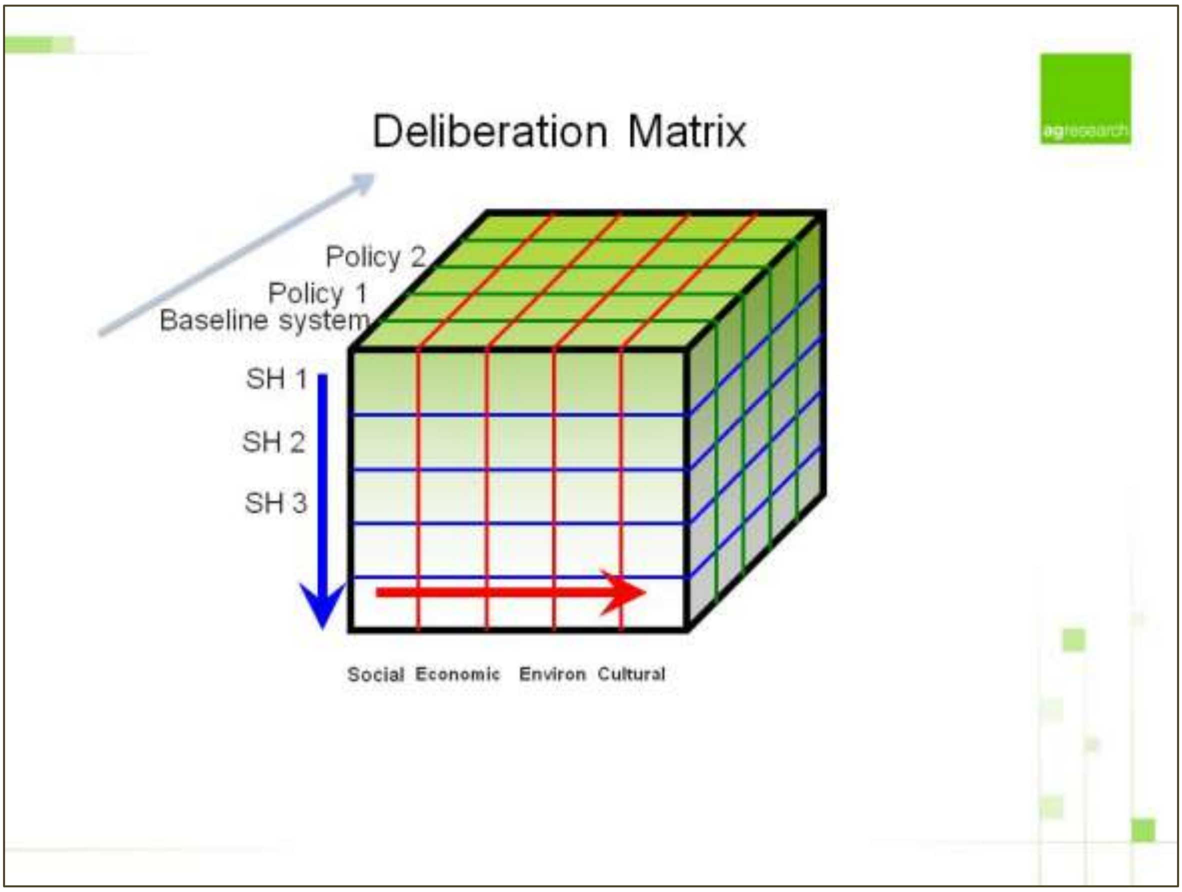

What factors and relationships does land fragmentation influence?

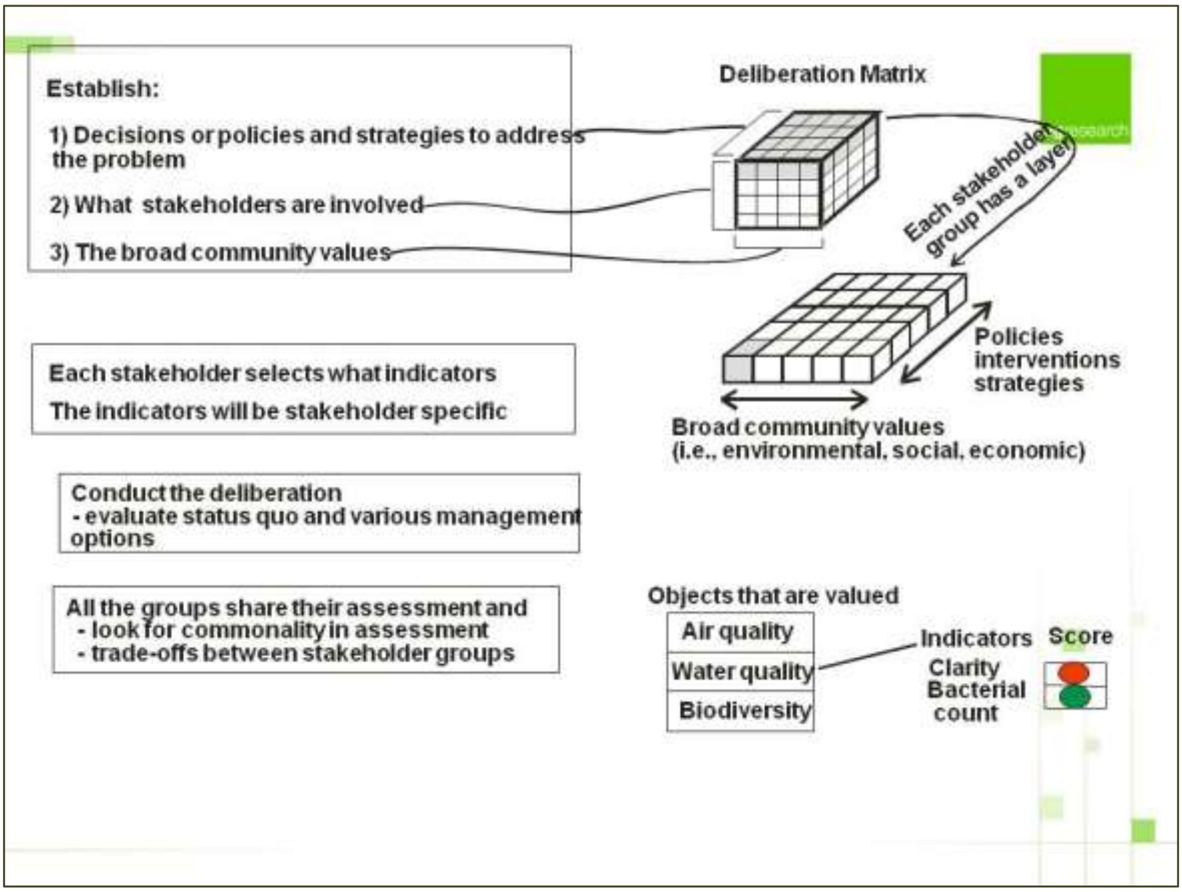

agresearch
AFFINITY DIAGRAMS
Life Style Values
Fashion
Space
Recreation
Quality of life
Privacy
Land use
Landscape Aesthetics
Natural Capital
Property Boundaries
Health services
Causal Loop Diagram
Deliberation Matrix


Life Style Values
Values e.g., self-sufficiency
Lifestyle
Fashion
Space
Recreation
Quality of life
Privacy
Demographic Change
Population
Demographics
Urban population growth
Housing
Urban proximity
Business
Farming supply retailers
Construction Companies
Shops and retail opportunities
Local businesses


Land use
Landscape Aesthetics
Recreation Amenity
Farm Enterprise
Natural Capital
Te ao Maori
Business
Employment
Government System
Property Boundaries
Infrastructure
Energy
Land Affordability
Demographics
Social Networks
Health services
Schools
Risk


agresearch
What factors and relationships does land fragmentation influence?
Land affordability
Landscape aesthetics
Schools
Housing
Social networks
Land Fragmentation
Service demand
Rates
Productive land use
Farm enterprise
Infrastructure
Water, nutrients
Employment

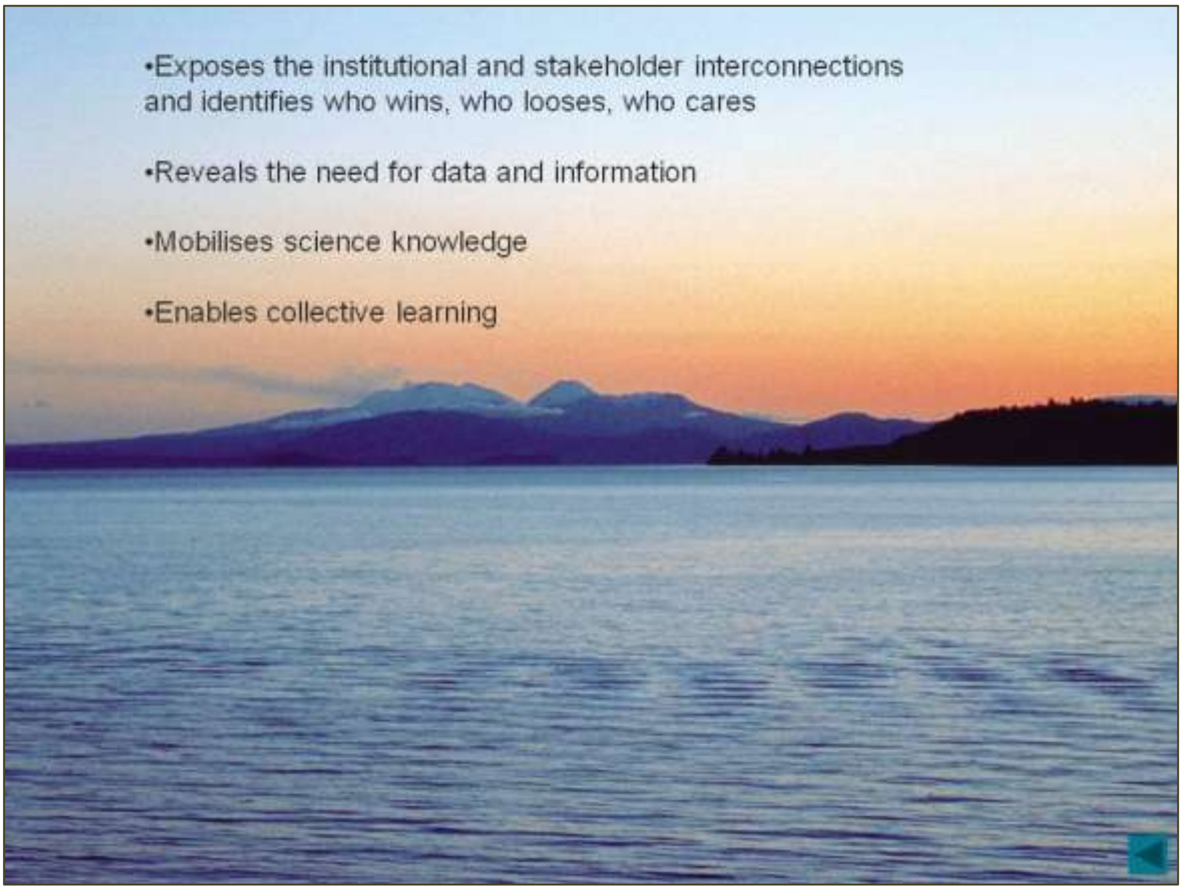

agresearch
Deliberation Matrix
Policy 2
Policy 1
Baseline system
SH 1
SH 2
SH 3
Social Economic Environ Cultural

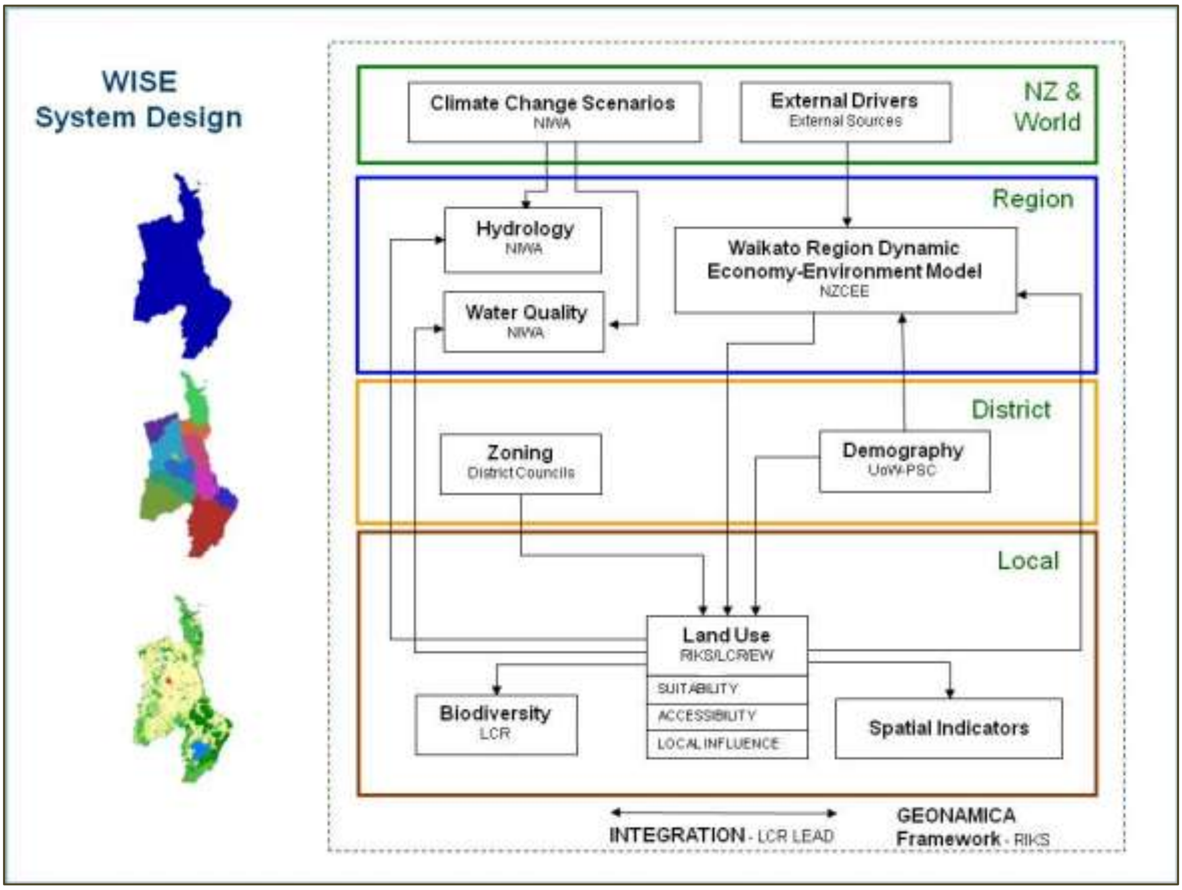


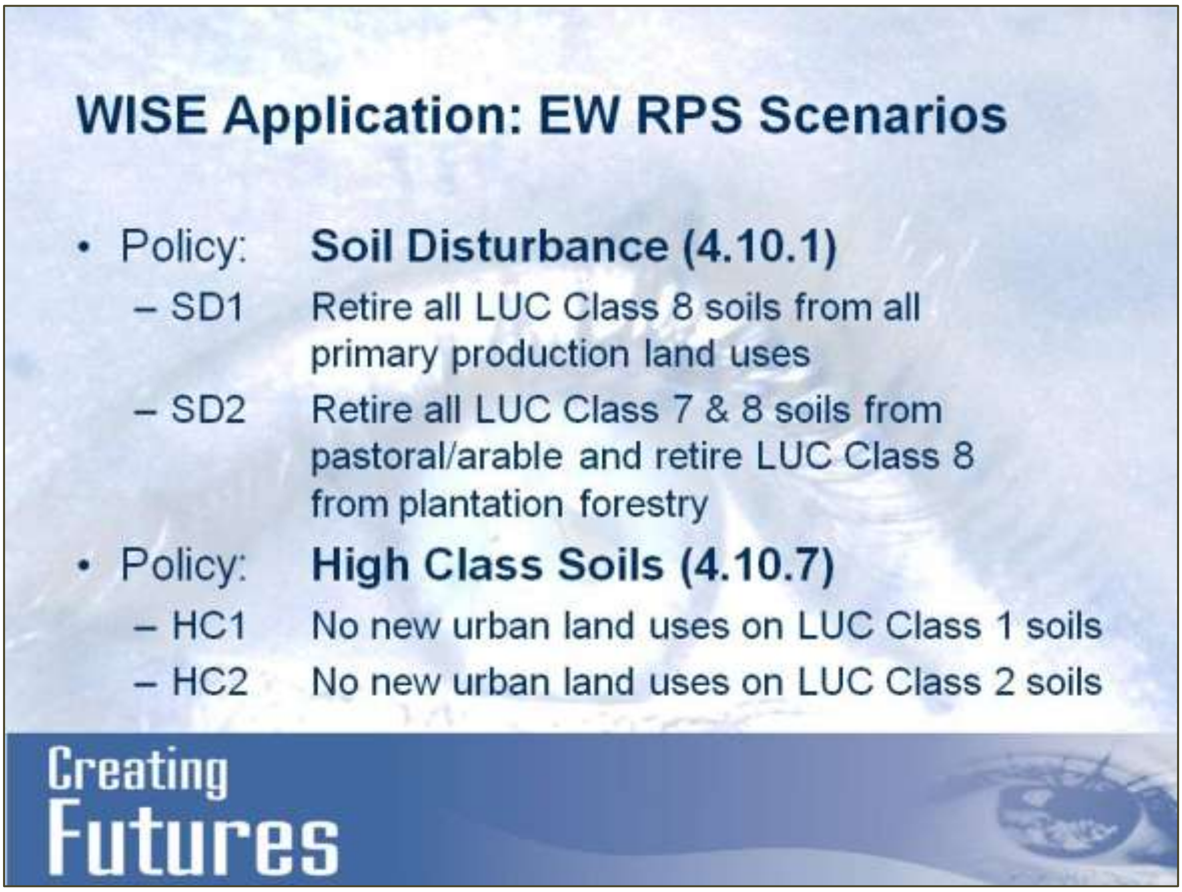
SH1 Health Board	Environment • Landuse • Landscape aesthetics • Water use • Pollution	Social equity Landuse	Social externalities Access to social services	Land use planning Social equity Access rights
SH2 Regional Planner	Water nutrients	Productivity per hectare	Social segregation	Governance
SH3 Academic	Environmental and cultural functions of land	Land affordability/land use	Quality of community Social networks Identities	Rules and reasons justifying affordability and access to diverse conditions of wellbeing
SH4 Land Use Scientist	Land use change	Opportunity	Social access Community extinction Community viability	Asymmetries of access
SH5 Policy Analyst	Land use • Suitability and versatility	Access to employment Access to education	Asymmetries of access to social services	Institutional Community choice
Stakeholders	Environment	Economic	Social	Cultural

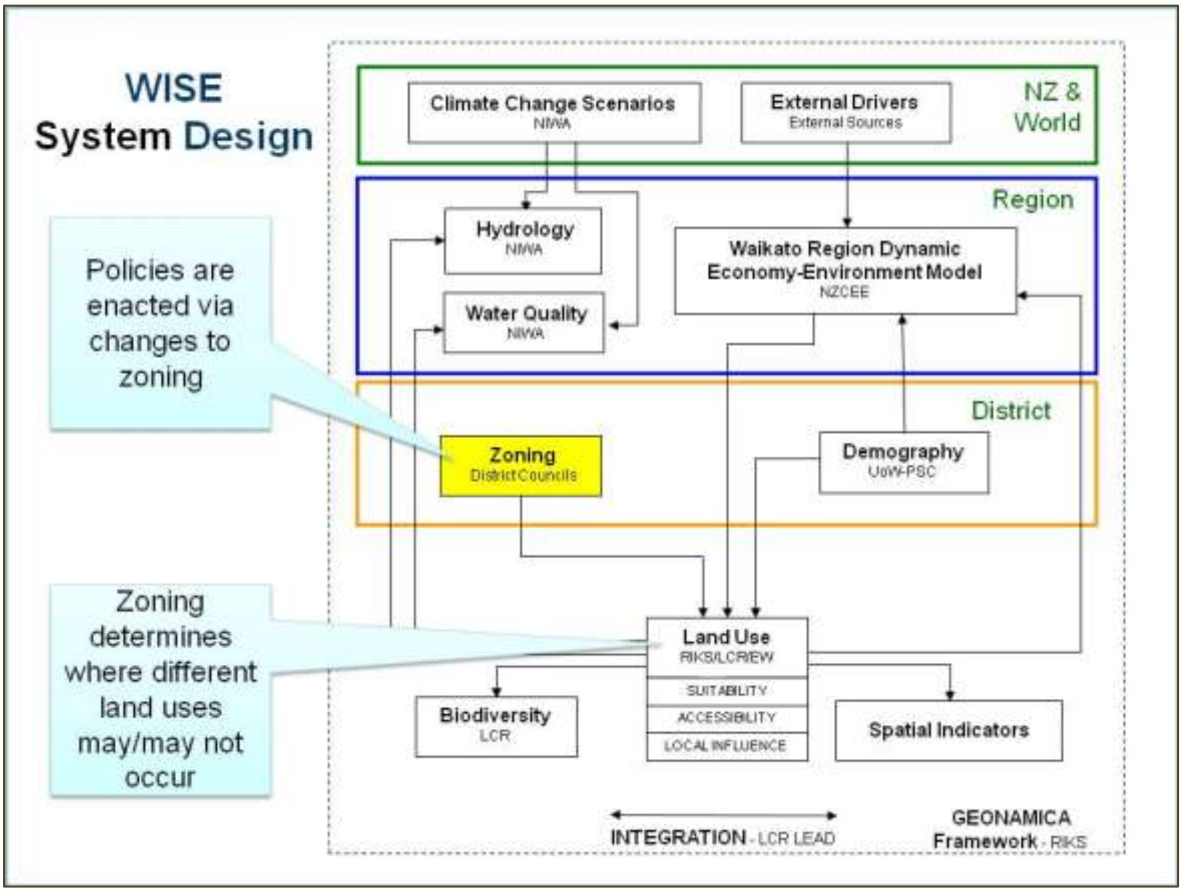
Current situation

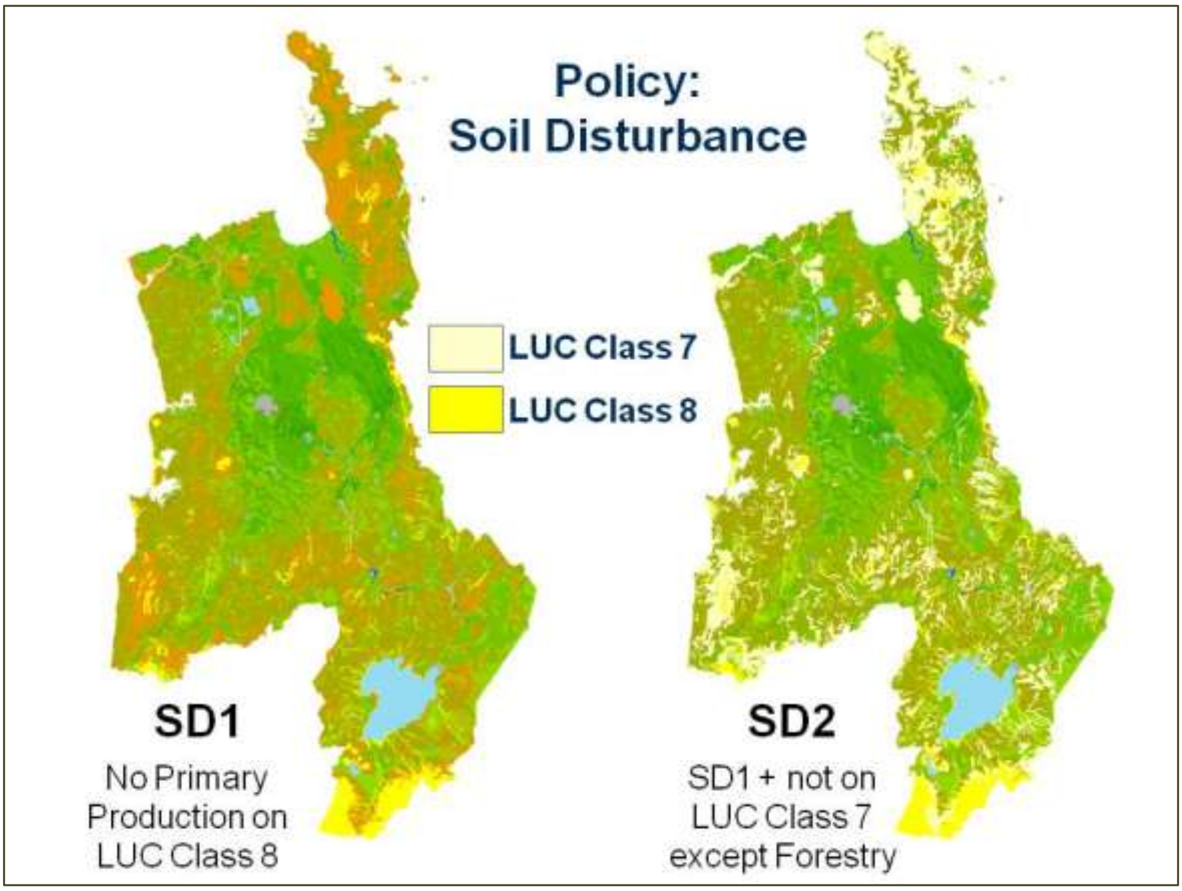
SH1 Health Board	So-So	Don't know		
SH2 Regional Planner	Good		Bad	
SH3 Academic				
SH4 Land Use Scientist				
SH5 Policy Analyst				
Stakeholders	Environment	Economic	Social	Cultural

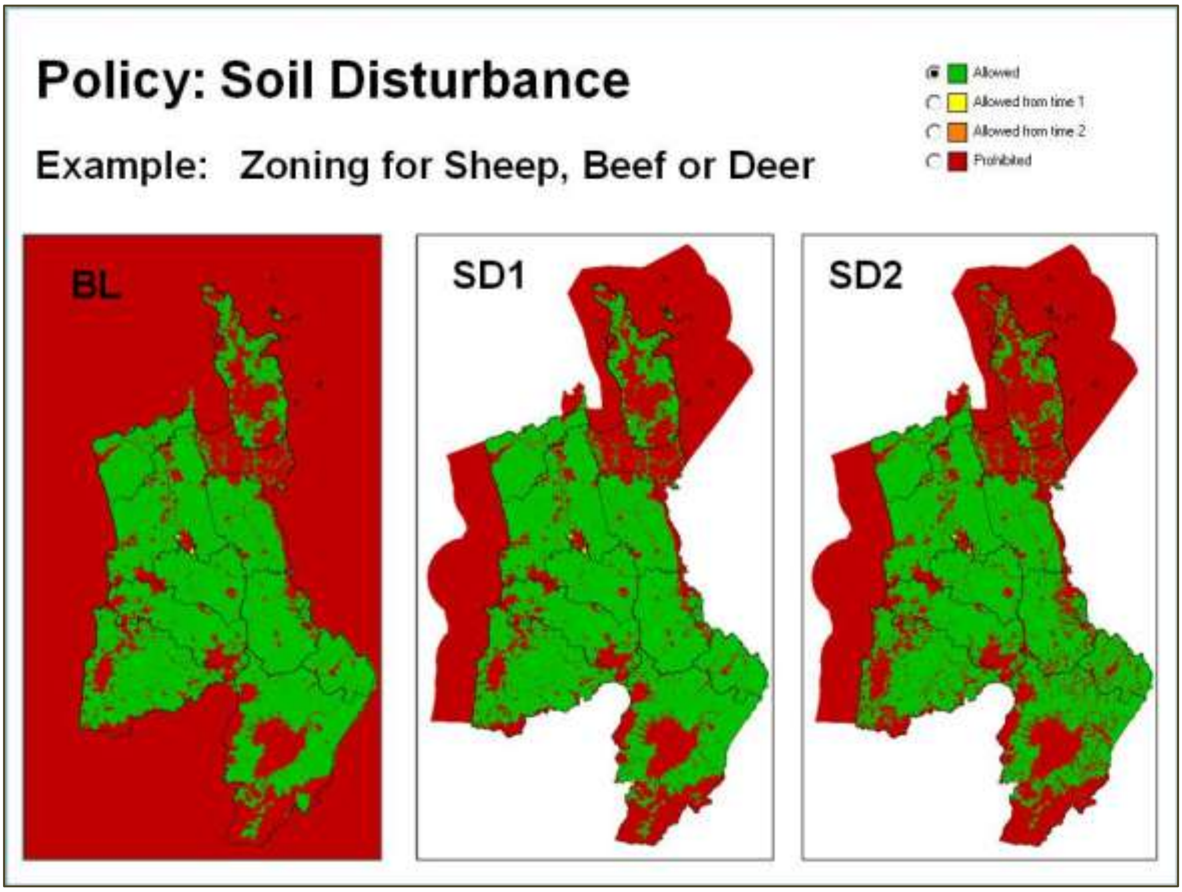

•Exposes the institutional and stakeholder interconnections and identifies who wins, who looses, who cares
•Reveals the need for data and information
•Mobilises science knowledge
•Enables collective learning

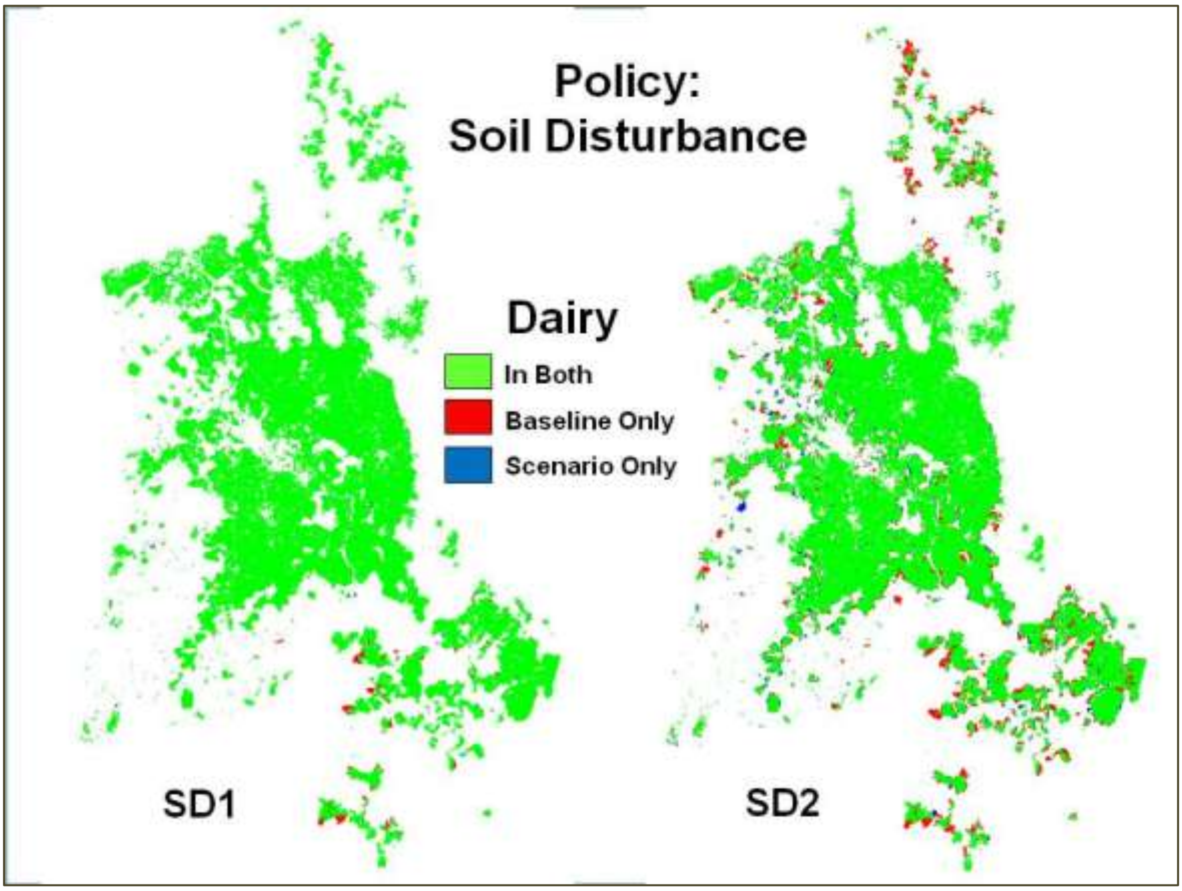

WISE
System Design
Climate Change Scenarios
NIWA
External Drivers
External Sources
NZ & World
Region
Hydrology
NIWA
Water Quality
NIWA
Waikato Region Dynamic Economy-Environment Model
NZCEE
District
Zoning
District Councils
Demography
UoW-PSC
Local
Land Use
RIKS/LCR/EW
SUITABILITY
ACCESSIBILITY
LOCAL INFLUENCE
Biodiversity
LCR
Spatial Indicators
INTEGRATION - LCR LEAD
GEONAMICA
Framework - RIKS

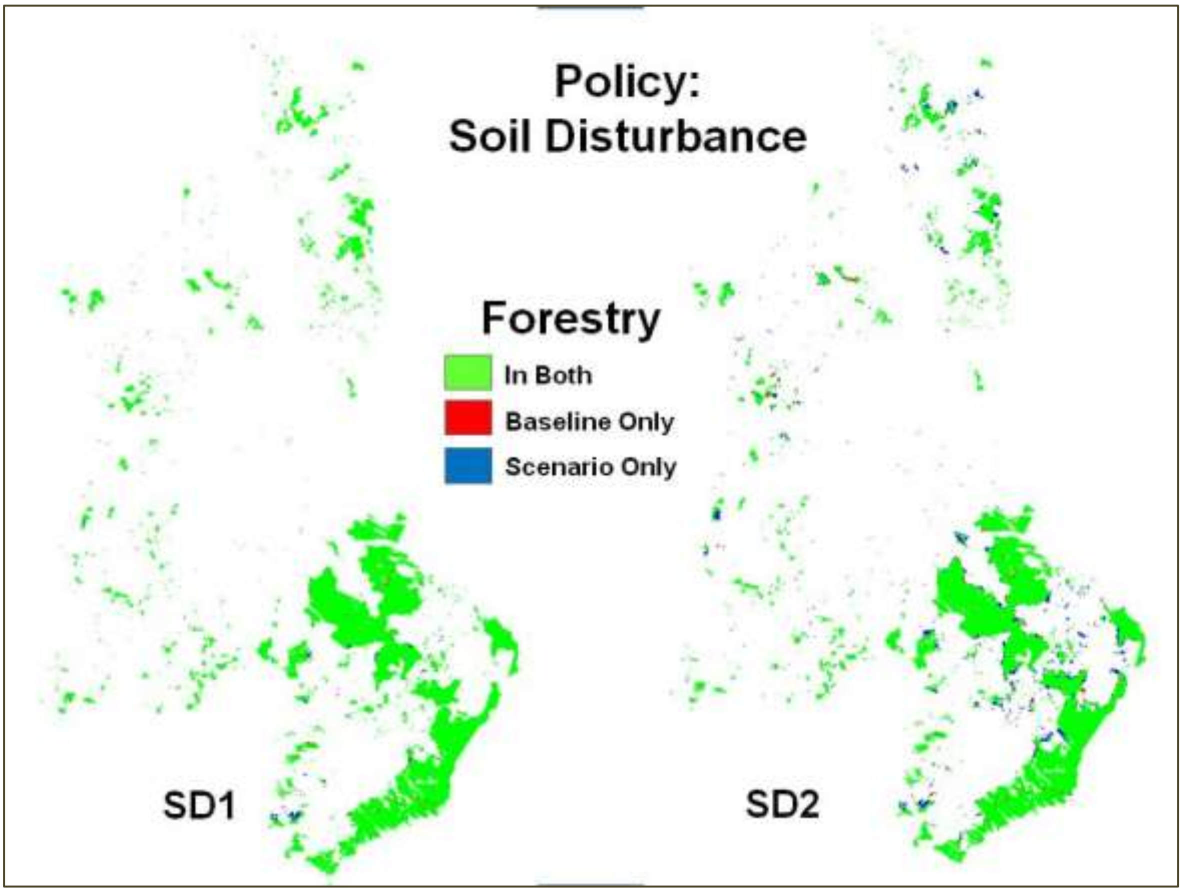

WISE Application: EW RPS Scenarios
• Policy: Soil Disturbance (4.10.1)
– SD1 Retire all LUC Class 8 soils from all primary production land uses
– SD2 Retire all LUC Class 7 & 8 soils from pastoral/arable and retire LUC Class 8 from plantation forestry
• Policy: High Class Soils (4.10.7)
– HC1 No new urban land uses on LUC Class 1 soils
– HC2 No new urban land uses on LUC Class 2 soils
Creating Futures

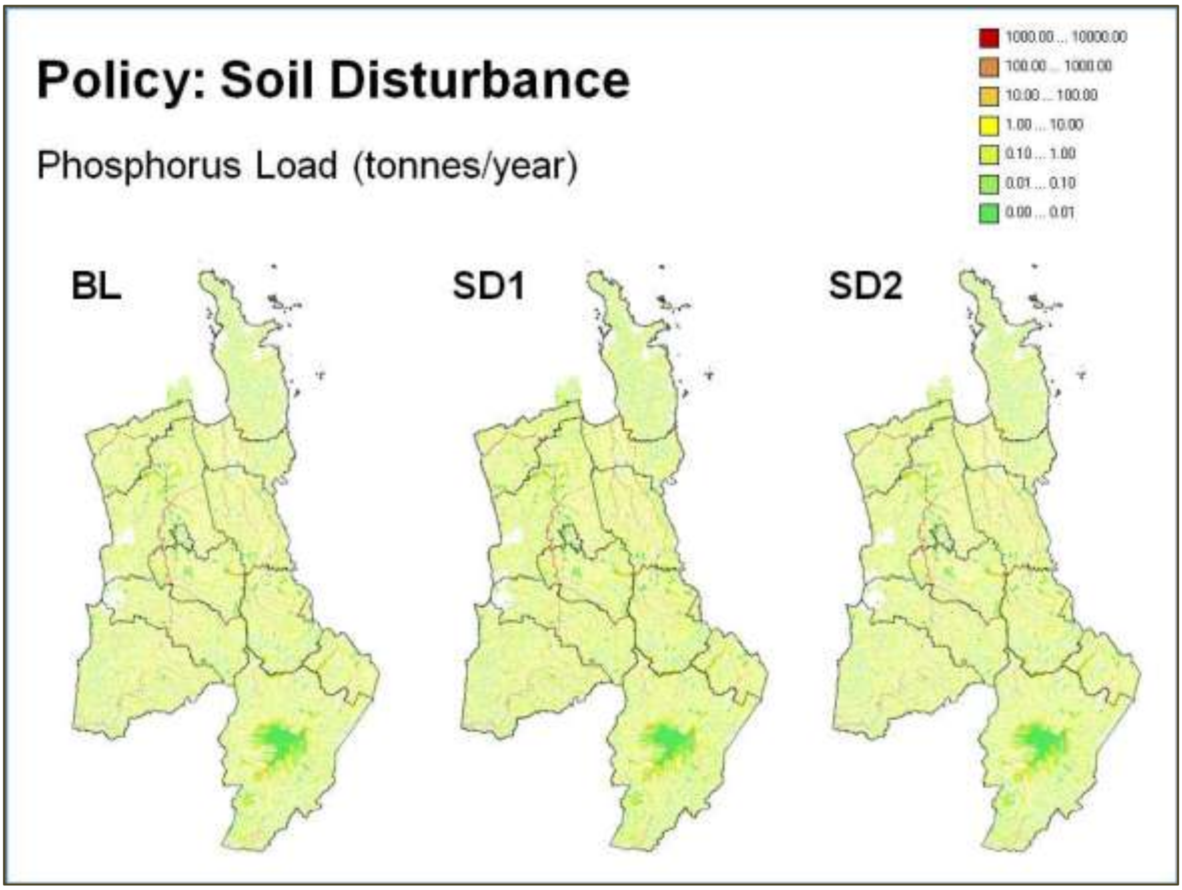

WISE System Design
Policies are enacted via changes to zoning
Zoning determines where different land uses may/may not occur
Climate Change Scenarios
NIWA
External Drivers
External Sources
NZ & World
Region
Hydrology
NIWA
Water Quality
NIWA
Waikato Region Dynamic Economy-Environment Model
NZCEE
District
Zoning
District Councils
Demography
UoW-PSC
Land Use
RIKS/LCR/EW
SUITABILITY
ACCESSIBILITY
LOCAL INFLUENCE
Biodiversity
LCR
Spatial Indicators
INTEGRATION - LCR LEAD
GEONAMICA Framework - RIKS

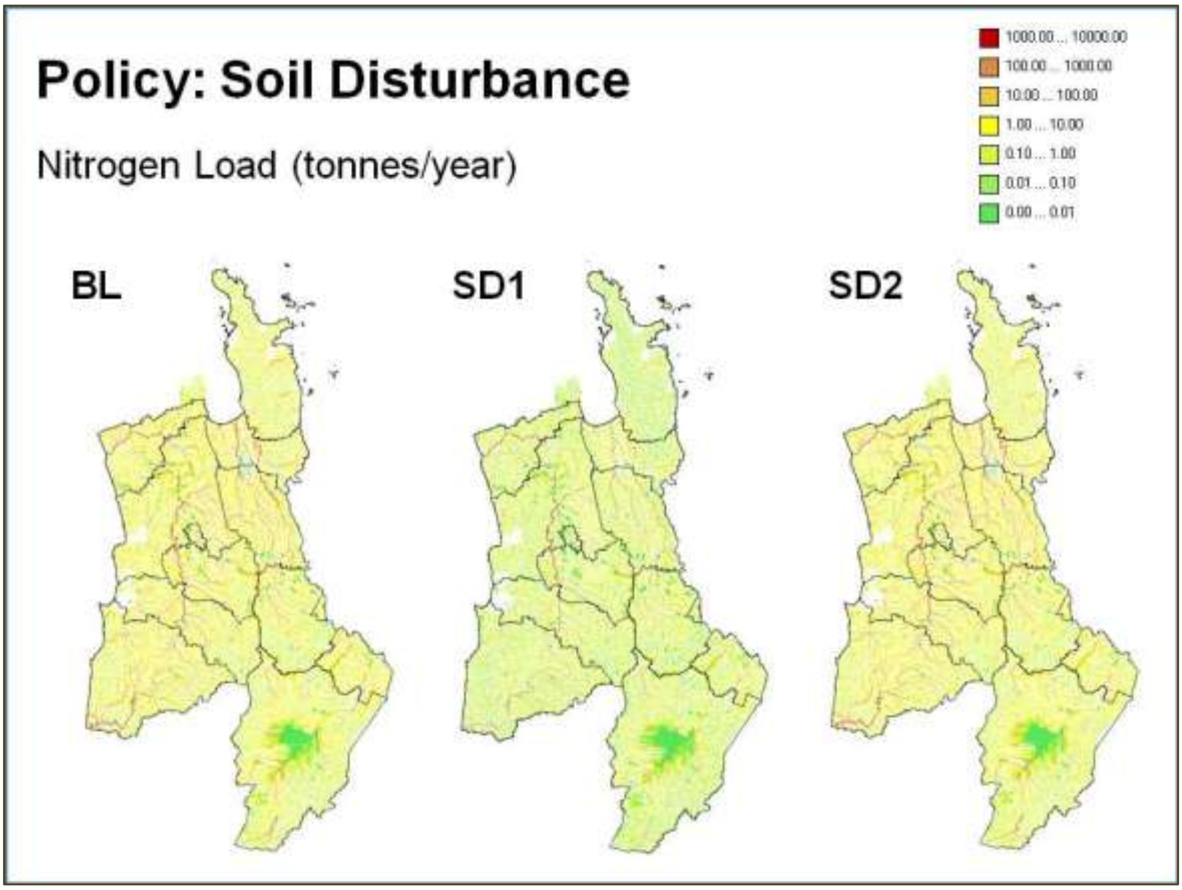

Policy:
Soil Disturbance
LUC Class 7
LUC Class 8
SD1
No Primary
Production on
LUC Class 8
SD2
SD1 + not on
LUC Class 7
except Forestry

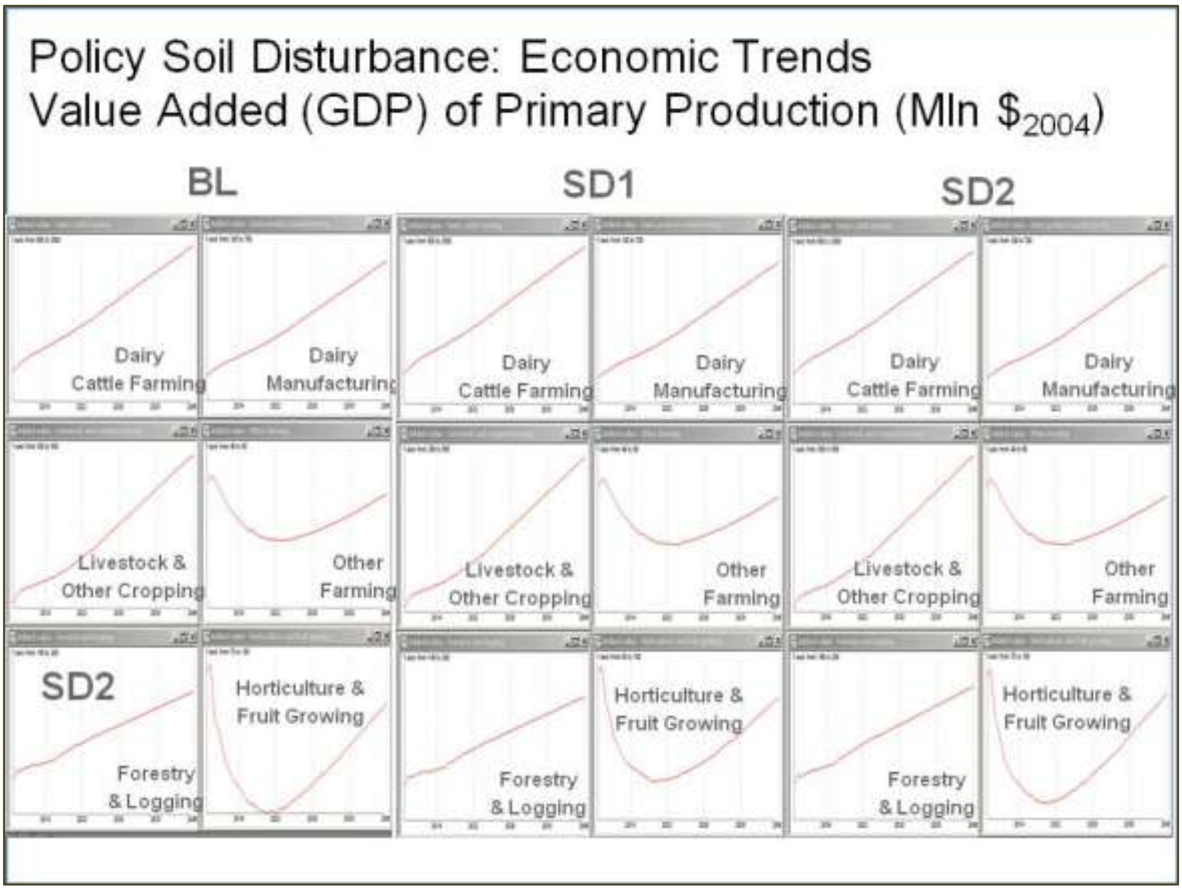

Policy: Soil Disturbance
Example: Zoning for Sheep, Beef or Deer
Allowed
Allowed from time 1
Allowed from time 2
Prohibited
BL
SD1
SD2

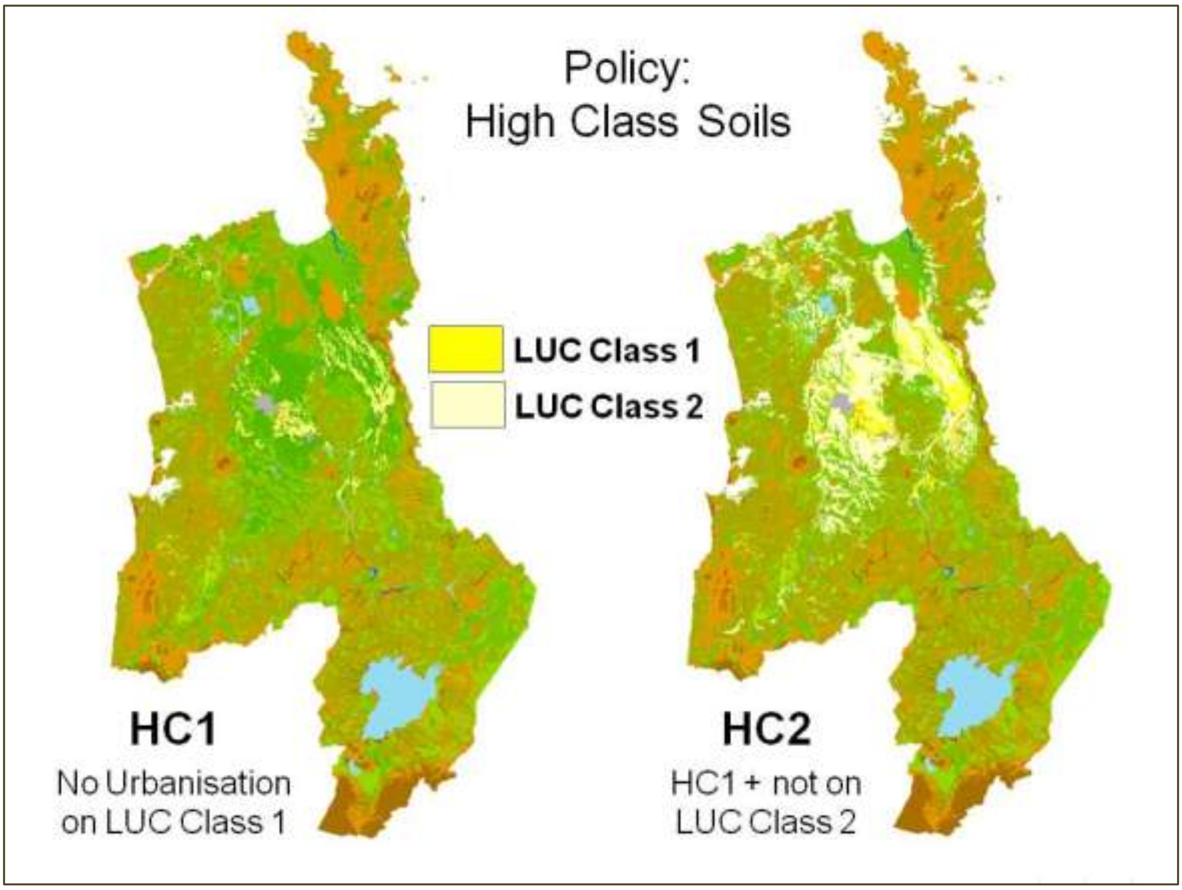

Policy:
Soil Disturbance
Dairy
In Both
Baseline Only
Scenario Only
SD1
SD2

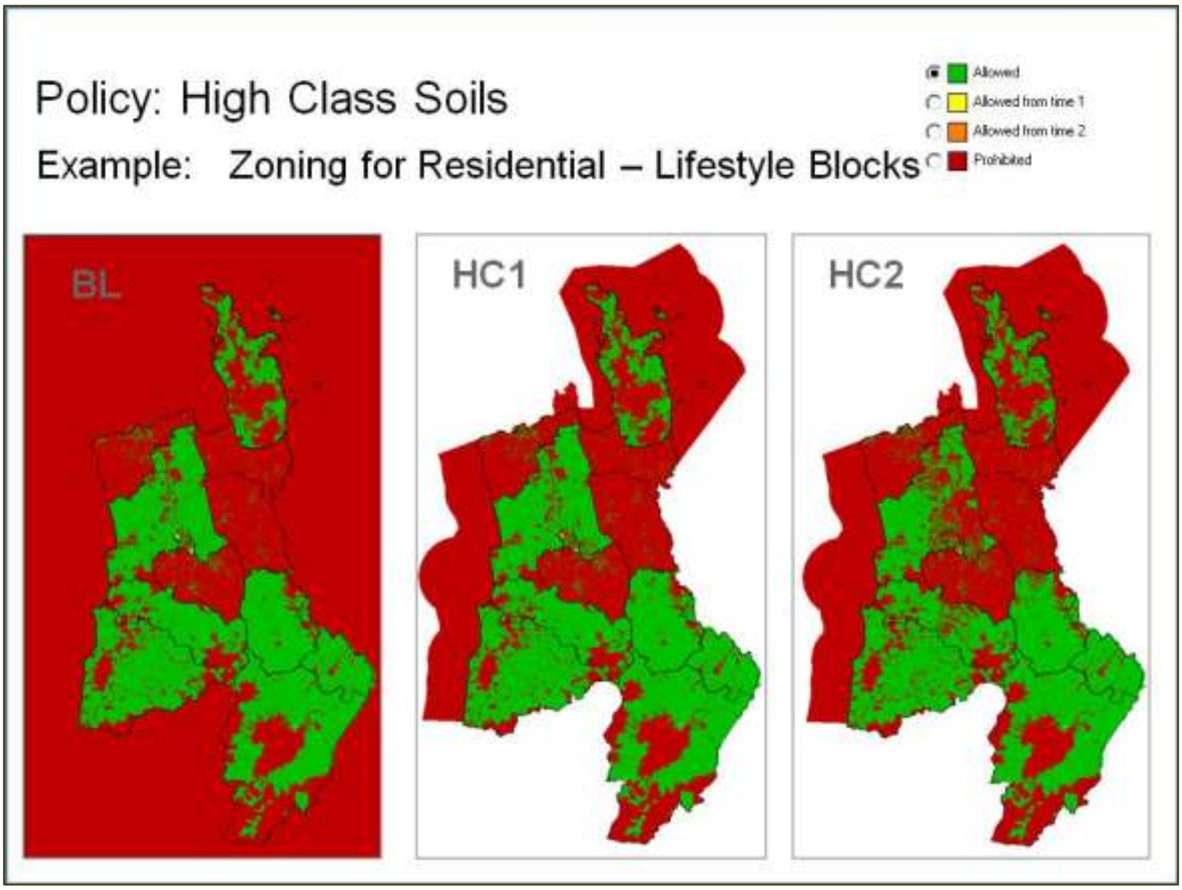

Policy:
Soil Disturbance
Forestry
In Both
Baseline Only
Scenario Only
SD1
SD2

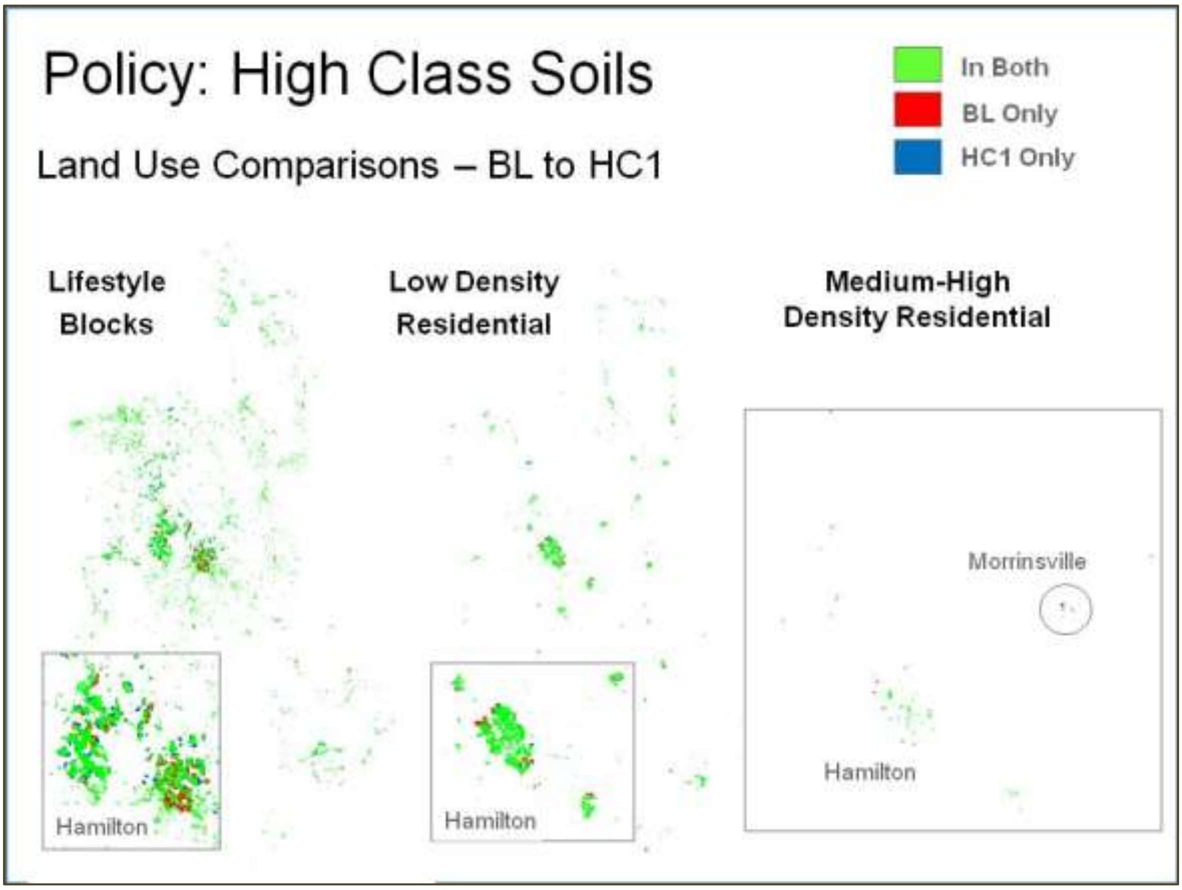

Policy: Soil Disturbance
Phosphorus Load (tonnes/year)
1000.00 ... 10000.00
100.00 ... 1000.00
10.00 ... 100.00
1.00 ... 10.00
0.10 ... 1.00
0.01 ... 0.10
0.00 ... 0.01
BL
SD1
SD2

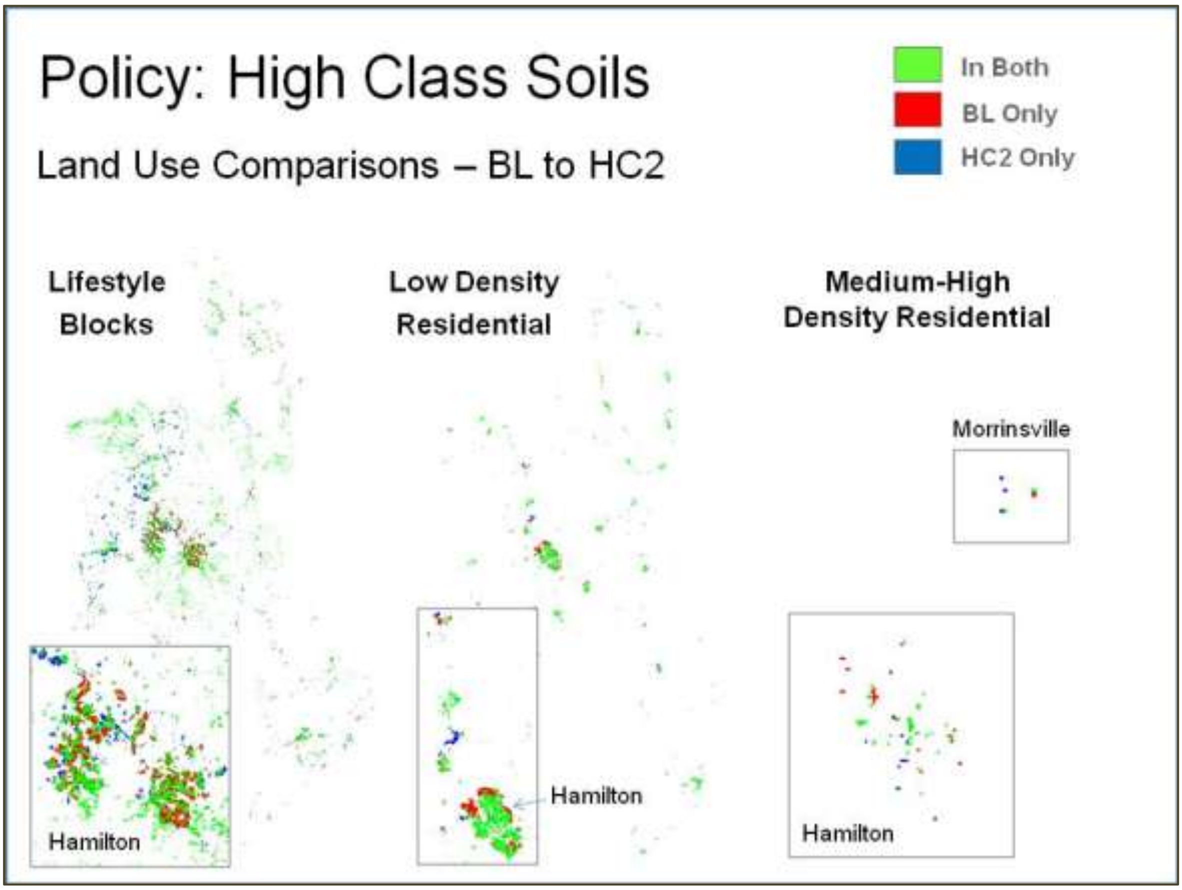

Policy: Soil Disturbance
Nitrogen Load (tonnes/year)
1000.00 ... 10000.00
100.00 ... 1000.00
10.00 ... 100.00
1.00 ... 10.00
0.10 ... 1.00
0.01 ... 0.10
0.00 ... 0.01
BL
SD1
SD2

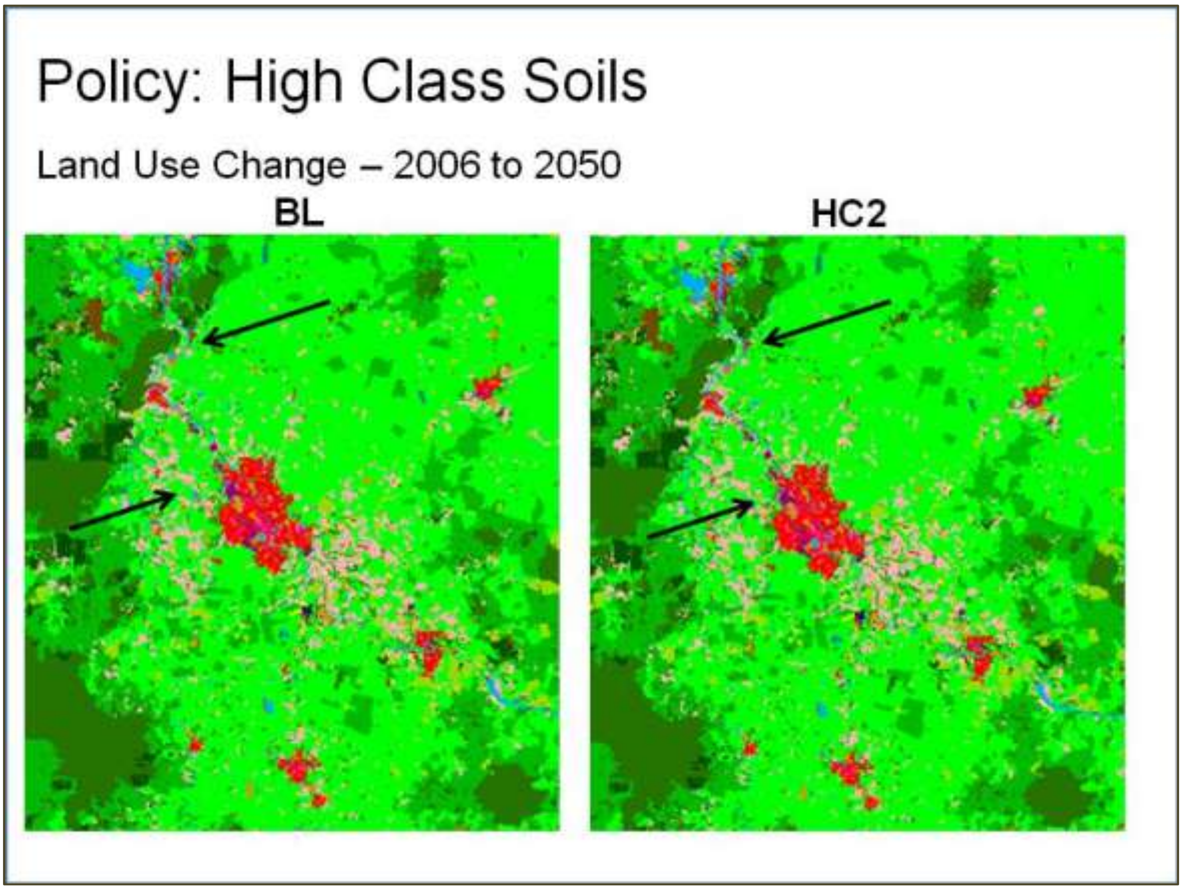

Policy Soil Disturbance: Economic Trends
Value Added (GDP) of Primary Production (Mln $2004)
BL
SD1
SD2
Dairy Cattle Farming
Dairy Manufacturing
Livestock & Other Cropping
Other Farming
SD2
Forestry & Logging
Horticulture & Fruit Growing


Policy:
High Class Soils
LUC Class 1
LUC Class 2
HC1
No Urbanisation on LUC Class 1
HC2
HC1 + not on LUC Class 2


Policy: High Class Soils
Example: Zoning for Residential – Lifestyle Blocks
Allowed
Allowed from time 1
Allowed from time 2
Prohibited
BL
HC1
HC2


Policy: High Class Soils
Land Use Comparisons – BL to HC1
In Both
BL Only
HC1 Only
Lifestyle Blocks
Low Density Residential
Medium-High Density Residential
Hamilton
Hamilton
Morrinsville
Hamilton


Policy: High Class Soils
Land Use Comparisons – BL to HC2
In Both
BL Only
HC2 Only
Lifestyle Blocks
Low Density Residential
Medium-High Density Residential
Morrinsville
Hamilton
Hamilton
Hamilton


Policy: High Class Soils
Land Use Change – 2006 to 2050
BL
HC2


Lessons for successful interdisciplinary multi-agency science/policy collaboration (so far):
Allow significant time at the start of a project to develop shared understanding, an agreed project vision and strong relationships
Develop uptake and implementation strategy to optimize end users buy-in through:
✓ Improving knowledge of tools
✓ Making tools relevant (case studies), useable and credible
✓ Provide support: data management, training, model set-up
✓ Collaboratively identify and implement improvements
User interaction crucial during the development – champions
✓ Usefulness and user-friendliness
✓ Adoption in user organisation
✓ How models work and how models are coupled
Creating Futures


More Lessons (#2)
Time / effort for individual components vs integration
Prototyping improves understanding and hence facilitates discussion and builds trust
Hands-on experience with practical examples was valued positively by users – library of documented examples
Be ready for the unexpected – reserve funding!
Create an implementation plan
Creating Futures

How WISE may help Environment Waikato

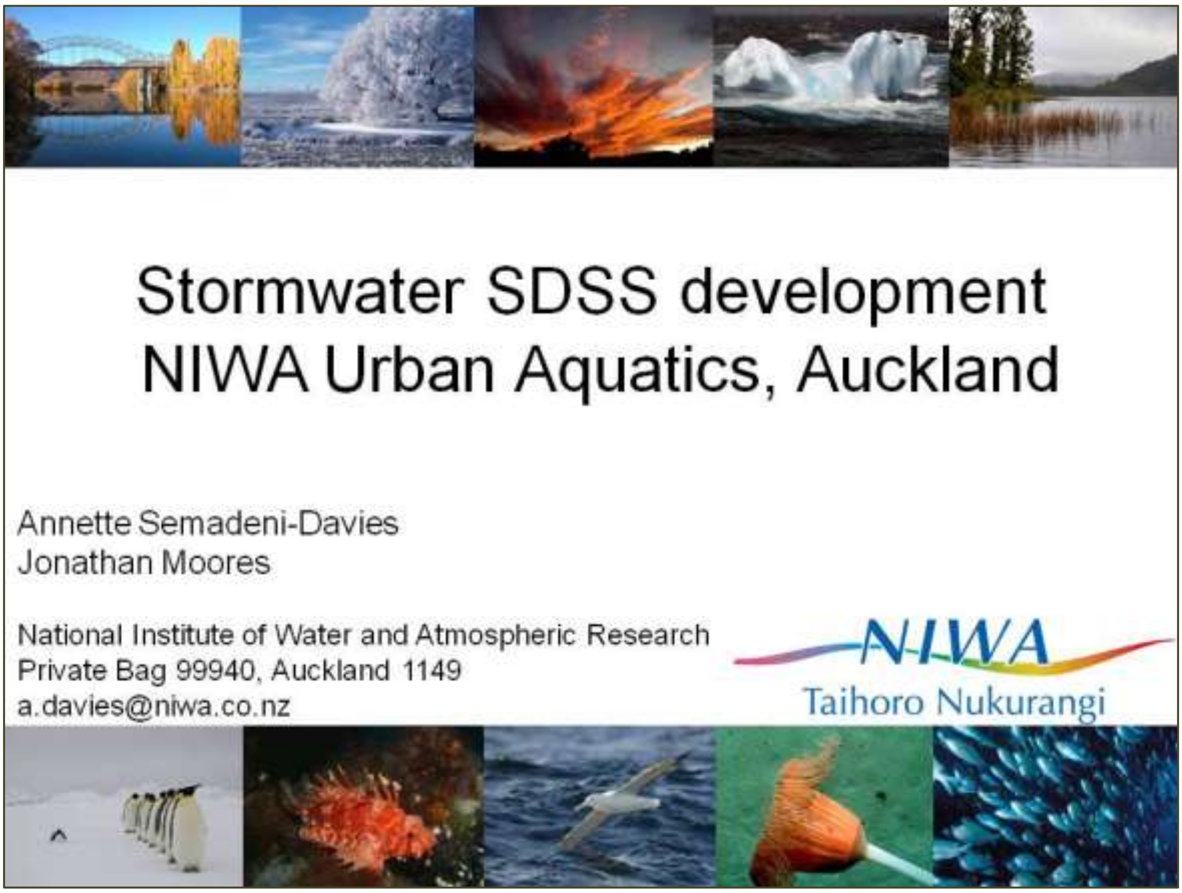
- Linking science to policy (evidence-based)
- Up-to-date data and information
- Access to expert knowledge from all disciplines
- Explore alternative policy options for statutory planning
- Non-statutory planning (regional development and sub-regional strategies) - Future Proof project
- Assess trade-offs and prioritise issues (integration)
- Cumulative effects of policy and consents (over space/time)

Creating Futures

Future Directions

- We are only just beginning...
- EW Strategic Scanning Team
- WISE User & Support Team (policy, science, GIS/IT)
  - External support and advise (WISE partners and others)
  - Data management, updating and maintenance of models, licences
  - Training – building capability and capacity in spatial planning
  - Integration into council planning and decision-making processes
- WISE development is ongoing
  - additional model components, functionality, new knowledge/methods
- Other regions / NZ
  - SP2 (Auckland and Wellington councils)
  - National Advisory Group for spatial planning tools

Creating Futures


Stormwater SDSS development
NIWA Urban Aquatics, Auckland
Annette Semadeni-Davies
Jonathan Moores
National Institute of Water and Atmospheric Research
Private Bag 99940, Auckland 1149
a.davies@niwa.co.nz
NIWA
Taihoro Nukurangi


C-CALM
CATCHMENT
CONTAMINANT
ANNUAL
LOADS
MODEL
Model overview
NIWA
Taihoro Nukurangi

What is C-CALM?

- Planning tool for stormwater management developed under sub-contract to Landcare Research as part of FoRST funded LIUDD programme
- Based on ARC CLM spreadsheet model
- Purpose: to determine impact of urbanisation on stormwater quality and evaluate treatment options
- Outcome: long-term TSS, Zn and Cu loads at sub-catchment scale
- Model brief:
  - SIMPLE to use
  - MINIMAL data and set-up time
  - GIS platform (ArcMap)

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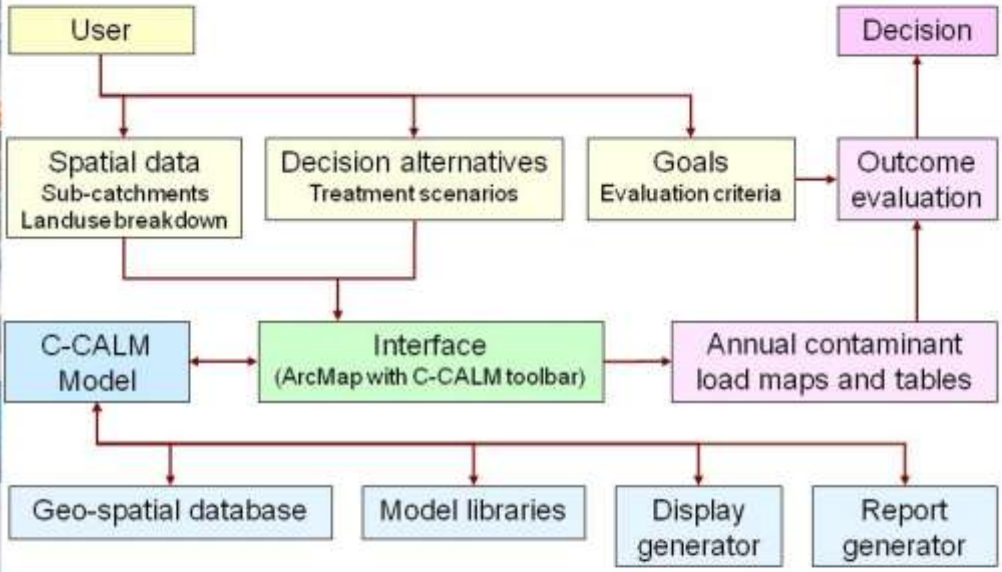
C-CALM:
a spatial decision support system



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Running C-CALM

Scenario: raingardens, catchpit inserts, filters, porous paving and wetlands

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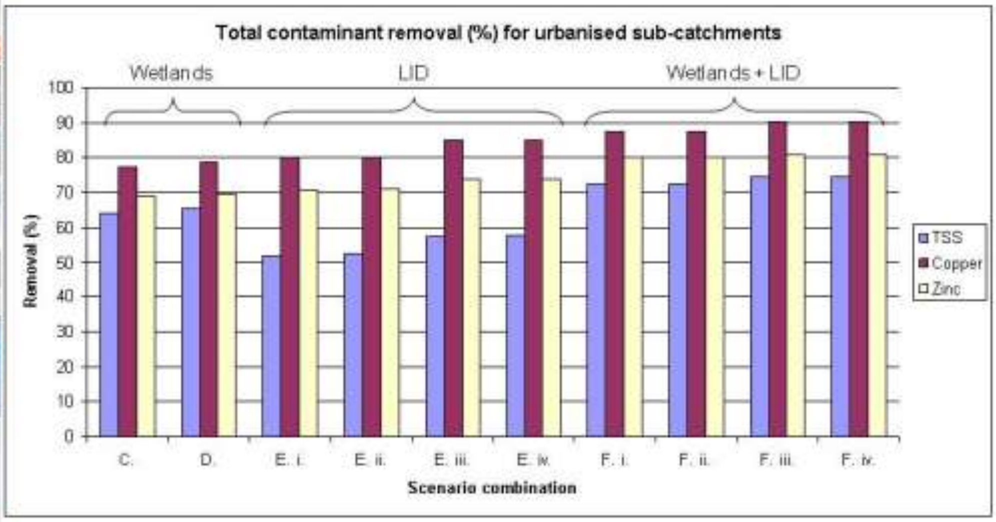
Evaluation of treatment strategies



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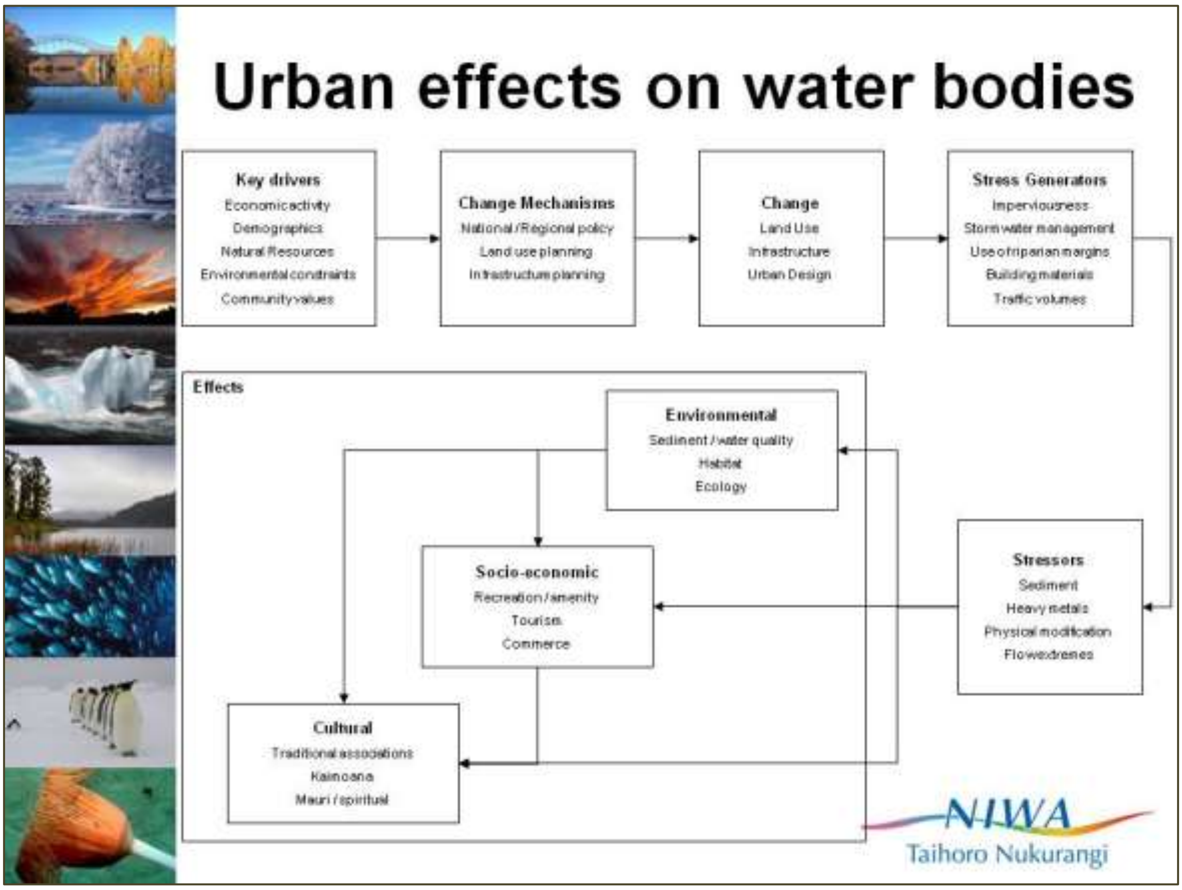
C-CALM State of Play

- Model and performance library are currently being evaluated by the Auckland Regional Council for use in stormwater planning.
- Manual and technical reports have been written.
- Model applied in projects for Waitakere City Council and Northland Regional Council.
- C-CALM will be freely available to users within New Zealand.

Urban Planning that Sustains Waterbodies (UPSW)


Urban effects on water bodies
Key drivers
Economic activity
Demographics
Natural Resources
Environmental constraints
Community values
Change Mechanisms
National /Regional policy
Land use planning
Infrastructure planning
Change
Land Use
Infrastructure
Urban Design
Stress Generators
Imperviousness
Storm water management
Use of riparian margins
Building materials
Traffic volumes
Effects
Environmental
Sediment / water quality
Habitat
Ecology
Socio-economic
Recreation / amenity
Tourism
Commerce
Stressors
Sediment
Heavy metals
Physical modification
Flow extremes
Cultural
Traditional associations
Kaimoana
Mauri / spiritual
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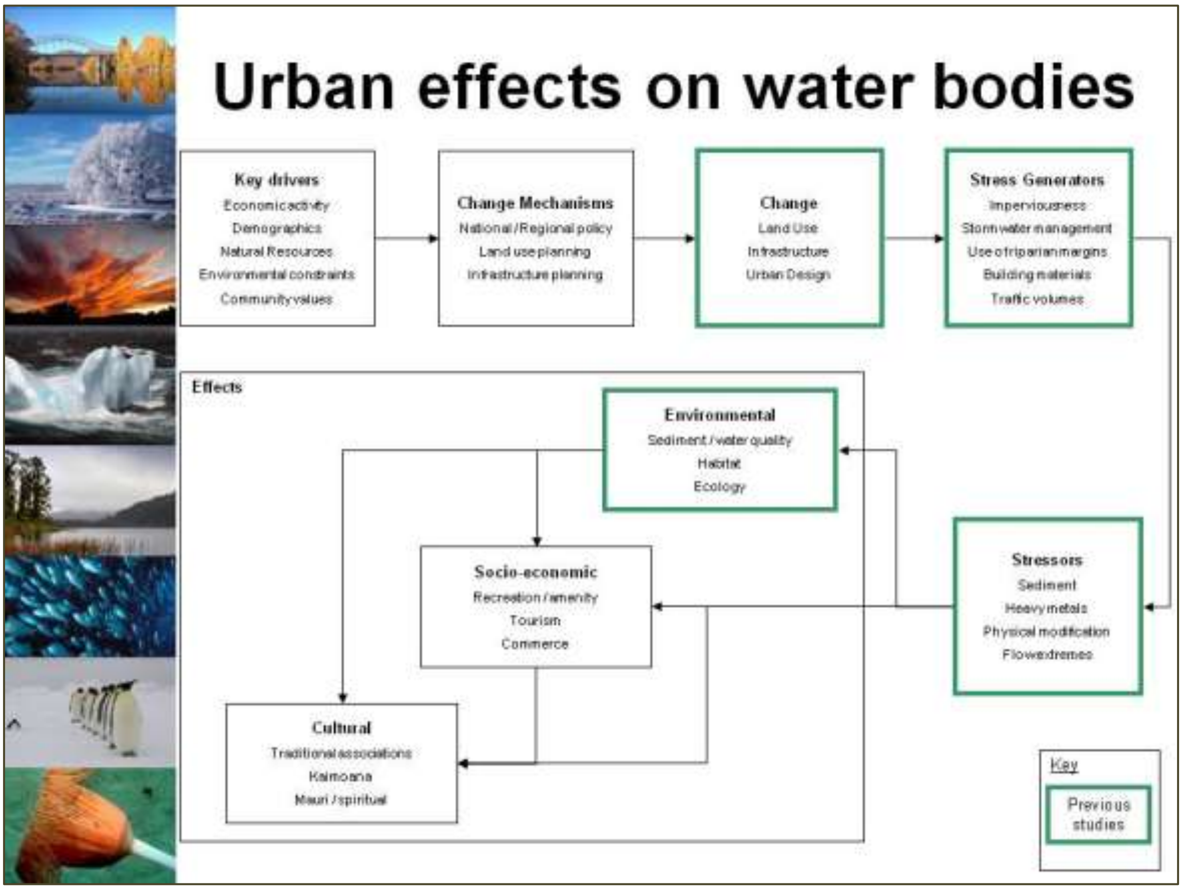
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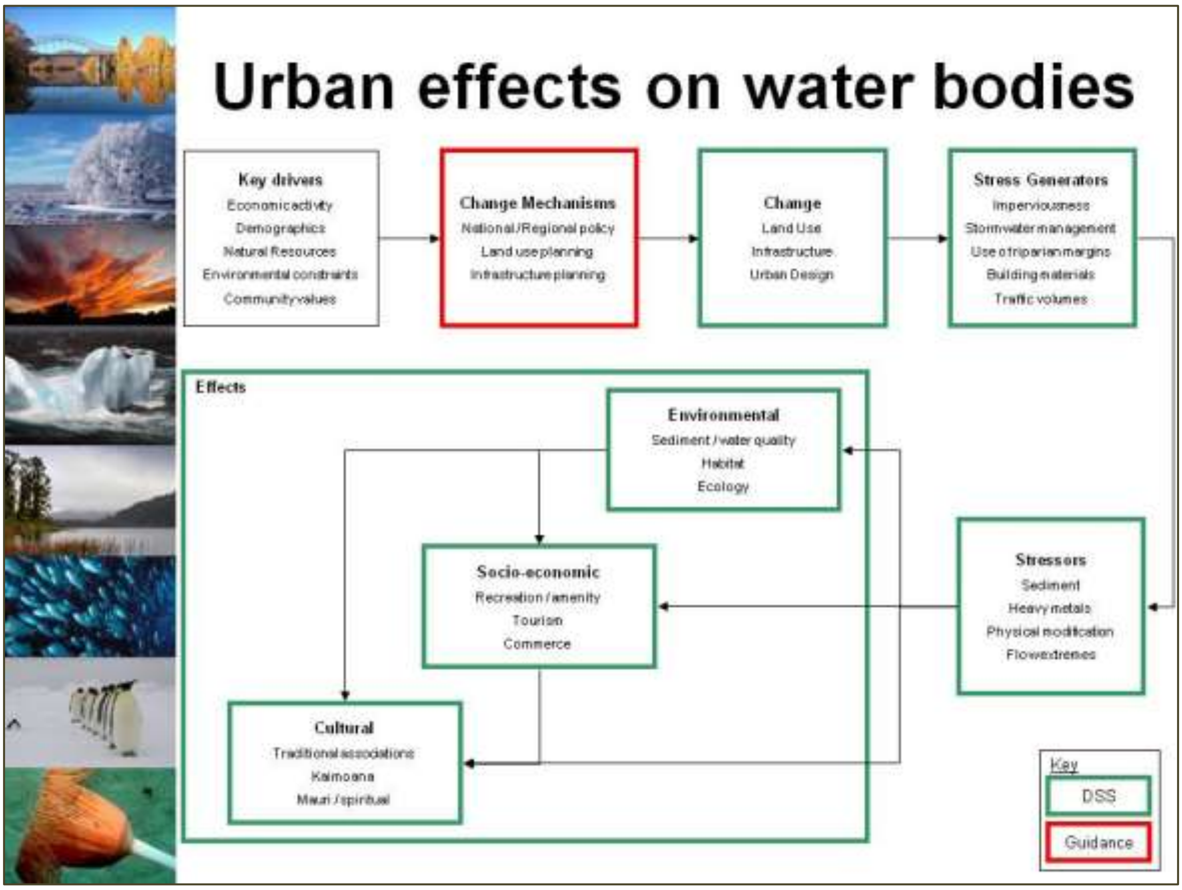
Mauri / spiritual
Key
Previous studies



Urban Planning tha Sustains Waterbodies

- FRST-funded 3 year project with Cawthron Institute, Tipa Associates, ARC, ECan, Christchurch City
- Provide guidance on effects of urban development on waterbodies to aid planning decisions
- Existing approaches use models to make predictions of environmental change
- Here we will consider broader impacts (social, cultural, economic)
- Aims of this research:
  (1) Develop a pilot spatial decision support system (SDSS)
  (2) Develop a sustainability indicator system
- Work with councils to test system on Auckland and Christchurch case studies

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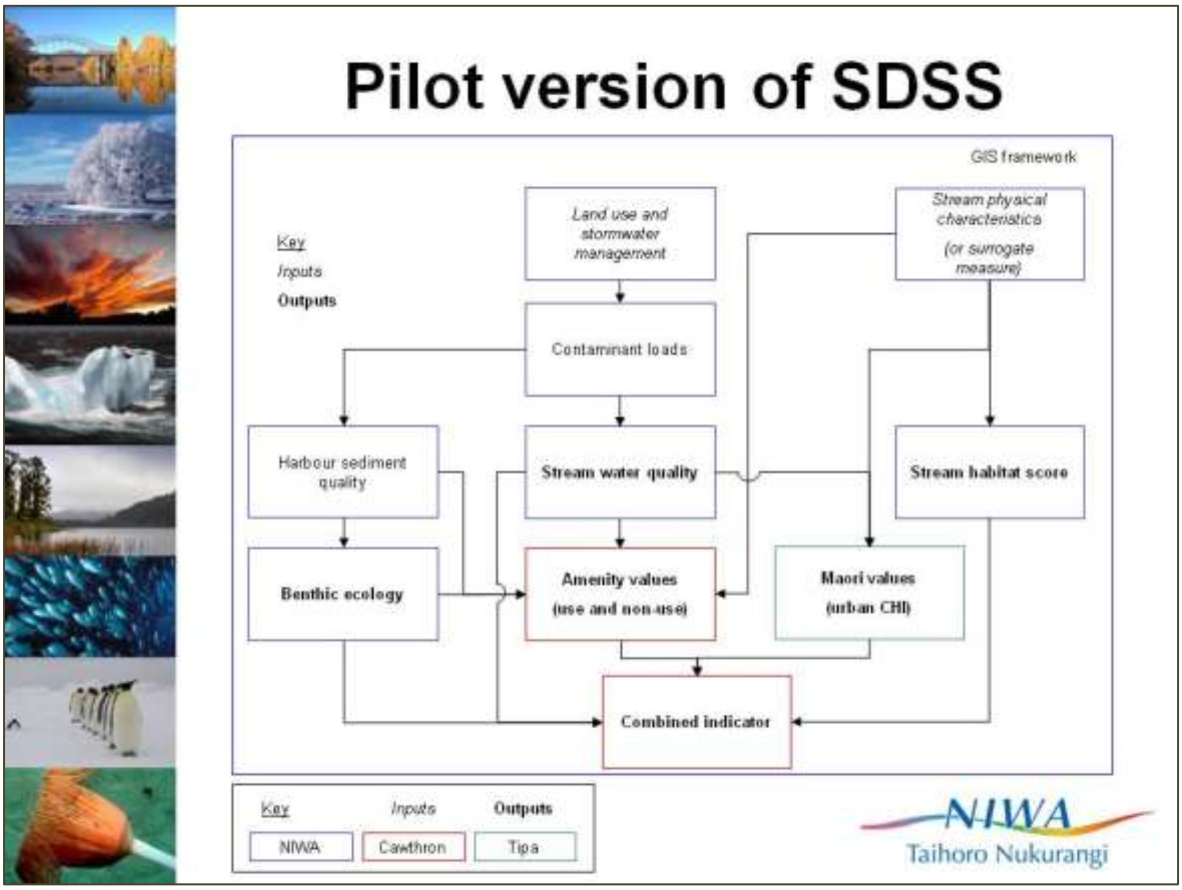

Questions ?

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