Northland Regional Council
Landcare Research
Science Exchange
April 2016

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Sustainable honey industry

Fiona Carswell (Pike Brown, Anne-Gaelle Ausseil, John Dymond, Sarah Richardson, Gary Houliston, Bevan Weir, Stan Bellgard)

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Cross-Landcare Research expertise

1) Survey design and analysis;
2) Spatial mapping of resources, constraints and ecosystem services;
3) Molecular tools for rapid identification of disease (including commercial EcoGene service);
4) Ecosystem models of environmental drivers of resource flows/constraints.

Colony Loss and Survival Survey

- MPI and national beekeepers groups contracted LR to run first national survey of colony loss and survival (baseline info.)
- Represents c. 40% of all hives (Autumn 15)
- Colony loss gen. caused by queen problems, colony death, wasps.
- MPI has commissioned further research on pathogen (pest and disease) levels in New Zealand colonies.

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Colony death

- Colony death is due to observable causes such as starvation, pest presence, disease indicators or temperature
- Starvation implicated more frequently than environmental toxins (dead bees in hives rather than in front of hives)
- Highlighted emerging challenges of border stacking, theft etc…

Limiting resources for honey bees

Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Spring b uild up			Clover & Kiwifruit pollination		Summer Honey Flow		Autumn preparation for winter			Over-wintering		

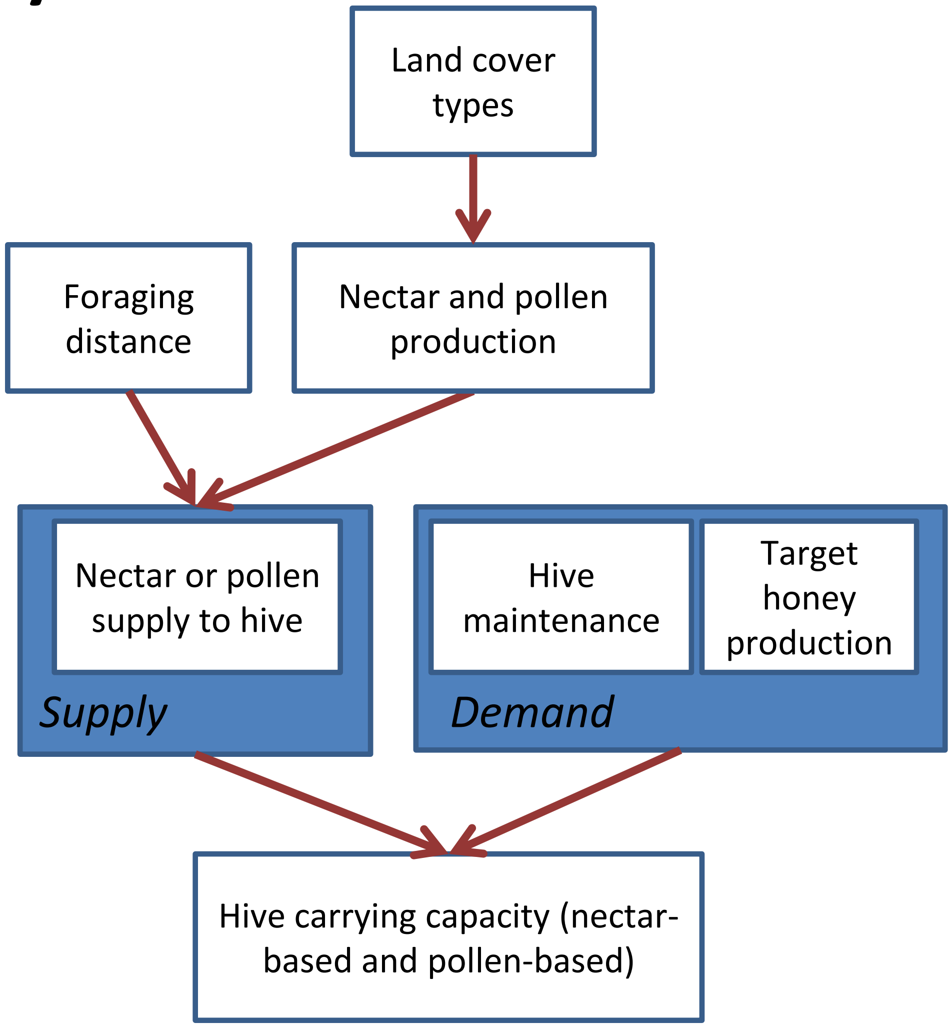
Protein Rich Pollen

Target Crop for pollination

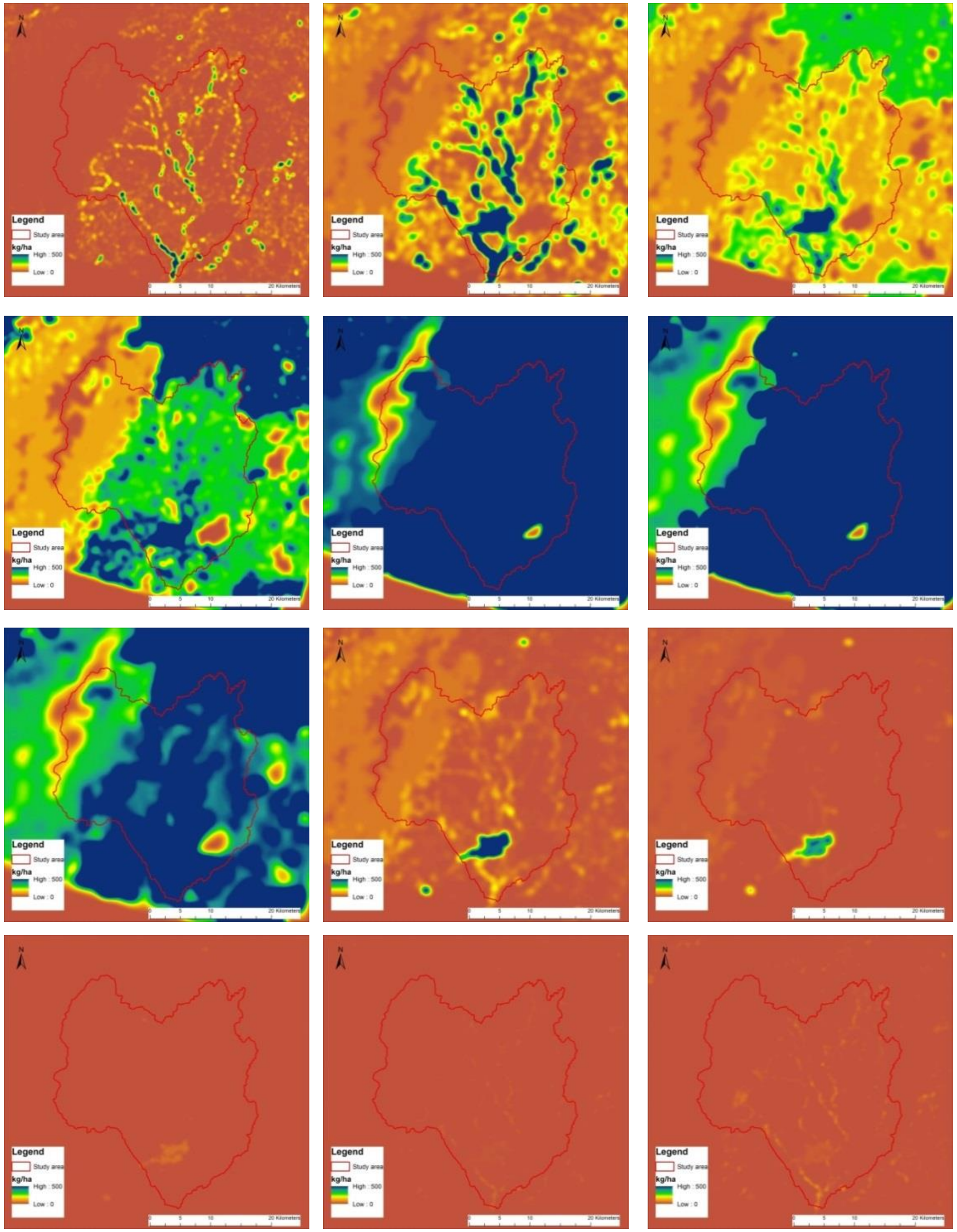
Good Honey Plants

Protein Rich Pollen

Spatial framework for hive carrying capacity



Nectar supply through the year



August – October (spring)
build-up

November – january (summer)
Honey flow, target crop
for pollination

February – April (autumn)
Preparation for winter
High demand for nectar

May – july (winter)
Over-wintering

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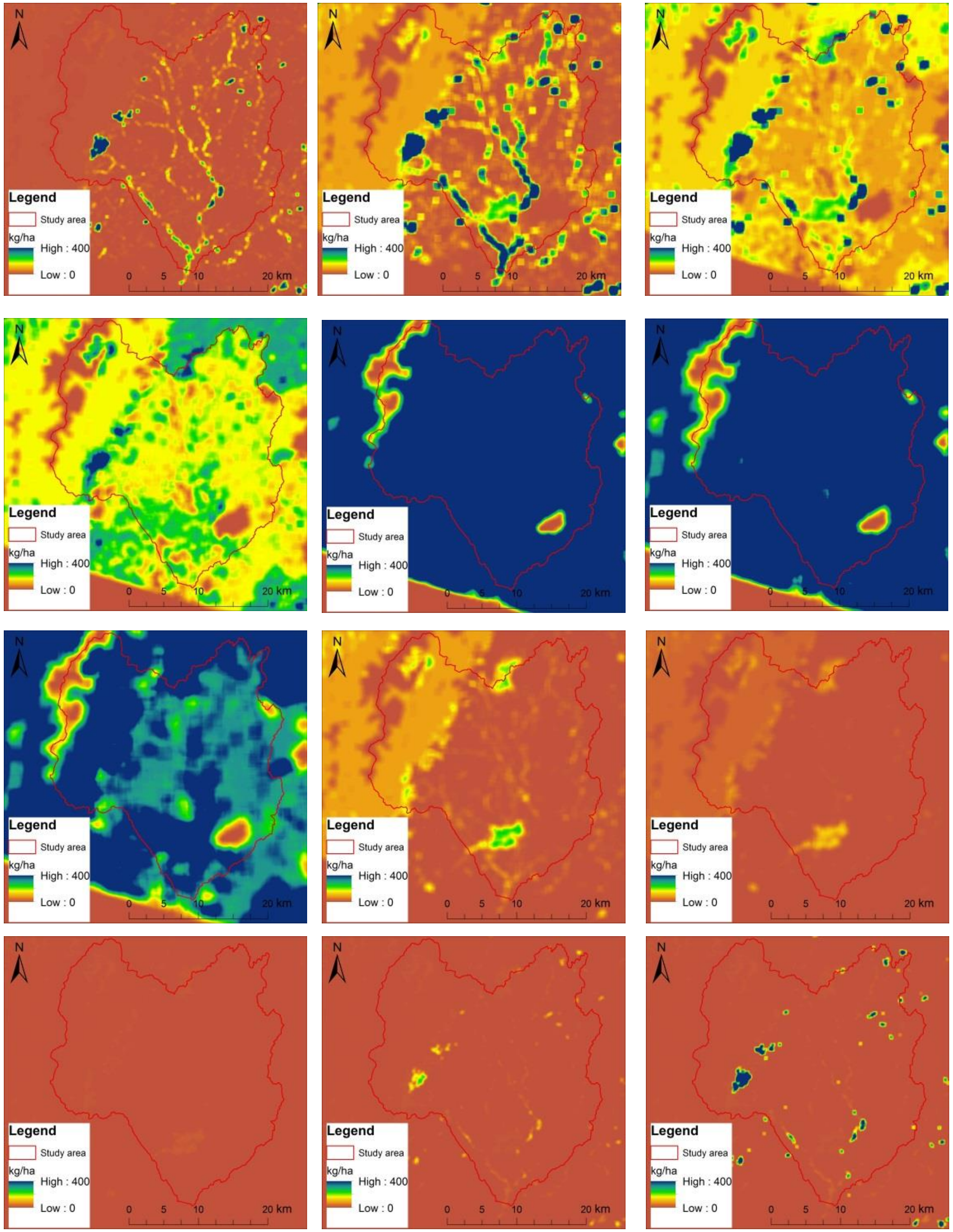
Pollen supply through the year



August – October (spring)
build-up – high demand for
pollen

November – january (summer)
Honey flow, target crop
for pollination

February – April (autumn)
Preparation for winter

May – july (winter)
Over-wintering

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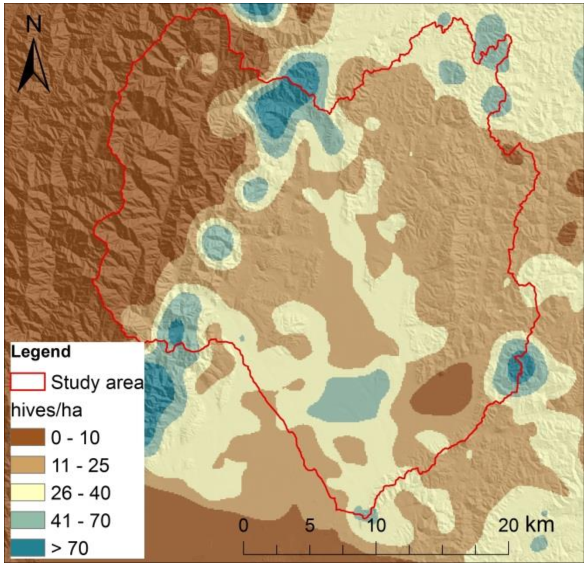
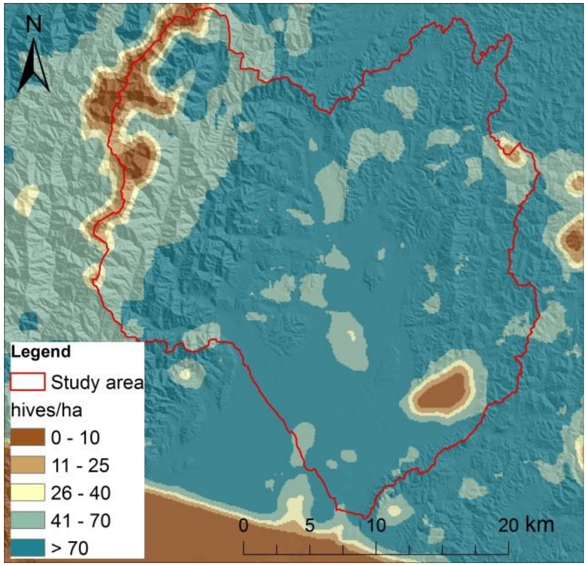
What we can answer

- Where and how many hives can we leave all year-round?
- Which areas are pollen- or nectar-limited?
- How many hives can we have for summer honey collection?
- What is the benefit of restoration planting for floral resources?

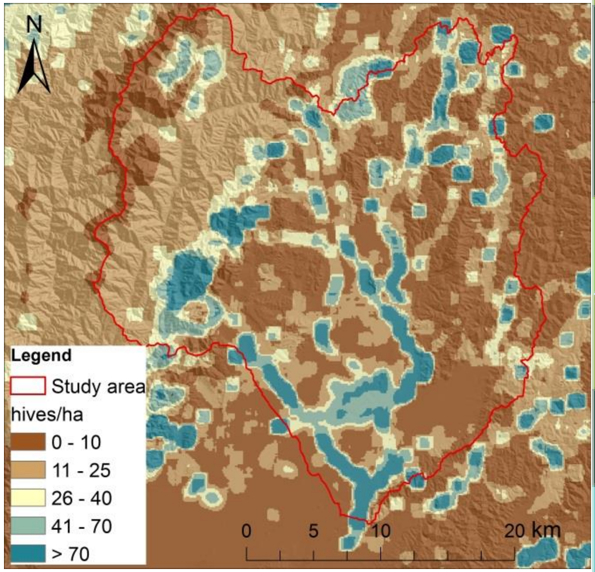
Where and how many hives can we leave all year-round?



Based on nectar availability for the year



Based on pollen availability for the year



Based on pollen availability for september

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Next steps…

- Improving biological resolution of nectar and pollen availability (empirical, catchment-scale fieldwork);
- Determining environmental drivers of nectar and pollen production (flowering records, citizen science, climatic records…);
- Honey provenance (including genetics);
- Regional scale management by producers for sustainable honey industry – Te Tai Tokerau Honey is a project partner.

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We work on sustainable harvest of existing indigenous forests…

With

- Tūhoe Tuawhenua Trust (Urewera – tawa & podocarps)
- Waitutu Incorporation (Southland – silver beech)
- Mangatu Incorporation (BoP – tawa & podocarps)
- MPI (N Westland – beech)

FSC

Designing low-impact systems

- Tree dynamics
- Weed invasions
- Fungal communities
- Deadwood dynamics
- Thinning trials

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Including how much is too much to take of dead wood…

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Update on soils information

Alison Collins, Linda Lilburne, Sam Carrick and others

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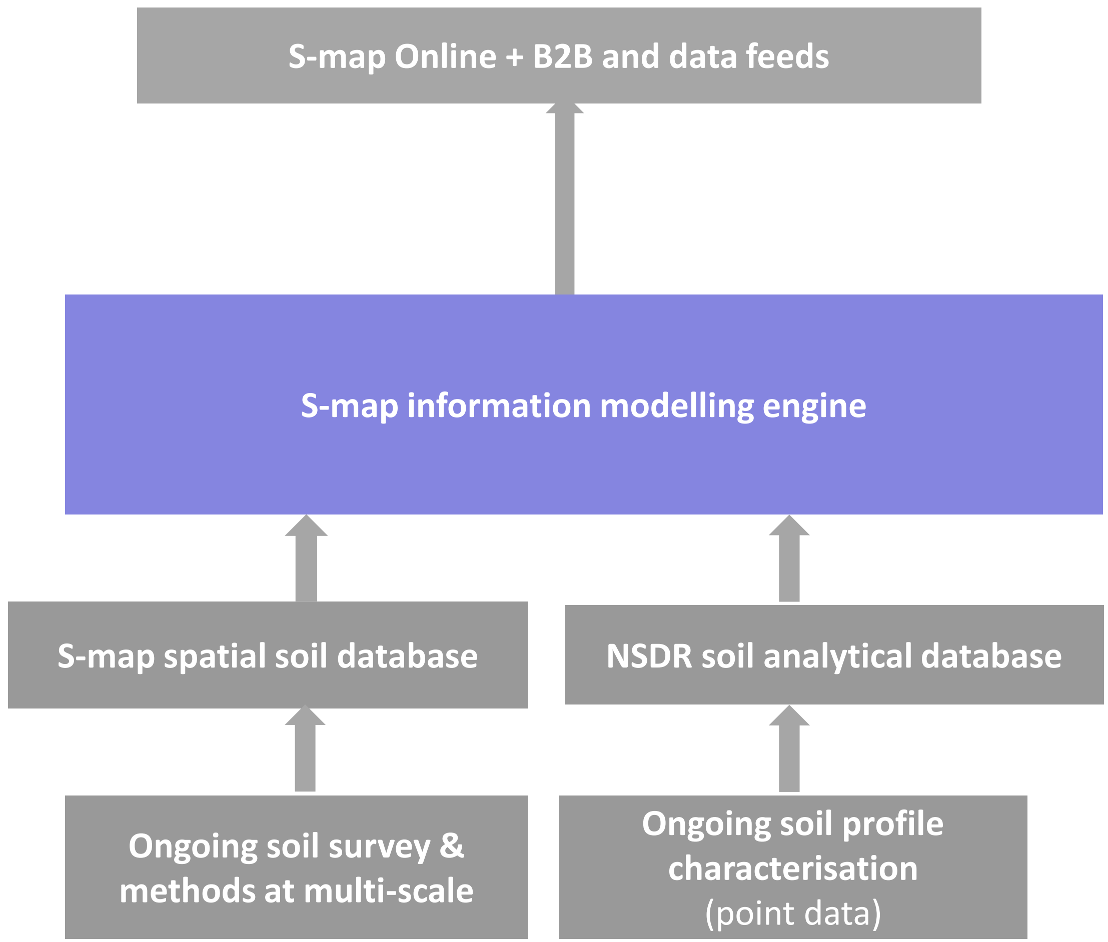
Soil information – what is S-map?



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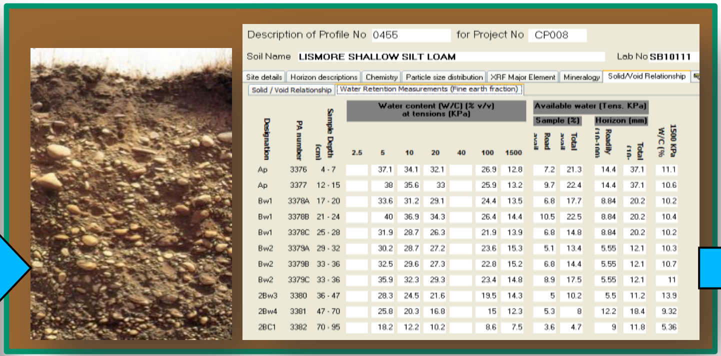
Journey – observations to information



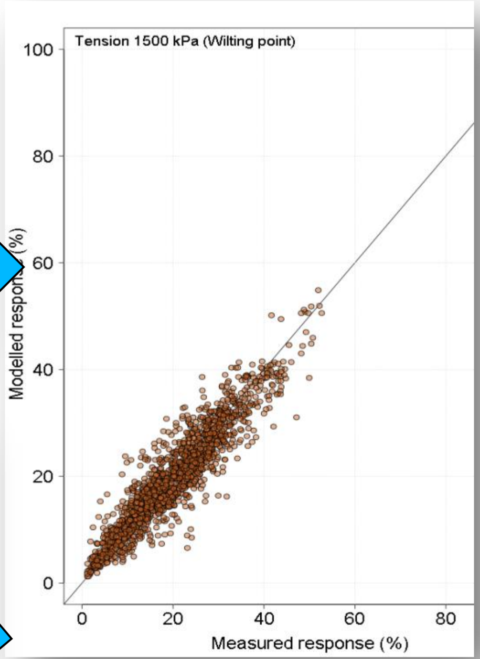
Description of Profile No 0455 for Project No CP008

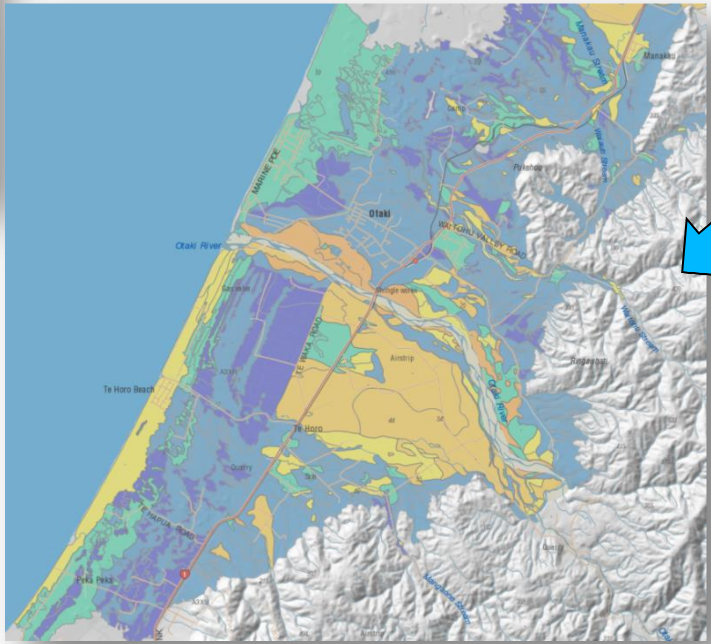
Soil Name LISMORE SHALLOW SILT LOAM Lab No SB10111

Site details | Horizon descriptions | Chemistry | Particle size distribution | XRF Major Element | Mineralogy | Solid/Void Relationship

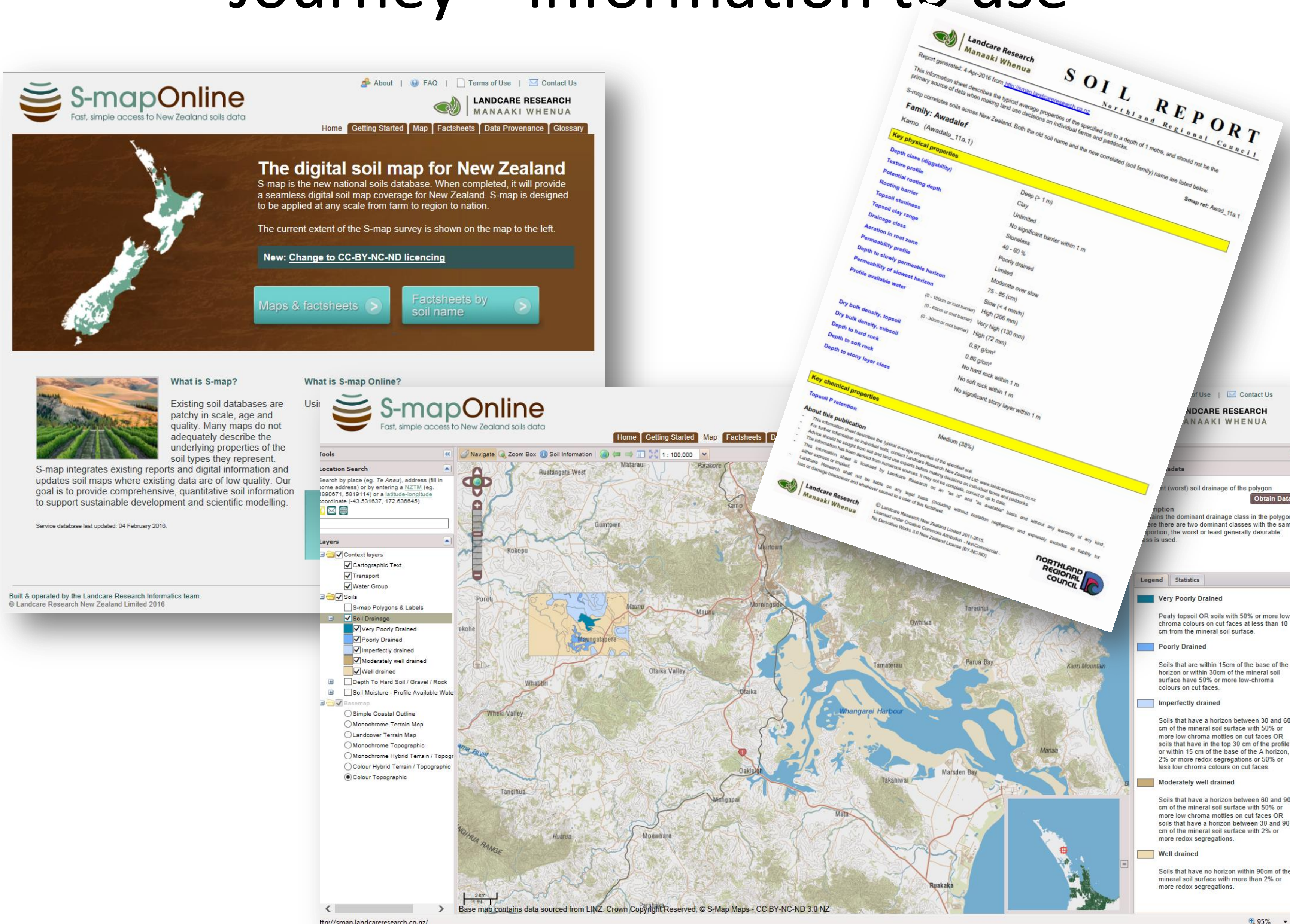
Solid / Void Relationship | Water Retention Measurements (Fine earth fraction)

Designation	PA number	Sample Depth (cm)	Water content (W/C) (% v/v) at tensions (KPa) 2.5	5	10	20	40	100	1500	Available water (Tens. KPa) Sample (%) Read avail	Total avail	Horizon (mm) Readily (10-100)	Total (10-1500)	1500 KPa W/C (%)
Ap	3376	4 - 7		37.1	34.1	32.1		26.9	12.8	7.2	21.3	14.4	37.1	11.1
Ap	3377	12 - 15		38	35.6	33		25.9	13.2	9.7	22.4	14.4	37.1	10.6
Bw1	3378A	17 - 20		33.6	31.2	29.1		24.4	13.5	6.8	17.7	8.84	20.2	10.2
Bw1	3378B	21 - 24		40	36.9	34.3		26.4	14.4	10.5	22.5	8.84	20.2	10.4
Bw1	3378C	25 - 28		31.9	28.7	26.3		21.9	13.9	6.8	14.8	8.84	20.2	10.2
Bw2	3379A	29 - 32		30.2	28.7	27.2		23.6	15.3	5.1	13.4	5.55	12.1	10.3
Bw2	3379B	33 - 36		32.5	29.6	27.3		22.8	15.2	6.8	14.4	5.55	12.1	10.7
Bw2	3379C	33 - 36		35.9	32.3	29.3		23.4	14.8	8.9	17.5	5.55	12.1	11
2Bw3	3380	36 - 47		28.3	24.5	21.6		19.5	14.3	5	10.2	5.5	11.2	13.9
2Bw4	3381	47 - 70		25.8	20.3	16.8		15	12.3	5.3	8	12.2	18.4	9.32
2BC1	3382	70 - 95		18.2	12.2	10.2		8.6	7.5	3.6	4.7	9	11.8	5.36



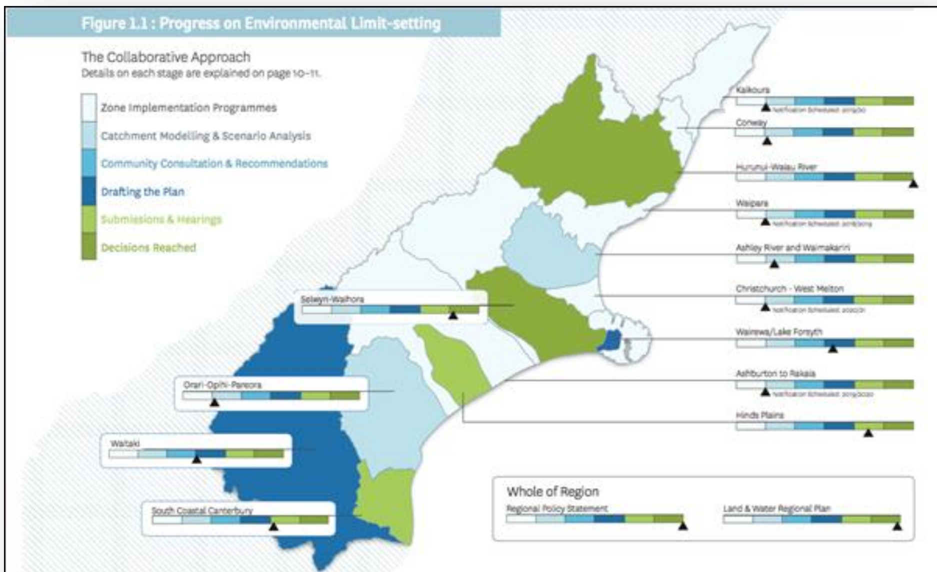


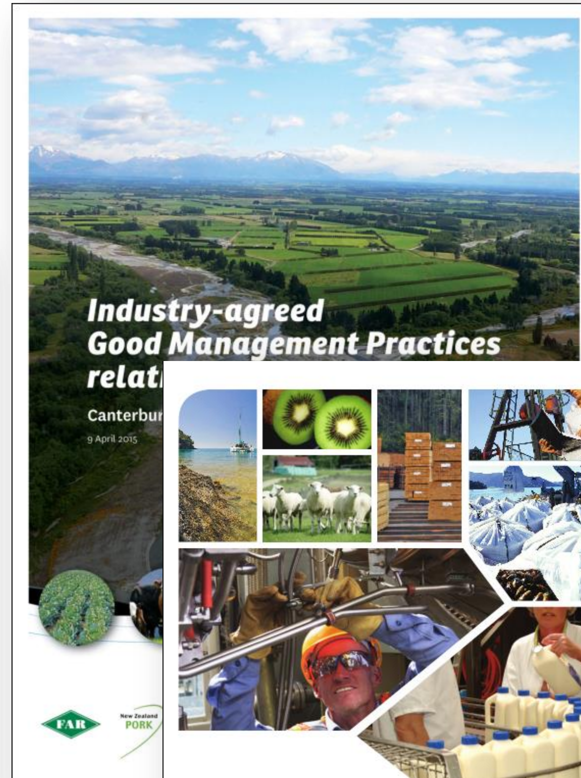
Journey – information to use

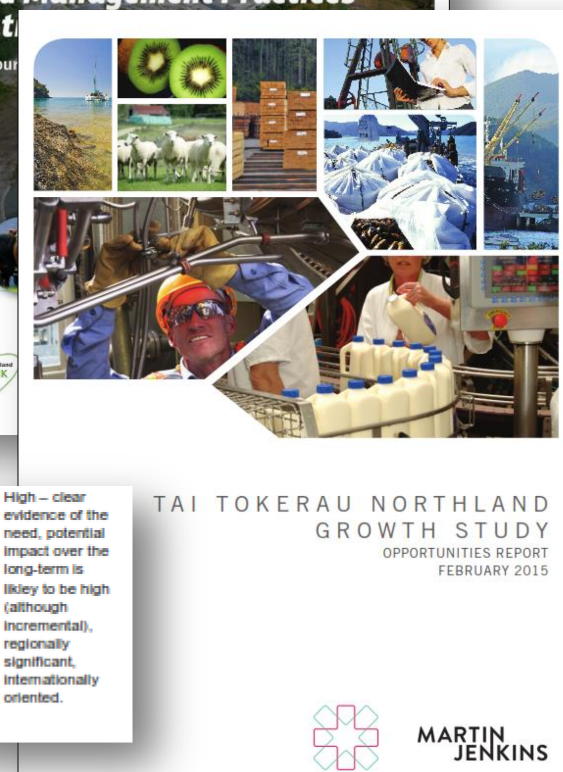


Journey – use to impact

OVERSEER®
For on-farm management and decision support





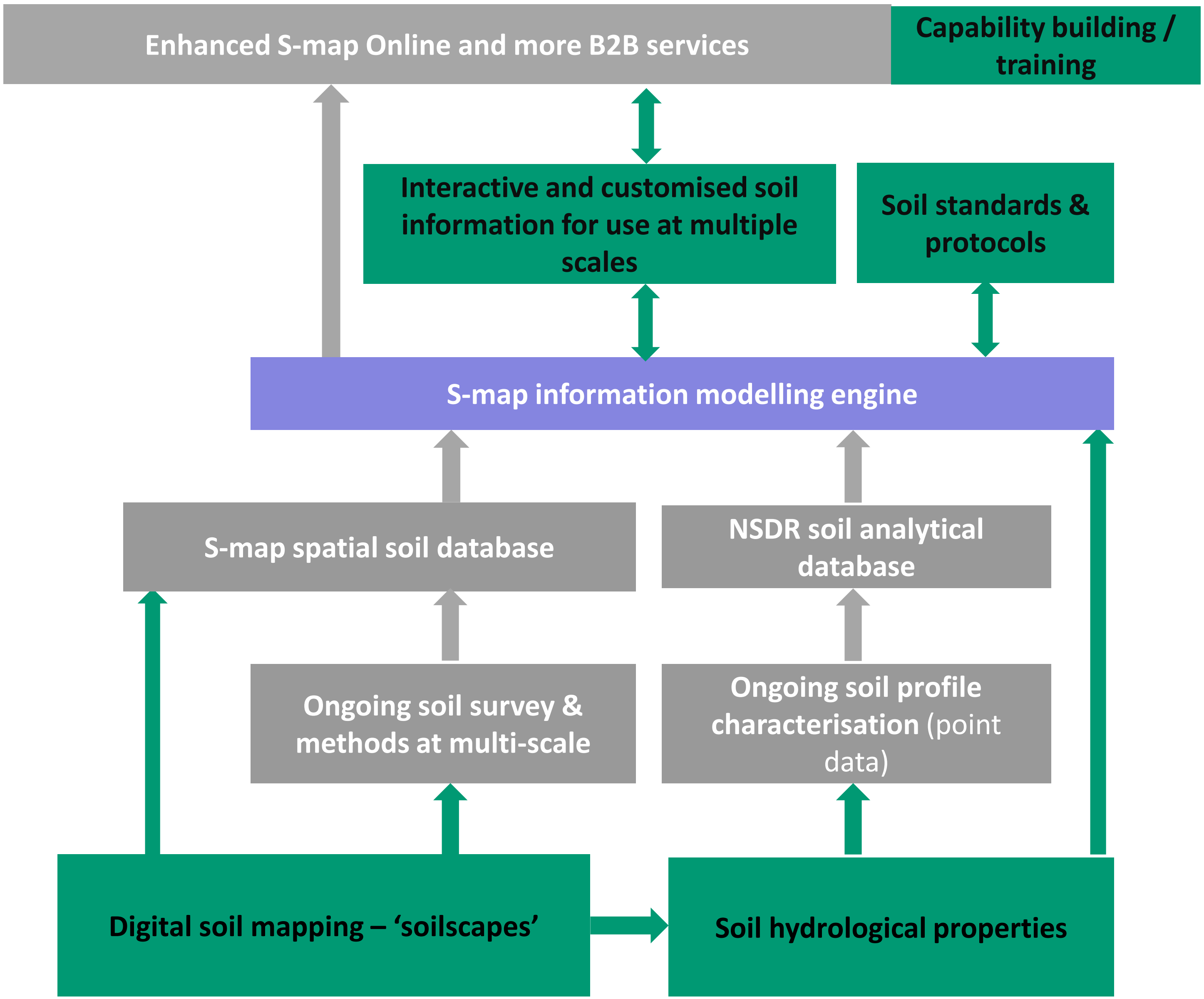


Improving on-farm management through an expansion of productivity initiatives	On-farm productivity improvements that move the middle 50 percent of Northland farmers to the upper quartile could deliver an estimated additional $50m of value per annum to the industry.	Famers and sharemilkers, DairyNZ, Northland Regional Council	Assess the benefits of seeding support for the expansion of Focus Farms to more locations and the introduction of Dairy Push with DairyNZ.	Up to $750k over three years (private and public)	2015-2017	High – clear evidence of the need, potential impact over the long-term is likley to be high (although incremental), regionally significant, internationally oriented.
Realise the dairy potential of Māori land	Bringing all Māori freehold land in the region into production or improving current productivity levels could increase GDP by $339m and support a further 331 jobs annually.	MPI, MBIE, Tai Tokerau Iwi Chief Executives Forum, Iwi Financial Institutions	MPI and MBIE to work with the Tai Tokerau Iwi Chief Executives Forum and financial institutions to develop options for providing support for commercial advice and bridging finance for dairy conversions and expansions, until settlements are finalised.	Unknown at this stage	Next 5 to 10 years	

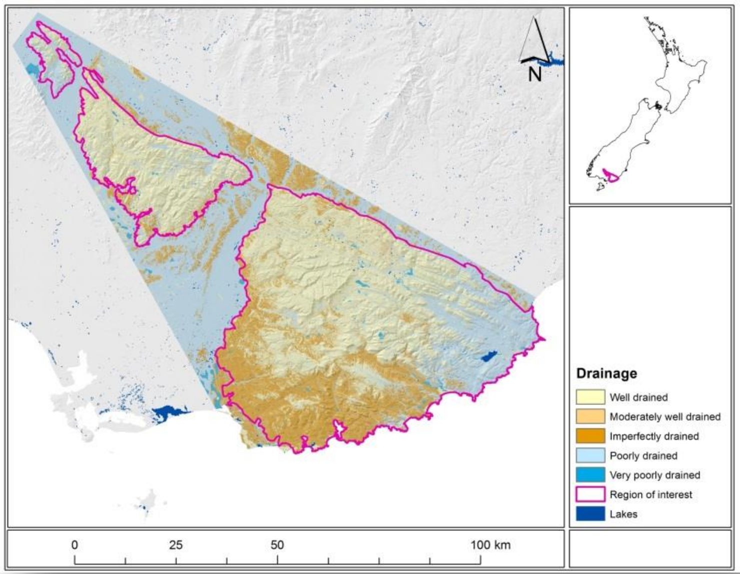
Current coverage

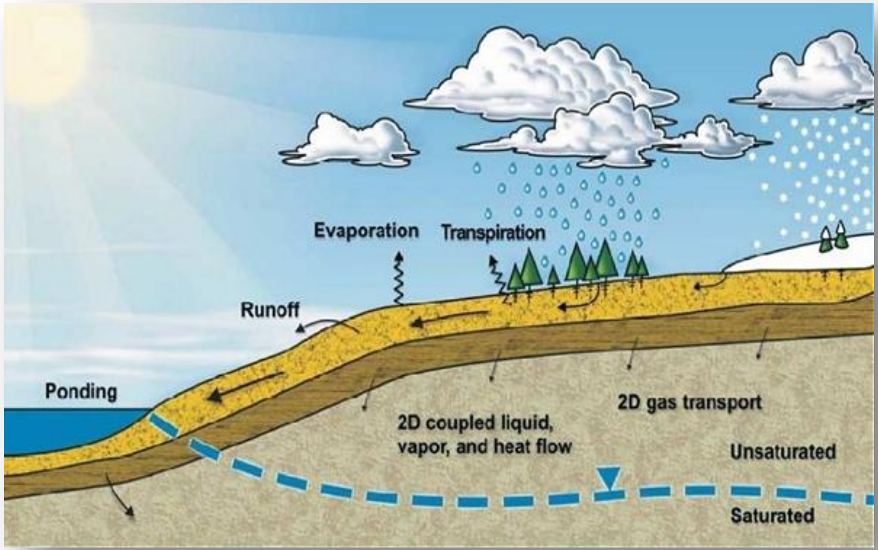
Land class	% NZ	% class covered
Multiple use	25%	56%
Pasture / Forestry	50%	21%
Conservation	22%	5%

Extending the impact



Extending impact





Land Resource Inventory - new data from satellite and LiDAR

MPI SLMACC LiDAR project in Northland

James Barringer – Project Leader and terrain analysis

James Shepherd – LiDAR processing

Ian Lynn – LUC classification

Les Basher - Erosion

David Palmer – Digital Soil Mapping

Malcolm McLeod - Pedologist

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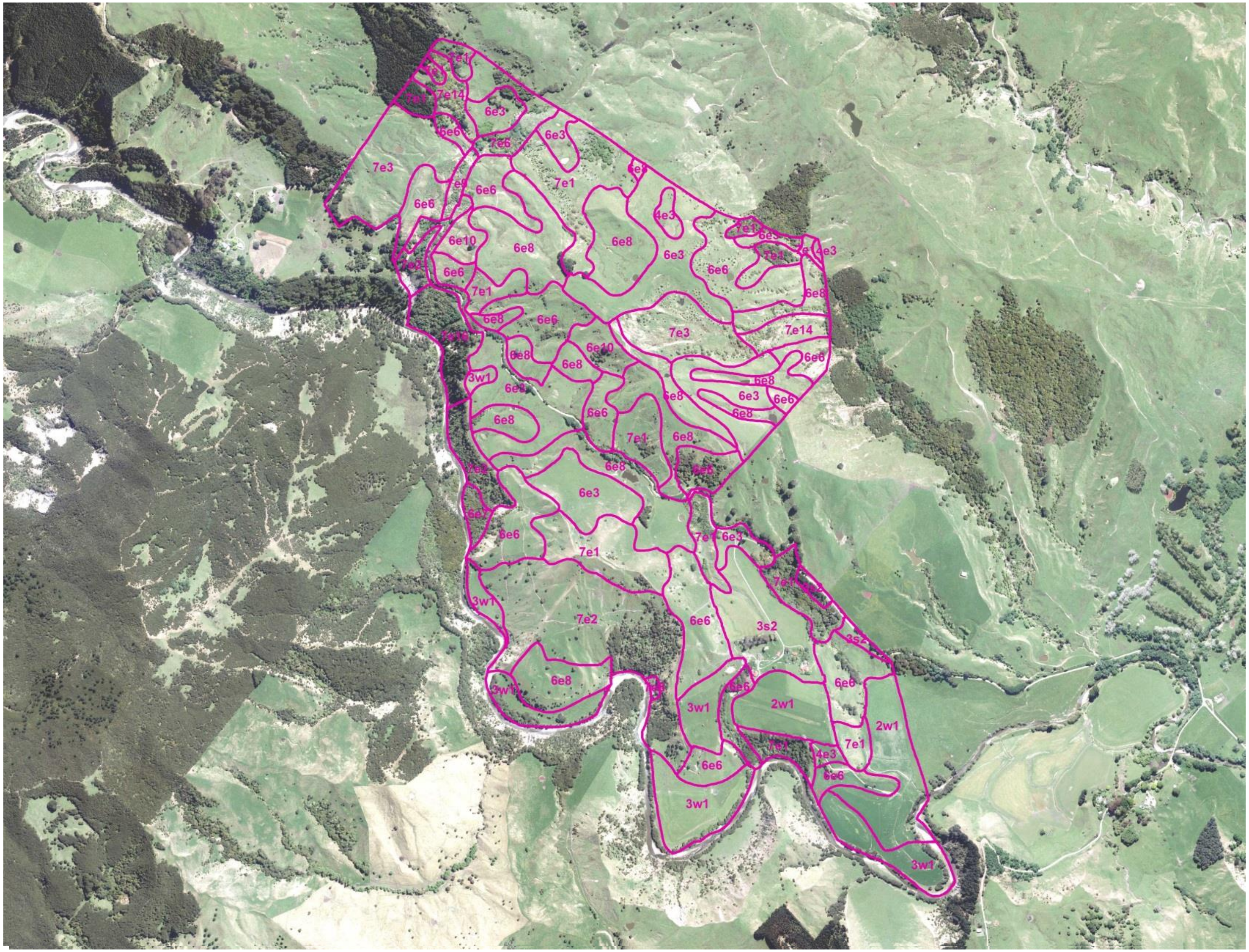
Traditional Farm-scale LUC mapping

In NZLRI
1:50k scale
312 hectares
14 polygons
10 LUC units



Farm Plan
1:10k scale
91 polygons
16 LUC units

So what's the Problem with traditional farm-scale mapping?

Costly ($10-$20 ha) ≈ say $15-25 million to map whole of Northland

Considerable subjectivity – hard to QA

Quality/consistency varies with mappers

No real "economies of scale" when extending mapping across similar terrain

Remapping costs broadly the same amount if you need to do it again.

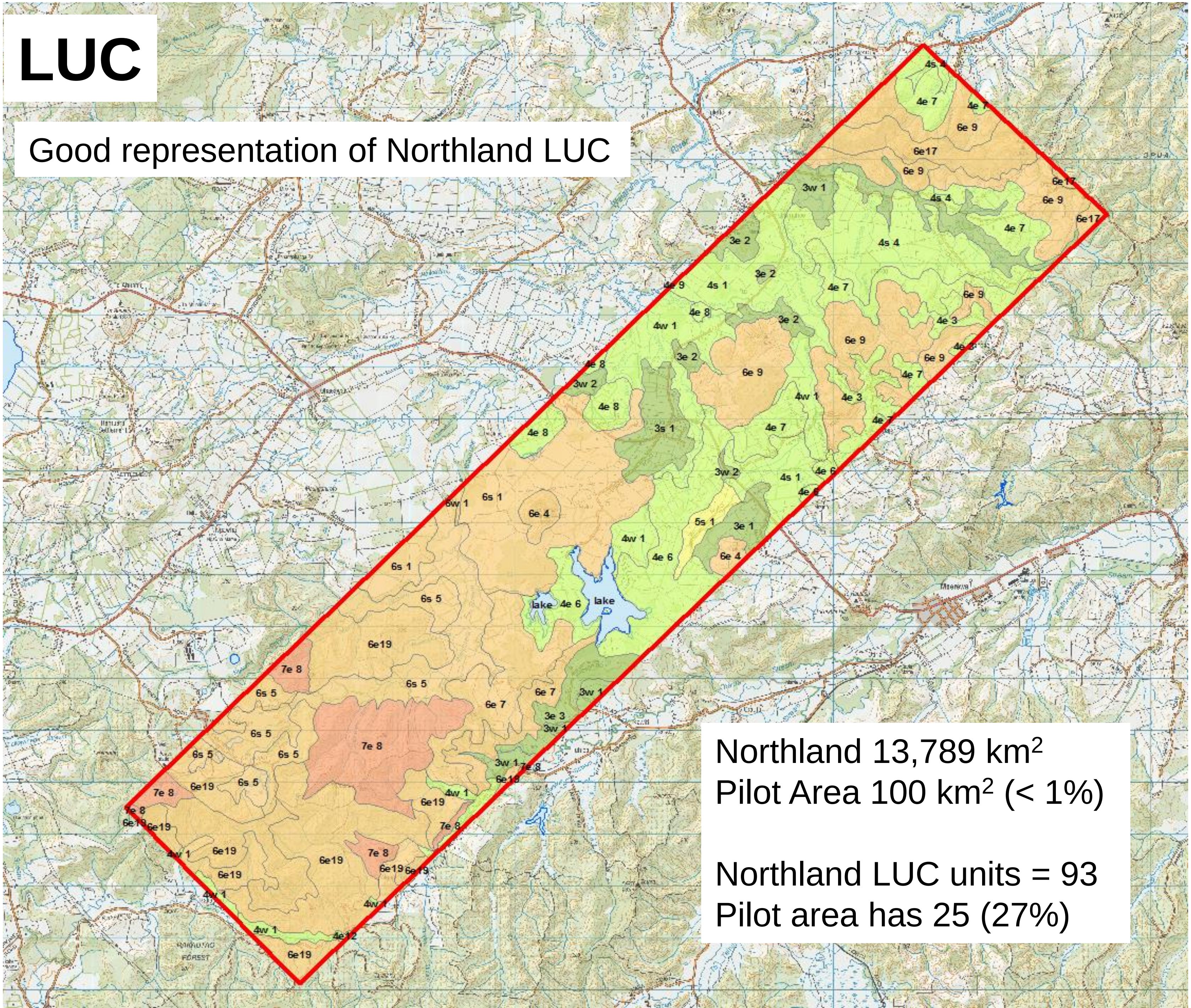
Our task?

Test new mapping techniques to:

- Improve resolution and accuracy of mapping?
- <u>Mapping that is fit for purpose?</u>
- Reduce overall cost per hectare?
- Make mapping more quantitative?
- Make mapping more consistent?
- Make <u>re</u>mapping less costly?

LUC

Good representation of Northland LUC



Northland 13,789 km^2
Pilot Area 100 km^2 (< 1%)

Northland LUC units = 93
Pilot area has 25 (27%)

LiDAR mapping Technology

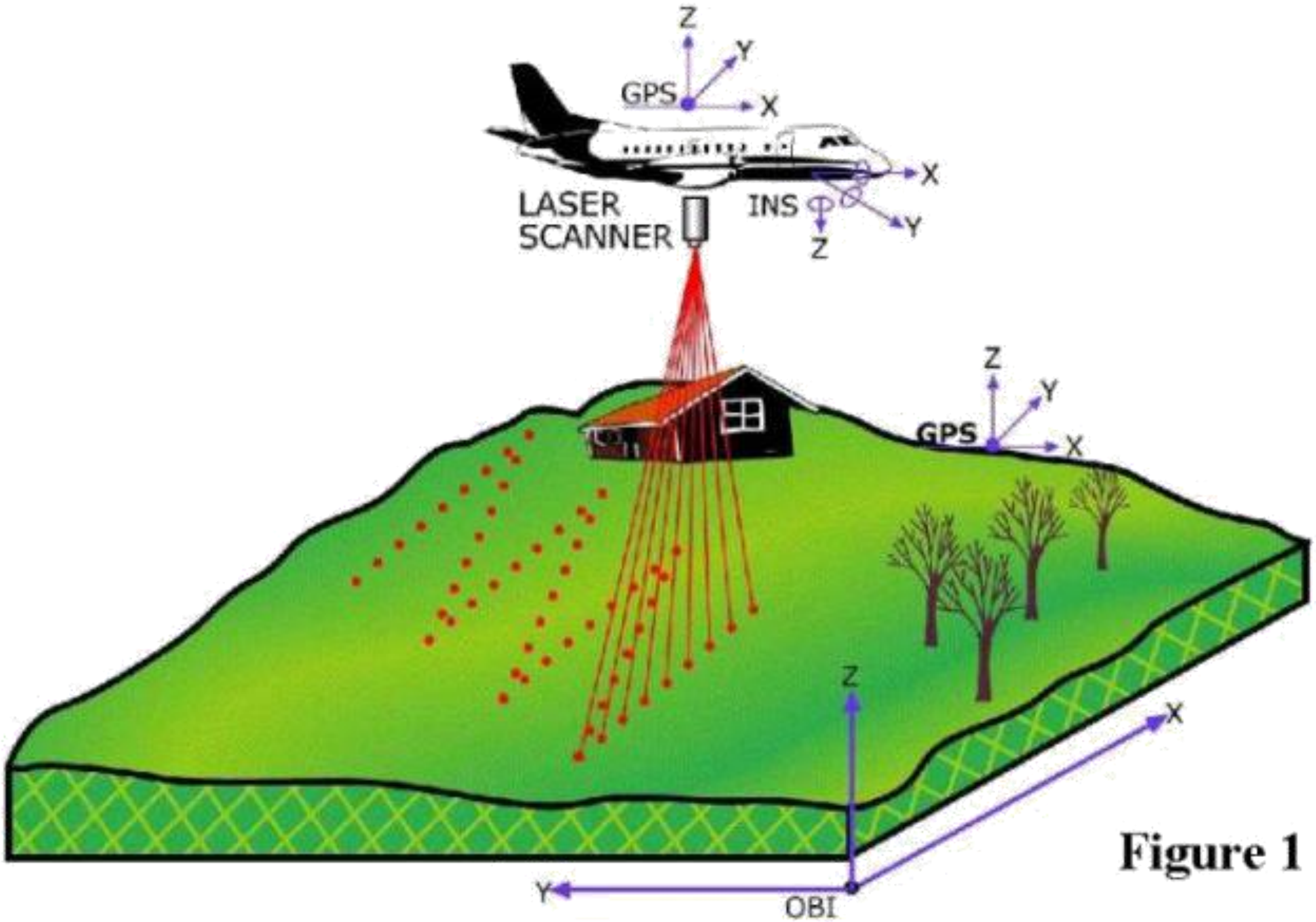
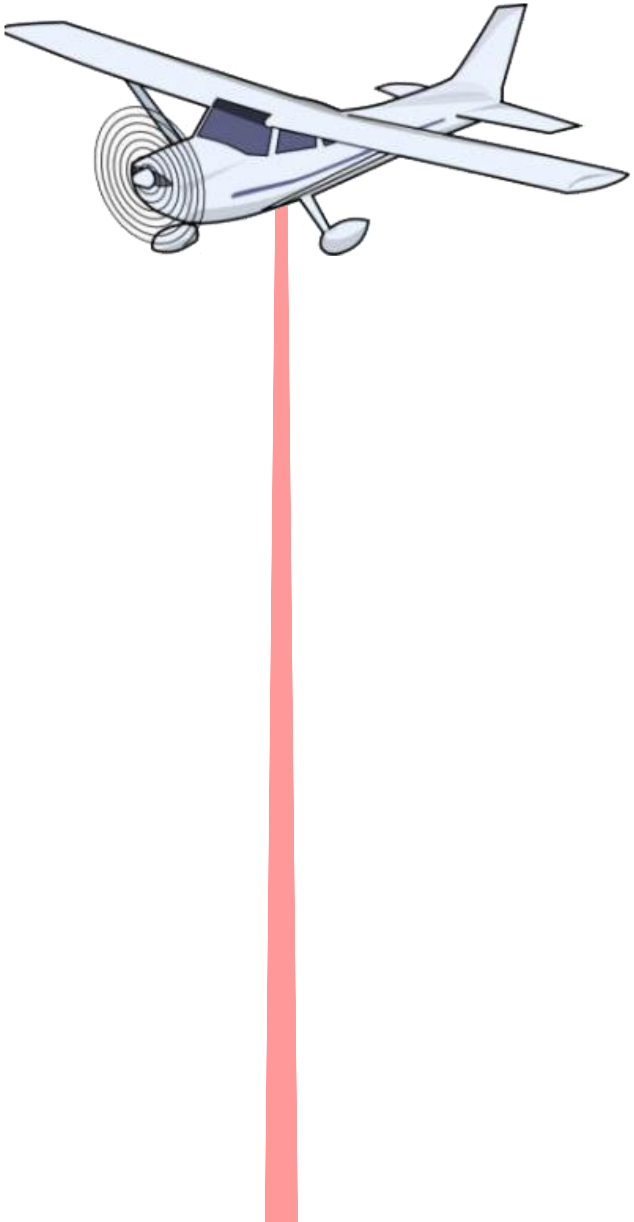
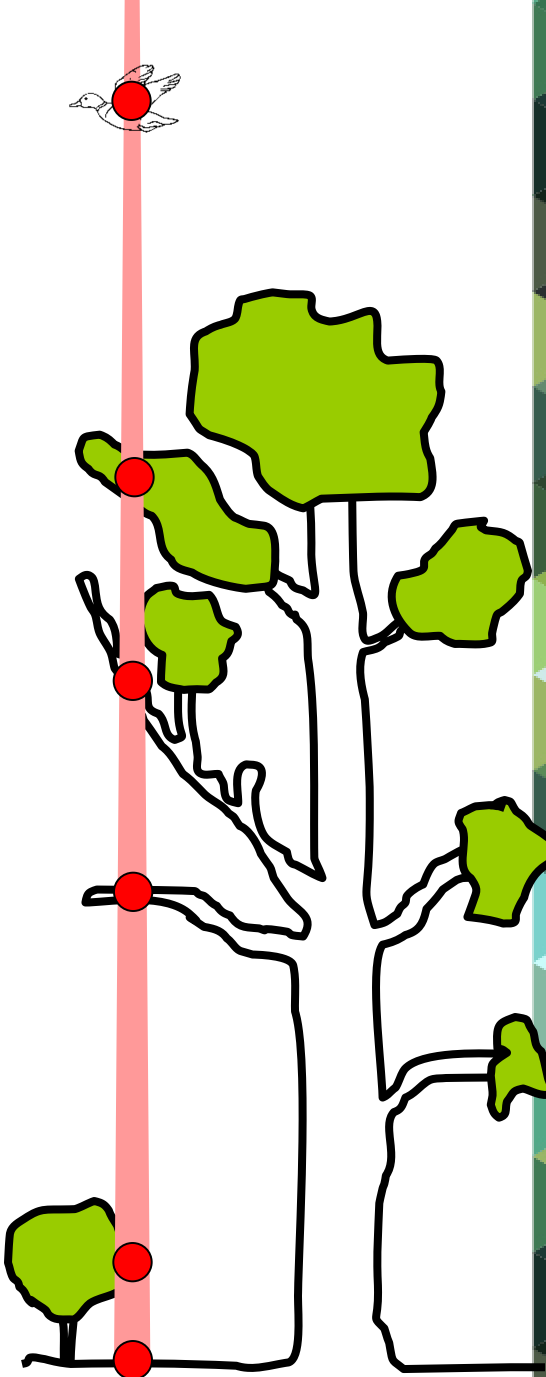


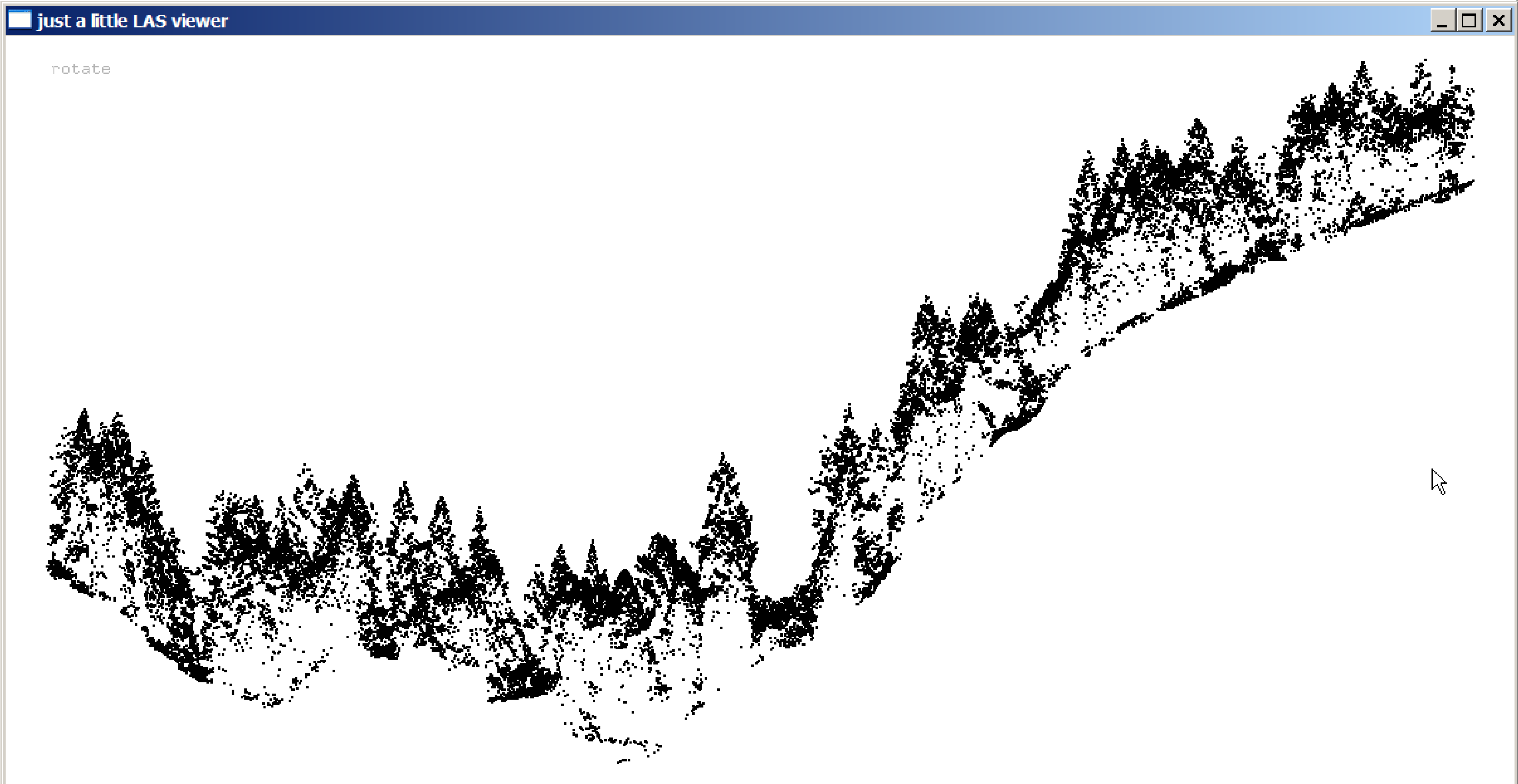
Figure 1

LiDAR Returns

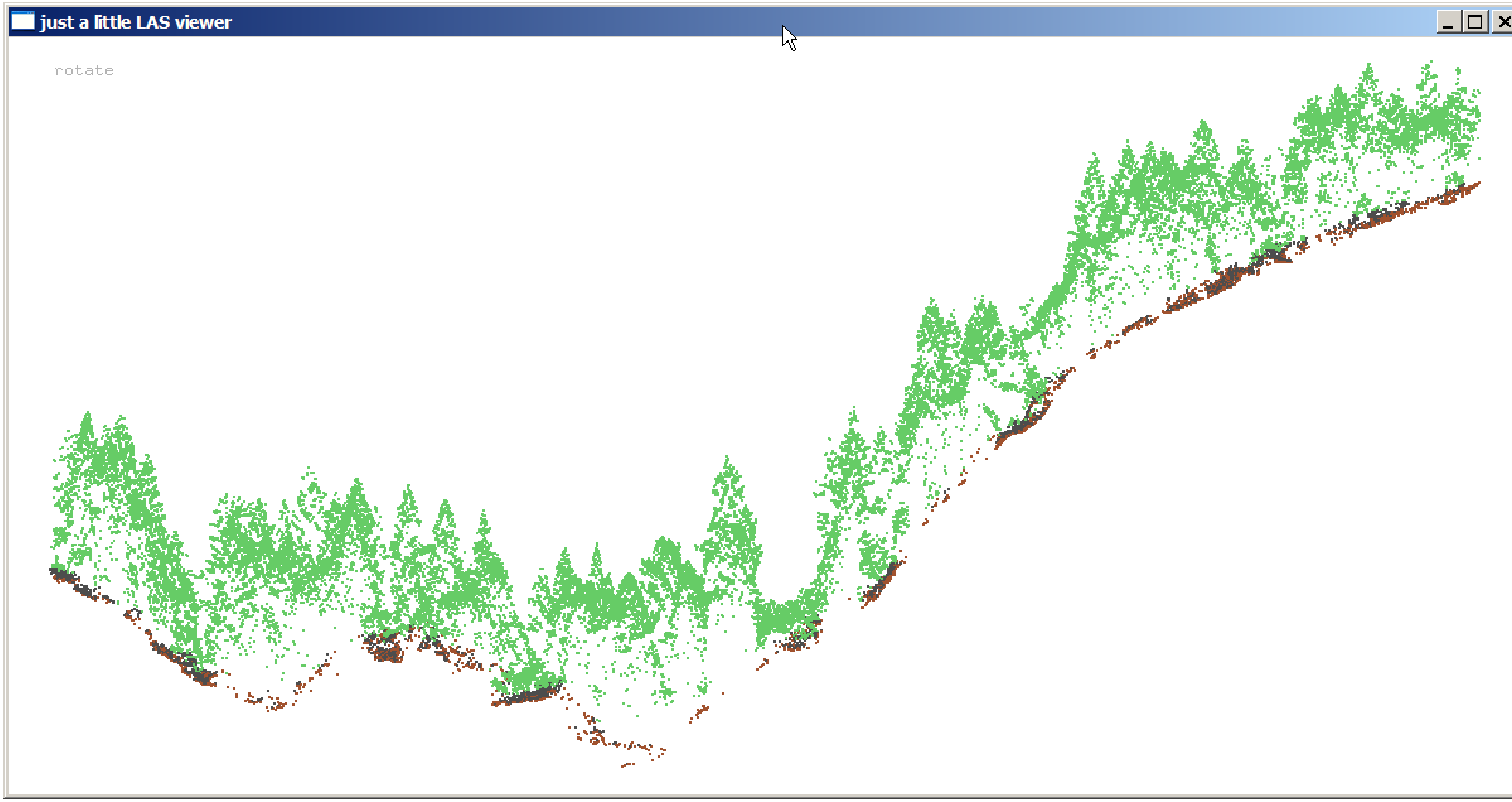




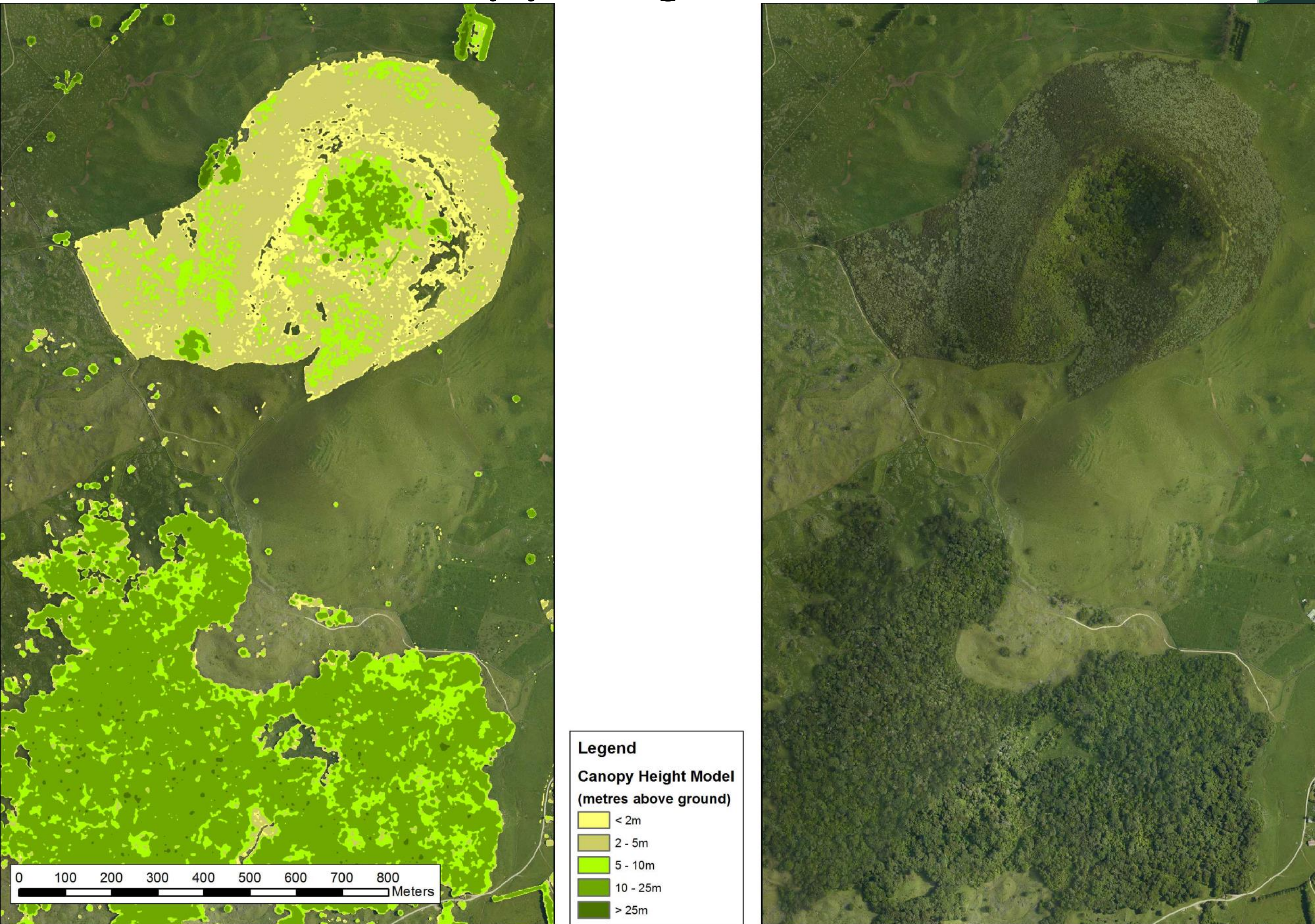
Raw Point Cloud



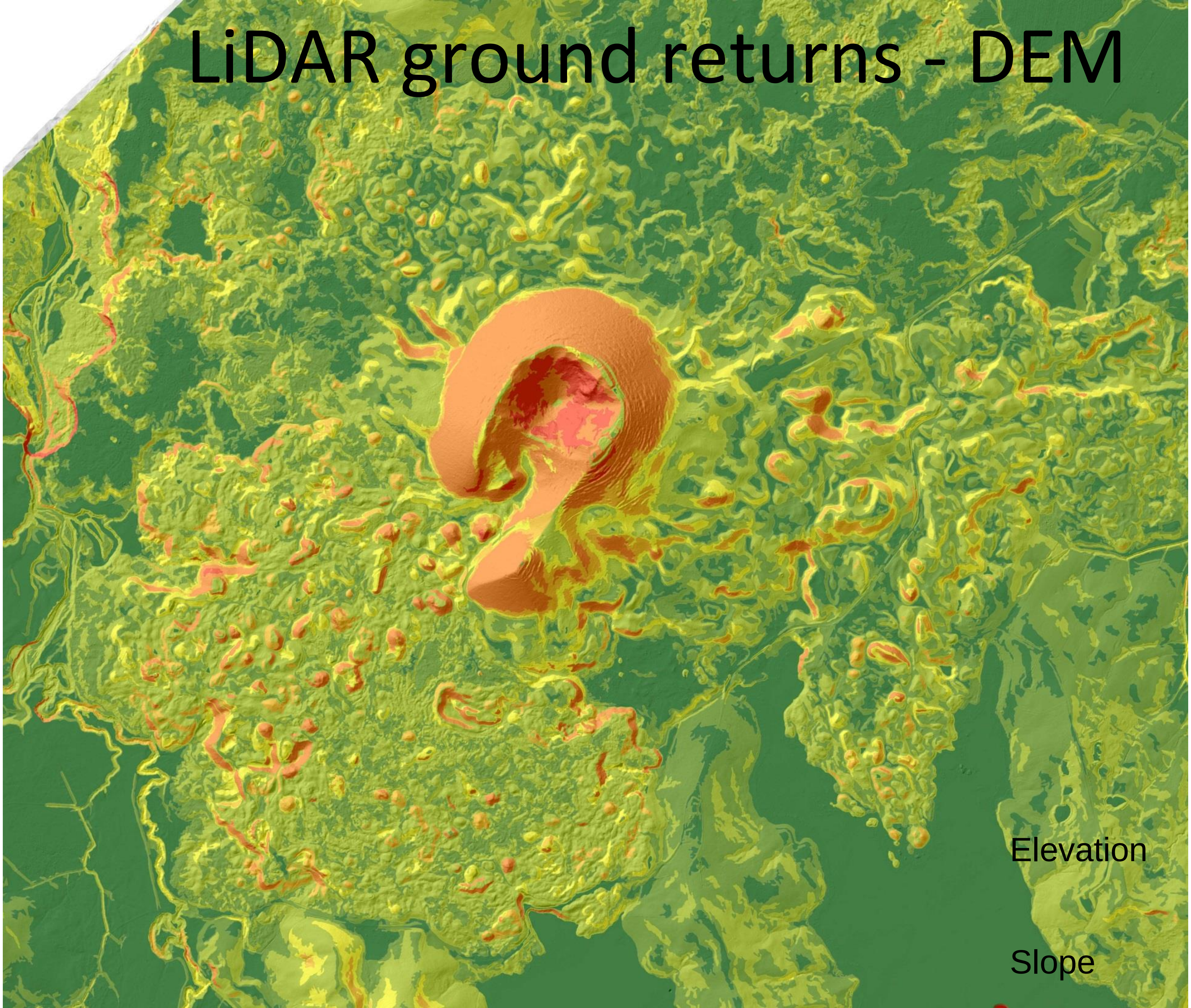
Classifying Canopy and Ground

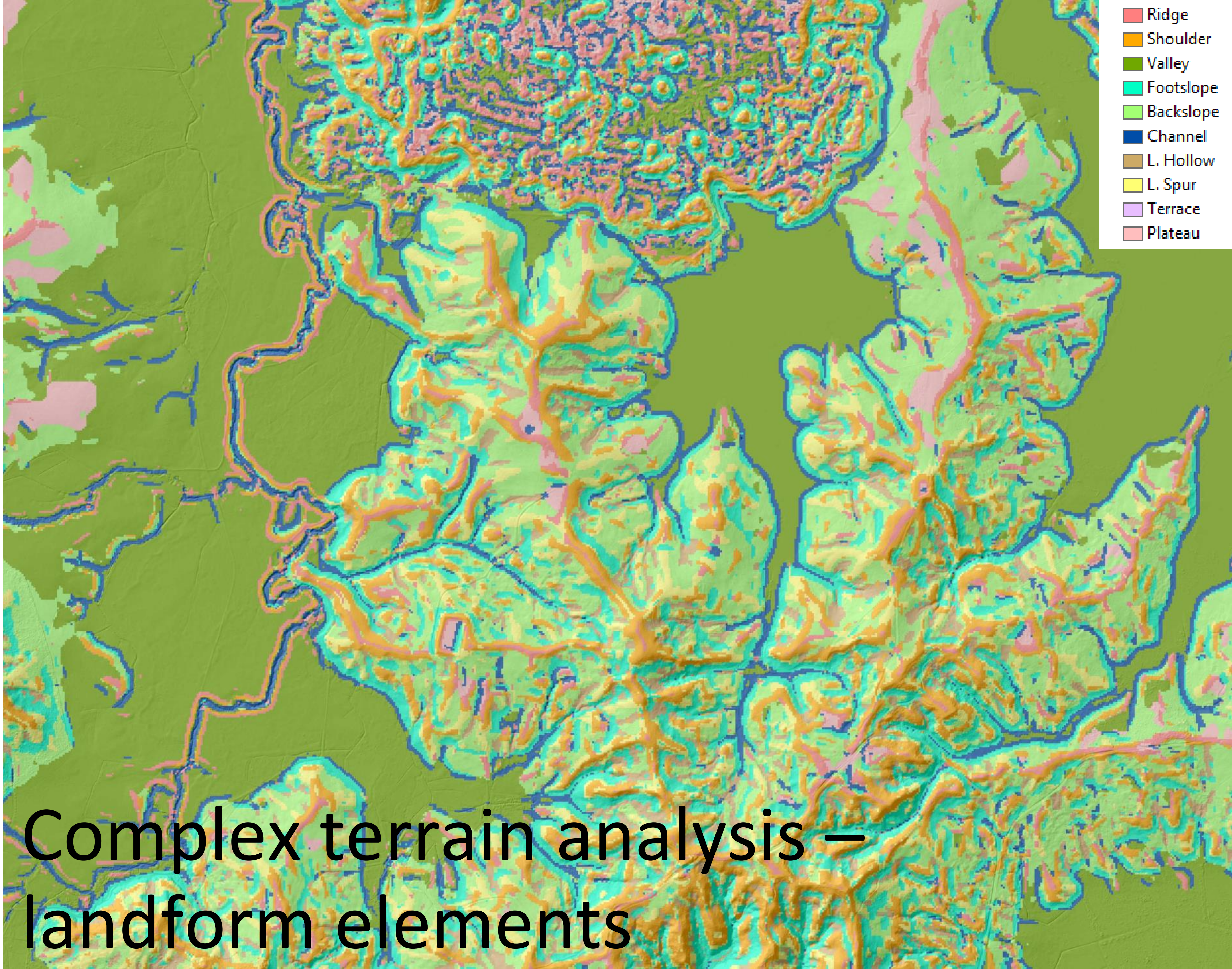


Canopy Height Model



LiDAR ground returns - DEM





Complex terrain analysis – landform elements

Digital Soil Mapping (DSM)

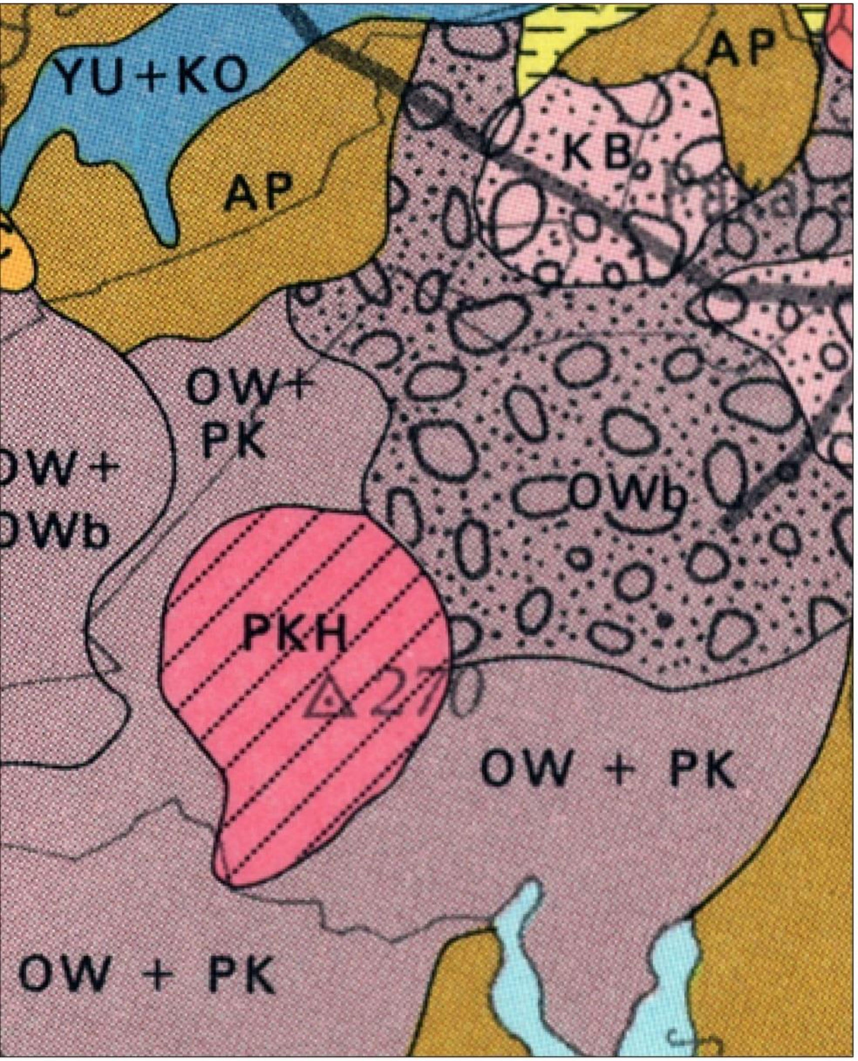
Observe soils/soil properties at points

Geostatistical correlation to environmental covariates ≈ *statistical matching of soils to covariates like parent material, terrain (e.g., slope, curvature), climate (e.g., rainfall).*

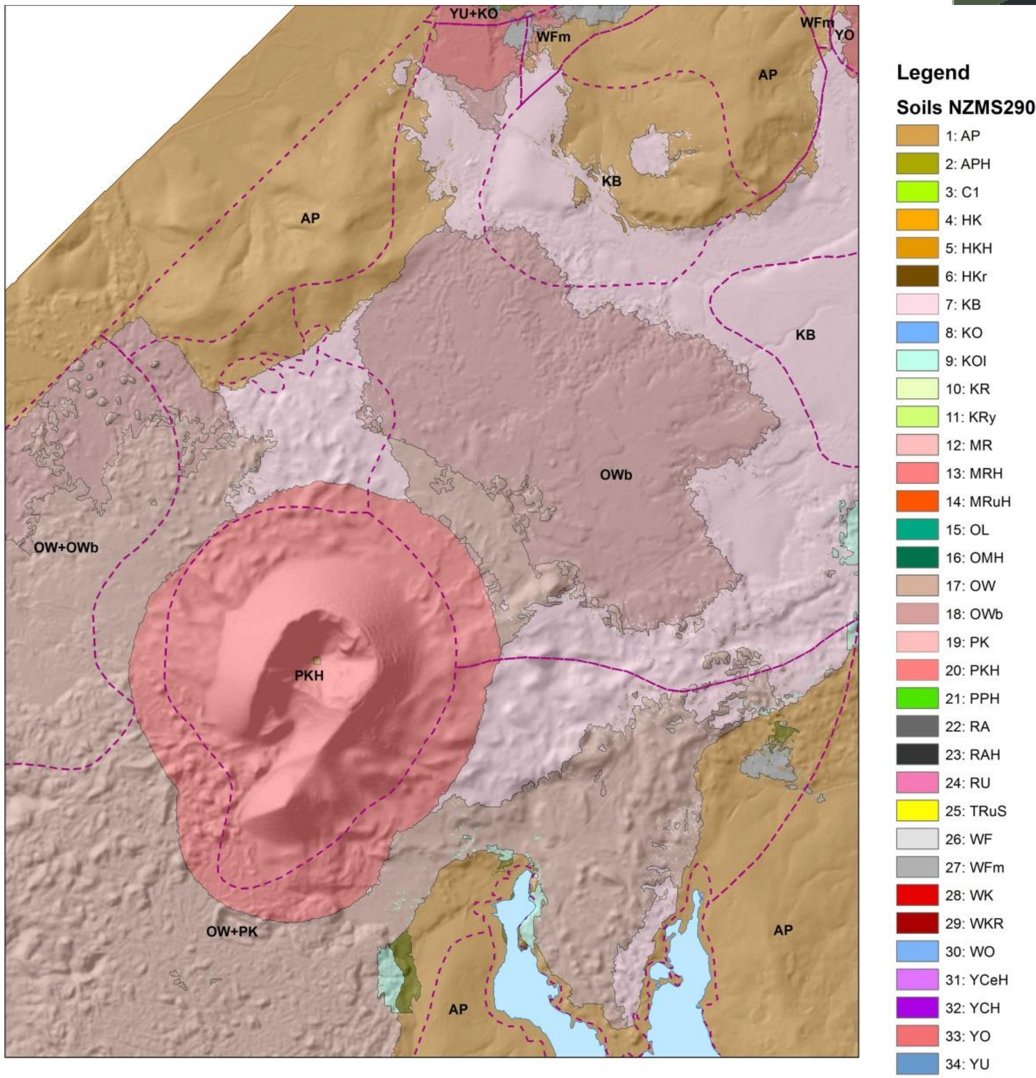
Spatial interpolation (estimating/mapping) soils/soil properties using those covariates

Compare modelled with measured soils to determine accuracy.

Preliminary DSM analyses



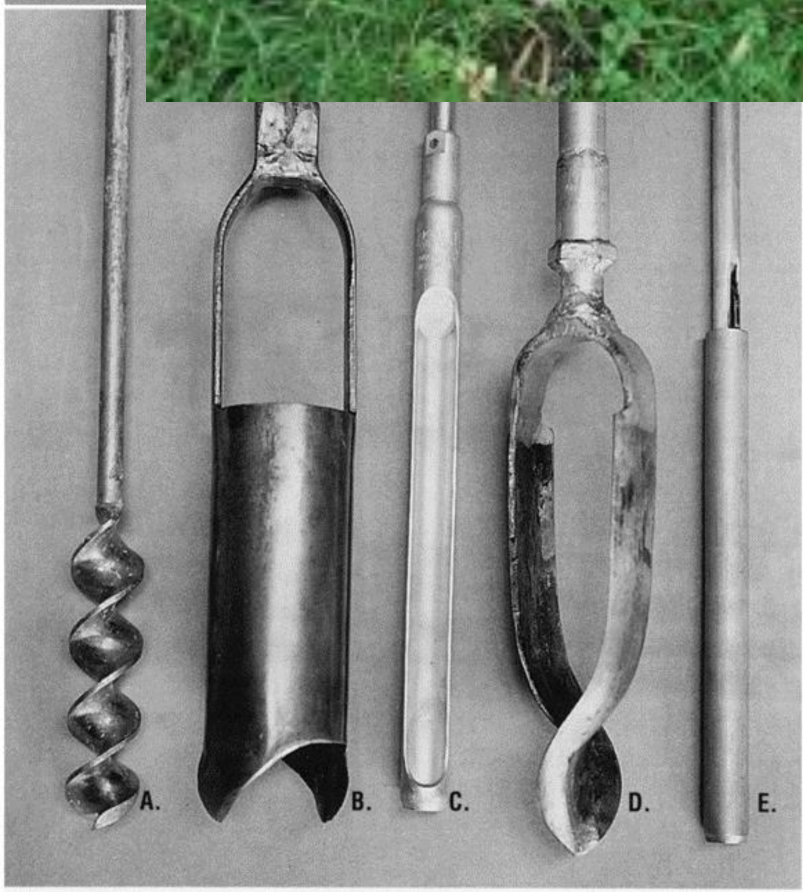
Northland Soil Series (NZMS290)



Northland Soil Series (DSMART v6)

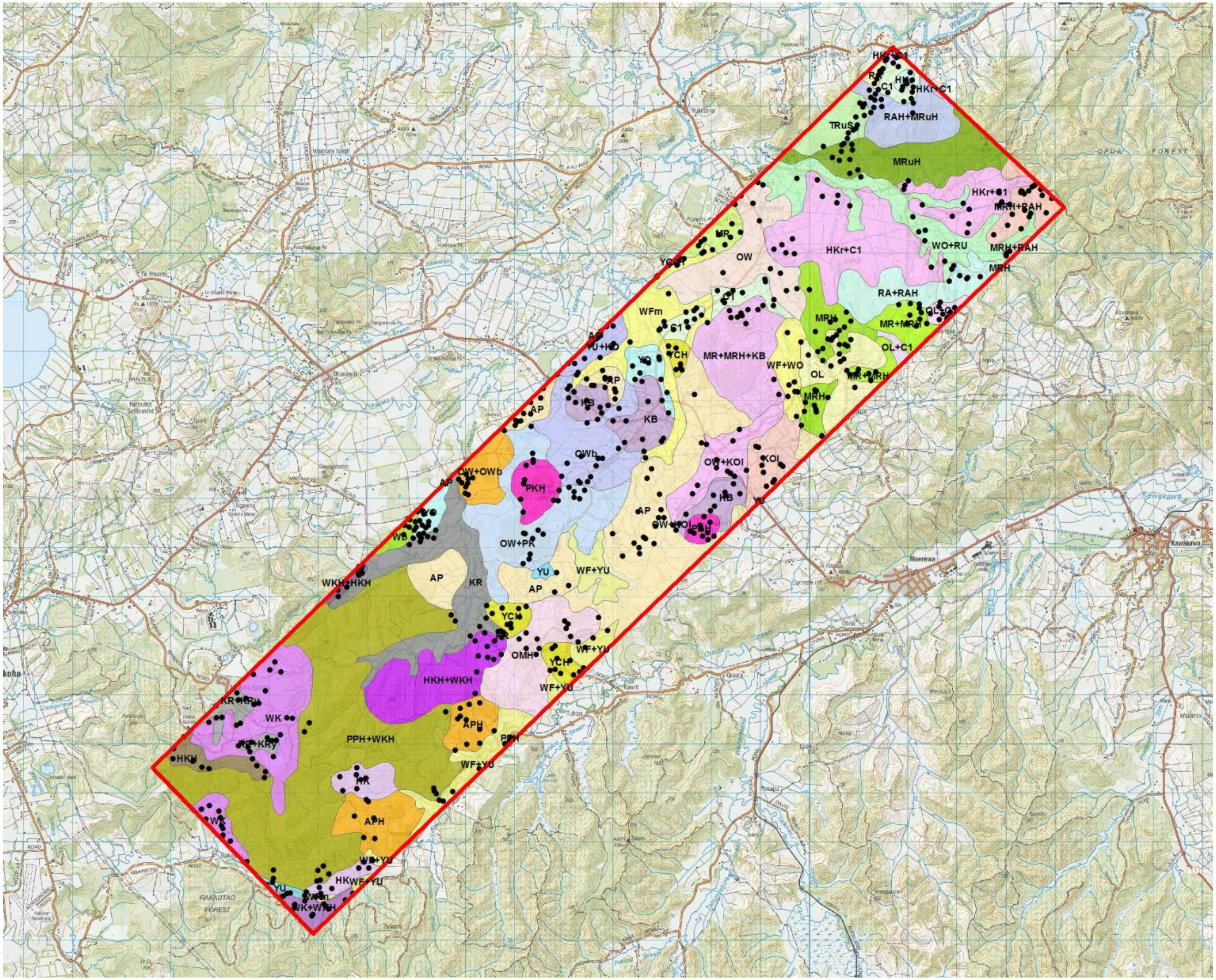
Soil Sampling

FIGURE 4-10

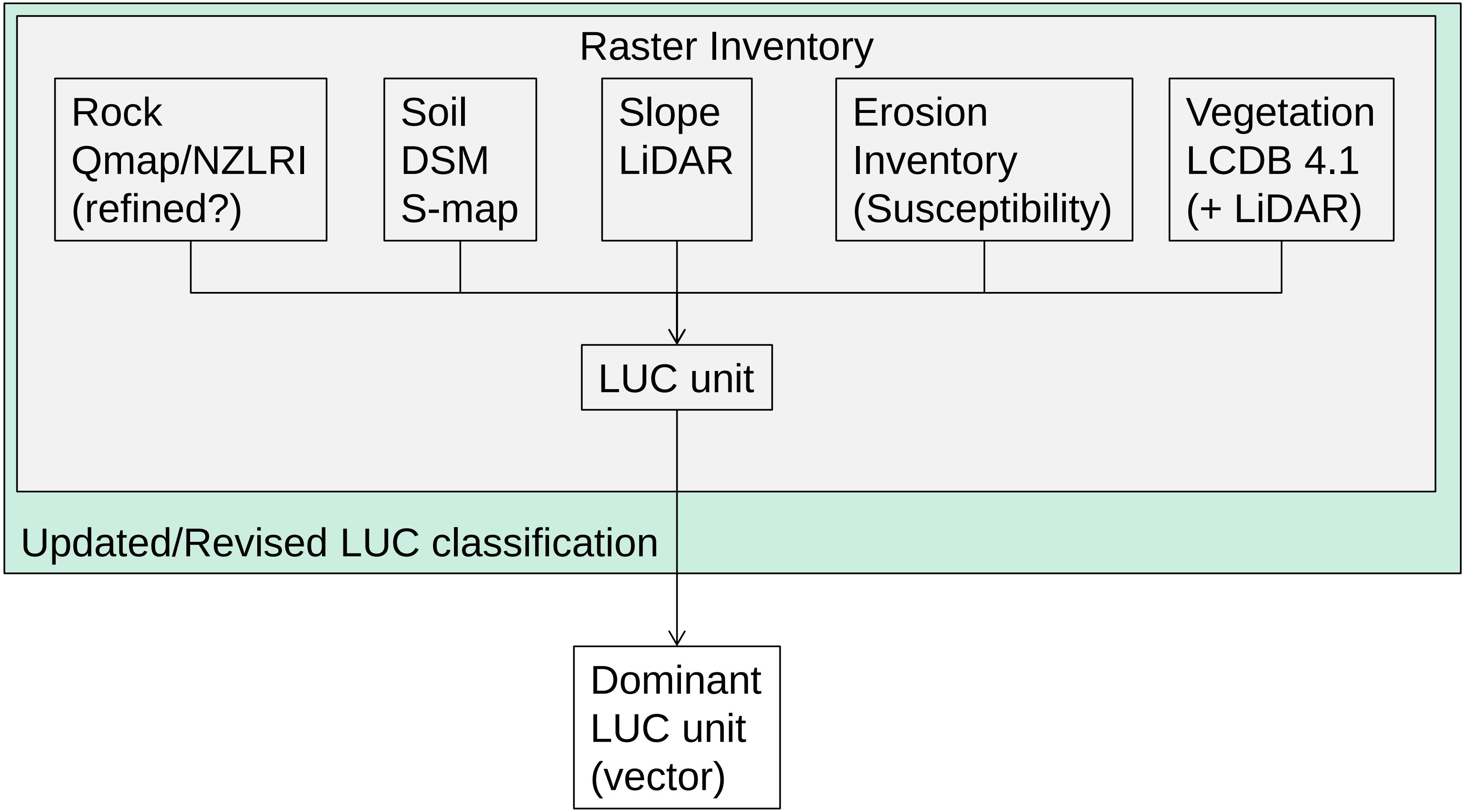


Soil augers and tubes: *A*, screw or worm auger; *B*, barrel auger; *C*, sampling tube; *D*, "Dutch""mud" auger; *E*, peat sampler.

Sampling Soils for DSM



LUC mapping from new inventory



How do we assess our mapping?

By comparison to what can be achieved using traditional mapping techniques

To current standards for farm-scale mapping

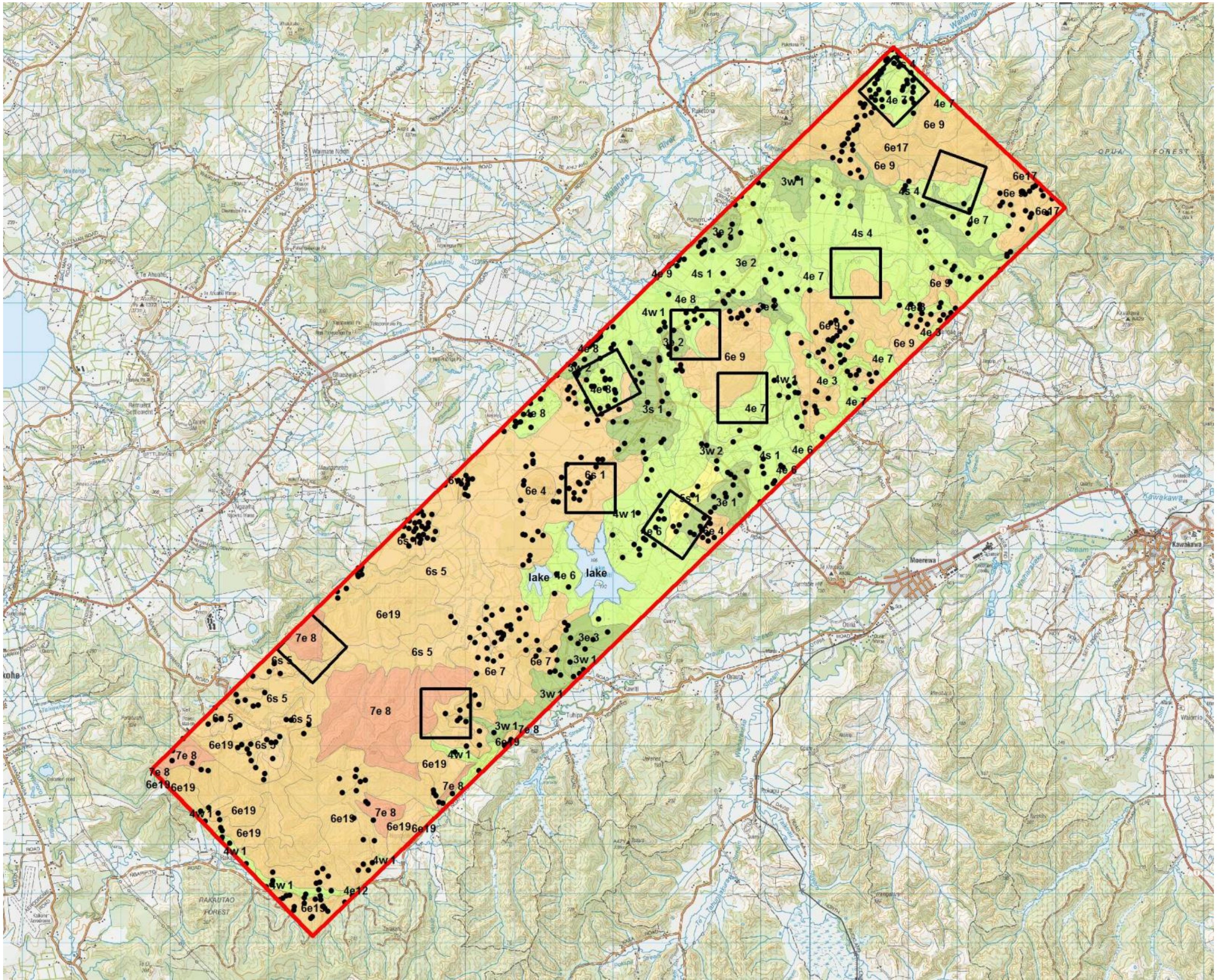
MUST maintain independence from the rest of the project

- Access to LiDAR hillshade for unit boundaries?
- Share raw soil field data or independent?
- Independent or shared LUC classification?

Statistical or Qualitative Comparison?

Technical and/or end user evaluation?

Traditional LUC 'windows'



Final Outcomes

A modern mapping protocol

Series of "inventory" layers for pilot area

A revised LUC regional legend (partial)

A combined LUC interpretation layer

Windows of traditional LUC mapping (≈10x1 km^2)

An evaluation of fitness for purpose of new LUC mapping

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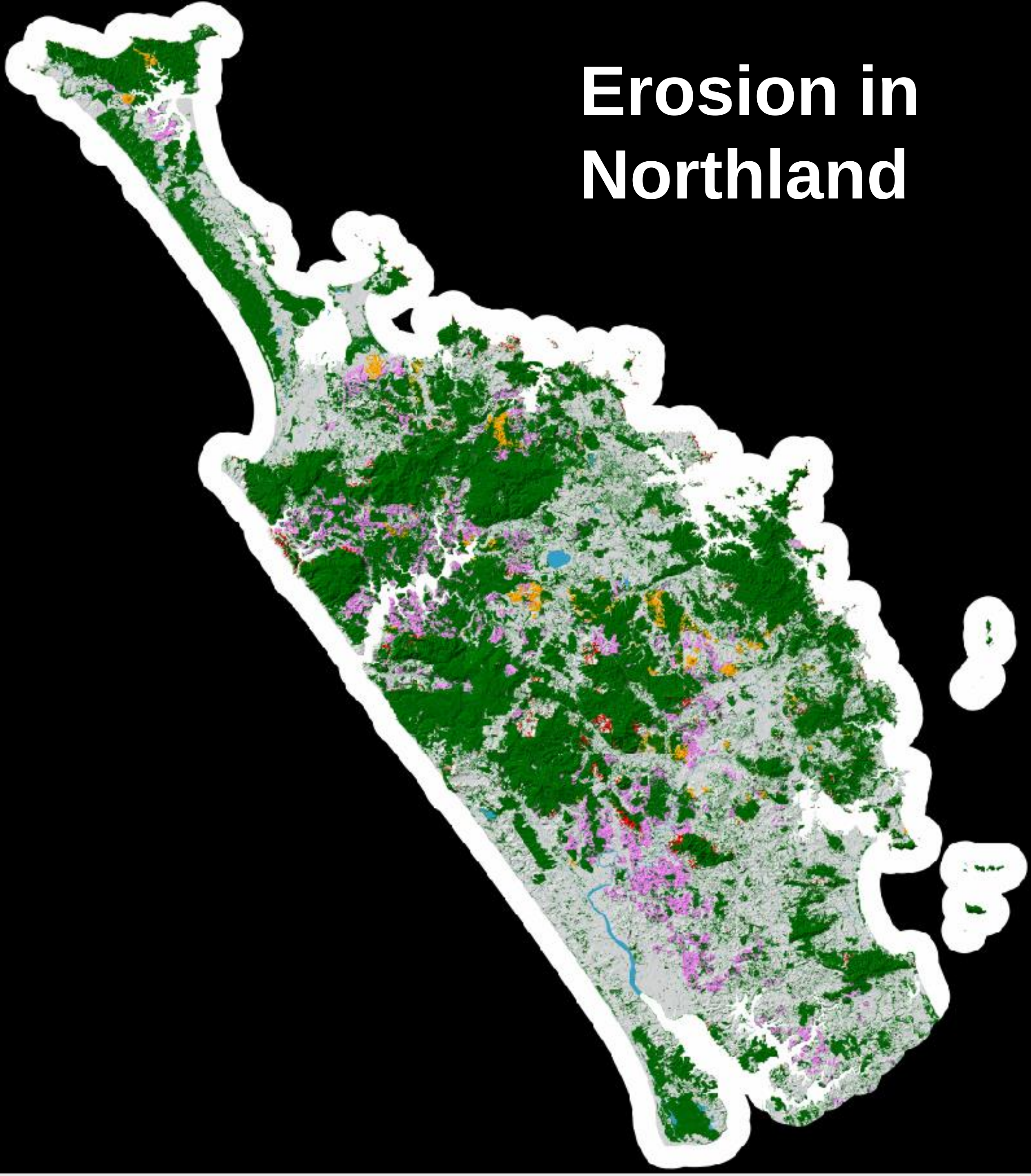
Erosion in Northland



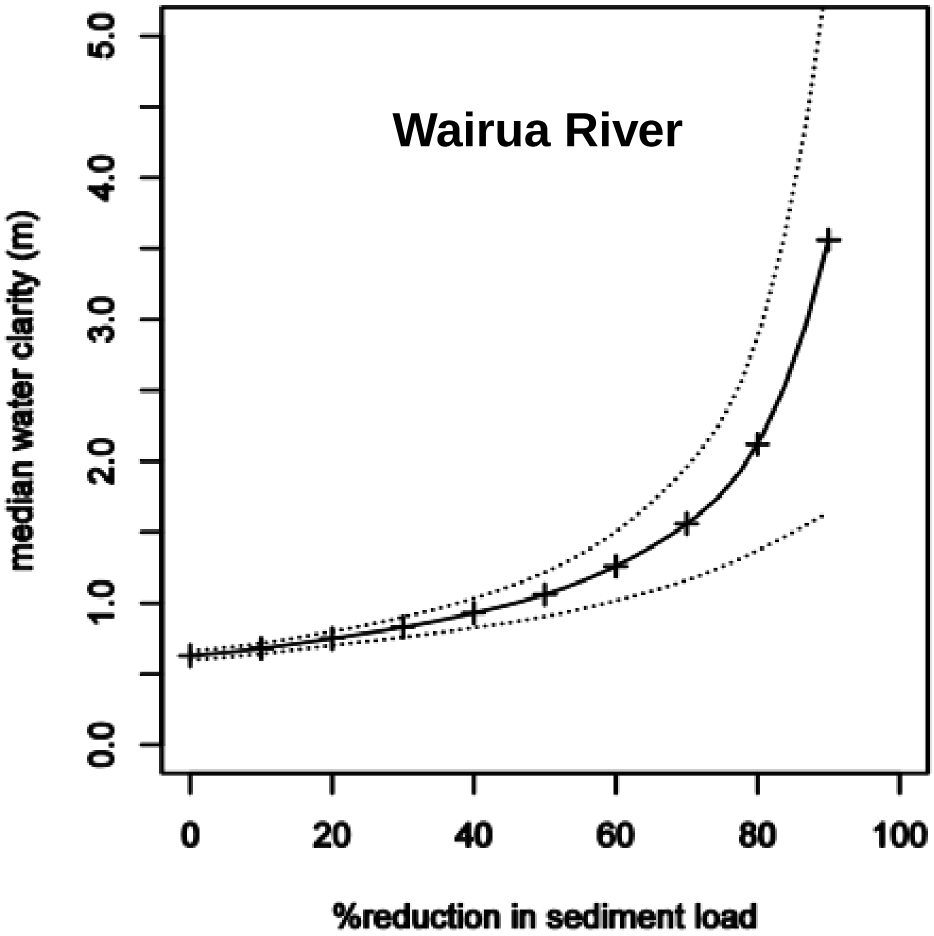
Pink: Earthflow erosion

Orange: Gully erosion

Red: Landslide erosion

Green: Woody vegetation

Relationship between reduction in sediment & water clarity



Sediment load mitigation

Afforestation:
~70%

Soil conservation plans:
~50%

NZFARM
NEW ZEALAND FOREST AND AGRICULTURE REGIONAL MODEL

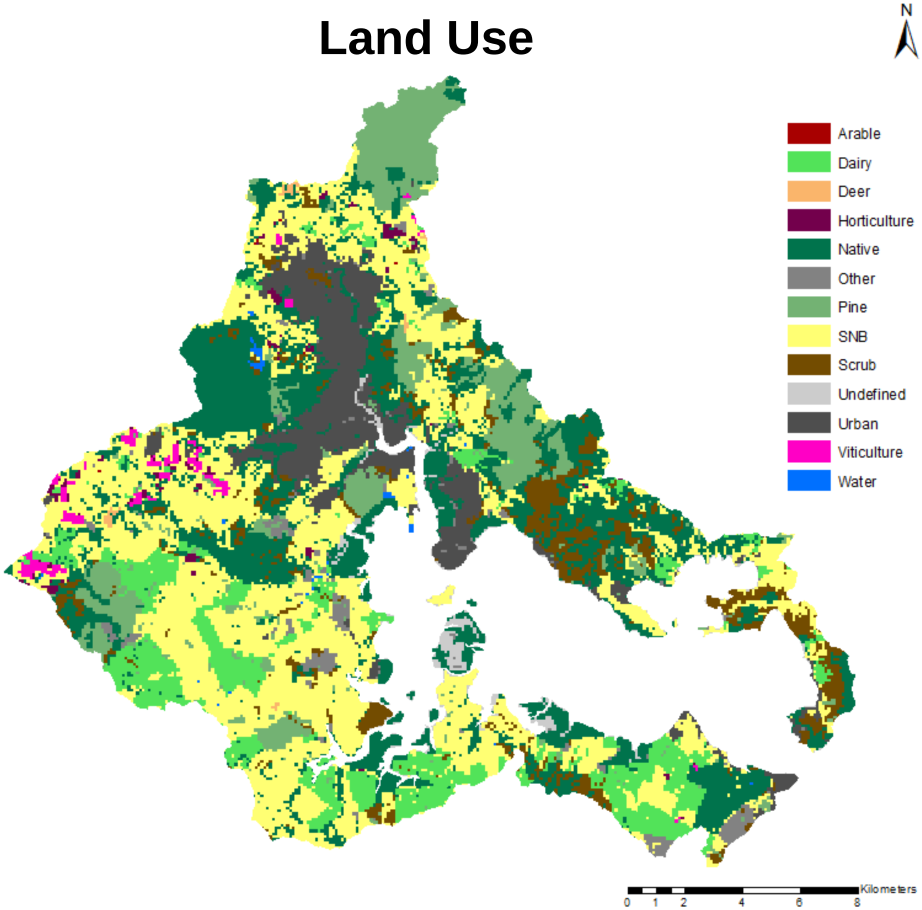
Spatial economic model of New Zealand land use:

- Objective is to maximise income (or minimise mitigation costs) from land-based activities
- Subject to environmental & input constraints
- Spatial scale at farm or sub-catchment level
- Models changes in land management & land use
- Key outputs include changes in farm income, practices, environmental outputs

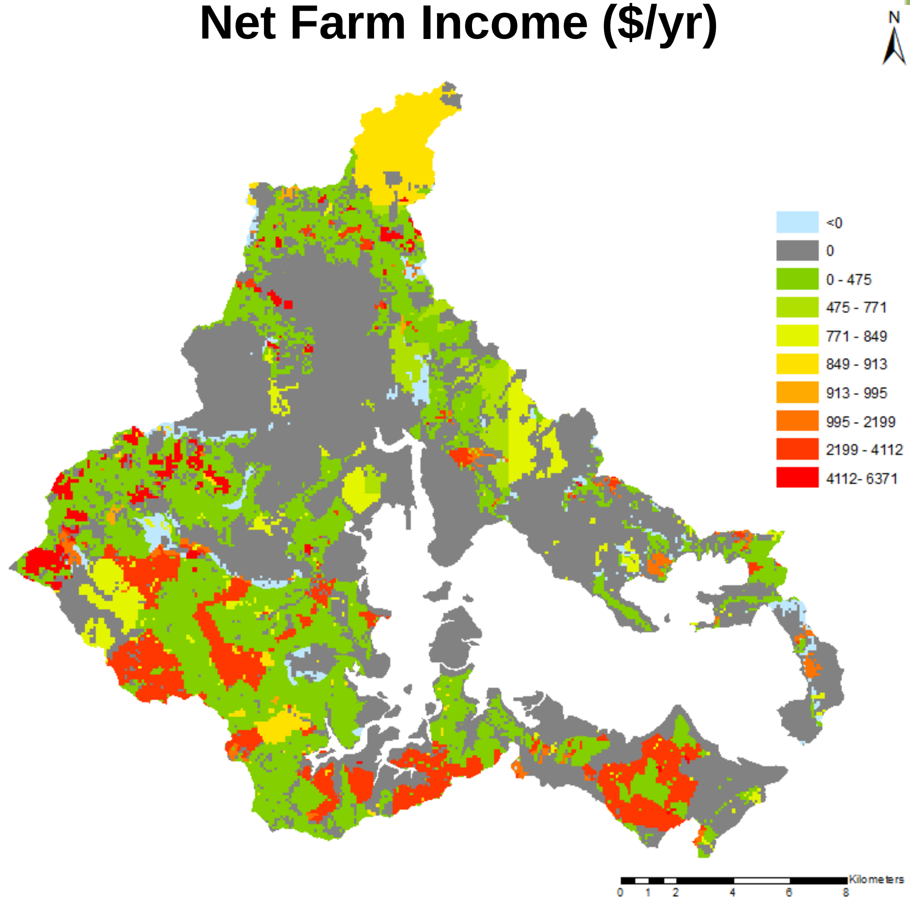
Designed to consistently compare the economic & environmental impacts of a range of policy scenarios

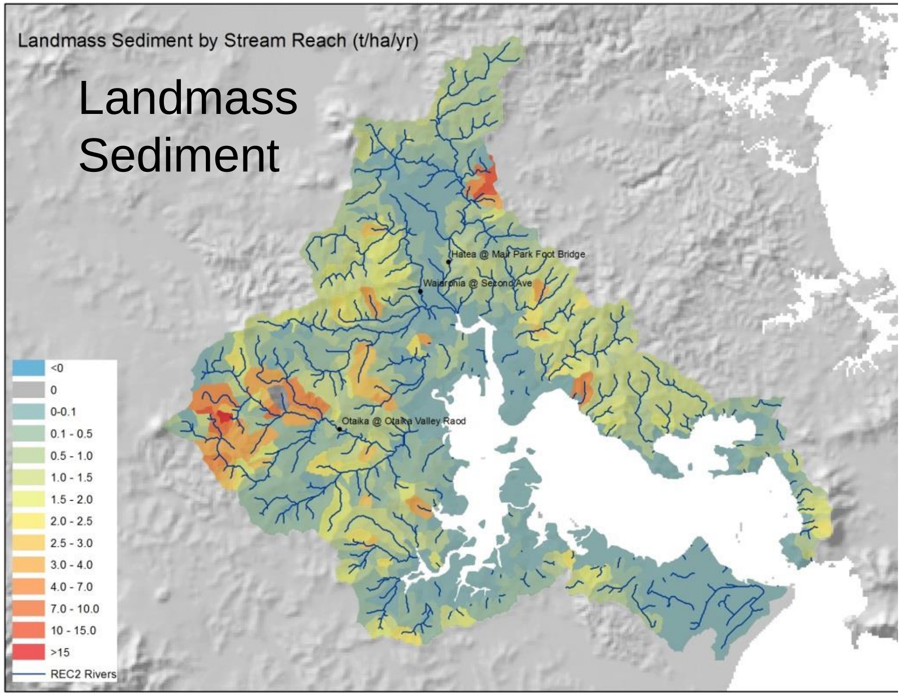
Application: Setting limits in Whangarei catchment

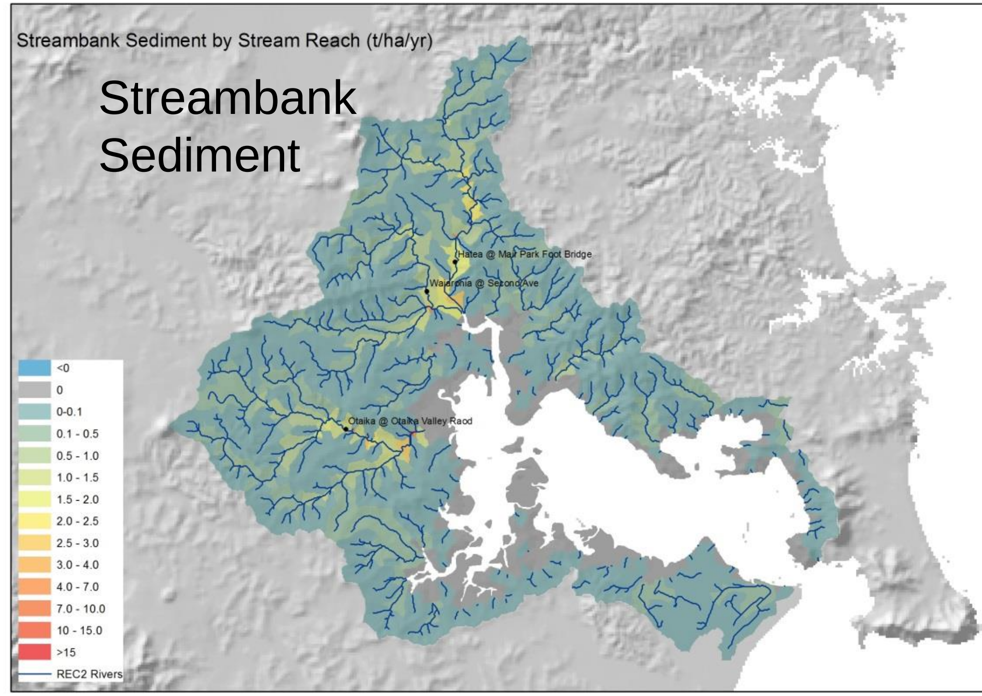
Land Use

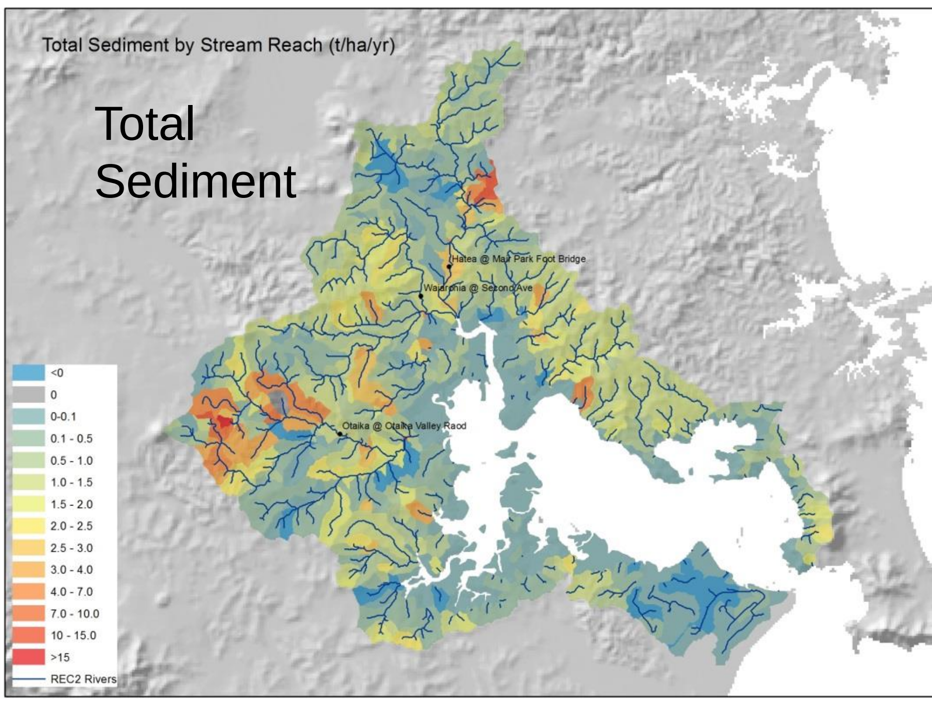


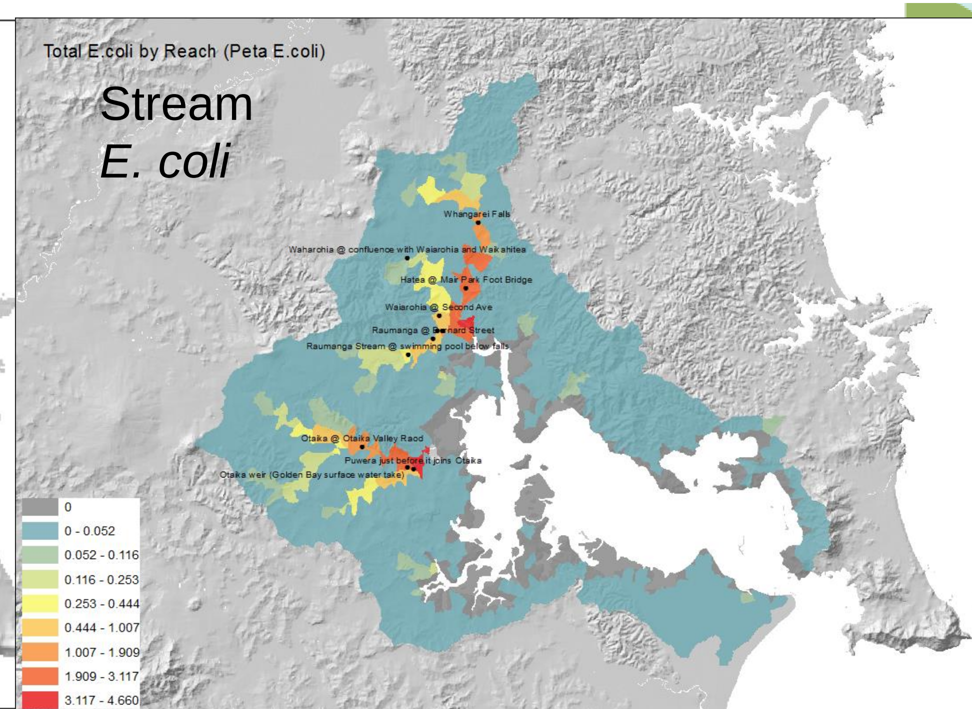
Net Farm Income ($/yr)




Landmass Sediment by Stream Reach (t/ha/yr)
Landmass Sediment
Hatea @ Mair Park Foot Bridge
Waiarohia @ Second Ave
Otaika @ Otaika Valley Raod
<0
0
0-0.1
0.1 - 0.5
0.5 - 1.0
1.0 - 1.5
1.5 - 2.0
2.0 - 2.5
2.5 - 3.0
3.0 - 4.0
4.0 - 7.0
7.0 - 10.0
10 - 15.0
>15
REC2 Rivers


Streambank Sediment by Stream Reach (t/ha/yr)
Streambank Sediment
Hatea @ Mair Park Foot Bridge
Waiarohia @ Second Ave
Otaika @ Otaika Valley Raod
<0
0
0-0.1
0.1 - 0.5
0.5 - 1.0
1.0 - 1.5
1.5 - 2.0
2.0 - 2.5
2.5 - 3.0
3.0 - 4.0
4.0 - 7.0
7.0 - 10.0
10 - 15.0
>15
REC2 Rivers

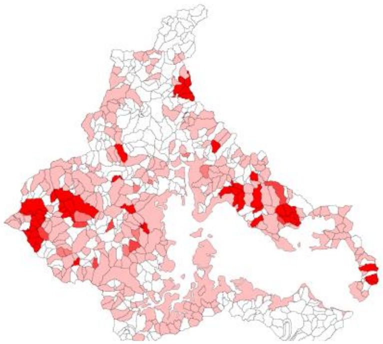

Total Sediment by Stream Reach (t/ha/yr)
Total Sediment
Hatea @ Mair Park Foot Bridge
Waiarohia @ Second Ave
Otaika @ Otaika Valley Raod
<0
0
0-0.1
0.1 - 0.5
0.5 - 1.0
1.0 - 1.5
1.5 - 2.0
2.0 - 2.5
2.5 - 3.0
3.0 - 4.0
4.0 - 7.0
7.0 - 10.0
10 - 15.0
>15
REC2 Rivers


Total E.coli by Reach (Peta E.coli)
Stream *E. coli*
Whangarei Falls
Waiarohia @ confluence with Waiarohia and Waikahitea
Hatea @ Mair Park Foot Bridge
Waiarohia @ Second Ave
Raumanga @ Bernard Street
Raumanga Stream @ swimming pool below falls
Otaika @ Otaika Valley Raod
Puwera just before it joins Otaika
Otaika weir (Golden Bay surface water take)
0
0 - 0.052
0.052 - 0.116
0.116 - 0.253
0.253 - 0.444
0.444 - 1.007
1.007 - 1.909
1.909 - 3.117
3.117 - 4.660

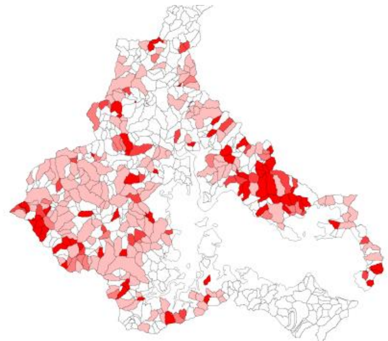
Impact of Select Scenarios

Scenario	Total Annual Cost (mil $/yr)	Total Erosion (t/yr)	*E. coli* Load - Stream (peta)
No Mitigation	$0.00	31,355	84.0
Change from No Mitigation Baseline			
Afforest all pasture	$12.04	-39%	-56%
Max wetlands	$1.47	-61%	-48%
Max farm plans	$0.35	-27%	0%
Fence all streams	$0.44	-5%	-53%
Reduce Sed 40%	$0.19	-39%	-15%
Reduce *E. coli* 40%	$0.42	-15%	-40%
Secondary Contact 'B'	$0.02	-1%	-15%
Secondary Contact 'A'	$0.31	-11%	-30%

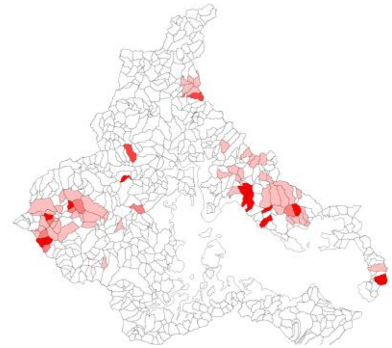
20% Reduction Harbour Deposition



Total Sediment

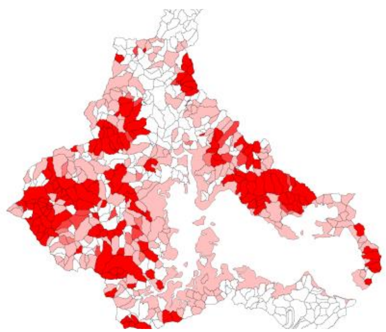


Stream *E. coli*

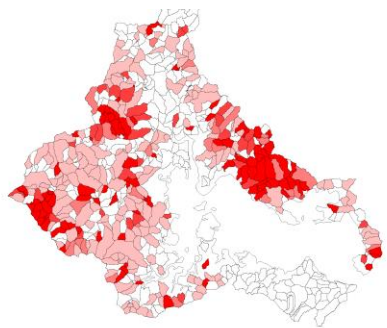


Net Revenue

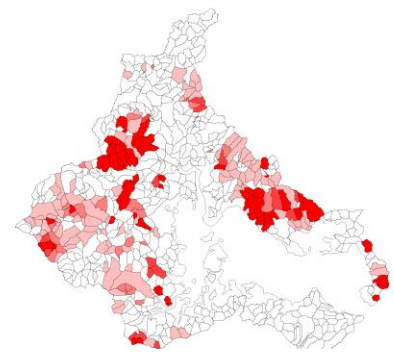
40% Reduction Harbour Deposition



Total Sediment

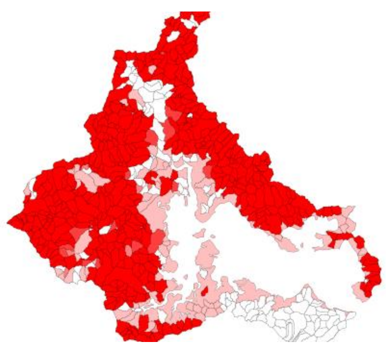


Stream *E. coli*

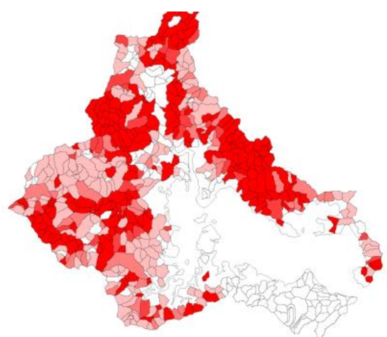


Net Revenue

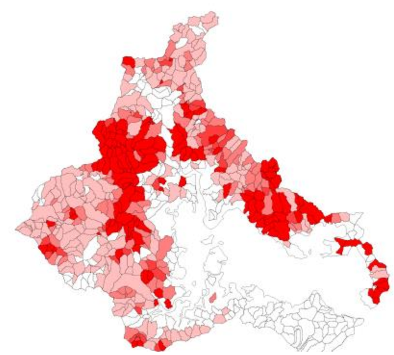
60% Reduction Harbour Deposition



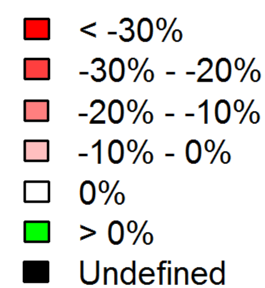
Total Sediment



Stream *E. coli*



Net Revenue



LUMASS - Land-Use Management Support System

Landscape System Dynamics Modelling Framework

Visual model development for non-programmers
Integration of legacy models
Big data support
Geospatial modelling and reporting workflows

Impact Assessment

Multi-objective spatial optimisation

Optimal spatial allocation of resources: land-use, water, fertiliser, etc.

Maximising land-use productivity
Assessing resource-use efficiency of land-use
Estimating headroom for agricultural development
Identifying prime spots for land-use development
Testing bio-physical feasibility of catchment limits and stakeholder expectations

Spatial Decision Support

Land-Use Optimisation

ecosystem services indicators

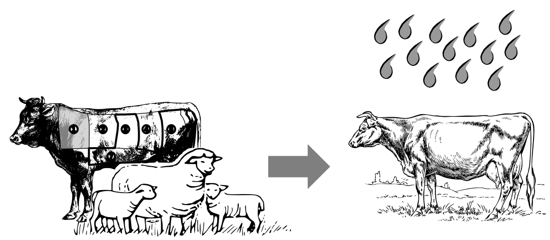
environmental limits

+ 30 %

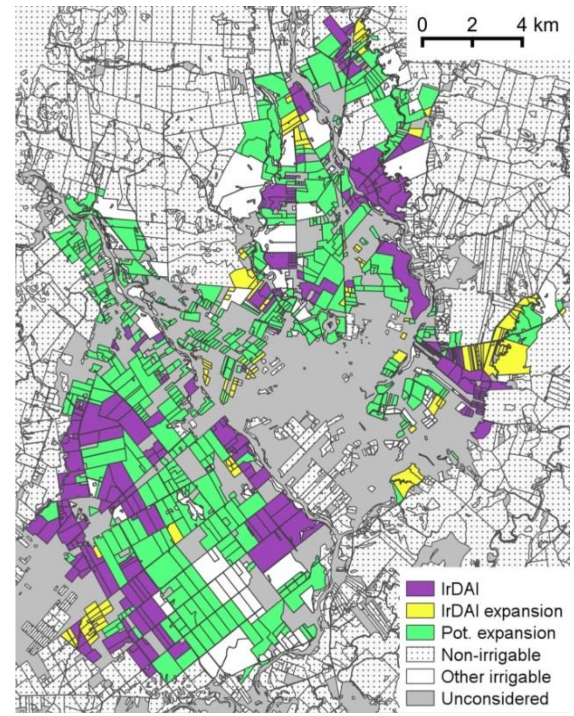
production targets

LUMASS

spatial optimisation



land-use conversion options

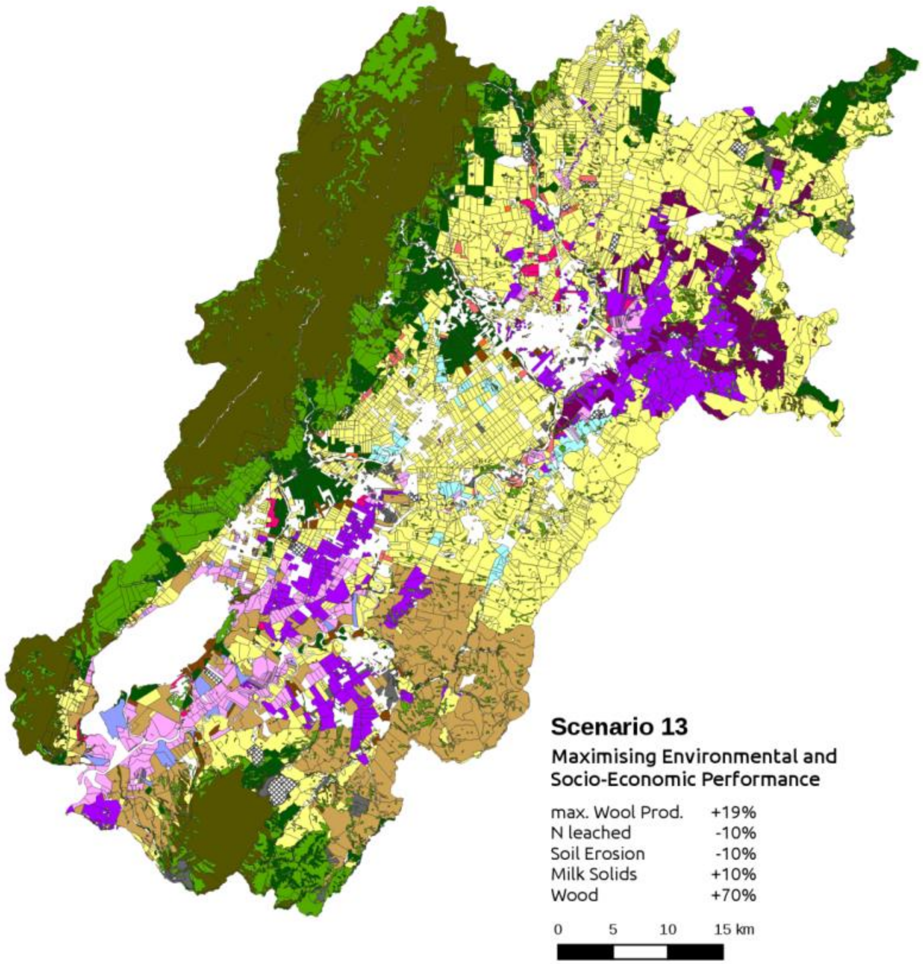


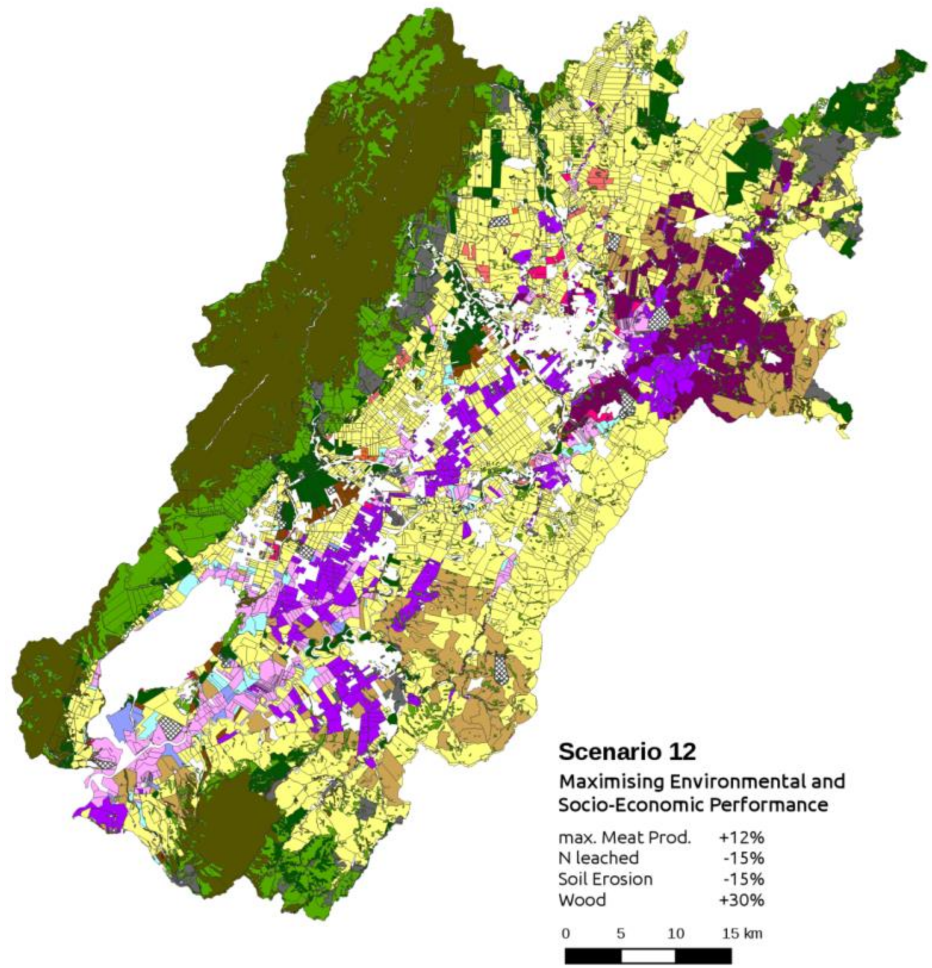
optimal land-use configuration (here: minimising N leaching)

NORTHLAND REGIONAL COUNCIL

LANDCARE RESEARCH MANAAKI WHENUA

Identifying prime spots for potential land-use development based on a multi-scenario analysis





Decisions, decisions …

Rural Decision Makers
SURVEY2015

LANDCARE RESEARCH
MANAAKI WHENUA

Conducted in 2013 & 2015

Northland coverage 8.6%

Questionnaire

Ownership and structure

Land use, land-use change

Livestock

Forestry practice

Water and irrigation

Land management

Technology adoption

Climate

Vertebrate, plant pests

Networks, farming support

Values, norms, preferences

Farming objectives, profitability

Labour

Demographics, education

Community participation

Opportunities, challenges

Future planning

288 questions

Example Northland results: fences/buffers

Primary Land Use	Survey Responses	Total Streams Fenced (%)	Streams Buffered Grass	Streams Buffered Native	Streams Buffered Exotic	No Plants/Not Managed
Dairy	41	95%	78%	44%	10%	12%
Deer	2	43%	100%	50%	0%	0%
Forestry	1	0%	0%	0%	0%	0%
Fruit/Nuts	7	54%	0%	57%	0%	14%
Grazing	6	64%	50%	17%	0%	33%
Kiwifruit	1	0%	0%	0%	0%	0%
Other stock	2	90%	100%	50%	0%	0%
Sheep/Beef	79	63%	59%	49%	15%	8%
Veg/Flowers	6	55%	50%	0%	0%	33%
Total	**145**	**71%**	**53%**	**44%**	**9%**	**12%**

Questions

LUMASS - References

Landscape System Dynamics Modelling

Herzig A, Rutledge D 2013. Integrated Land Systems Modelling and Optimisation. In: In Piantadosi, J., Anderssen, R.S. and Boland J. (eds) MODSIM2013, 20th International Congress on Modelling and Simulation. Modelling and Simulation Society of Australia and New Zealand, December 2013, pp. 880–886. ISBN: 978-0-9872143-3-1. http://www.mssanz.org.au/modsim2013/C8/herzig.pdf

Spatial Optimisation

Herzig A, Dymond J, Ausseil A-GE (accepted). Exploring Limits and Trade-Offs of Irrigation and Agricultural Intensification in the Ruamahanga Catchment, NZ. NZ Journal of Agricultural Research.

Herzig A, Ausseil A-GE, Dymond JR 2013. Spatial Optimisation of Ecosystem Services. In Dymond JR (ed.), Ecosystem Services in New Zealand - conditions and trends. Manaaki Whenua Press, Lincoln, New Zealand.

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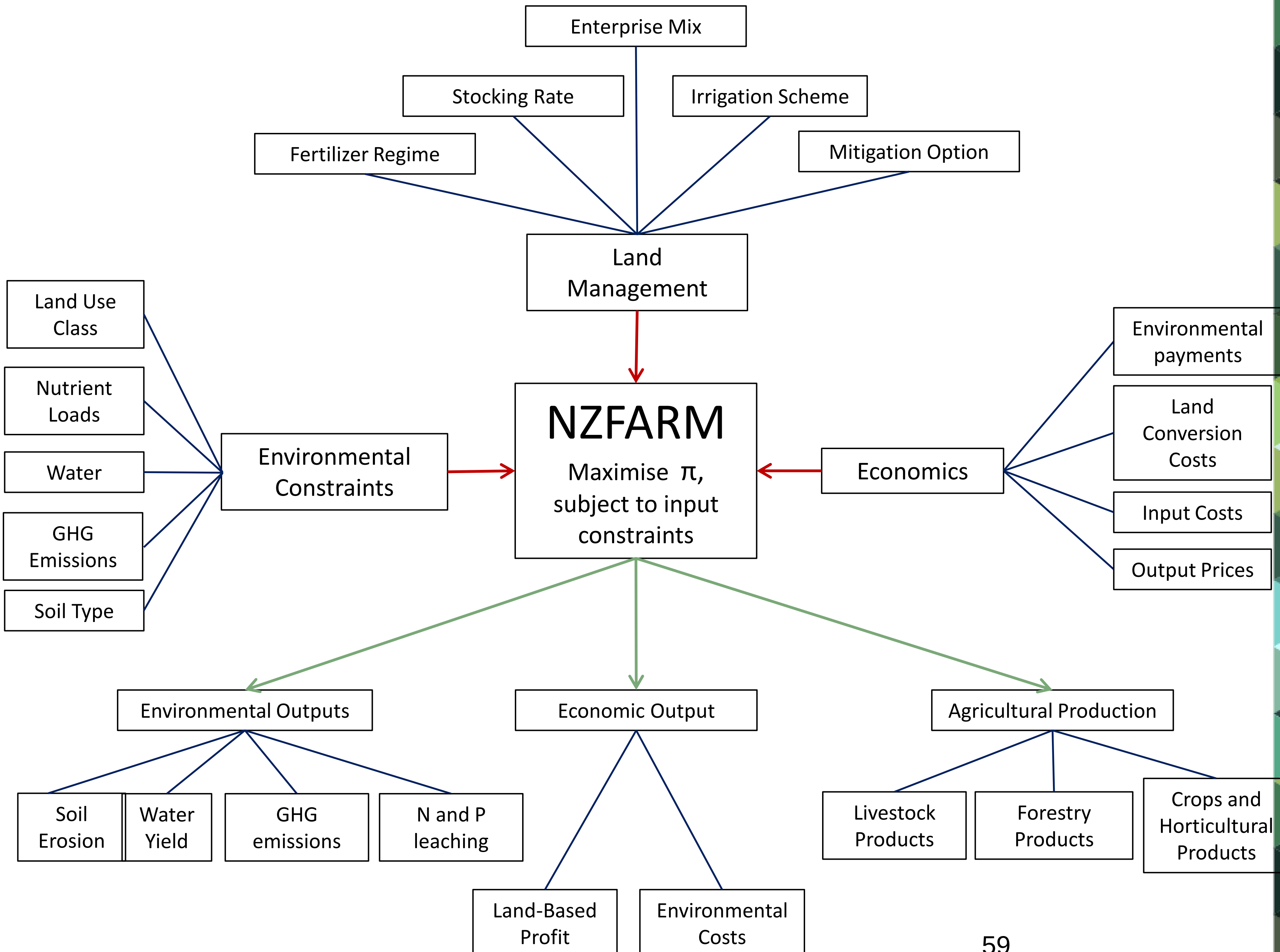
Ausseil A-GE, Herzig A, Dymond JR 2012. Optimising land use for multiple ecosystem service objectives: A case study in the Waitaki catchment, New Zealand. Proceedings: 6th International Congress on Environmental Modelling and Software (iEMSs 2012), Leipzig, Germany, 1-5 July 2012.



Enterprise Mix
Stocking Rate
Irrigation Scheme
Fertilizer Regime
Mitigation Option
Land Management
Land Use Class
Nutrient Loads
Water
GHG Emissions
Soil Type
Environmental Constraints
NZFARM
Maximise π, subject to input constraints
Economics
Environmental payments
Land Conversion Costs
Input Costs
Output Prices
Environmental Outputs
Economic Output
Agricultural Production
Soil Erosion
Water Yield
GHG emissions
N and P leaching
Land-Based Profit
Environmental Costs
Livestock Products
Forestry Products
Crops and Horticultural Products

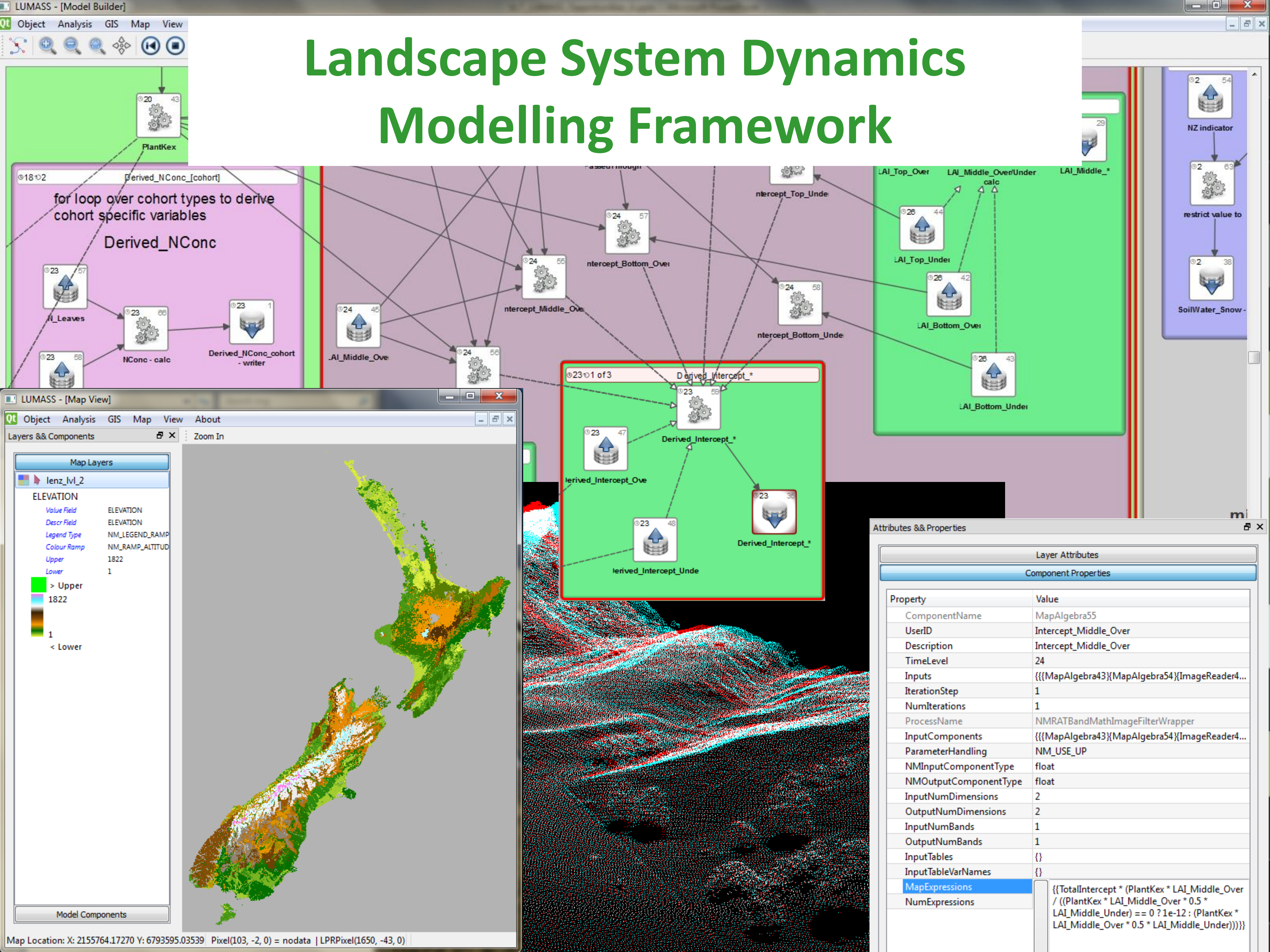
Catchment-wide Impacts: Practice-based approaches

Scenario	Total Annual Cost (mil $/yr)	Total Erosion (t/yr)	*E. coli* Load - Stream (peta)
No Mitigation	$0.00	31,355	84.0
Change from No Mitigation Baseline			
Afforest - All	$16.63	-49%	-73%
Afforest - Pasture	$12.04	-39%	-56%
Current Fencing	$0.11	-2%	-18%
Current Farm Plan	$0.03	-1%	0%
All Wetlands	$1.47	-61%	-48%
All Farm Plan	$0.35	-27%	0%
Fence All Streams	$0.44	-5%	-53%
Max Mitigation	$1.92	-66%	-62%

Catchment-wide Impacts: Outcome-based approaches

Scenario	Total Annual Cost (mil $/yr)	Total Erosion (t/yr)	Ecoli Load - Stream (peta)
No Mitigation	$0.00	31,355	84.0
Change from No Mitigation Baseline			
Harbour Sed 20%	$0.04	-20%	-12%
Harbour Sed 40%	$0.19	-39%	-15%
Harbour Sed 60%	$0.60	-59%	-43%
E. *coli* 20%	$0.19	-6%	-20%
E. *coli* 40%	$0.42	-15%	-40%
E. *coli* 60%	$0.76	-24%	-60%
Second Contact 'B'	$0.02	-1%	-15%
Second Contact 'A'	$0.31	-11%	-30%

Landscape System Dynamics Modelling Framework



Bicultural approach to biodiversity management and monitoring:

Te Uri o Hau biodiversity project

Mahuru Robb, Shaun Awatere, Garth Harmsworth

LANDCARE RESEARCH
MANAAKI WHENUA

Biodiversity and kaitiakitanga

- Māori communities are looking for a greater role in defining, measuring, understanding and forming kaitiakitanga responses to changes in biodiversity in their regions.
- Input into decision making
- Worked with 4 tūpuna marae in northern Kaipara
- Approach has been successful when working with iwi/ hapū and marae across the country

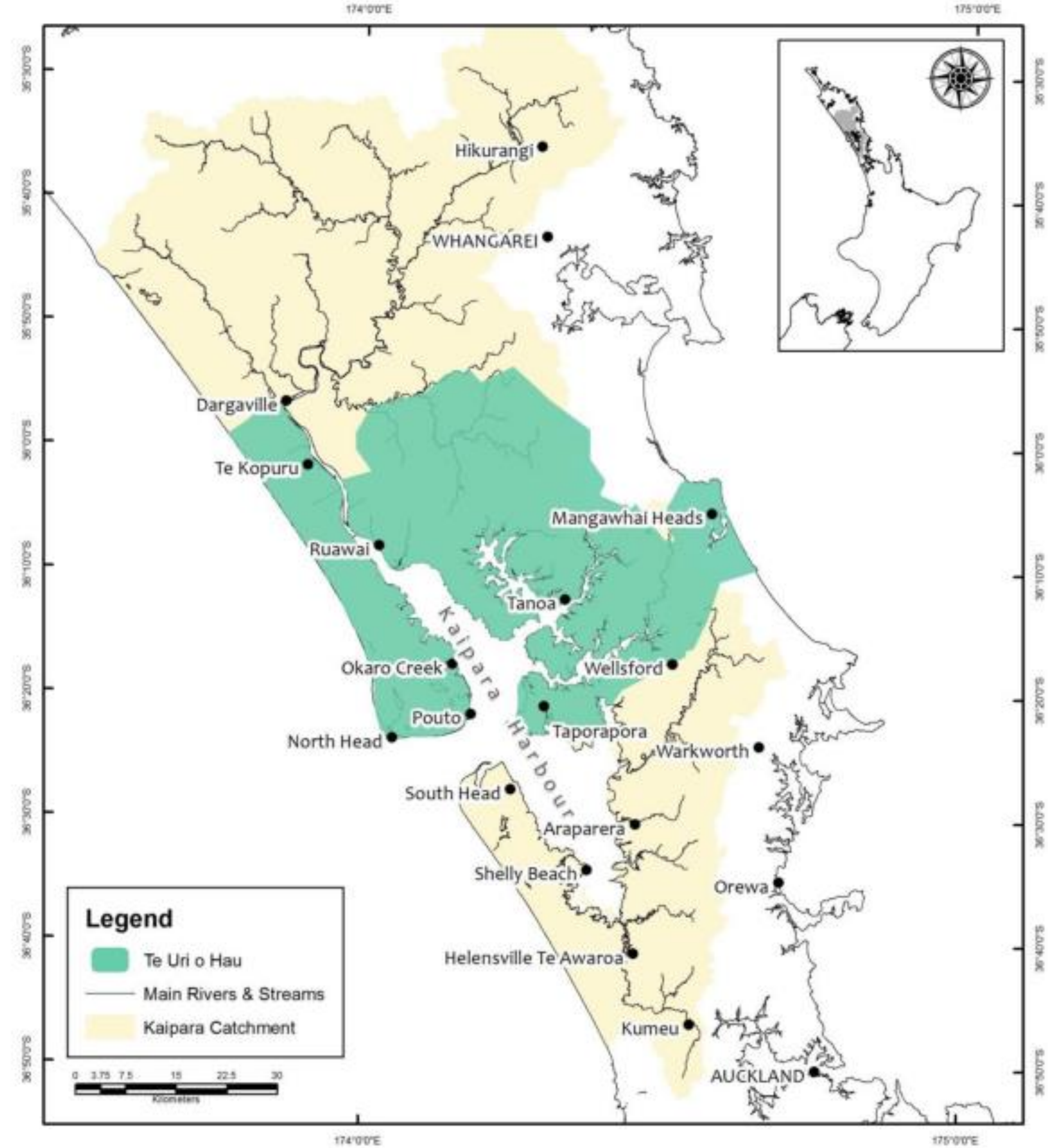
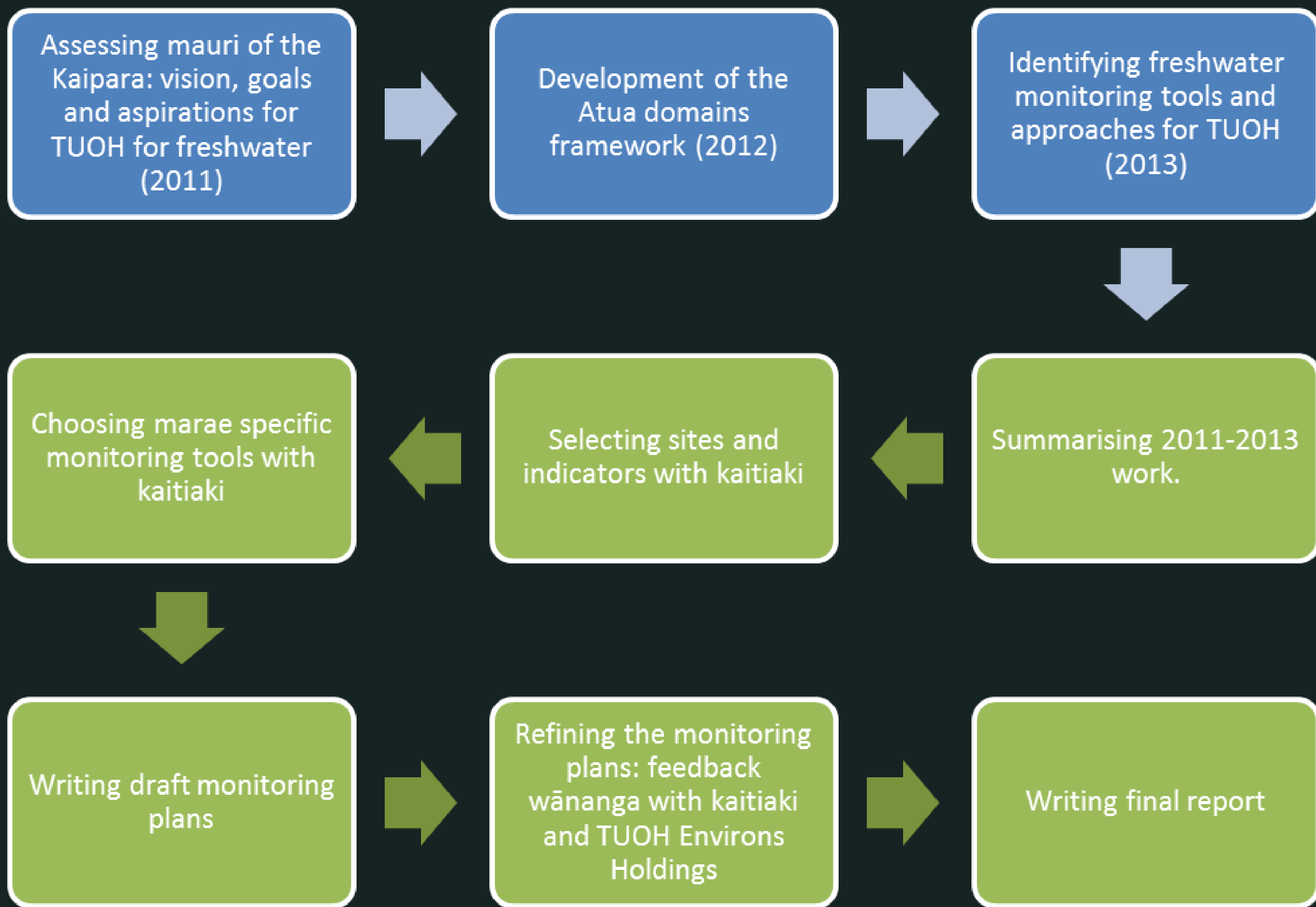


Figure 1 The TUOH statutory rohe (green) and Kaipara Harbour catchment (yellow).

Marae monitoring plans




Pouto Rd
Rangitāne Pā
Culvert
Pouto
Bird Monitoring Site