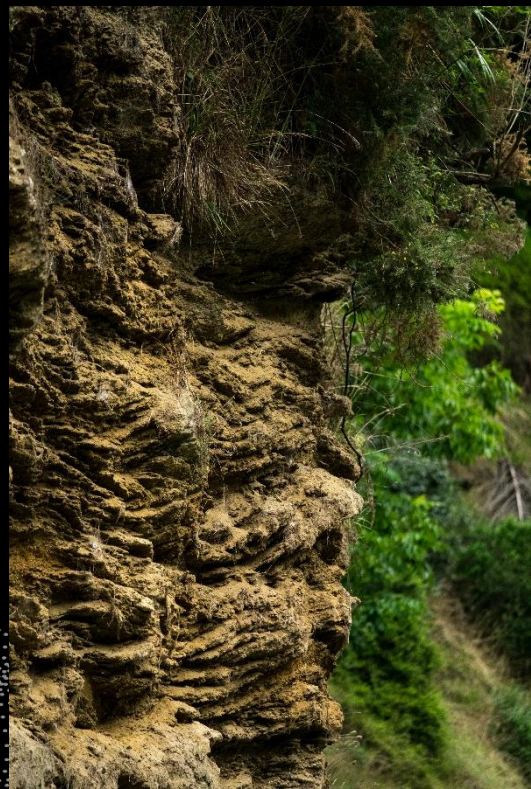
Manaaki Whenua
Landcare Research

The Secret's in the Soil

Linda Lilburne
Sam Carrick



What words describe S-map'?

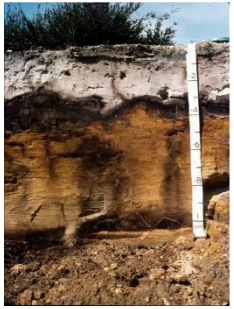
Outline – 3 parts & 4 questions

- S-map 101
- S-map inference engine
- Coverage and funding

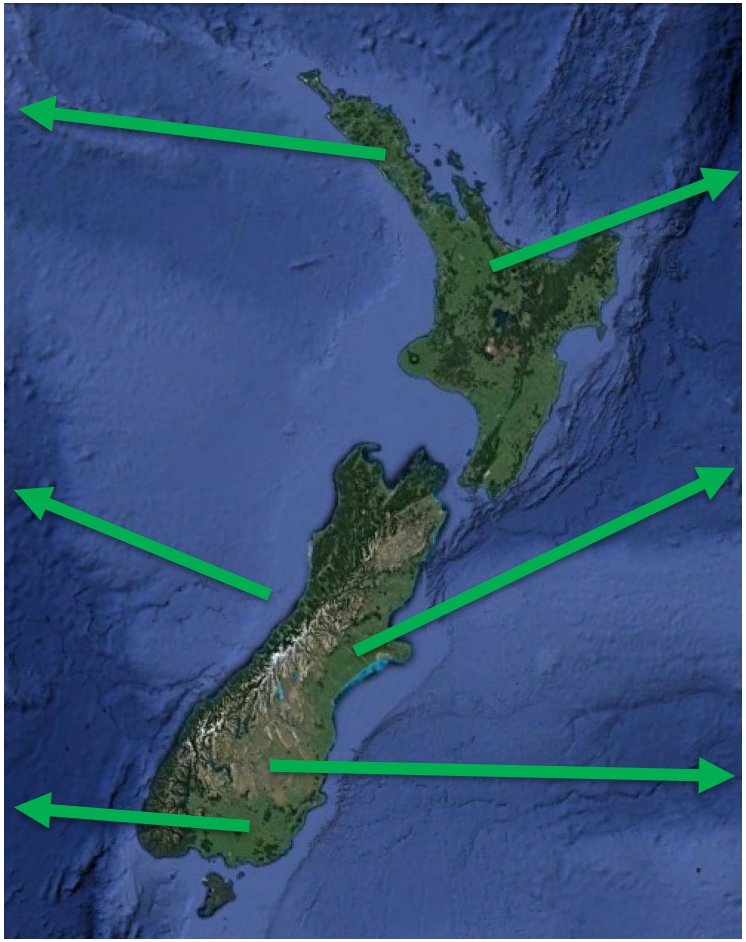
Part I: New Zealand is a land of high pedo-diversity

Old clays

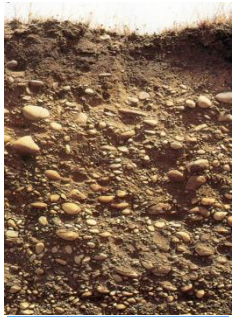
Rainforest Podzols



Loess downlands



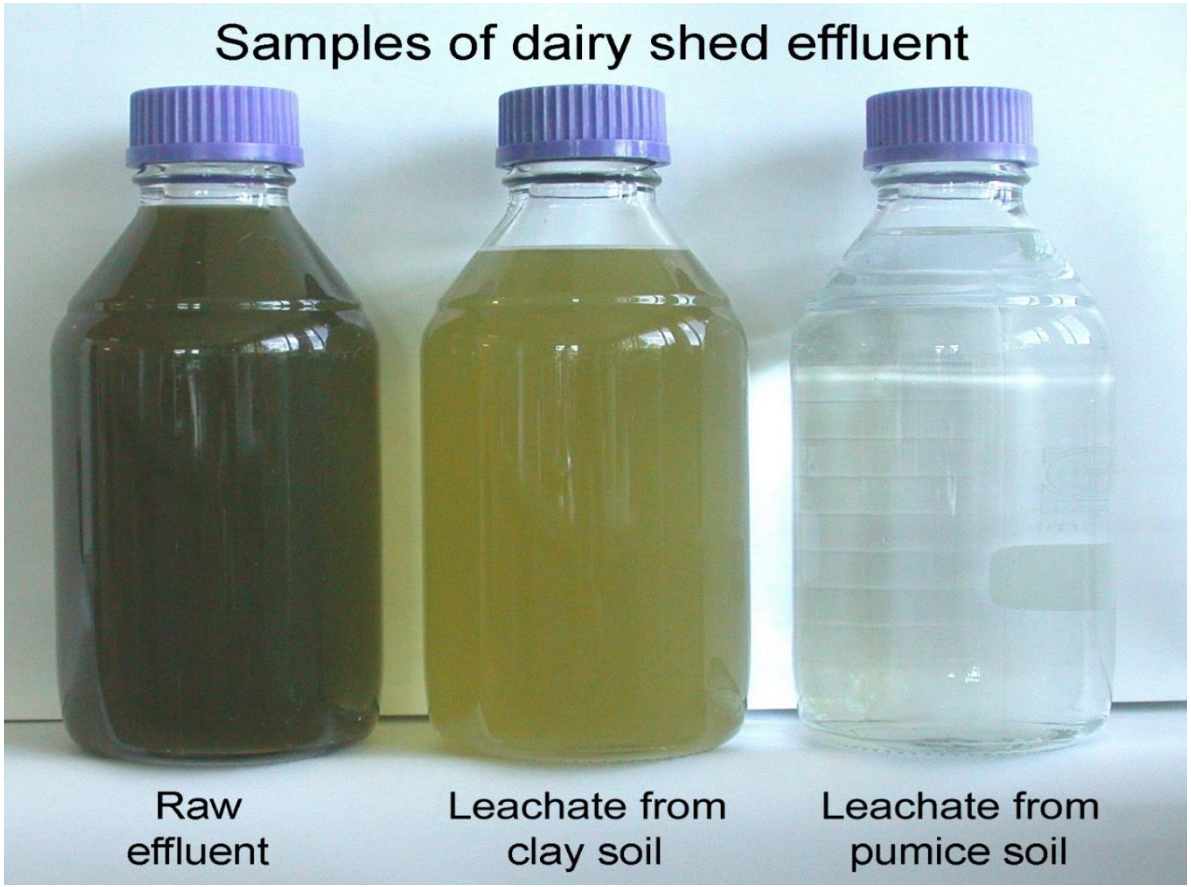
Volcanic Tephra



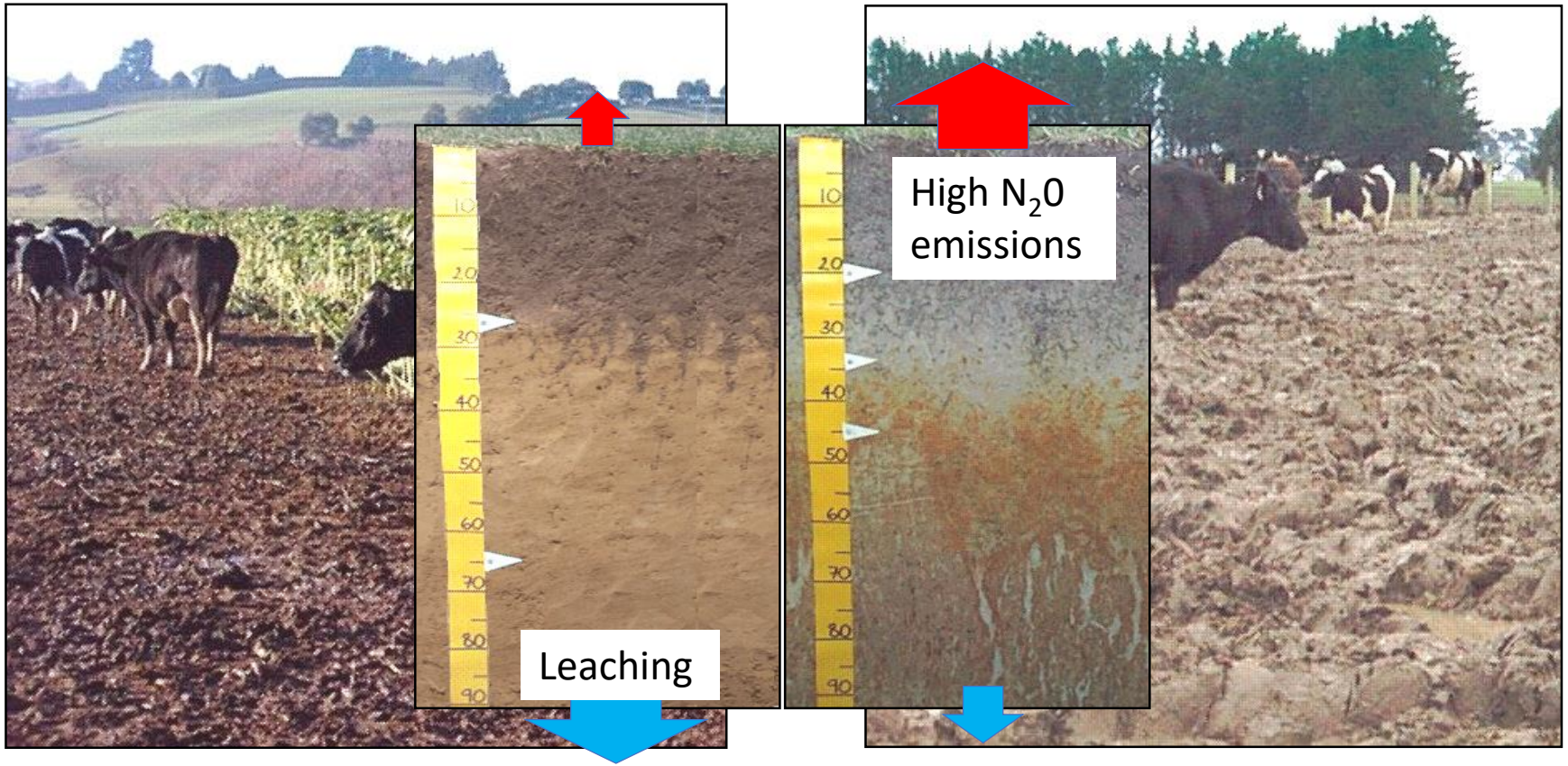
Glacial outwash

Semi-arid

Soils vary in filtering capacity



Soils respond differently to pressure



S-map

Prime Goals

- Comprehensive soil map for NZ
- Common and consistent standard
- Built upon the best available mapping/modelling techniques
- Quantitative information for every soil
- Adaptable to changing requirements
- Support decision-making at all scales: nation to farm
- Easy to access

Other related datasets

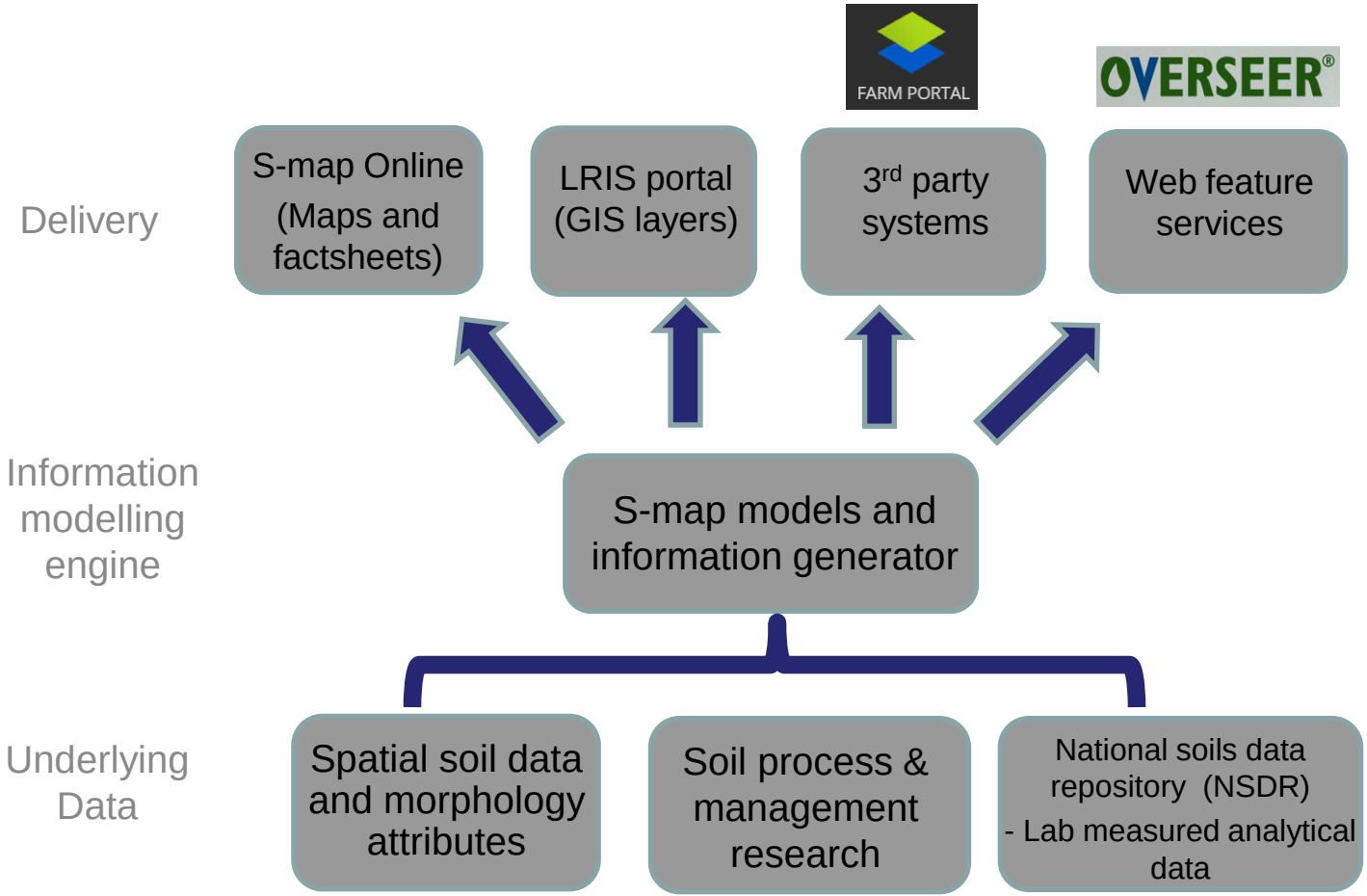
NSDR – the National Soil Data Repository of individual point observations (often with measured analytical data)

S-map – maps the spatial pattern of soil variability across the landscape

LRI – national scale inventory of 5 land attributes (Slope, Soil, Vegetation, Parent rock, Erosion)

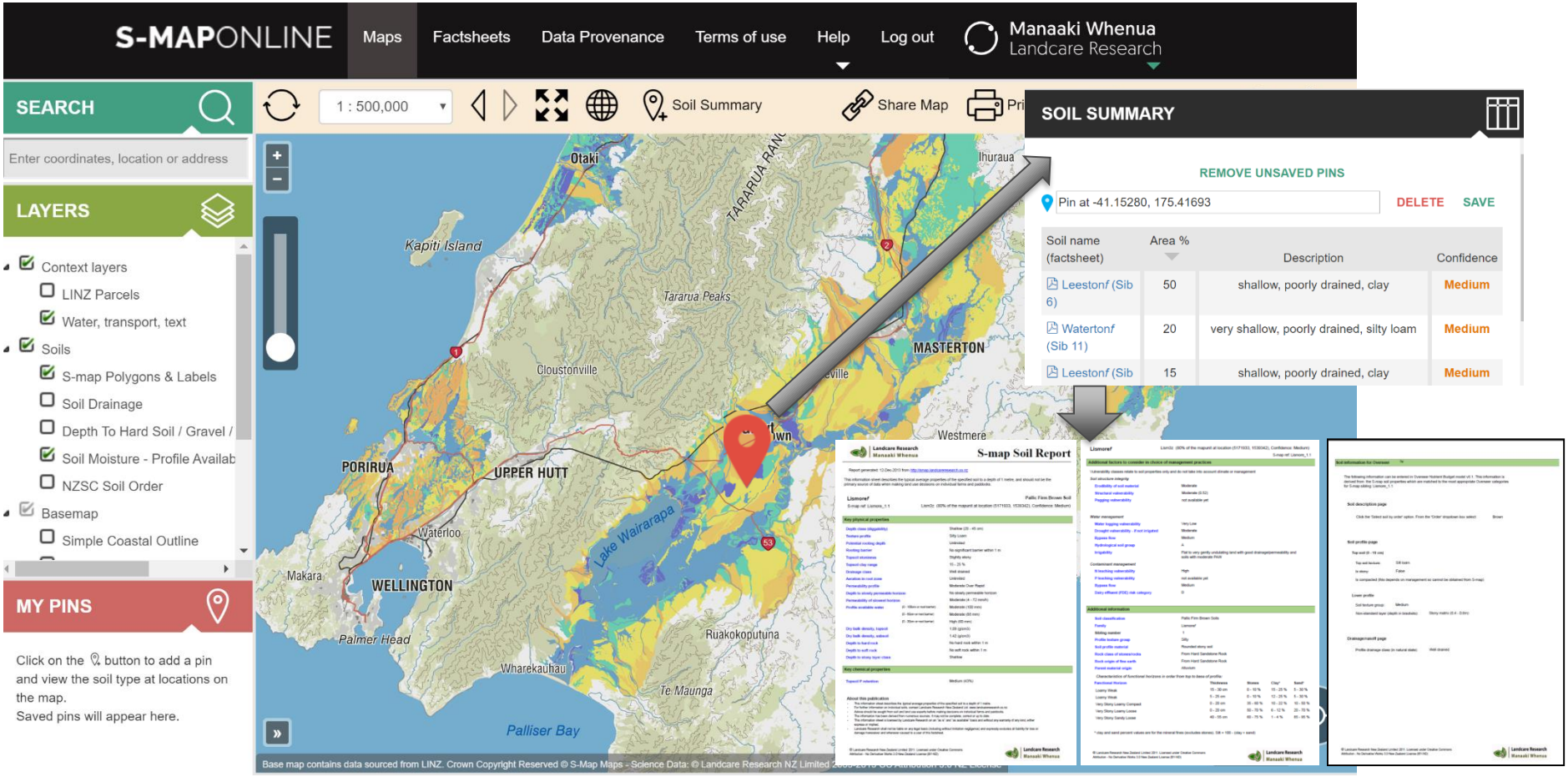
LUC – combines soil information with three other land attributes (climate, slope, parent material) to classify the overall capability of the land and erodibility.

S-map information system

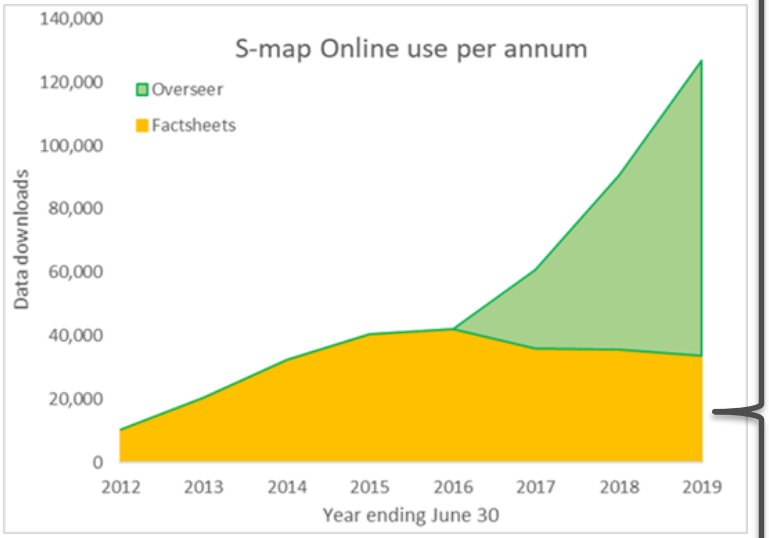


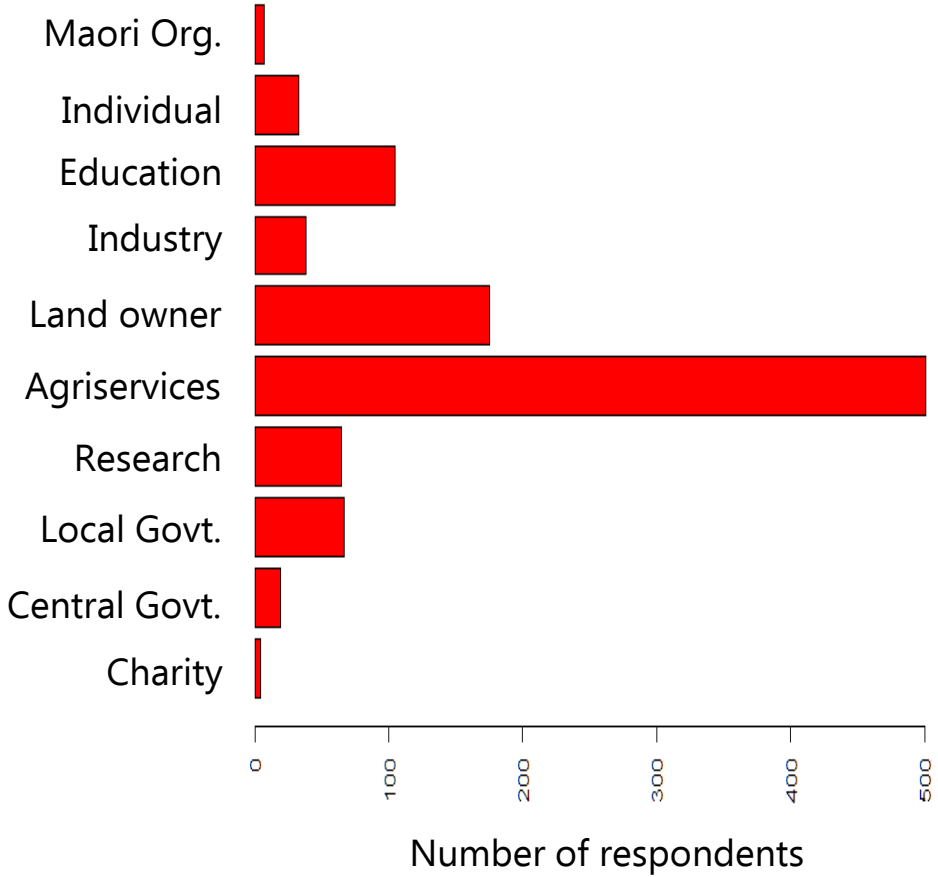
S-map Online

http://smap.landcareresearch.co.nz/home

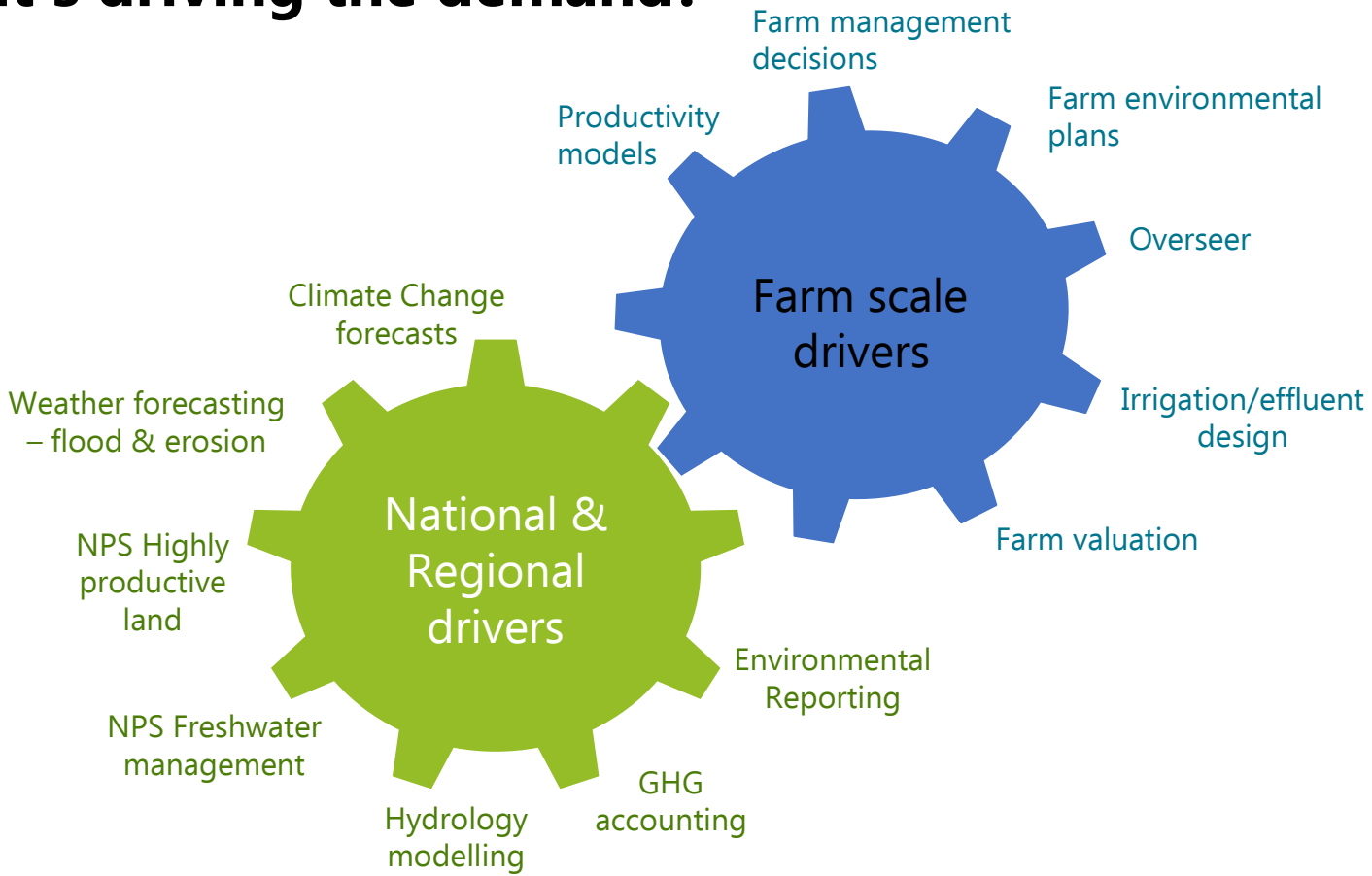


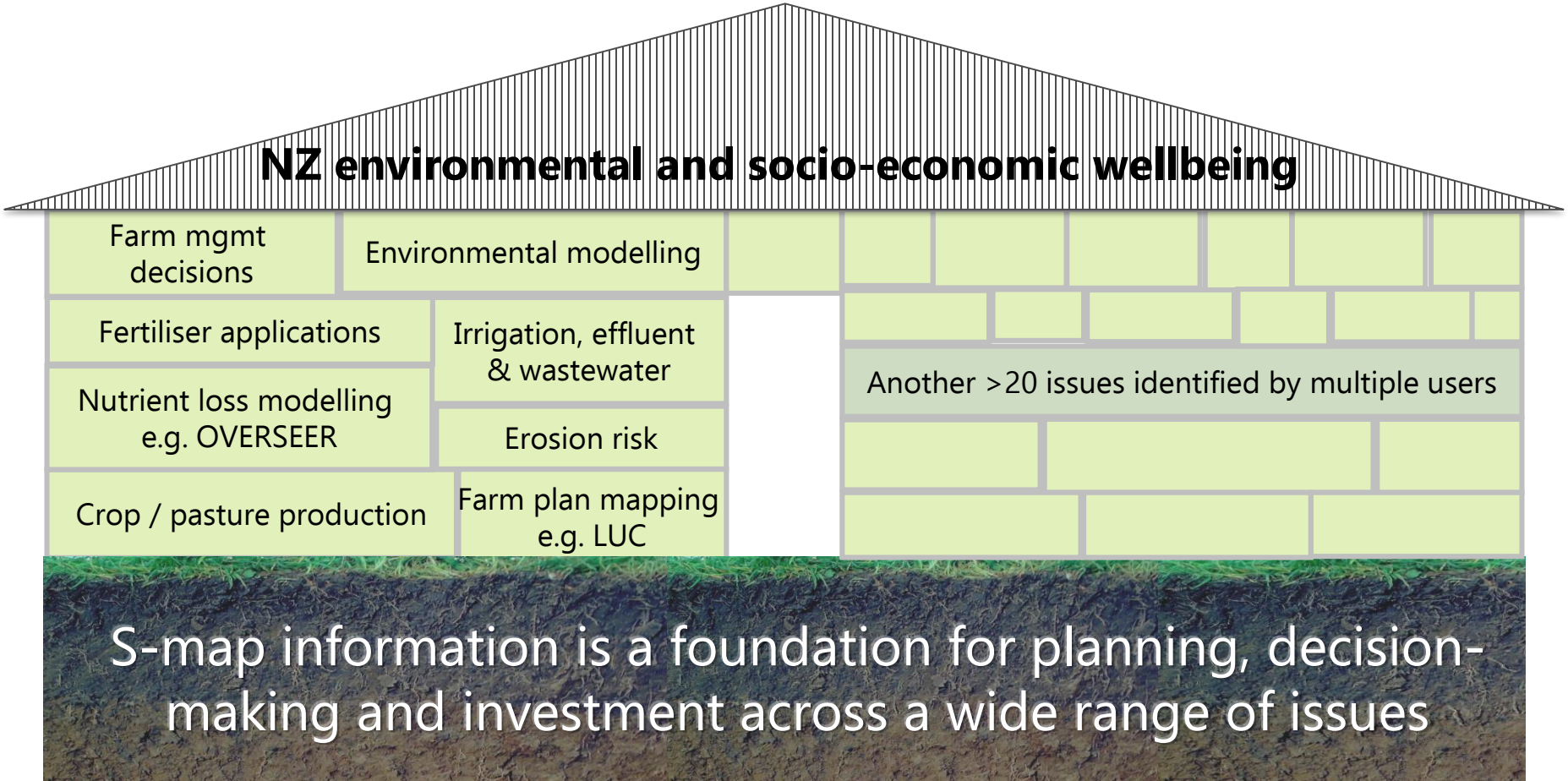
Who uses it?


S-map Online use per annum
Overseer
Factsheets
Data downloads
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
2012
2013
2014
2015
2016
2017
2018
2019
Year ending June 30


Maori Org.
Individual
Education
Industry
Land owner
Agriservices
Research
Local Govt.
Central Govt.
Charity
0
100
200
300
400
500
Number of respondents

What's driving the demand?




NZ environmental and socio-economic wellbeing
Farm mgmt decisions
Environmental modelling
Fertiliser applications
Irrigation, effluent & wastewater
Nutrient loss modelling e.g. OVERSEER
Erosion risk
Crop / pasture production
Farm plan mapping e.g. LUC
Another >20 issues identified by multiple users
S-map information is a foundation for planning, decision-making and investment across a wide range of issues

Part I: key take home message

Soil information is important for a wide range of issues and where available it is extensively used.

Interactive Question 2:

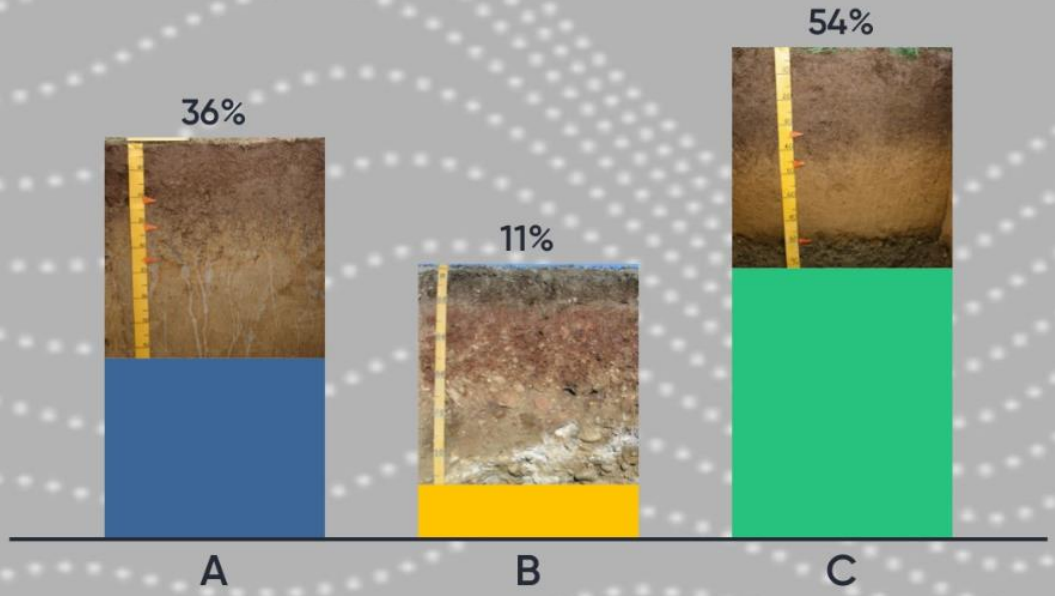
Which one of these soils has the greatest versatility for highly productive land?

Soil A

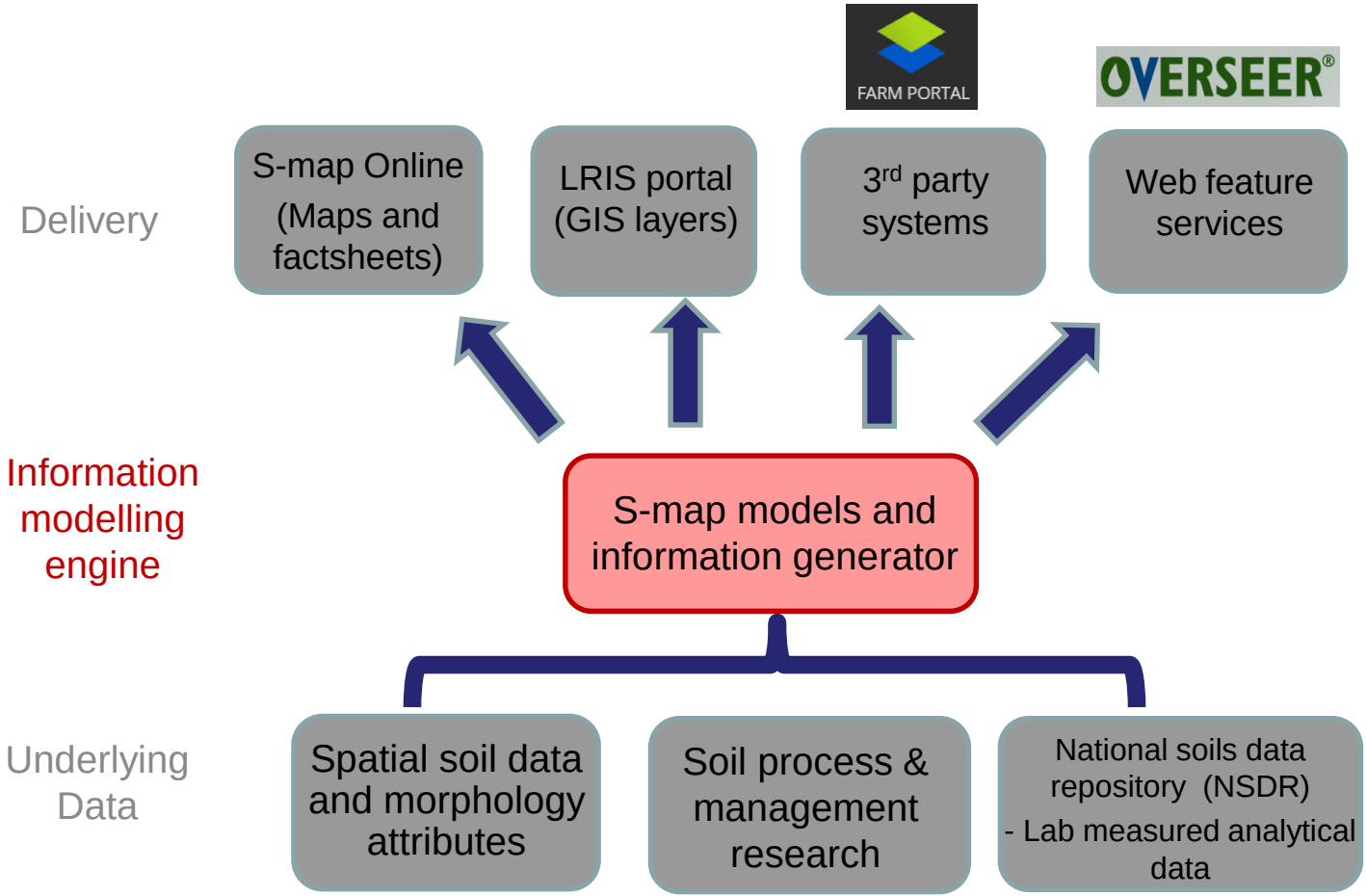
Soil B

Soil C ✓

Which one of these soil profiles has greatest versatility for highly productive land?



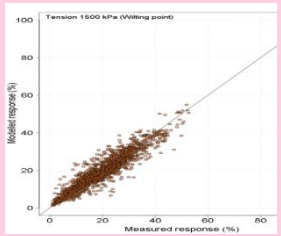
Part II: S-map inference engine



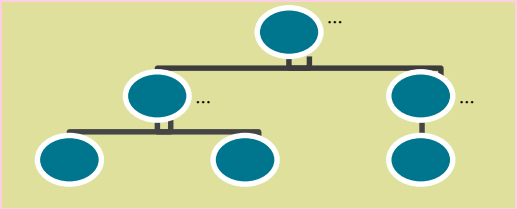
Soil information

S-map inference engine

$$Y = \int B\sqrt{K}dx$$



PTF CODE

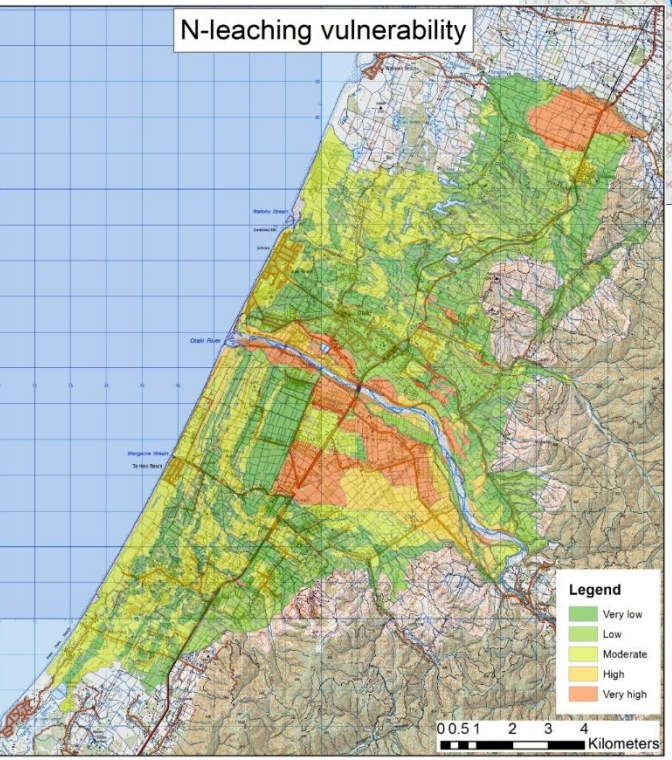


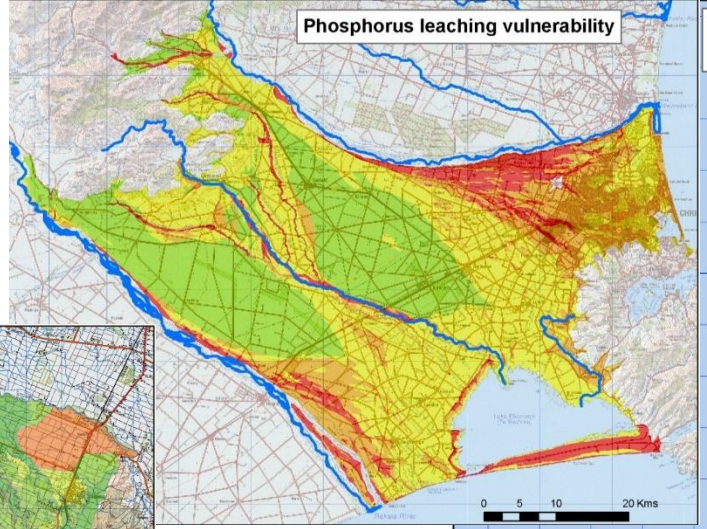
Research

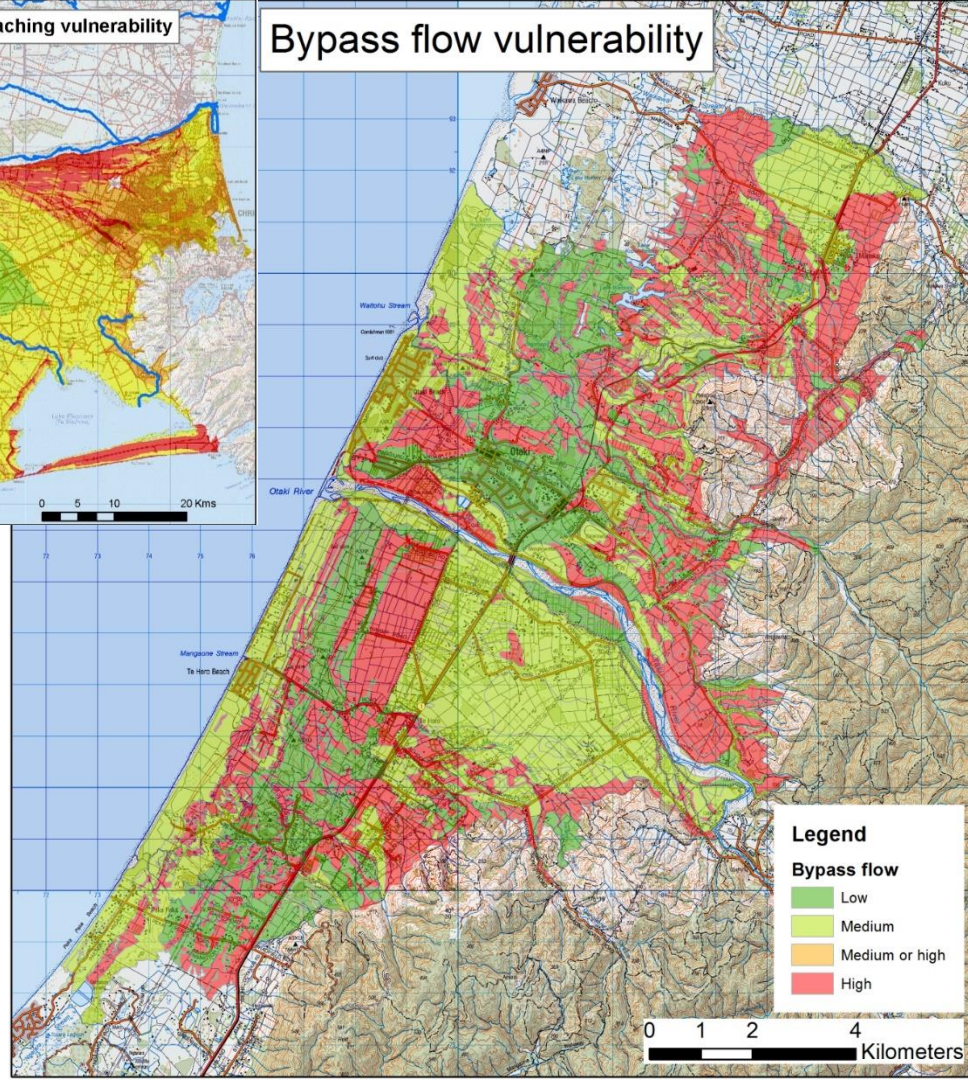
Soil Survey data

NSDR data

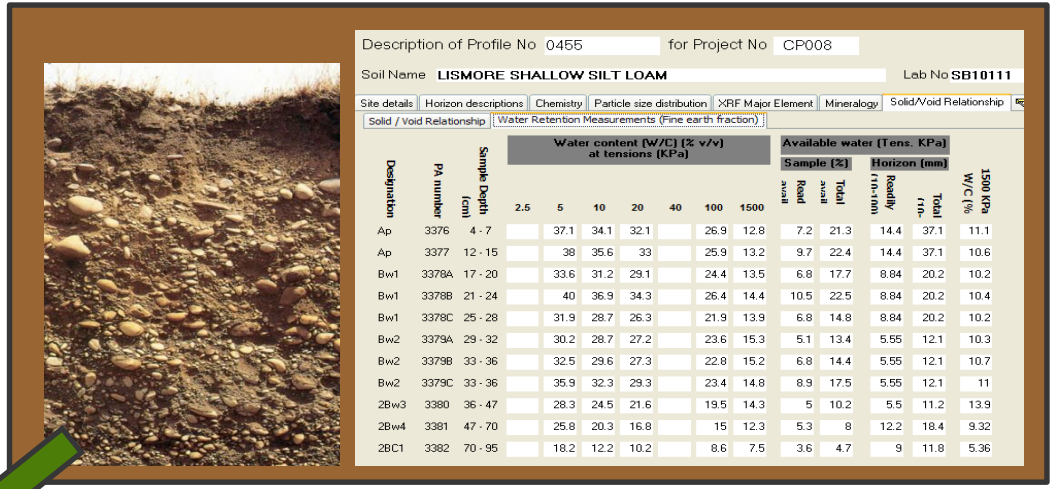
Risk mapping



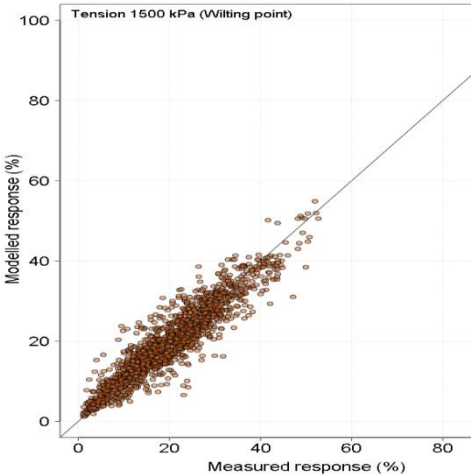


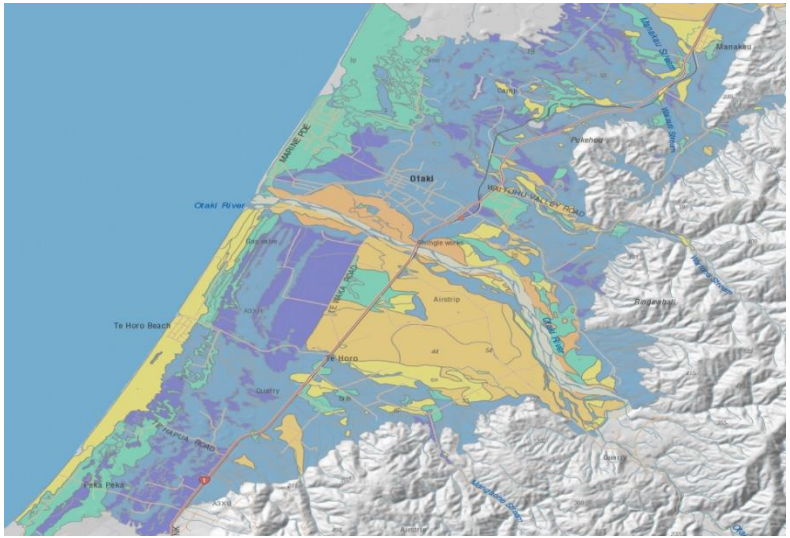


NSDR = point measurements of soil attributes



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 (%) Readily avail	Total avail	Horizon (mm) Readily (nn-nnn	Total (nn-	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





S-map => spatial variability

Predictions of the water retention curve gives us ….

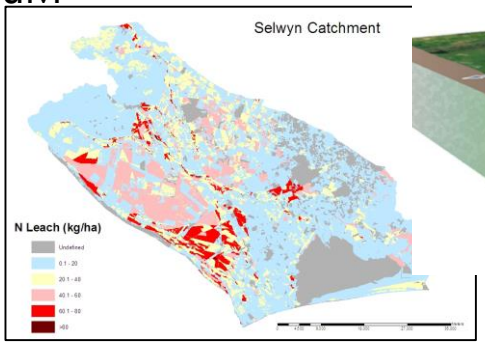
PAW = profile available water, i.e., the capacity of the soil to store water. Essential for:

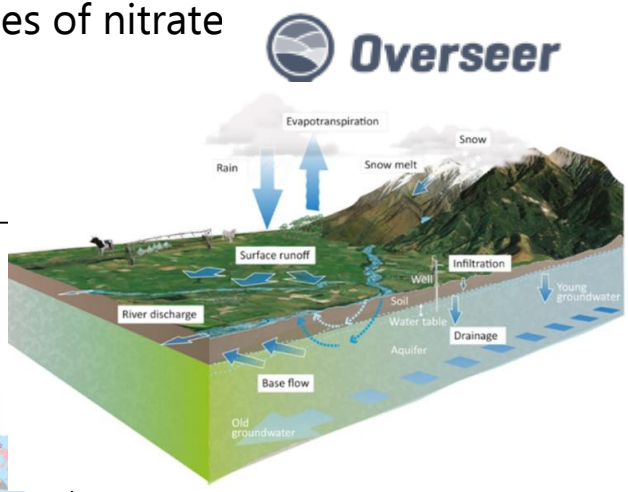
- Irrigation and effluent design / operation

- 9 soil moisture values for Overseer – essential for estimates of nitrate nitrous oxide emissions

- Soil hydrology parameters for NZWaM

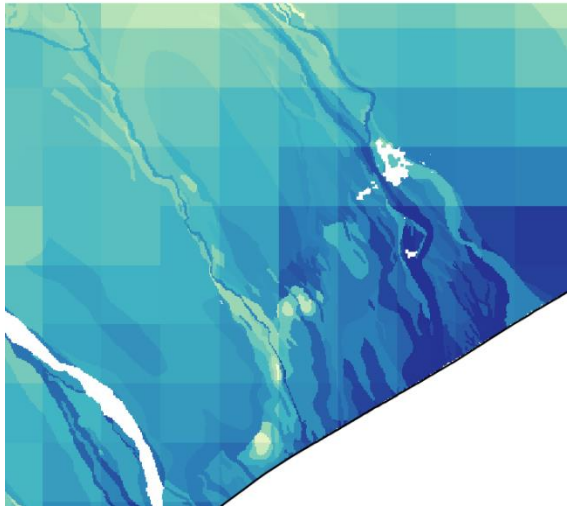
- Coming: NZ Drought Index



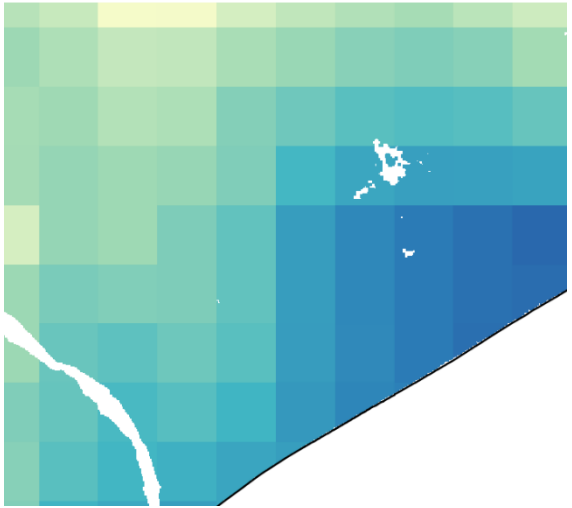


Droughtiness modelling

(a) 100 m S-map



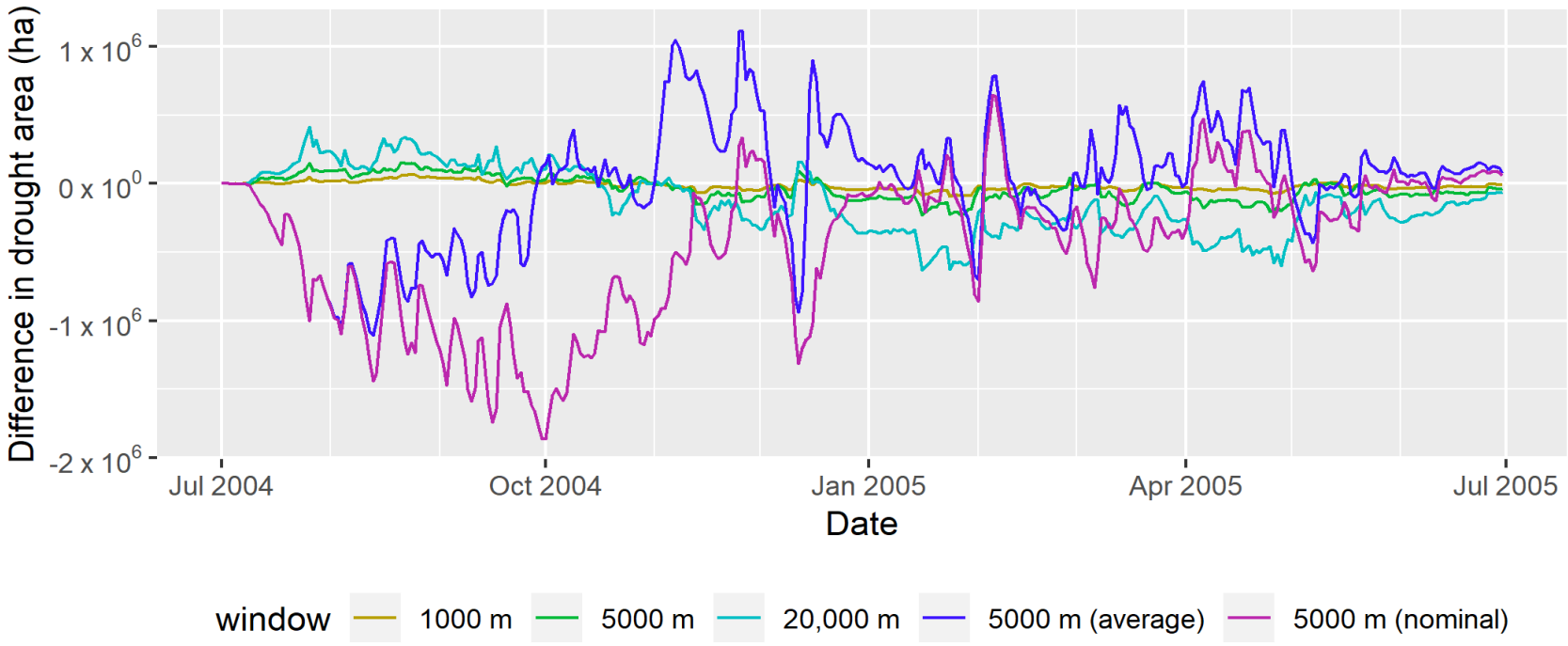
(e) 5000 m nominal soil

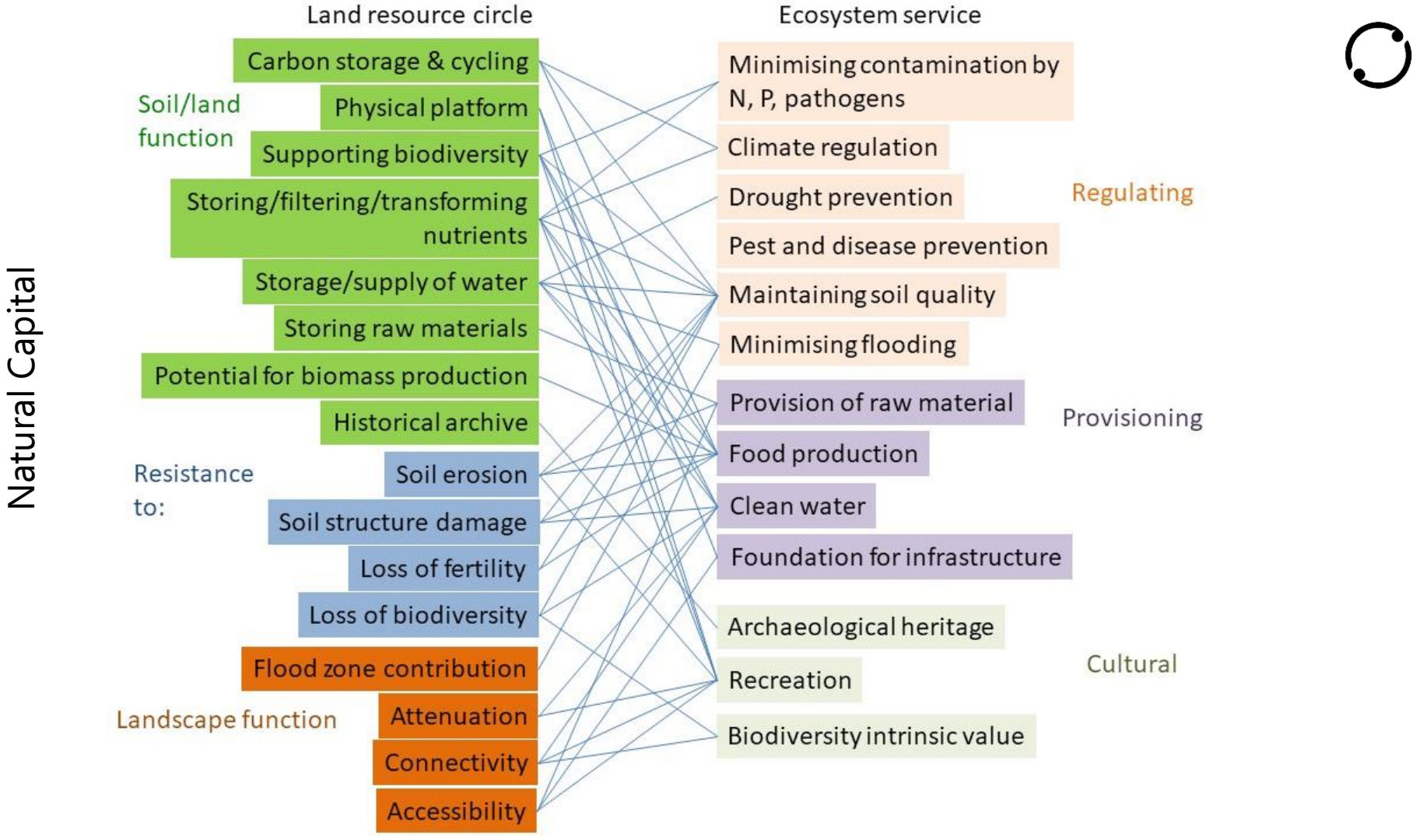


0 5 10 15 20 km

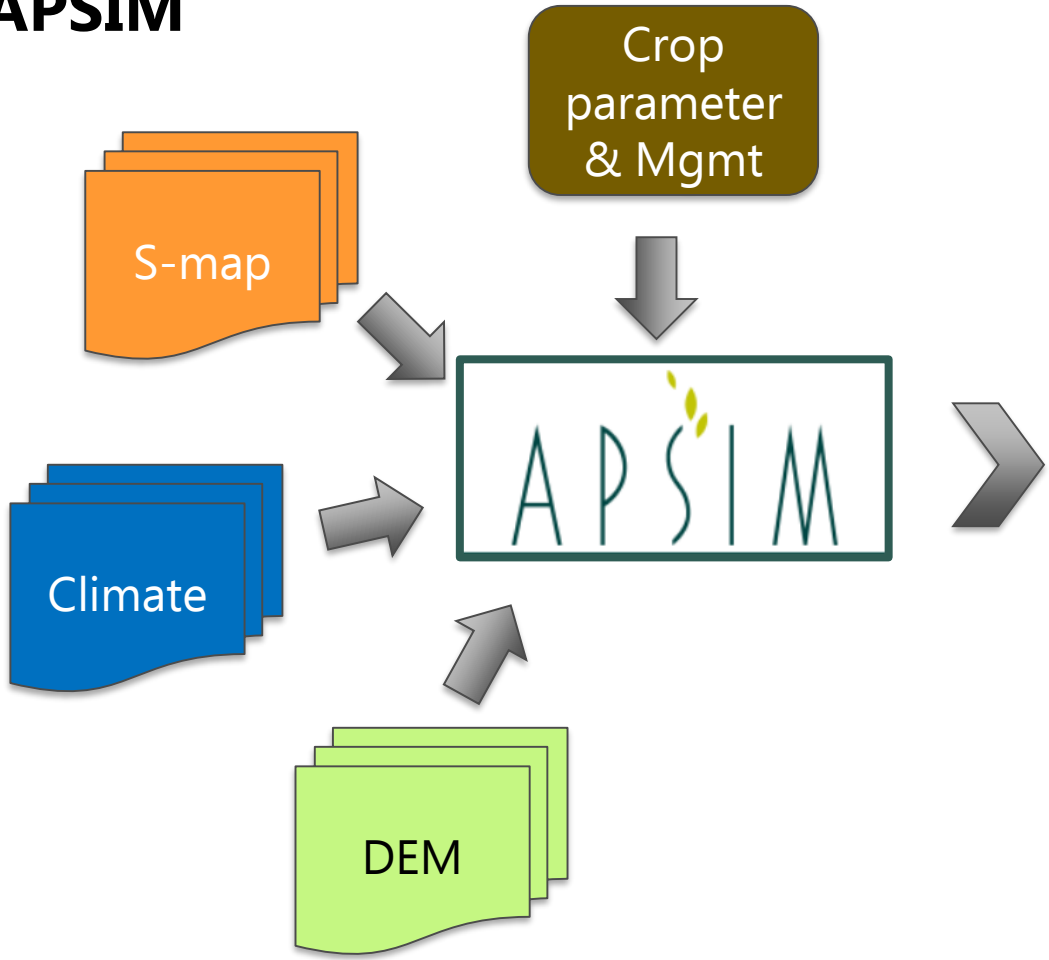
CWD (mm)
250
312
375
438
500

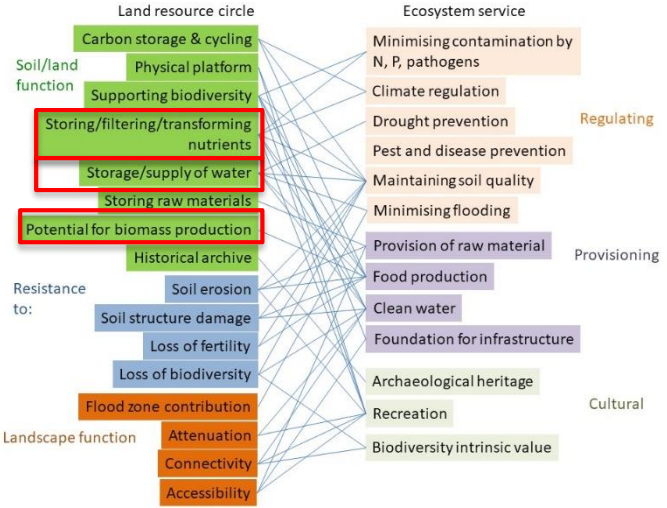
Droughtiness modelling




Natural Capital
Land resource circle
Ecosystem service
Soil/land function
Carbon storage & cycling
Physical platform
Supporting biodiversity
Storing/filtering/transforming nutrients
Storage/supply of water
Storing raw materials
Potential for biomass production
Historical archive
Resistance to:
Soil erosion
Soil structure damage
Loss of fertility
Loss of biodiversity
Landscape function
Flood zone contribution
Attenuation
Connectivity
Accessibility
Minimising contamination by N, P, pathogens
Climate regulation
Drought prevention
Pest and disease prevention
Maintaining soil quality
Minimising flooding
Regulating
Provision of raw material
Food production
Clean water
Foundation for infrastructure
Provisioning
Archaeological heritage
Recreation
Biodiversity intrinsic value
Cultural

APSIM


Crop parameter & Mgmt
S-map
Climate
DEM
APSIM


Land resource circle
Ecosystem service
Carbon storage & cycling
Soil/land function
Physical platform
Supporting biodiversity
Storing/filtering/transforming nutrients
Storage/supply of water
Storing raw materials
Potential for biomass production
Historical archive
Resistance to:
Soil erosion
Soil structure damage
Loss of fertility
Loss of biodiversity
Flood zone contribution
Landscape function
Attenuation
Connectivity
Accessibility
Minimising contamination by N, P, pathogens
Climate regulation
Drought prevention
Pest and disease prevention
Maintaining soil quality
Minimising flooding
Regulating
Provision of raw material
Food production
Clean water
Foundation for infrastructure
Provisioning
Archaeological heritage
Recreation
Biodiversity intrinsic value
Cultural

S-map Next Generation MBIE Endeavour programme

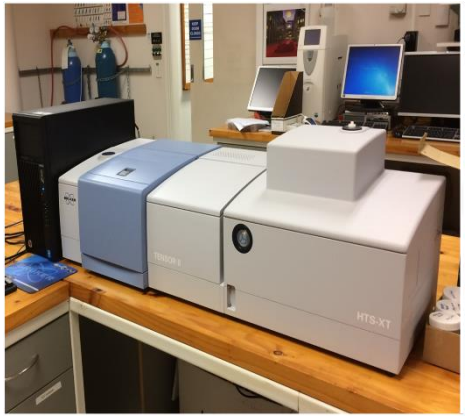
Major focus is soil hydrology – better understanding and mapping of water in soil

- Doubling measured points from 313 to c 700 sites
- New efficient and quantitative measurement techniques
- New modelling techniques
- New attributes (e.g. water movement)
- Effect of land management (artificial drainage, irrigation, cultivation)
- Effects of different types of stones on soil water storage

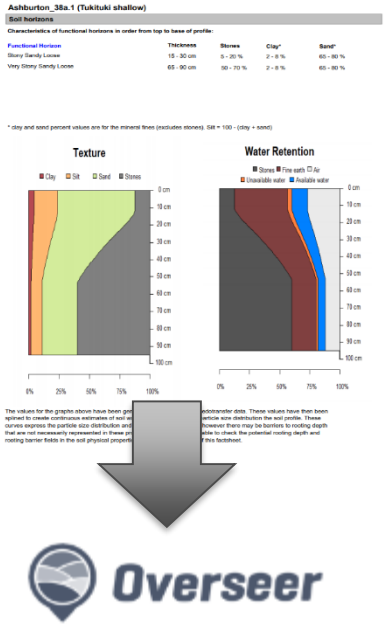
→ New PTFs (water storage, water movement, bulk density, cation and anion storage capacity, pH)

Farm scale tools

- Developing tools to bring power of the S-map inference engine to farm-scale

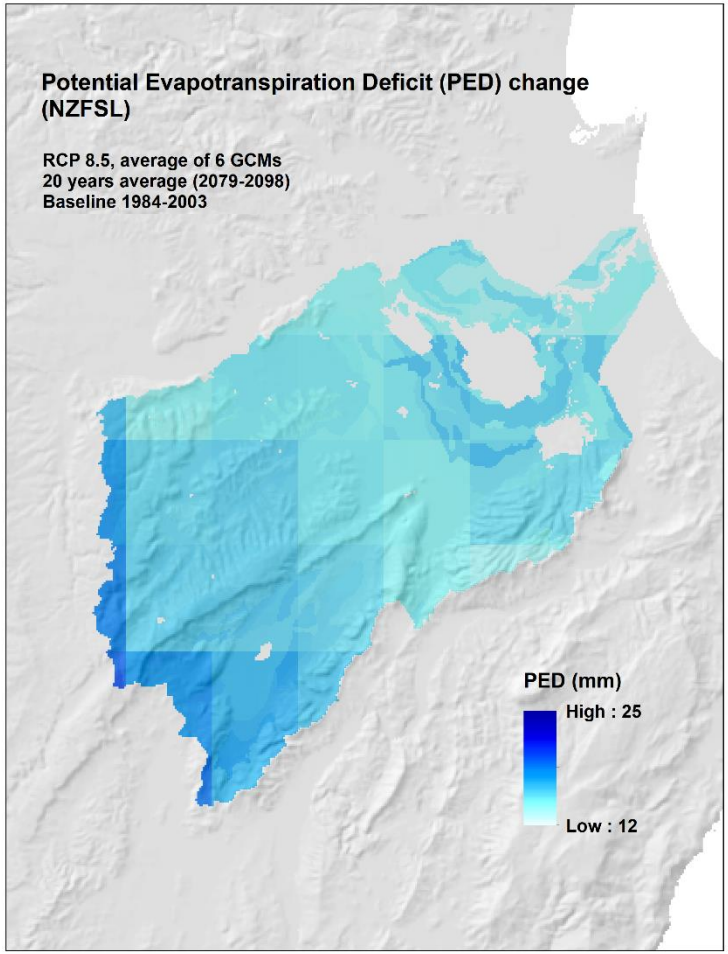


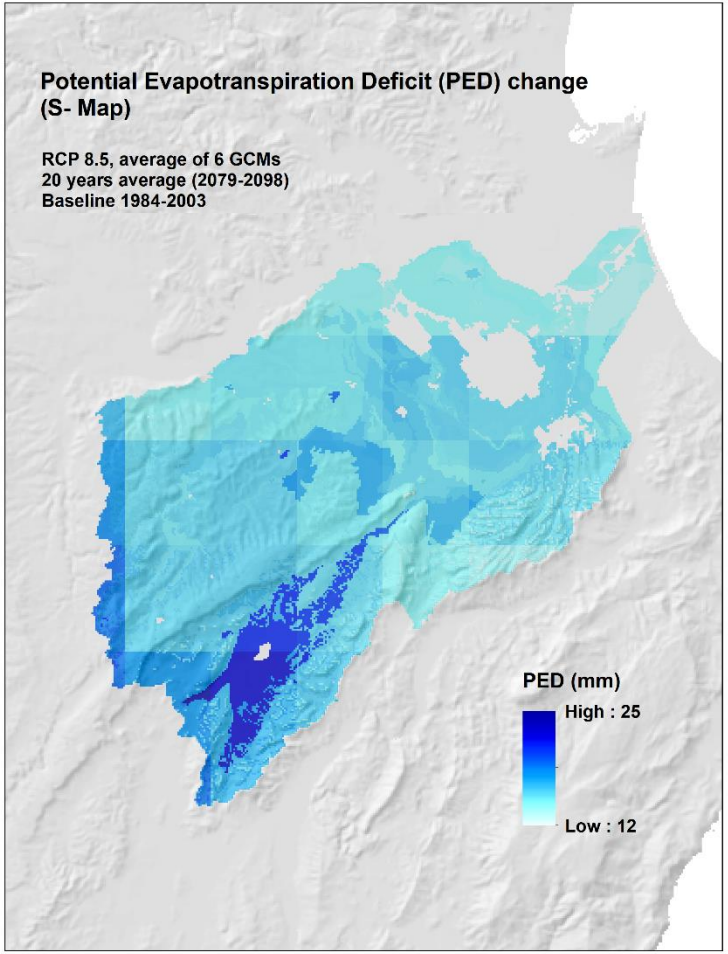
S-map



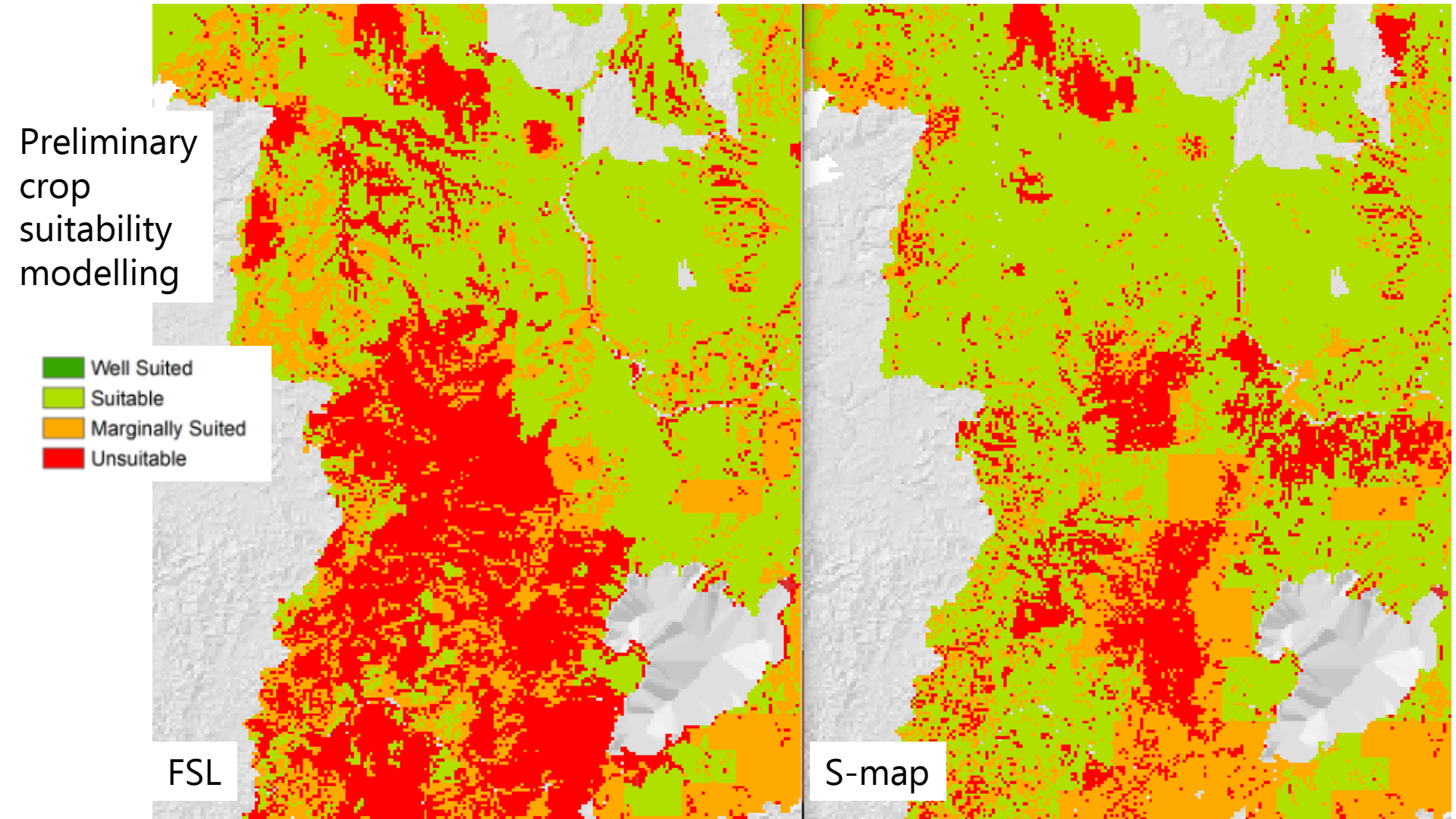
- Published with Regional Councils the NZ Soil Mapping Guidelines (2019)

What happens if poor quality soil info is used …

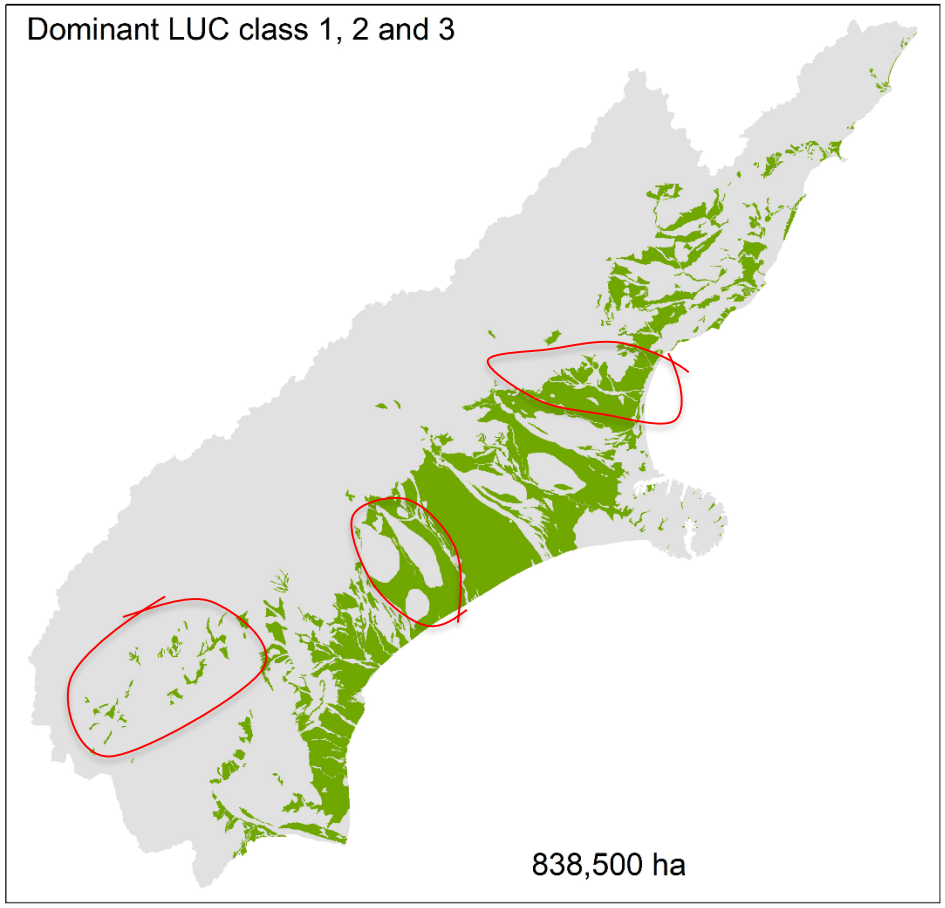


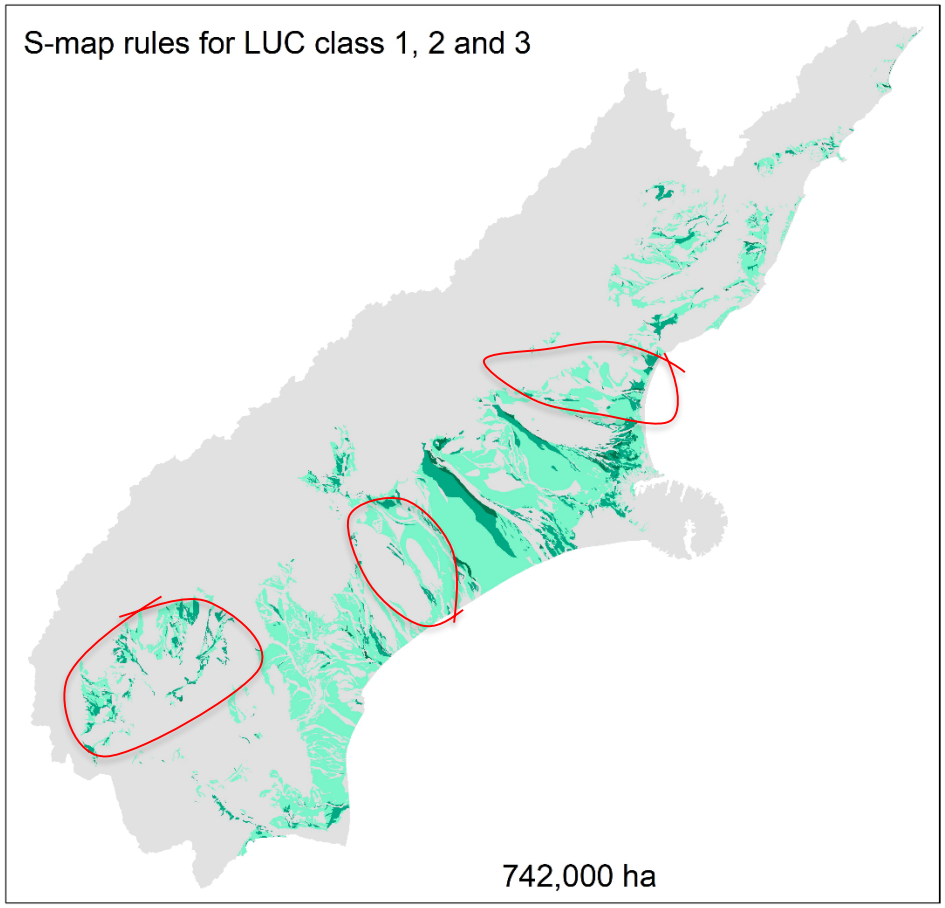


Preliminary crop suitability modelling



NPS HPL: Effect of updating LUC 1 – 3 map with S-map





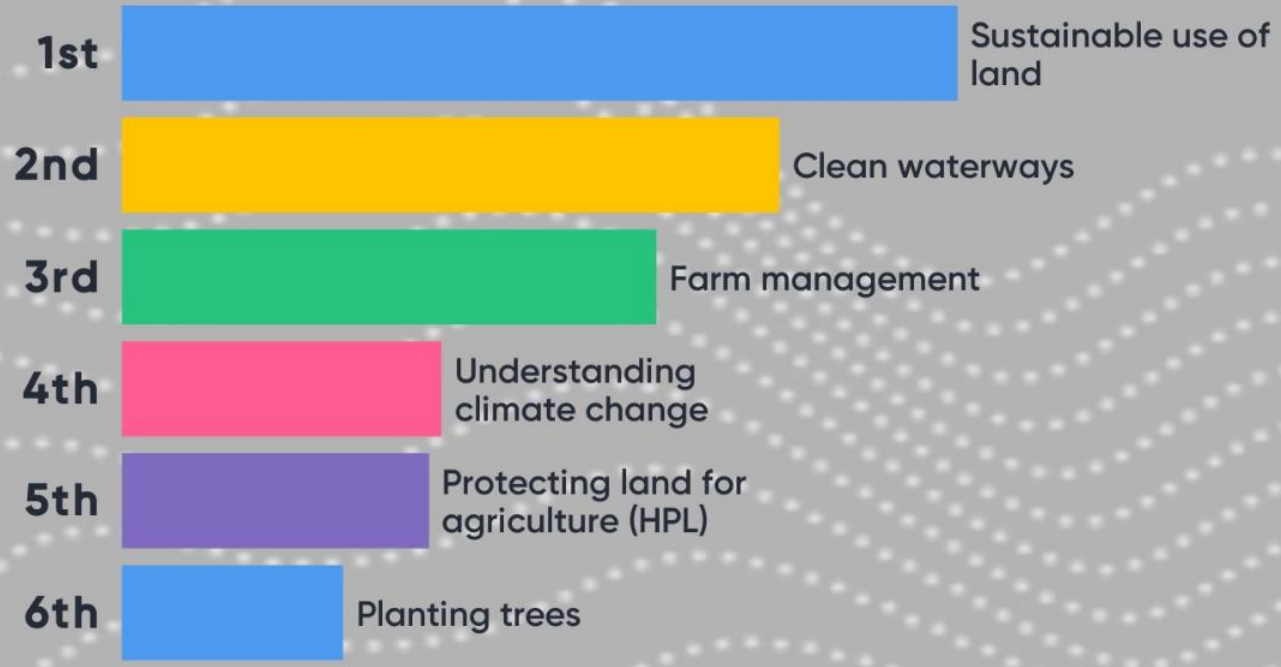
Part II: key take home message

Good science underpins transforming soil data into information & products. But quality information is needed to avoid expensive mistakes or lost opportunities.

Interactive Question 3: Rank the importance of the following uses of soil information from your perspective

Rank the importance of the following uses of soil information from your perspective:

Manaaki Whenua
Landcare Research



28

Part III: Coverage of S-map

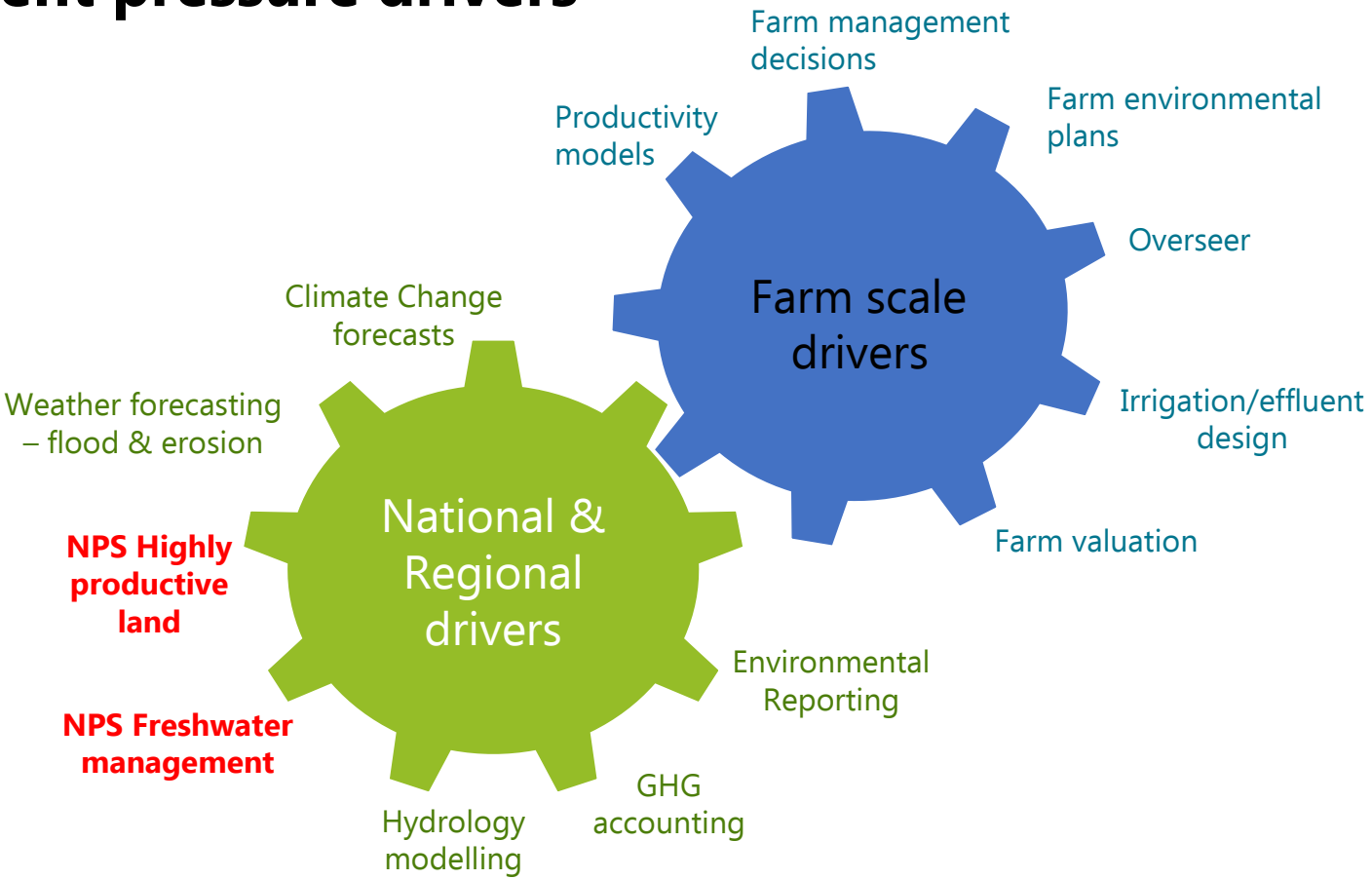
34% mapped = c. 8M ha

Tho 45% NZ is class 7 - 8

So we have covered 62% of class 1 – 6 land

High diversity mapped thus far, c. 5,000 soil types

Current pressure drivers

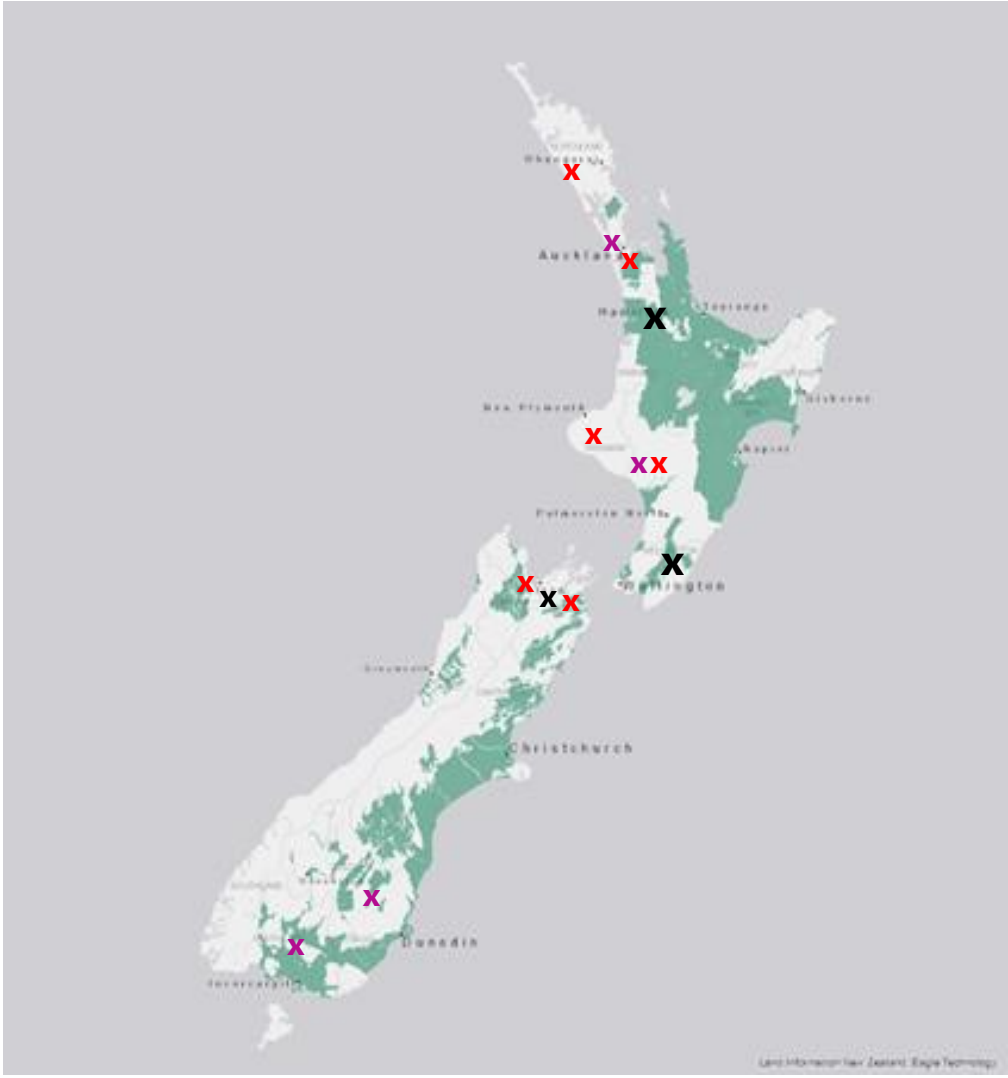


Pressure points for funding soil information

X = current mapping work

X = NPS HPL

X = Overseer



S-map funding streams

Regional Govt funding

Contestable funding, ~ 1 – 2 FTE (Mapping coverage)

Govt contestable open round funding

5yr Govt funding, all NZ contestable ~ 6 FTE (Science excellence & development)

Landcare SSIF funding

7yr Govt funding, internally competitive ~ 2 FTE (Infrastructure + modelling)

Nationally significant database & collections

Fixed funding ~ 1.5 FTE (NSDR database)

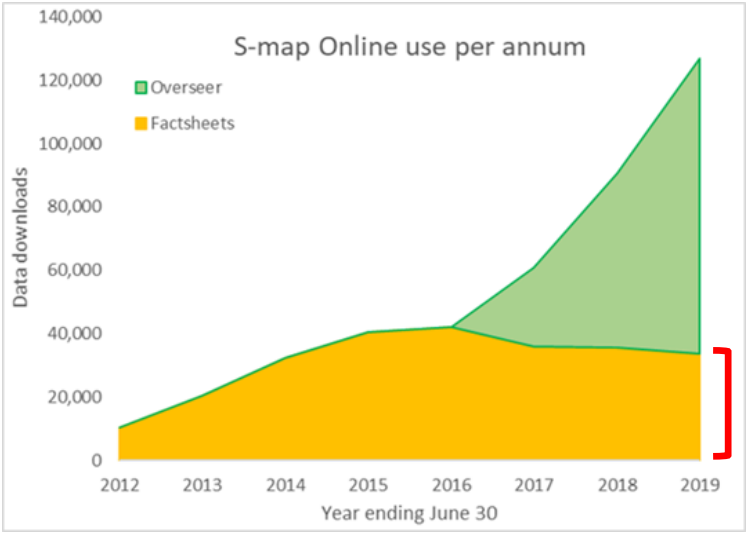
Commercial funding

Annual data licence commercial users ~ 0.5 FTE (Data supply & maintenance)

Cost to complete

Land suitability	% NZ	% NZ <u>not</u> in S-map	Cost $/ha	Estimated completion cost ($M)
Multiple use	25	9	6	14
Pasture/forest	30	19	3	15
Class7 & 8	45	39	0.5	4
Total				34

Investment value

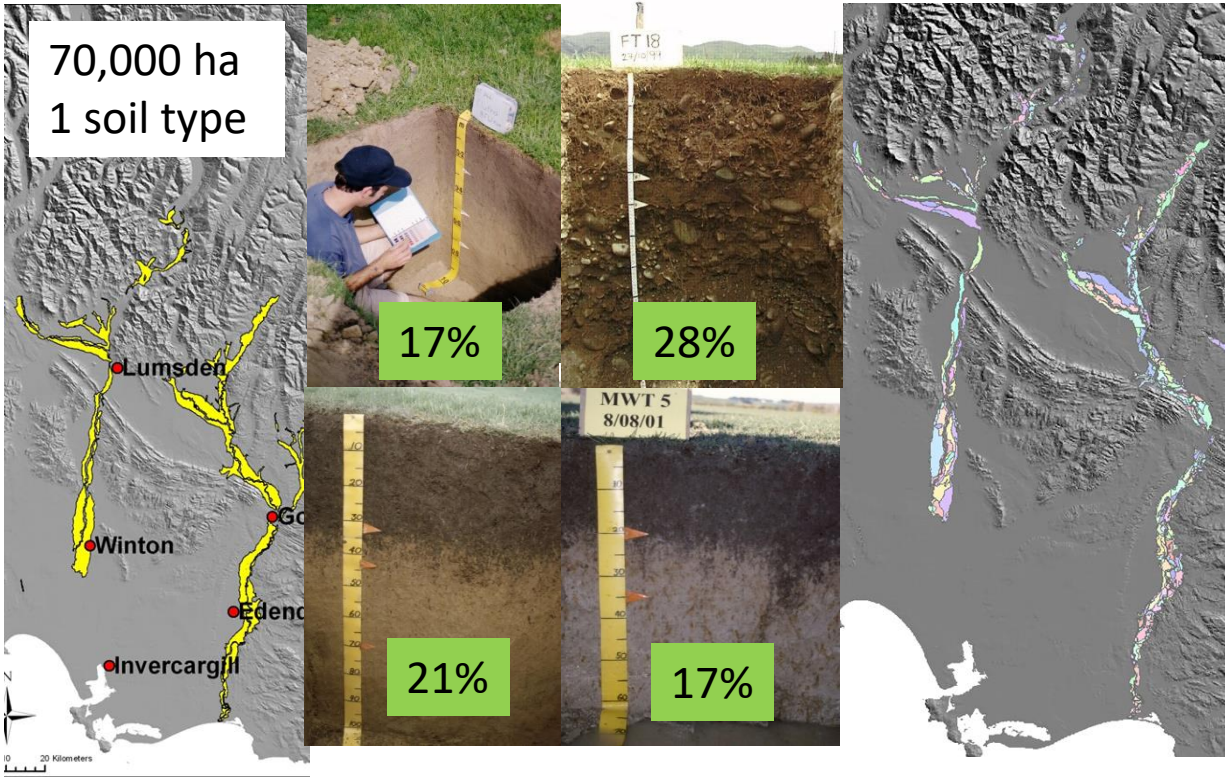


Market Economics 2019 analysis of S-map online users:

- Current direct benefits to users $19.5M p.a
- Potential use value of completing S-map $11.8M p.a.
- **Note**: Indirect Public benefits are additional, and there are many more users of S-map not covered in this survey

This is consistent with previous NZ and International CBA

Case study of CBA: Managing nitrogen leaching in Matura catchment



Spatially targeting mitigation to 25% dairy farms on hot spot soils:

- 30% mitigation efficiency
- CBR 1:6 in year 1

Benefits from N retained

- Farmer $17/Kg/N/yr
- Community $25/kg/N/yr

Carrick S, Vesely É, Hewitt A 2010. Economic value of improved soil natural capital assessment: a case study on nitrogen leaching. 19th World Soil Congress of soil Science, Brisbane, Australia, 1st - 6th August 2010. Four page extended abstract.

Completing S-map: Looking forward

Case is being developed for investment required to complete S-map:

- Briefing paper published for central Government (Oct 2019)
- User survey report (July 2019)
- Expected benefits assessment paper (Sept 2019)
- 1 page summary (todays A3 handout)

Aim is to provide evidence base for you and others to help us argue the case

Part III: key take home message

S-map contains information on one of NZ's most important natural resources. Ongoing financial support for this information system is a critical investment in NZ's future.

Interactive Question 4: What are your ideas for making this investment happen?

Who should we/you talk to?
What else do we need to prepare?
Suggested next steps?

Many thanks to everyone who participated in this interactive seminar. The information provided will be used in our planning.

To keep the conversation going please contact
Sam (carricks@landcareresearch.co.nz) or
Linda (lilburnel@landcareresearch.co.nz)