Landcare Research
Manaaki Whenua

Improving water quality – revealing the role of soil information

Linda Lilburne & Sam Carrick

Link Seminar, Wellington, 25th Feb 2014

Discussion Outline

S-map Introduction

- Does soil matter?
- S-map 101
- Current S-map status & funding

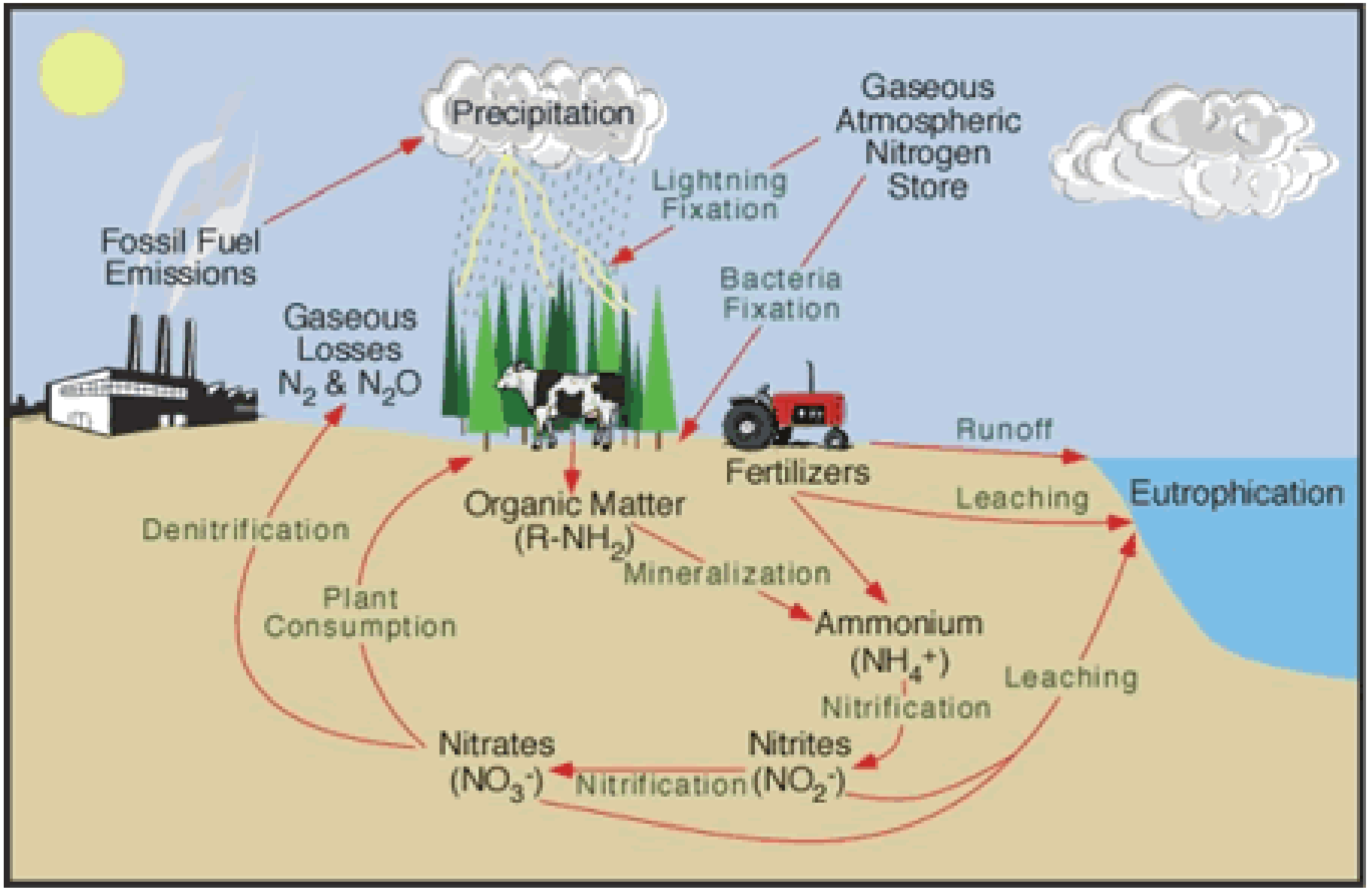
S-map: Under the hood

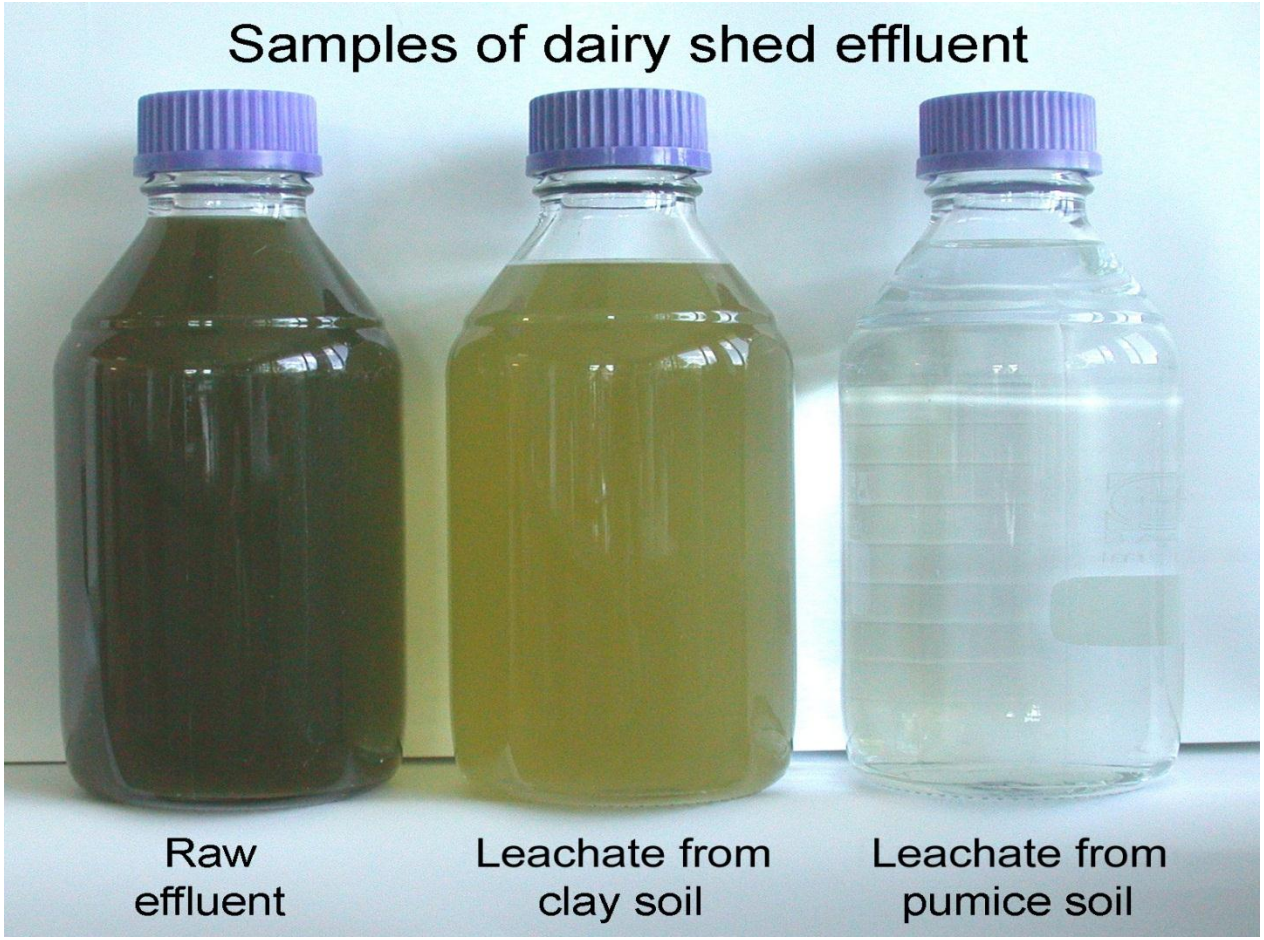
- Underpinning data – the NSD
- Inference engine – inbuilt models
- S-map & regional policy

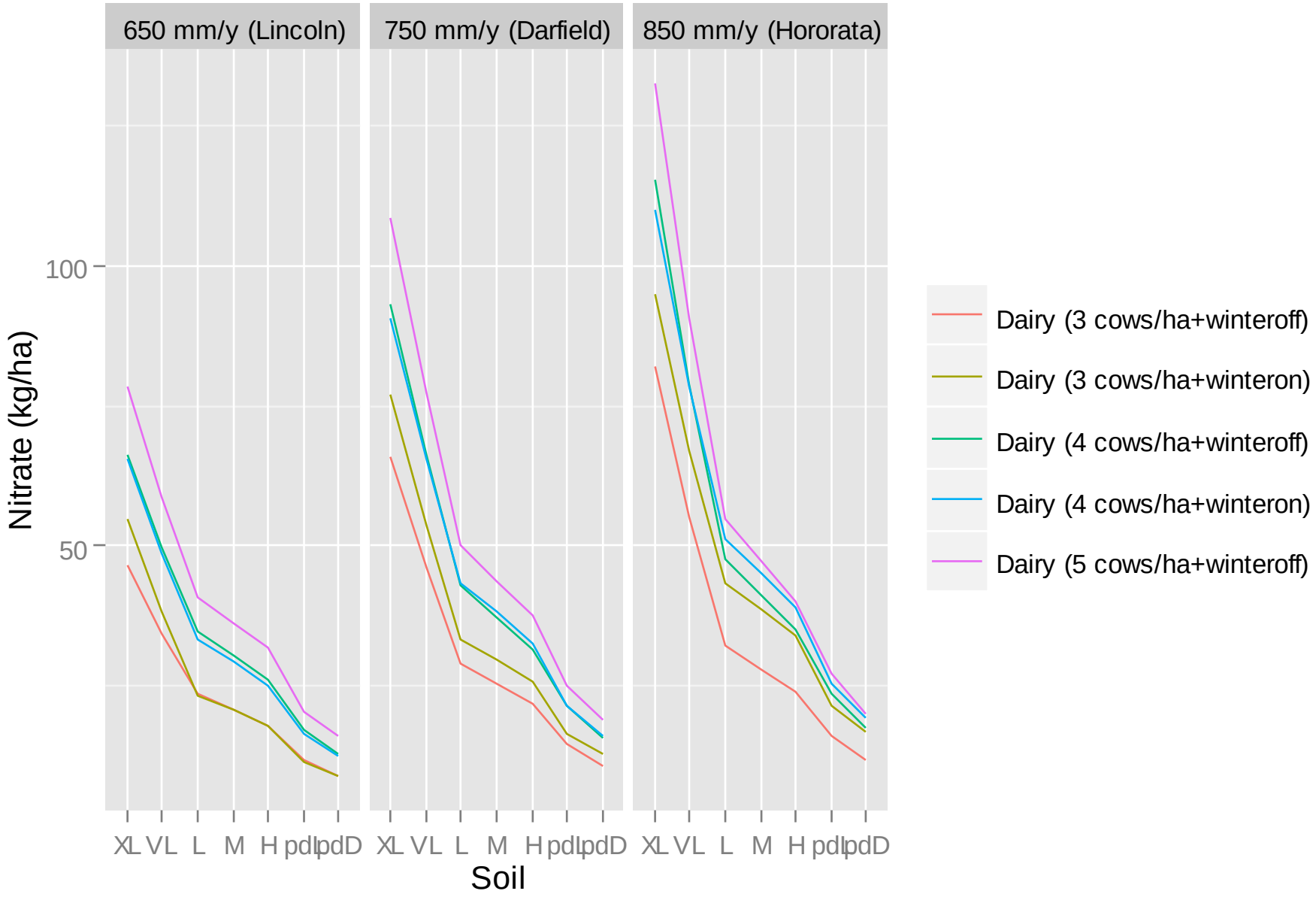
S-map in the future

- S-map @ the farm scale
- National mapping standards / methods / protocols

Does soil matter? N cycling

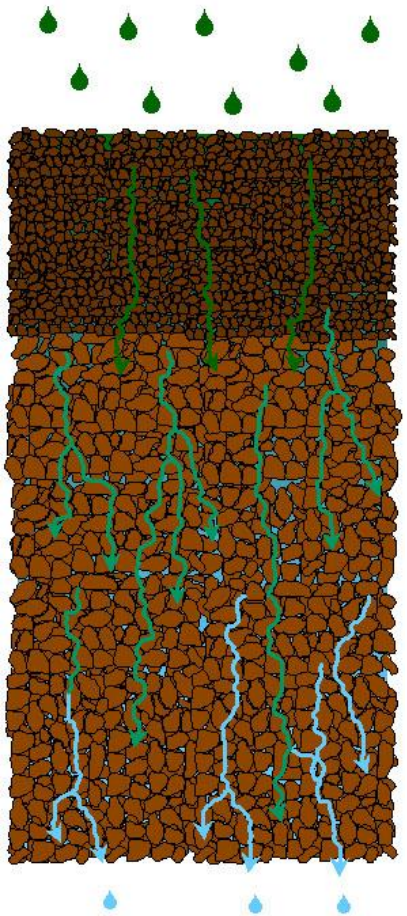



Samples of dairy shed effluent
Raw effluent
Leachate from clay soil
Leachate from pumice soil

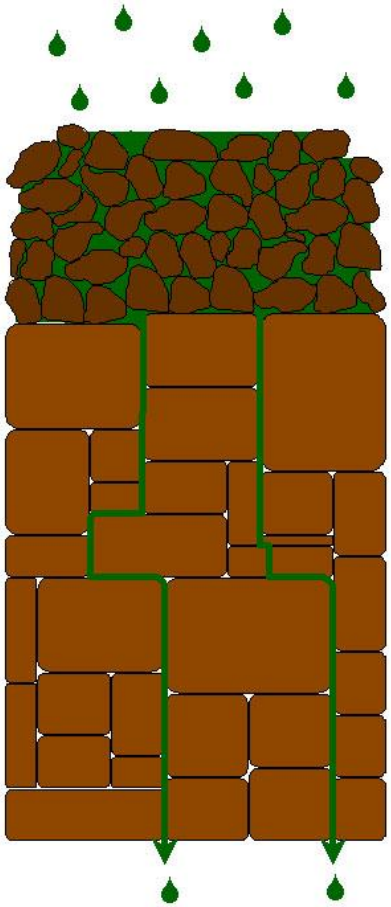

650 mm/y (Lincoln)
750 mm/y (Darfield)
850 mm/y (Hororata)
Nitrate (kg/ha)
100
50
XL VL L M H pdl pdD
Soil
Dairy (3 cows/ha+winteroff)
Dairy (3 cows/ha+winteron)
Dairy (4 cows/ha+winteroff)
Dairy (4 cows/ha+winteron)
Dairy (5 cows/ha+winteroff)

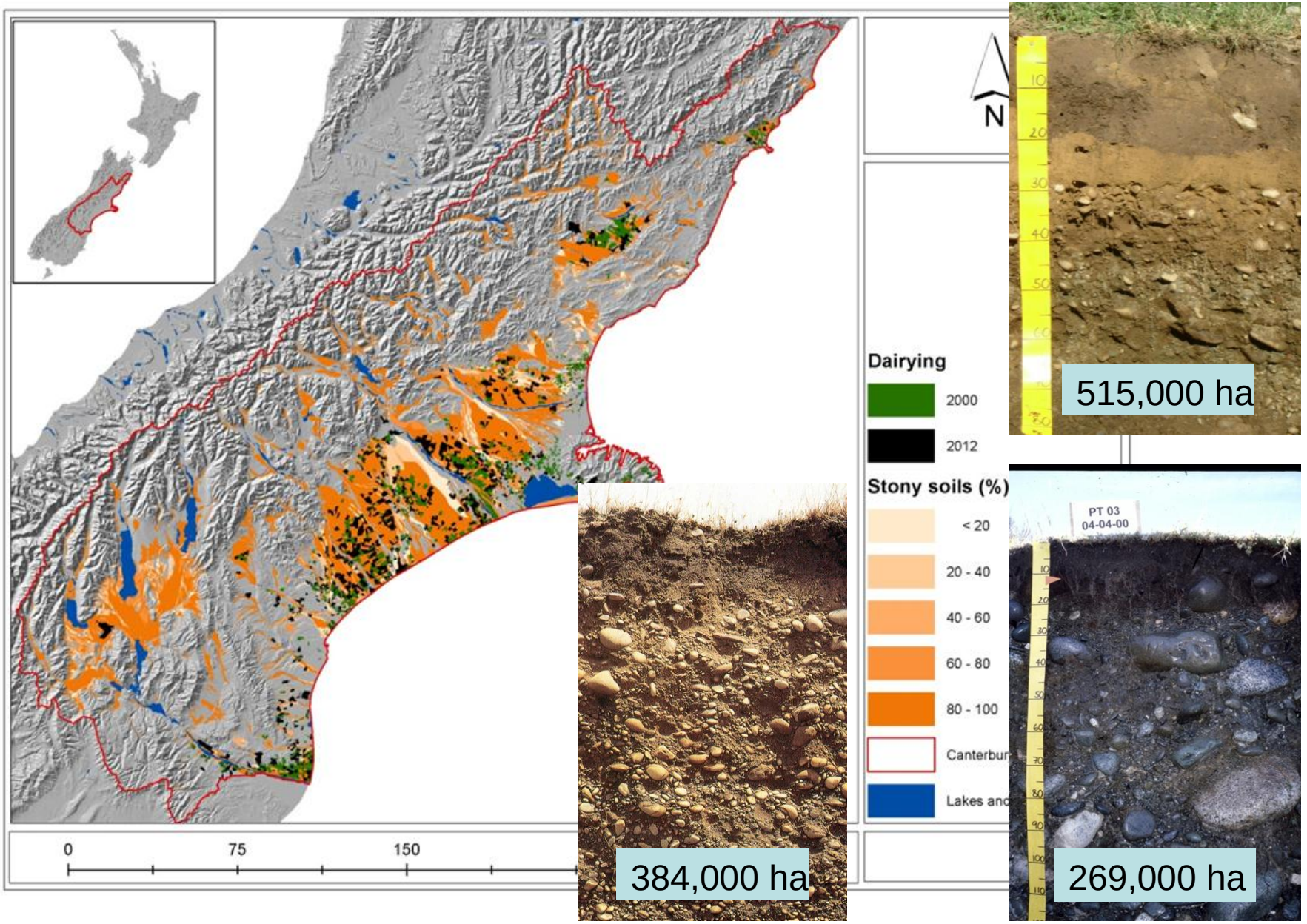
Soil variability

Matrix



Bypass

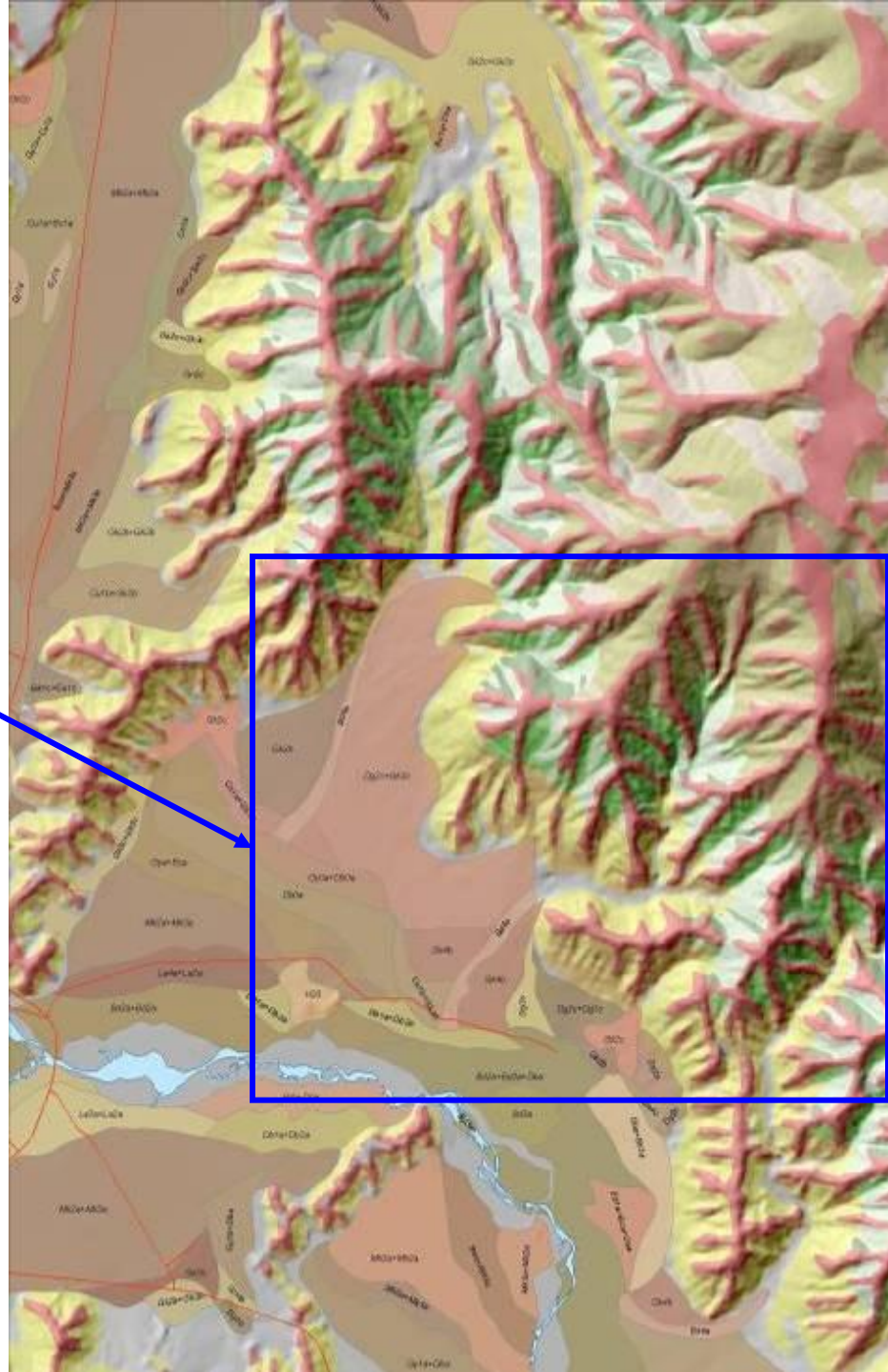



N
Dairying
2000
2012
Stony soils (%)
< 20
20 - 40
40 - 60
60 - 80
80 - 100
0
75
150
515,000 ha
384,000 ha
PT 03
04-04-00
269,000 ha

S-map 101

Prime Goals

- One complete soil map for NZ
- Upgrade good data + fill gaps
- Best available mapping/modelling techniques
- Quantitative information for every soil
- Customised outputs
- Support management at all scales



OVERSEER®

Wairarapa Water Use Project

Canterbury Water

OVERSEER®

Delivery

Smap Online (Maps and factsheets)

LRIS portal (GIS layers)

Government organisations

Web feature services

Inference Engine

S-map models and information

Key to funding source

Landcare

Regional council / Envirolink

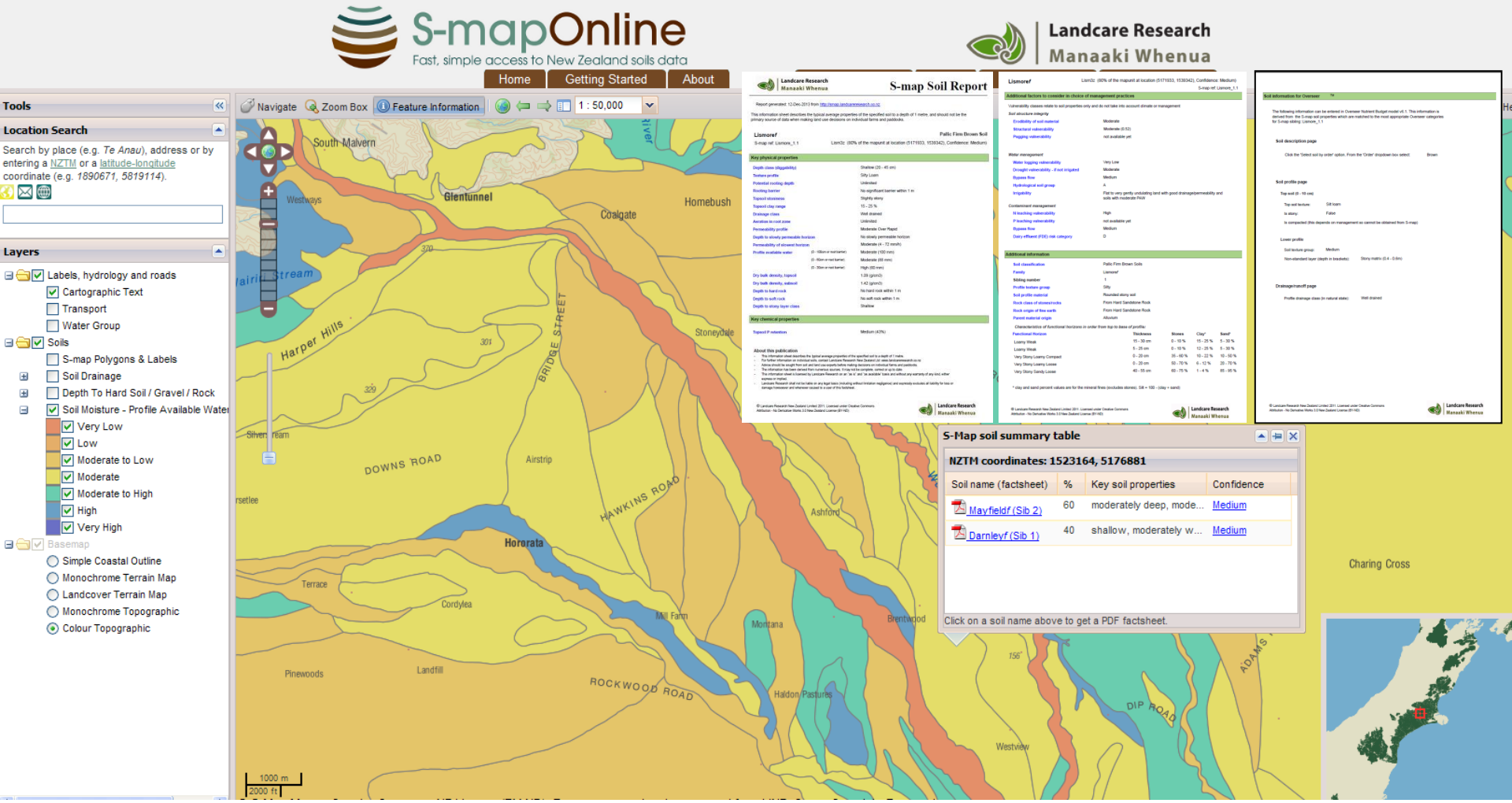
Underlying Data

Spatial soil data and morphology attributes

National soils database (NSD)

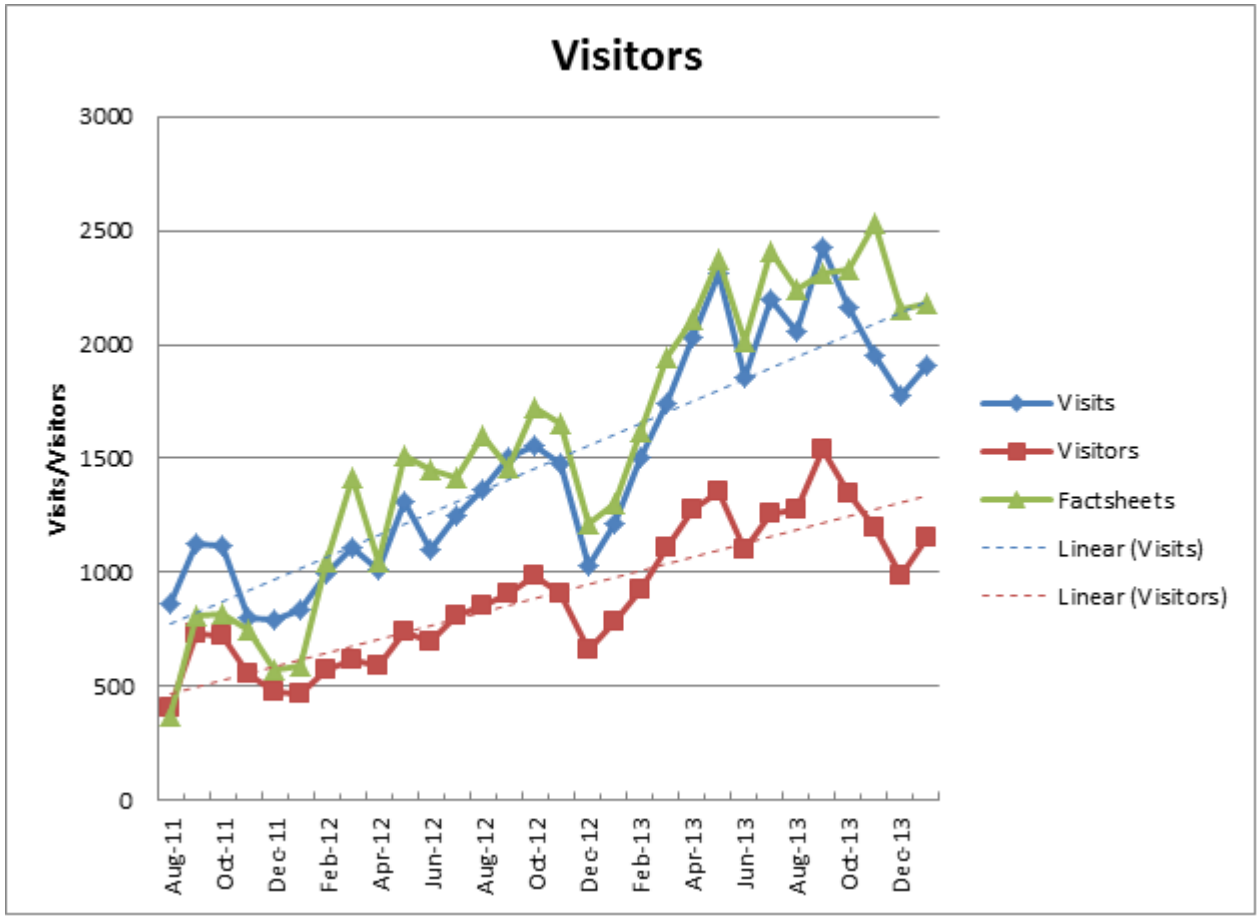
S-mapOnline

Fast, simple access to New Zealand soils data



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

Current demand for soil information



Present coverage of S-map

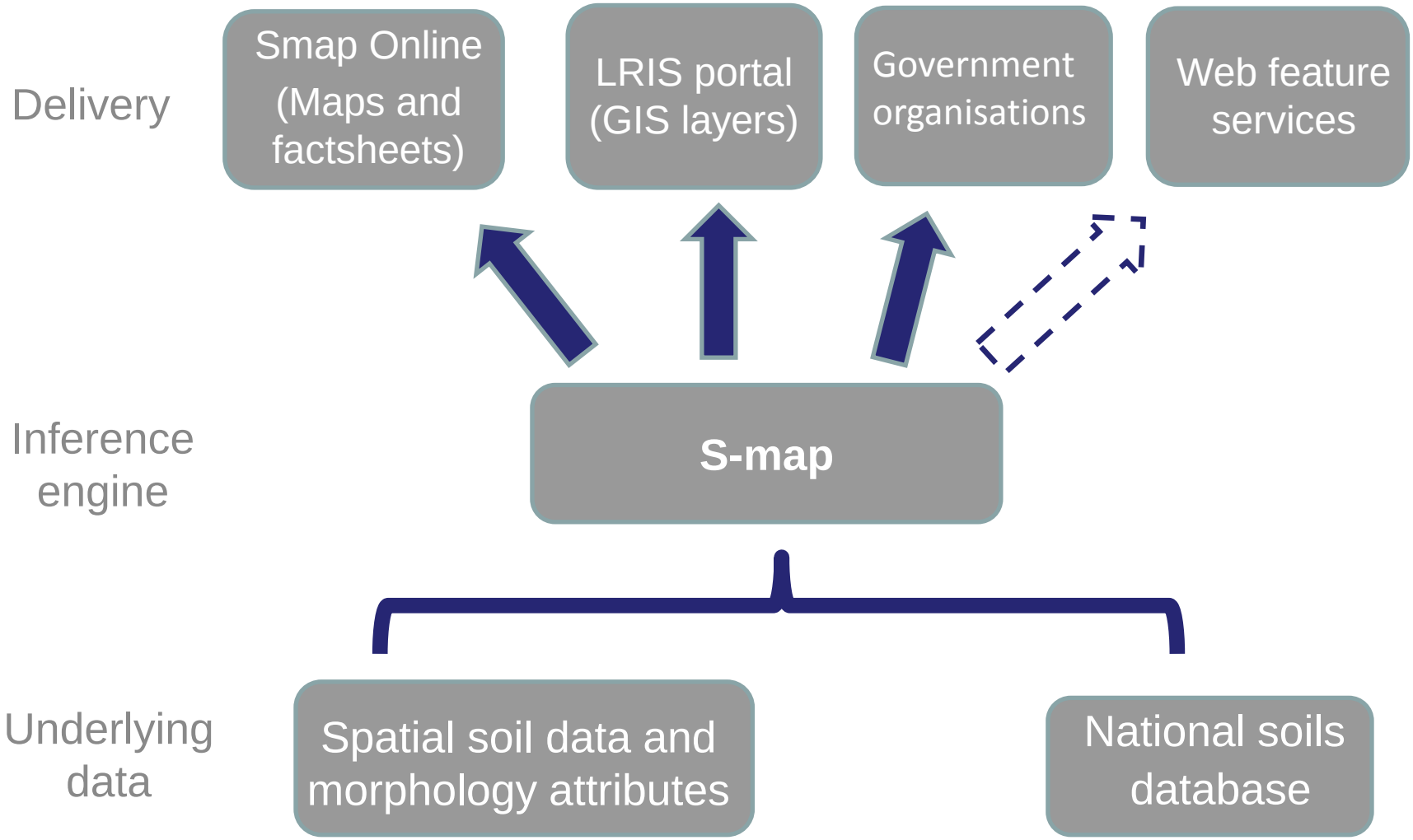
Total coverage = 21%

Land class	% NZ	% class covered
Multiple use	26%	37%
Pasture / Forestry	33%	20%
Conservation	39%	7%

Key messages (S-map)

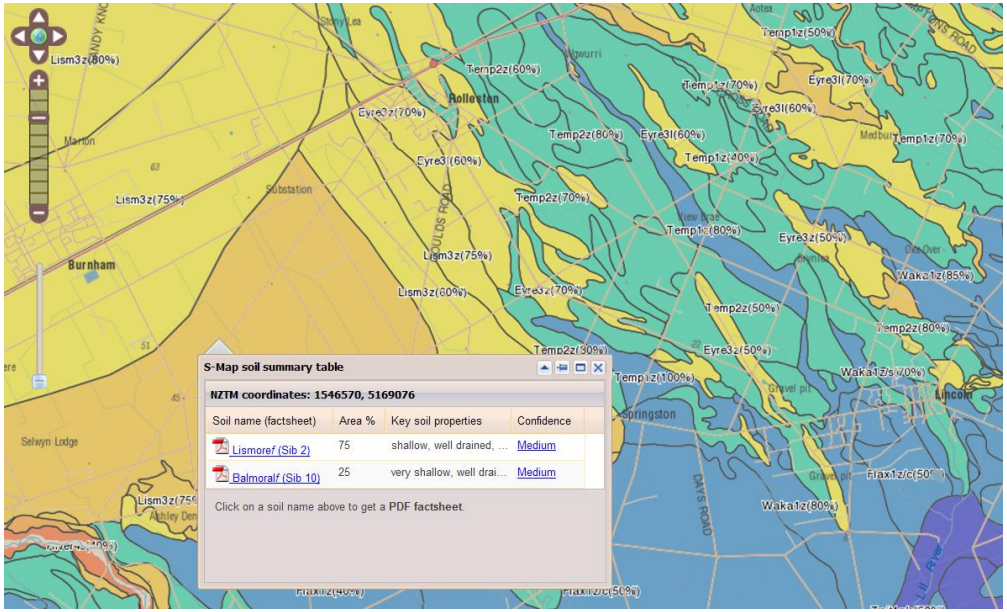
- S-map is delivering …. but need to extend the coverage
- Regional councils are key funders (so far) – hence the focus on their needs.
- As we will show, the power and flexibility of S-map means that it has great potential at multiple scales for multiple stakeholders

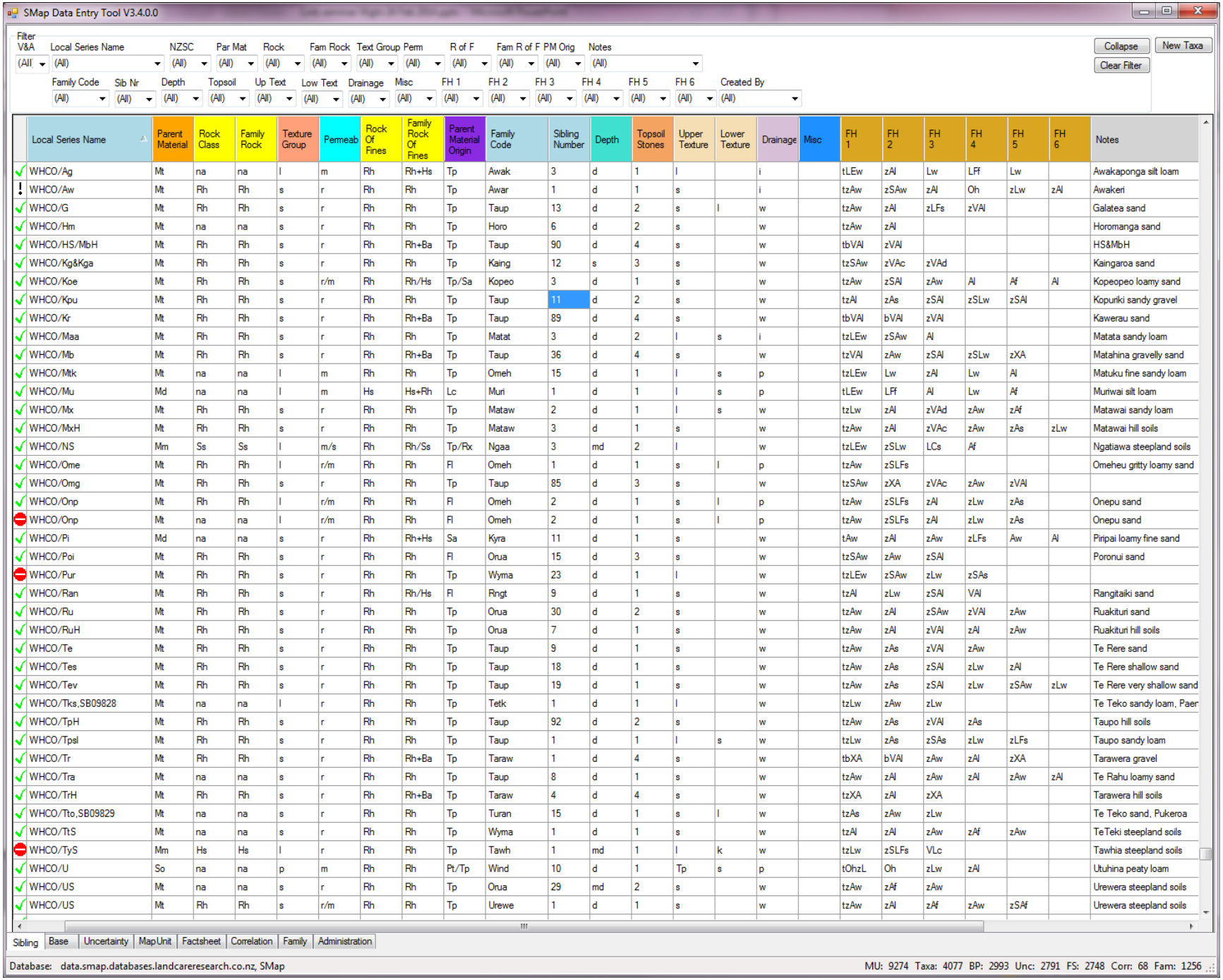
2. S-map : under the hood


Delivery
Smap Online (Maps and factsheets)
LRIS portal (GIS layers)
Government organisations
Web feature services
Inference engine
S-map
Underlying data
Spatial soil data and morphology attributes
National soils database

S-map vs National Soils Database

S-map = spatial variability




SMap Data Entry Tool V3.4.0.0
Filter
V&A
Local Series Name
NZSC
Par Mat
Rock
Fam Rock
Text Group
Perm
R of F
Fam R of F
PM Orig
Notes
Collapse
New Taxa
Clear Filter
Family Code
Sib Nr
Depth
Topsoil
Up Text
Low Text
Drainage
Misc
FH 1
FH 2
FH 3
FH 4
FH 5
FH 6
Created By
Local Series Name
Parent Material
Rock Class
Family Rock
Texture Group
Permeab
Rock Of Fines
Family Rock Of Fines
Parent Material Origin
Family Code
Sibling Number
Depth
Topsoil Stones
Upper Texture
Lower Texture
Drainage
Misc
FH 1
FH 2
FH 3
FH 4
FH 5
FH 6
Notes
WHCO/Ag Mt na na l m Rh Rh+Hs Tp Awak 3 d 1 l i tLEw zAl Lw LFf Lw Awakaponga silt loam
WHCO/Aw Mt Rh Rh s r Rh Rh Tp Awar 1 d 1 s i tzAw zSAw zAl Oh zLw zAl Awakeri
WHCO/G Mt Rh Rh s r Rh Rh Tp Taup 13 d 2 s l w tzAw zAl zLFs zVAl Galatea sand
WHCO/Hm Mt na na s r Rh Rh Tp Horo 6 d 2 s w tzAw zAl Horomanga sand
WHCO/HS/MbH Mt Rh Rh s r Rh Rh+Ba Tp Taup 90 d 4 s w tbVAl zVAl HS&MbH
WHCO/Kg&Kga Mt Rh Rh s r Rh Rh Tp Kaing 12 s 3 s w tzSAw zVAc zVAd Kaingaroa sand
WHCO/Koe Mt Rh Rh s r/m Rh Rh/Hs Tp/Sa Kopeo 3 d 1 s w tzAw zSAl zAw Al Af Al Kopeopeo loamy sand
WHCO/Kpu Mt Rh Rh s r Rh Rh Tp Taup 11 d 2 s w tzAl zAs zSAl zSLw zSAl Kopuriki sandy gravel
WHCO/Kr Mt Rh Rh s r Rh Rh+Ba Tp Taup 89 d 4 s w tbVAl bVAl zVAl Kawerau sand
WHCO/Maa Mt Rh Rh s r Rh Rh Tp Matat 3 d 2 l s i tzLEw zSAw Al Matata sandy loam
WHCO/Mb Mt Rh Rh s r Rh Rh+Ba Tp Taup 36 d 4 s w tzVAl zAw zSAl zSLw zXA Matahina gravelly sand
WHCO/Mtk Mt na na l m Rh Rh Tp Omeh 15 d 1 l s p tzLEw Lw zAl Lw Al Matuku fine sandy loam
WHCO/Mu Md na na l m Hs Hs+Rh Lc Muri 1 d 1 l s p tLEw LFf Al Lw Af Muriwai silt loam
WHCO/Mx Mt Rh Rh s r Rh Rh Tp Mataw 2 d 1 l s w tzLw zAl zVAd zAw zAf Matawai sandy loam
WHCO/MxH Mt Rh Rh s r Rh Rh Tp Mataw 3 d 1 s w tzAw zAl zVAc zAw zAs zLw Matawai hill soils
WHCO/NS Mm Ss Ss l m/s Rh Rh/Ss Tp/Rx Ngaa 3 md 2 l w tzLEw zSLw LCs Af Ngatiawa steepland soils
WHCO/Ome Mt Rh Rh l r/m Rh Rh Fl Omeh 1 d 1 s l p tzAw zSLFs Omeheu gritty loamy sand
WHCO/Omg Mt Rh Rh s r Rh Rh Tp Taup 85 d 3 s w tzSAw zXA zVAc zAw zVAl
WHCO/Onp Mt Rh Rh l r/m Rh Rh Fl Omeh 2 d 1 s l p tzAw zSLFs zAl zLw zAs Onepu sand
WHCO/Onp Mt na na l r/m Rh Rh Fl Omeh 2 d 1 s l p tzAw zSLFs zAl zLw zAs Onepu sand
WHCO/Pi Md na na s r Rh Rh+Hs Sa Kyra 11 d 1 s w tAw zAl zAw zLFs Aw Al Piripai loamy fine sand
WHCO/Poi Mt Rh Rh s r Rh Rh Fl Orua 15 d 3 s w tzSAw zAw zSAl Poronui sand
WHCO/Pur Mt Rh Rh s r Rh Rh Tp Wyma 23 d 1 l w tzLEw zSAw zLw zSAs
WHCO/Ran Mt Rh Rh s r Rh Rh/Hs Fl Rngt 9 d 1 s w tzAl zLw zSAl VAl Rangitaiki sand
WHCO/Ru Mt Rh Rh s r Rh Rh Tp Orua 30 d 2 s w tzAw zAl zSAw zVAl zAw Ruakituri sand
WHCO/RuH Mt Rh Rh s r Rh Rh Tp Orua 7 d 1 s w tzAw zAl zVAl zAl zAw Ruakituri hill soils
WHCO/Te Mt Rh Rh s r Rh Rh Tp Taup 9 d 1 s w tzAw zAs zVAl zAw Te Rere sand
WHCO/Tes Mt Rh Rh s r Rh Rh Tp Taup 18 d 1 s w tzAw zAs zSAl zLw zAl Te Rere shallow sand
WHCO/Tev Mt Rh Rh s r Rh Rh Tp Taup 19 d 1 s w tzAw zAs zSAl zLw zSAw zLw Te Rere very shallow sand
WHCO/Tks,SB09828 Mt na na l r Rh Rh Tp Tetk 1 d 1 l w tzLw zAw zLw Te Teko sandy loam, Paer
WHCO/TpH Mt Rh Rh s r Rh Rh Tp Taup 92 d 2 s w tzAw zAs zVAl zAs Taupo hill soils
WHCO/Tpsl Mt Rh Rh s r Rh Rh Tp Taup 1 d 1 l s w tzLw zAs zSAs zLw zLFs Taupo sandy loam
WHCO/Tr Mt Rh Rh s r Rh Rh+Ba Tp Taraw 1 d 4 s w tbXA bVAl zAw zAl zXA Tarawera gravel
WHCO/Tra Mt na na s r Rh Rh Tp Taup 8 d 1 s w tzAw zAl zAw zAl zAw zAl Te Rahu loamy sand
WHCO/TrH Mt Rh Rh s r Rh Rh+Ba Tp Taraw 4 d 4 s w tzXA zAl zXA Tarawera hill soils
WHCO/Tto,SB09829 Mt na na s r Rh Rh Tp Turan 15 d 1 s l w tzAs zAw zLw Te Teko sand, Pukeroa
WHCO/TtS Mt na na s r Rh Rh Tp Wyma 1 d 1 s w tzAl zAl zAw zAf zAw TeTeki steepland soils
WHCO/TyS Mm Hs Hs l r Rh Rh Tp Tawh 1 md 1 l k w tzLw zSLFs VLc Tawhia steepland soils
WHCO/U So na na p m Rh Rh Pt/Tp Wind 10 d 1 Tp s p tOhzL Oh zLw zAl Utuhina peaty loam
WHCO/US Mt na na s r Rh Rh Tp Orua 29 md 2 s w tzAw zAf zAw Urewera steepland soils
WHCO/US Mt Rh Rh s r/m Rh Rh Tp Urewe 1 d 1 s w tzAw zAl zAf zAw zSAf Urewera steepland soils
Sibling
Base
Uncertainty
MapUnit
Factsheet
Correlation
Family
Administration
Database: data.smap.databases.landcareresearch.co.nz, SMap
MU: 9274 Taxa: 4077 BP: 2993 Unc: 2791 FS: 2748 Corr: 68 Fam: 1256

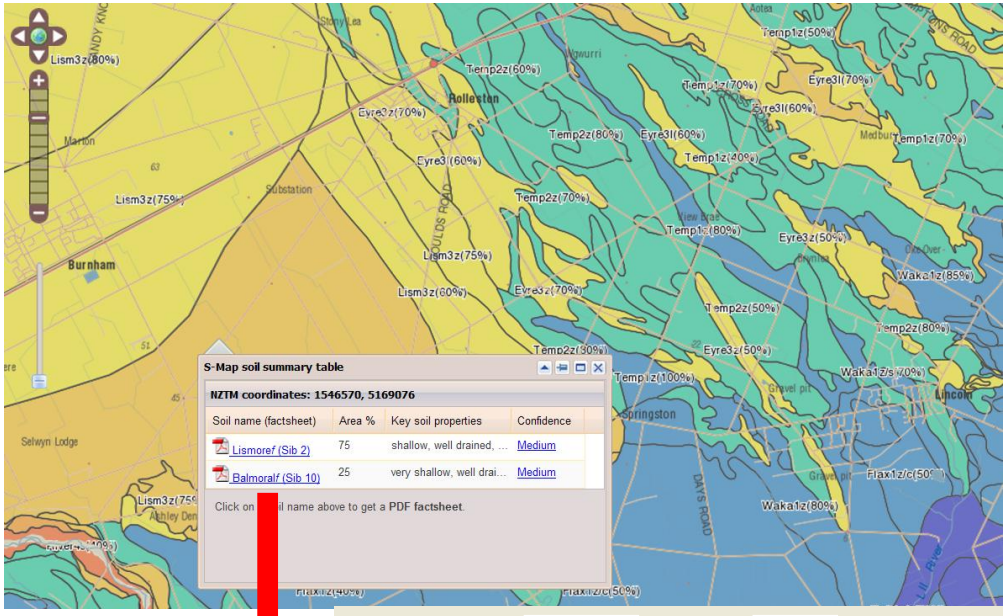
S-map vs National Soils Database

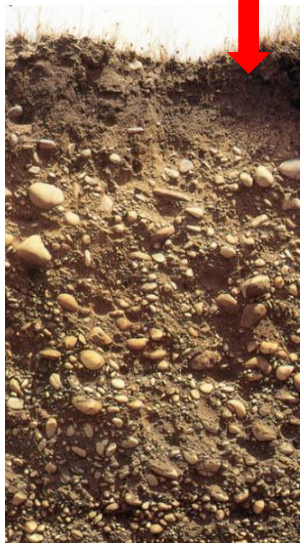
S-map = spatial variability

S-map siblings
= 3,000 in 21% area

NSD = 1,500 profiles for whole country

NSD = point measurements of soil attributes





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 (%) Readily avail	Total avail	Horizon (mm) Readily (10-100)	Total (10-	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

National Soils Database

- Archival database from the Soil Bureau
- Nationally significant database

- ~1500 profiles with analytical data

➢ Sounds a lot…..BUT,

- Many profiles only limited analyses

➢ Only 416 sites with soil water data

NSD redevelopment Yr1

Focus: Rebuilding the database infrastructure to meet modern needs

Archival → Alive !!!!

Capability: Database not just limited to classic pedology data

Soil data generation in NZ

Public funding generates vast amount of soil data per annum

Example 1:

Some numbers from one CRI lab:

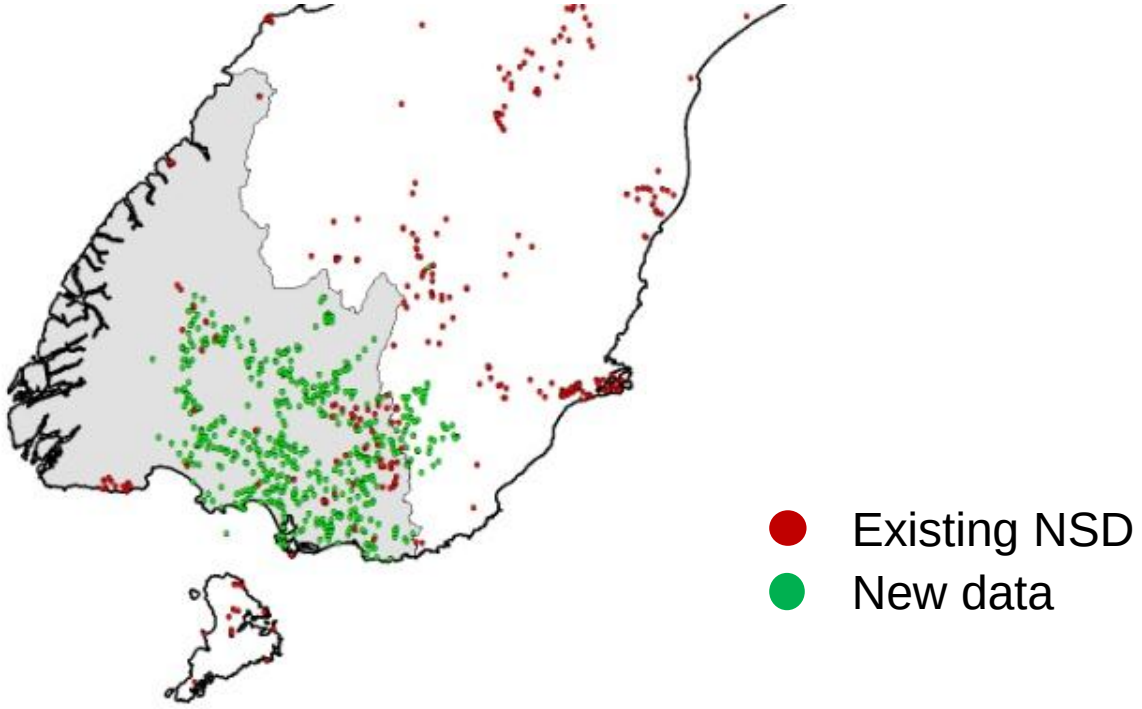
2,724	14,680	65 : 35
samples	attributes	source

Imagine the per annum data generation by the major soil research agencies:

3 CRI's, 3 Universities, 11 regional councils ….

Soil data generation in NZ

Example 2: Southland



Soil data generation in NZ

Example 3: Waikato

Agriculture, Ecosystems and Environment 185 (2014) 34–40

Contents lists available at ScienceDirect

Agriculture, Ecosystems and Environment

journal homepage: www.elsevier.com/locate/agee

Soil C and N contents in a paired survey of dairy and dry stock pastures in New Zealand

A.L. Barnett[a,b], L.A. Schipper[a,*], A. Taylor[b], M.R. Balks[a], P.L. Mudge[c]

Data generated : 25 paired sites (50)
C, N, Bulk density
3 depths each site

450 attribute measurements !!!

Key messages (NSD)

- NZ generates huge amount of soil data annually
- … poor data management means minimal benefit for that investment
- Landcare is building this essential database

- **But** … we need your support.

Inference Engine (models)

S-map & NSD

Soil properties
Soil-based risk/vulnerability
Soil ecosystem services

S-map/NSD + climate

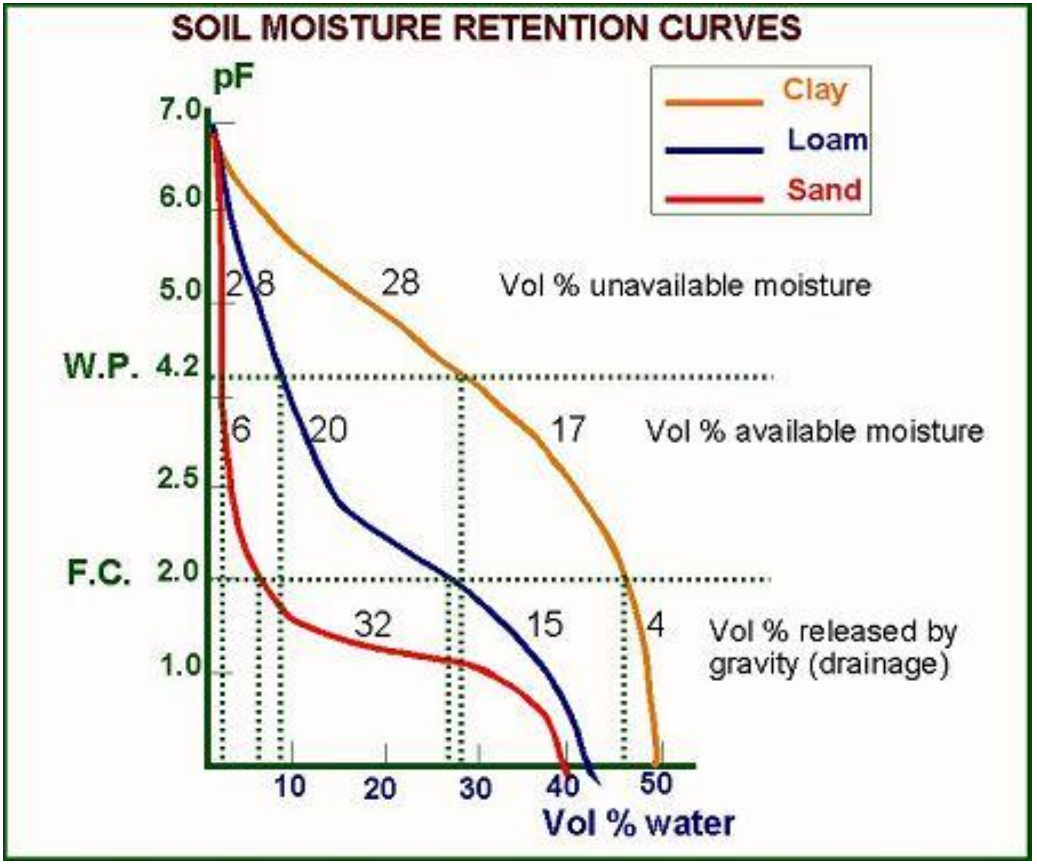
Drainage
Soil-climate based risk/vulnerability
Soil-climate suitability
Irrigation schemes

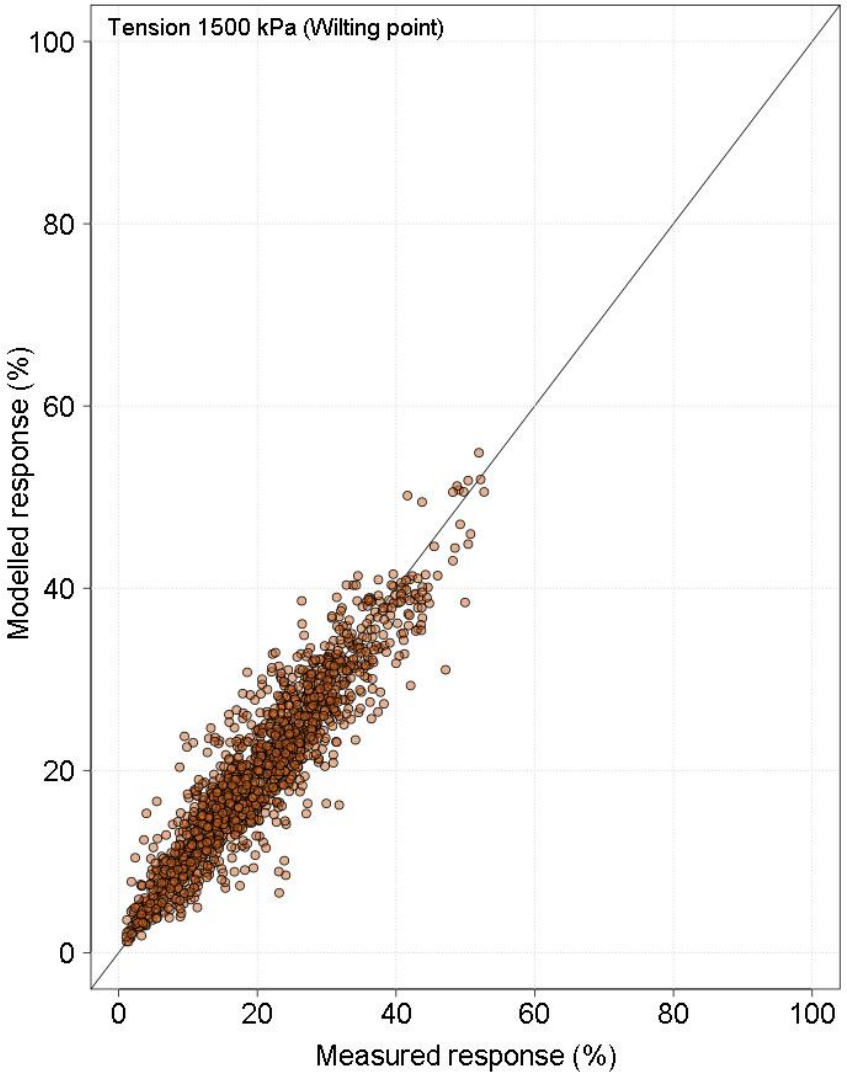
S-map/NSD + climate + land management

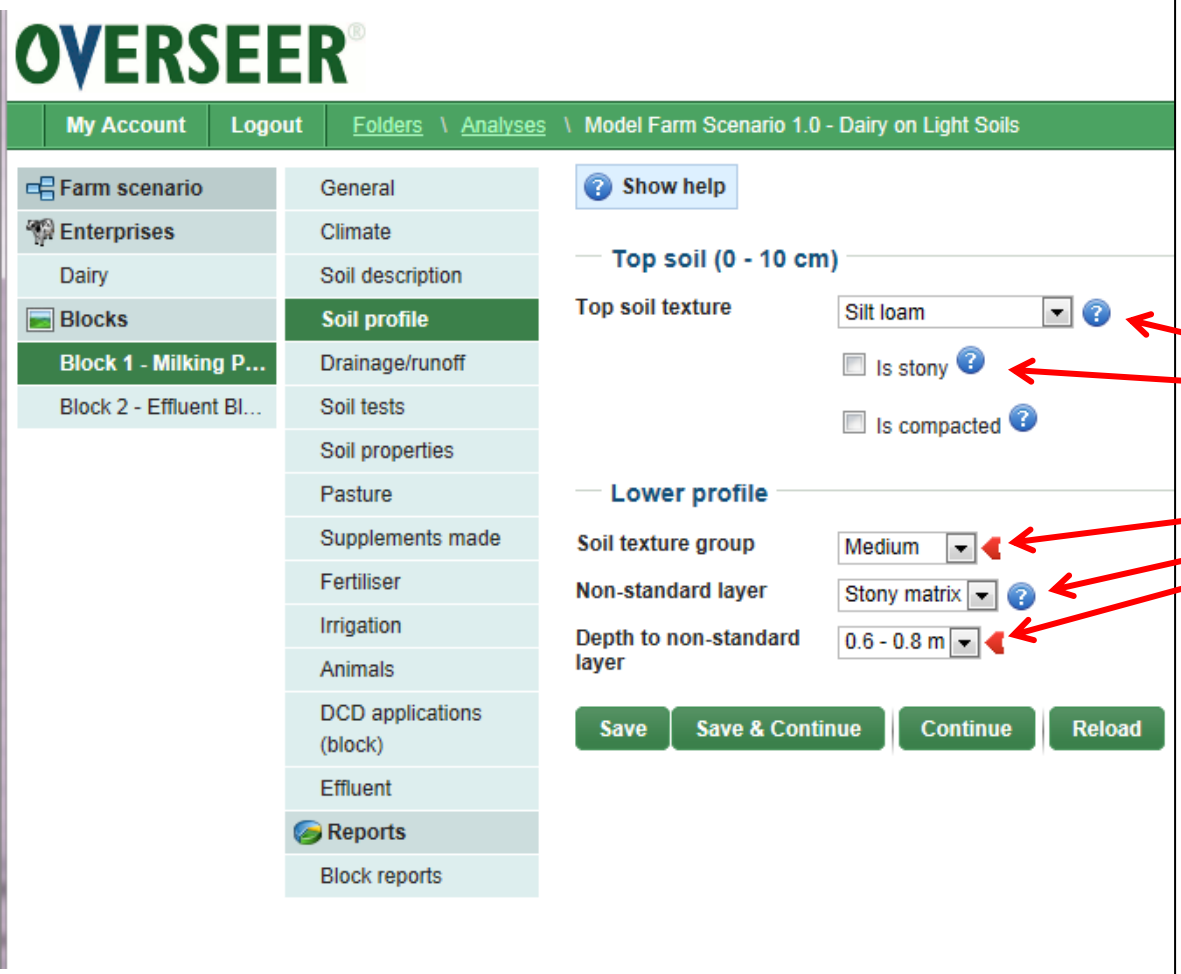
Nutrient loads
Irrigation impacts
Monitoring of high risk sites

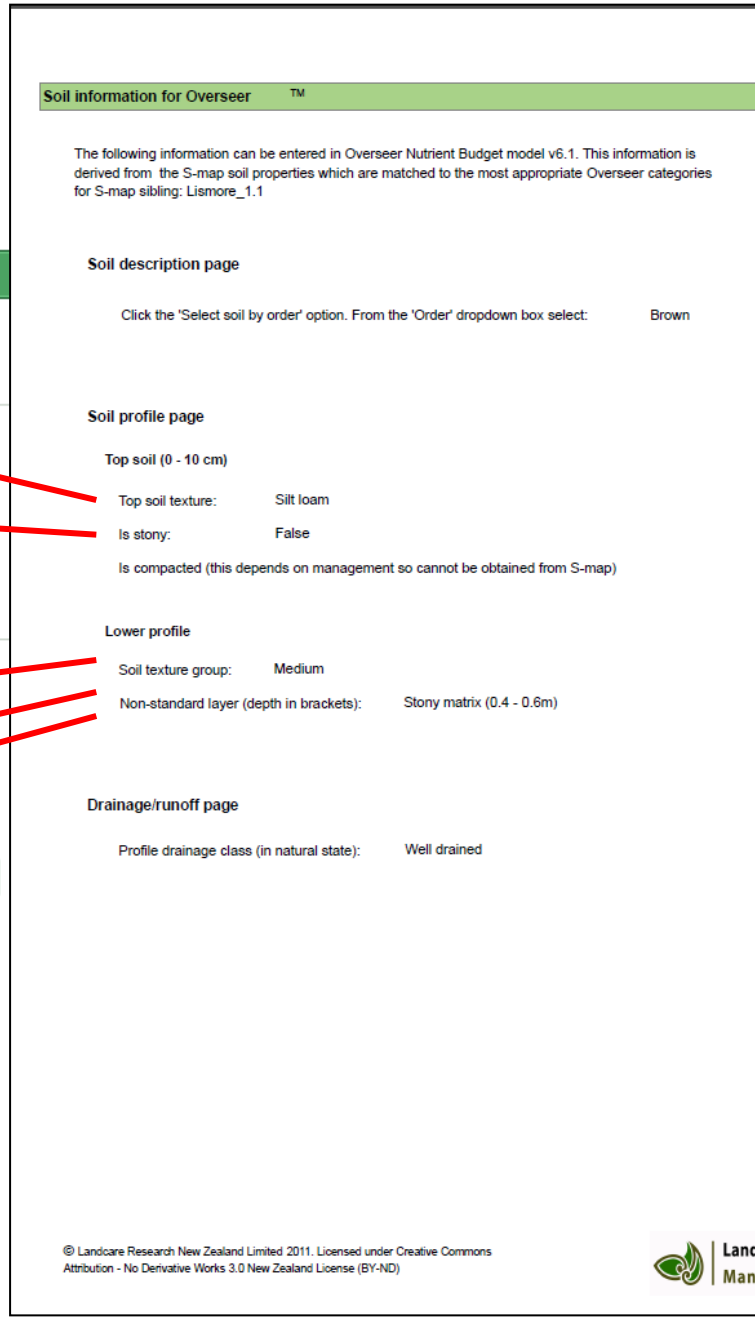
NSD pedo-transfer functions

- Measurements of the water retention curve from NSD
- Statistical analysis to derive predictive equations for points on the curve, i.e. estimates of field capacity, wilting point and saturation …. and available water


SOIL MOISTURE RETENTION CURVES
pF
7.0
6.0
5.0
W.P. 4.2
2.5
F.C. 2.0
1.0
Clay
Loam
Sand
2
8
28
Vol % unavailable moisture
6
20
17
Vol % available moisture
32
15
4
Vol % released by gravity (drainage)
10
20
30
40
50
Vol % water


Tension 1500 kPa (Wilting point)
Modelled response (%)
Measured response (%)
0
20
40
60
80
100





Soil information for Overseer ™

The following information can be entered in Overseer Nutrient Budget model v6.1. This information is derived from the S-map soil properties which are matched to the most appropriate Overseer categories for S-map sibling: Lismore_1.1

Soil description page

Click the 'Select soil by order' option. From the 'Order' dropdown box select: Brown

Soil profile page

Top soil (0 - 10 cm)

Top soil texture: Silt loam

Is stony: False

Is compacted (this depends on management so cannot be obtained from S-map)

Lower profile

Soil texture group: Medium

Non-standard layer (depth in brackets): Stony matrix (0.4 - 0.6m)

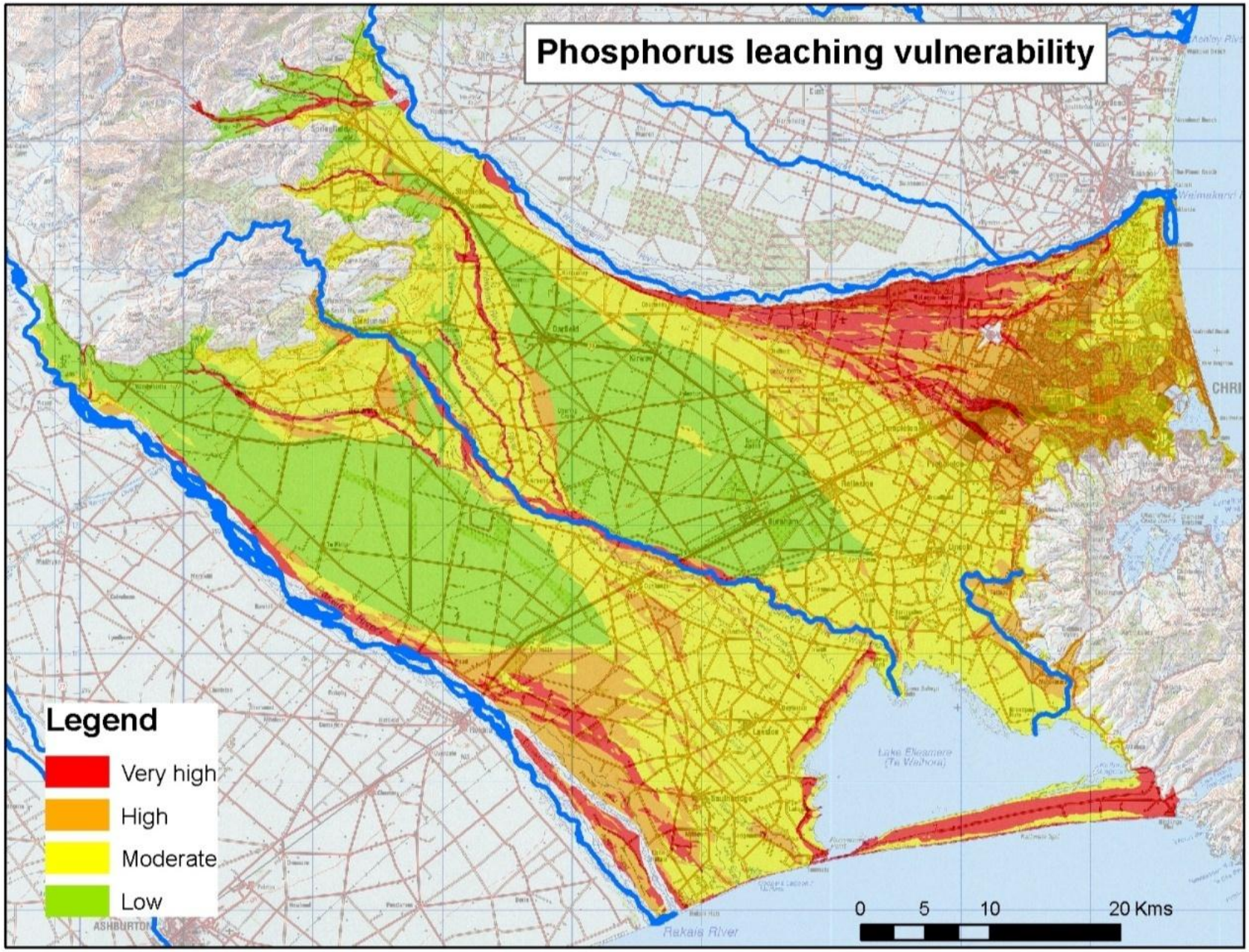
Drainage/runoff page

Profile drainage class (in natural state): Well drained

Soil vulnerability mapping

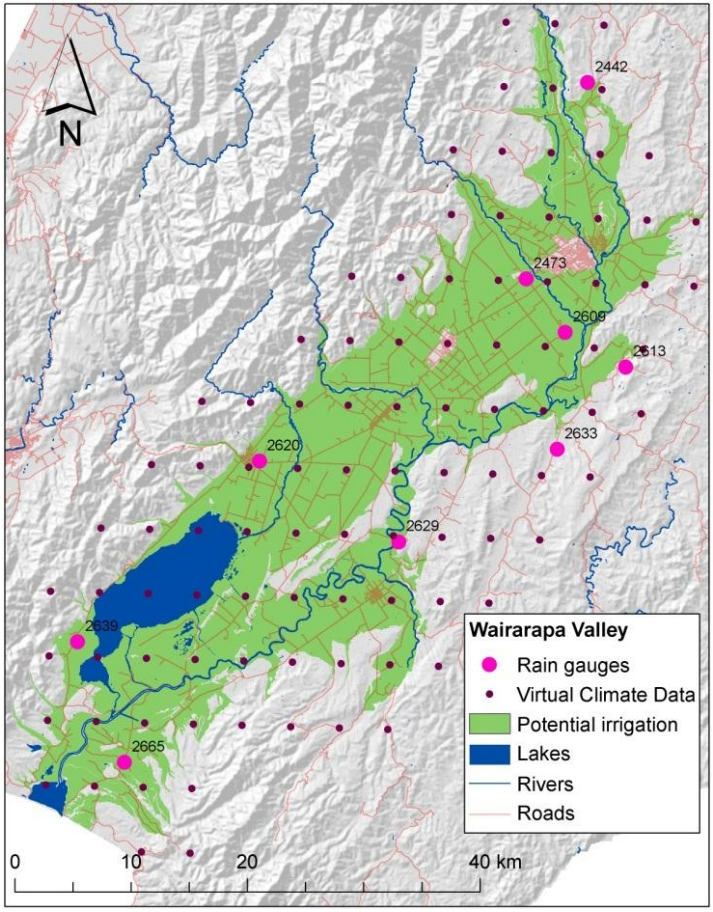
Soil factors affecting

- Leaching (N and P)
- By pass flow
- Potential Runoff

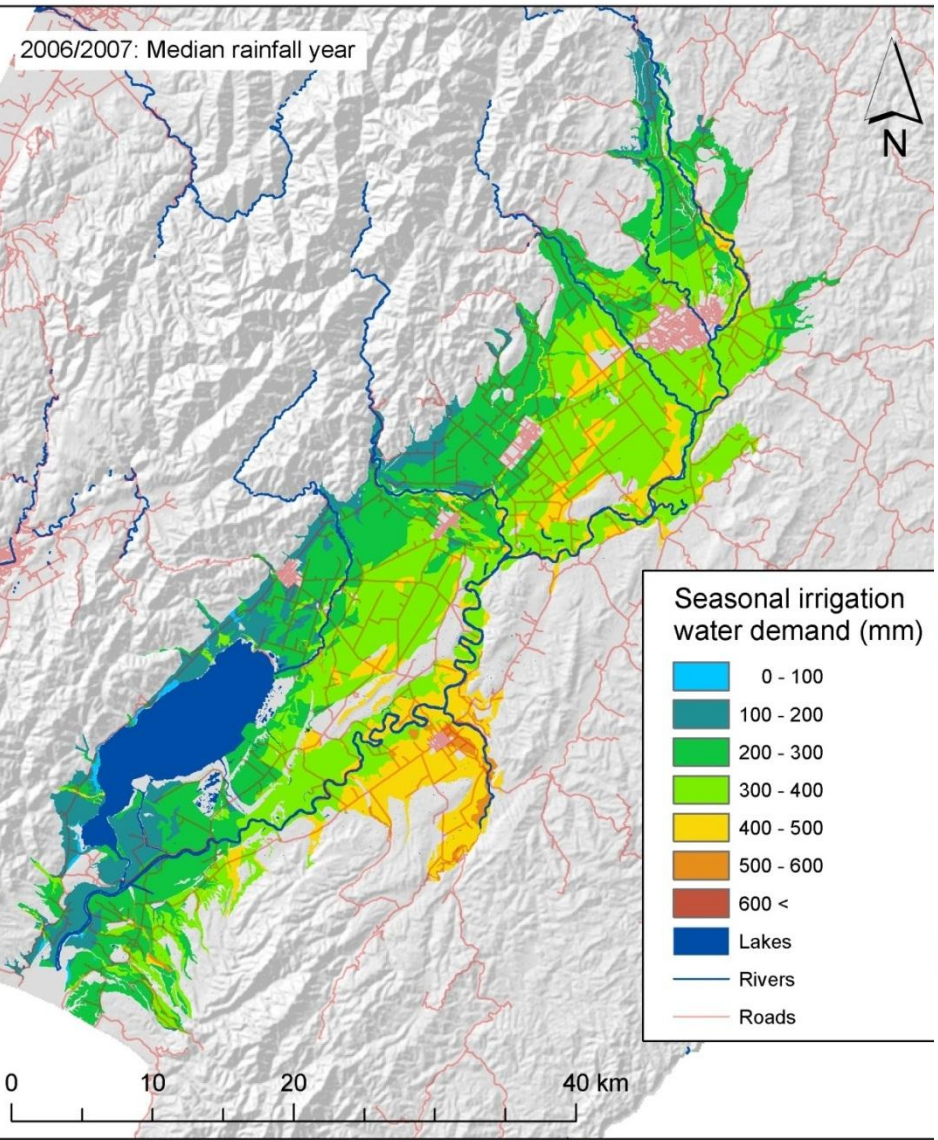

Phosphorus leaching vulnerability
Legend
Very high
High
Moderate
Low
0
5
10
20 Kms

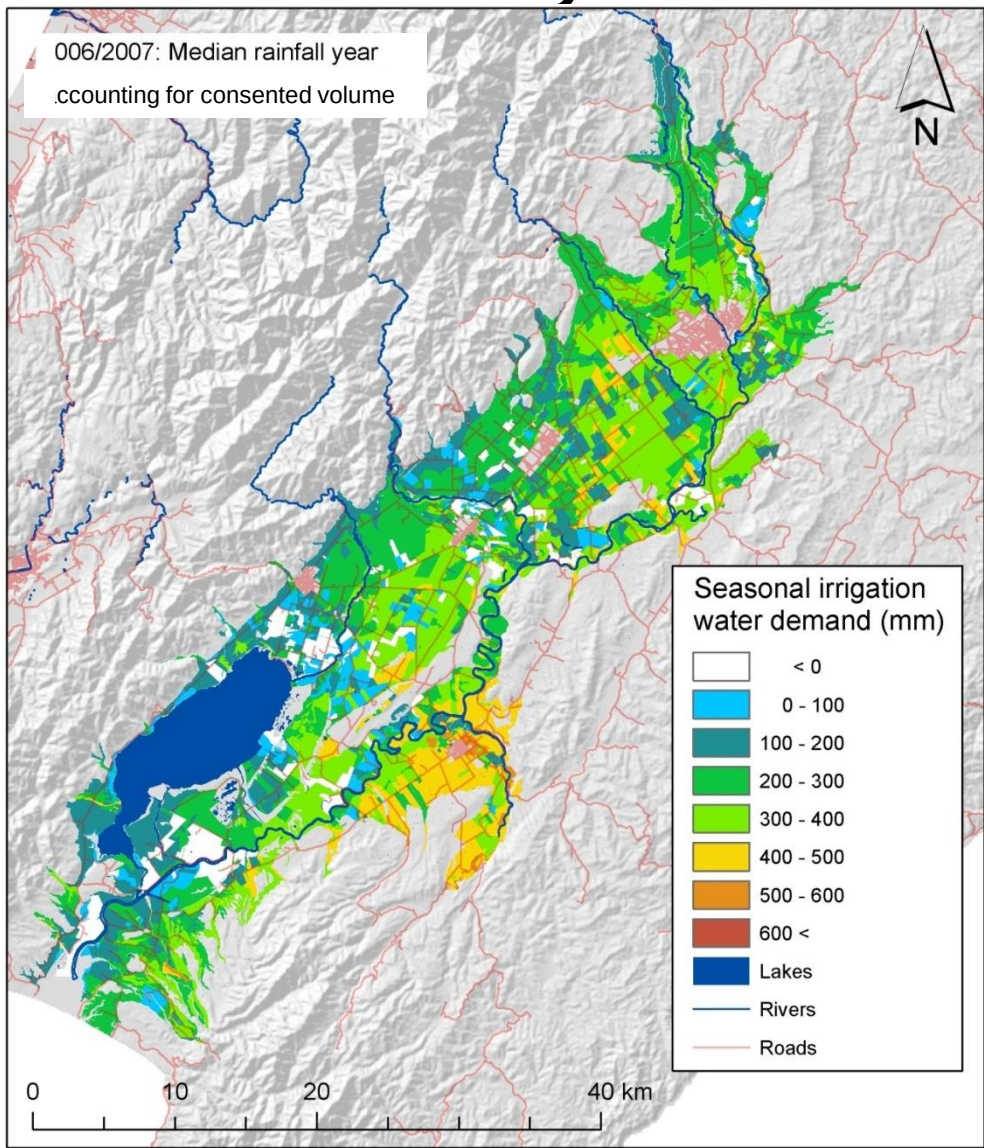
Soil + climate (water demand)

- Run a daily water balance using Niwa Virtual Climate Stations
- Irrigate when at 50% PAW
- Takes into account the storage capacity of the soil and capillary flow from groundwater

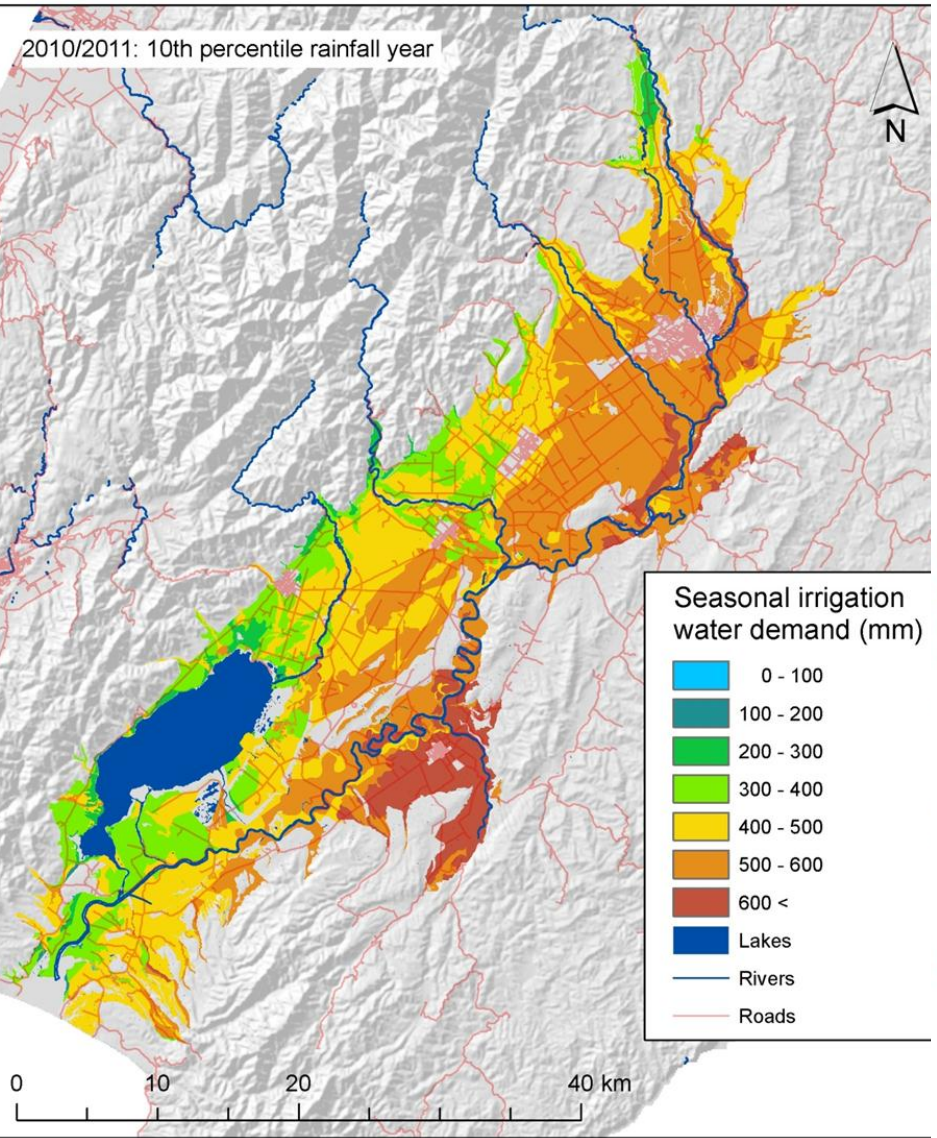


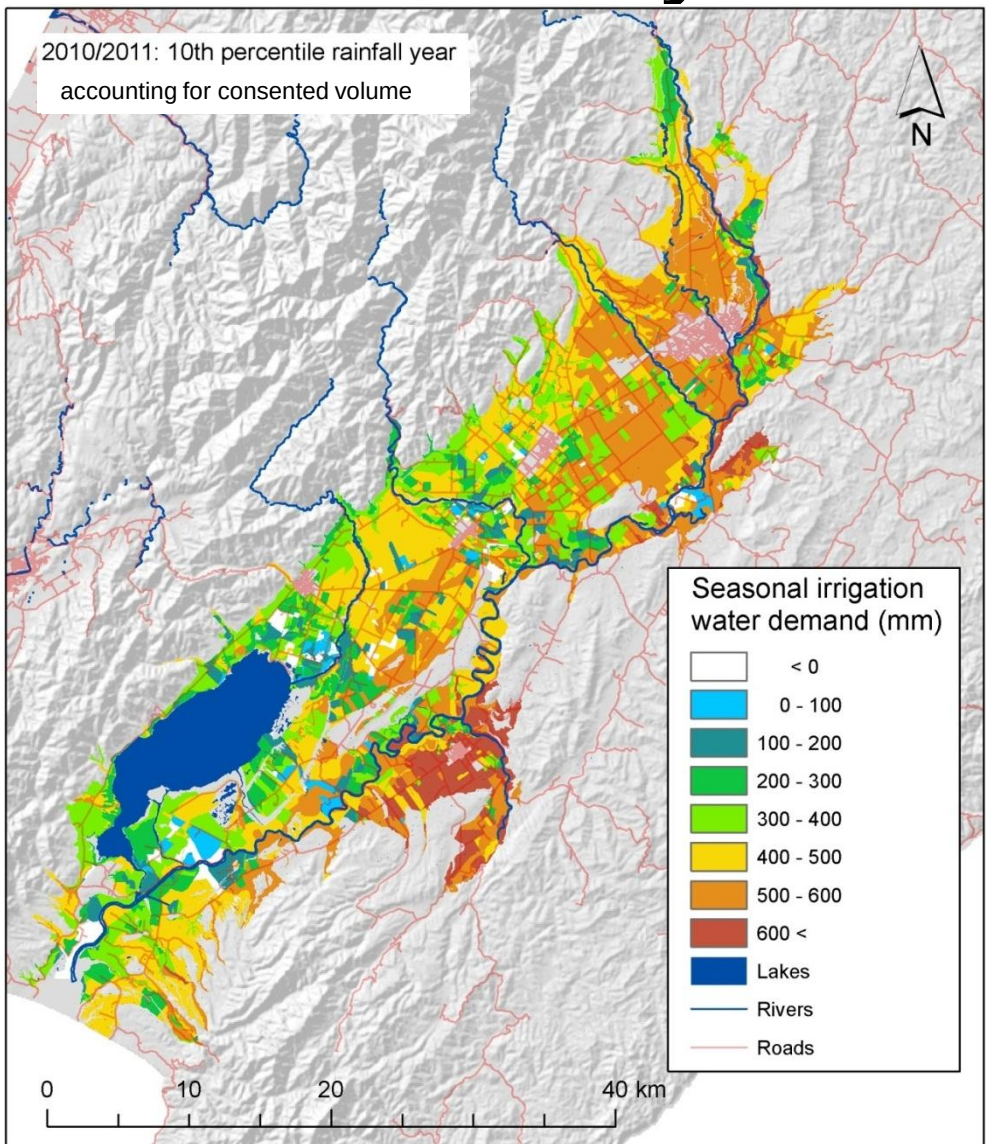
Water demand across irrigation season for median rainfall year





Water demand across irrigation season for 10th percentile rainfall year



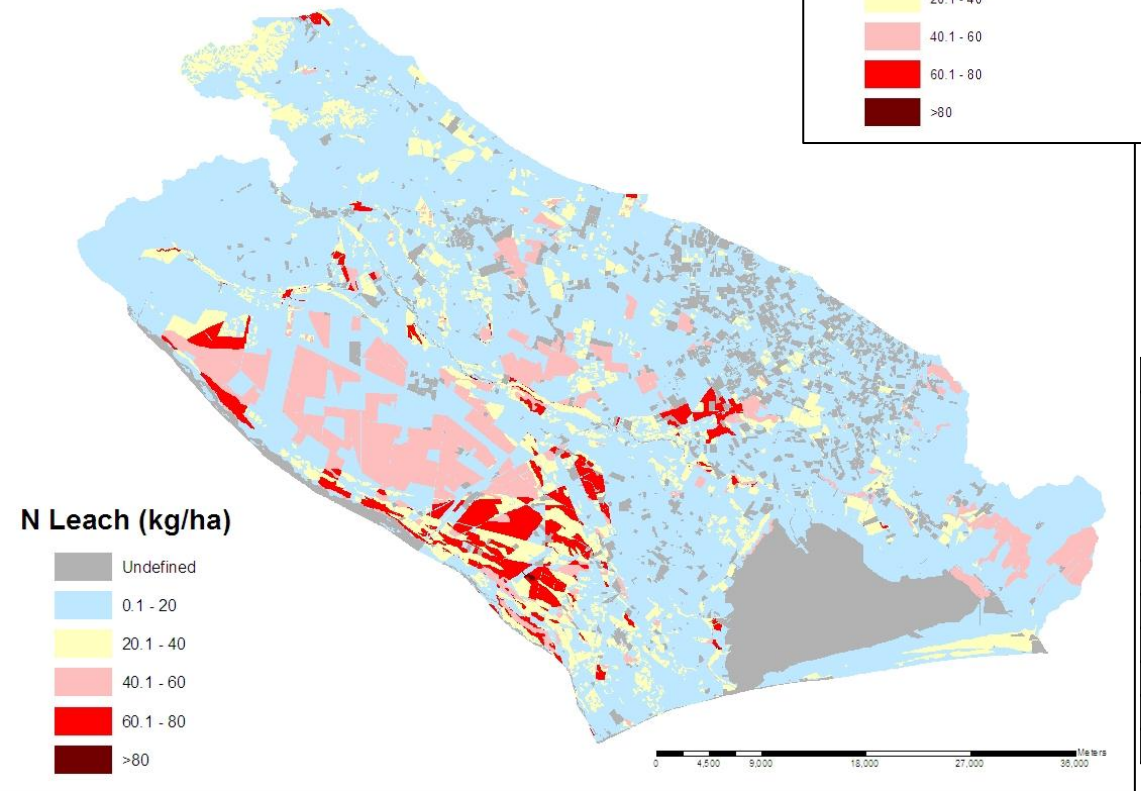


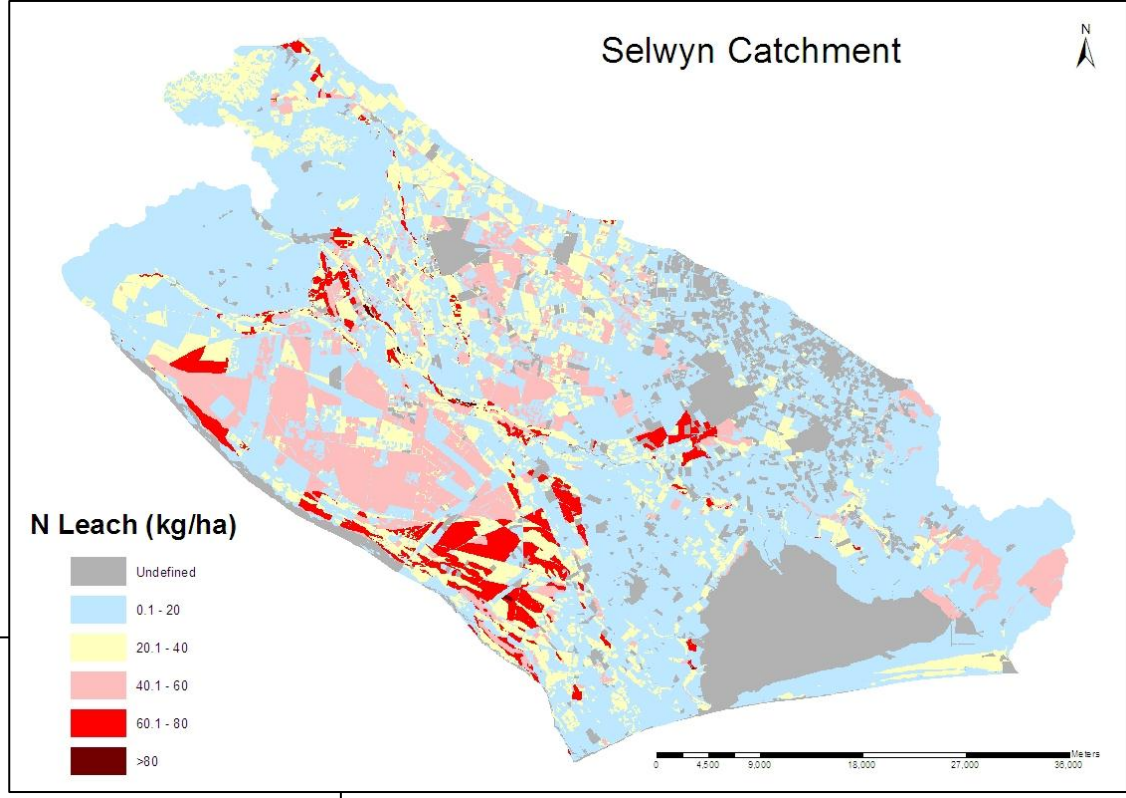
Soil + climate + land management

- Land management = Pressure (past, current or potential)
- Model agricultural impact: climate, soil, and farm type & management, irrigation vs dryland on
  - nutrient losses
  - contaminants
  - soil health
  - N saturation

Catchment loads (nitrate)

Baseline scenario





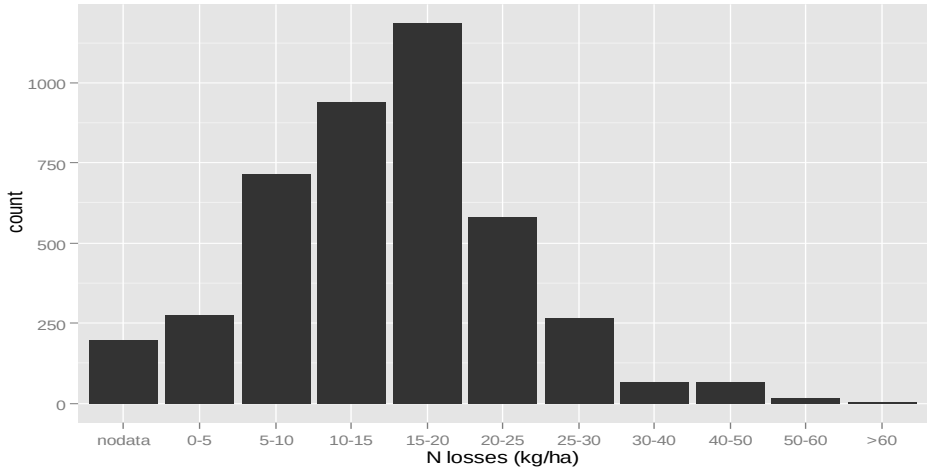
Development scenario

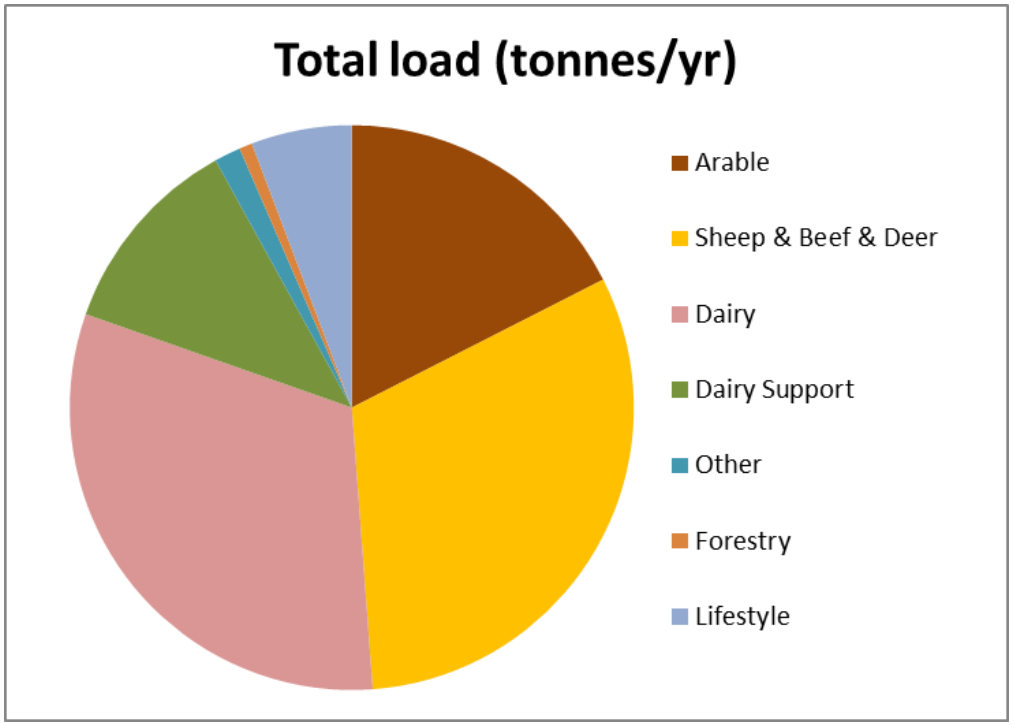
	Baseline			Development	
Enterprise	Net Farm Revenue (million $)	N Load (tonnes)		Net Farm Revenue (million $)	N Load (tonnes)
Dairy	$178.6	1,940		$221.1	2364
Dairy Support	$8.3	293		$11.2	417
Arable	$32.4	470		$40.9	675
Sheep & Beef	$56.8	1,756		$48.5	1589
Horticulture	$6.0	5		$5.5	5
Forestry	$8.5	10		$6.9	8
Other	$1.3	15		$1.1	13
Total	$292.0	4,490		$335.3	5,070

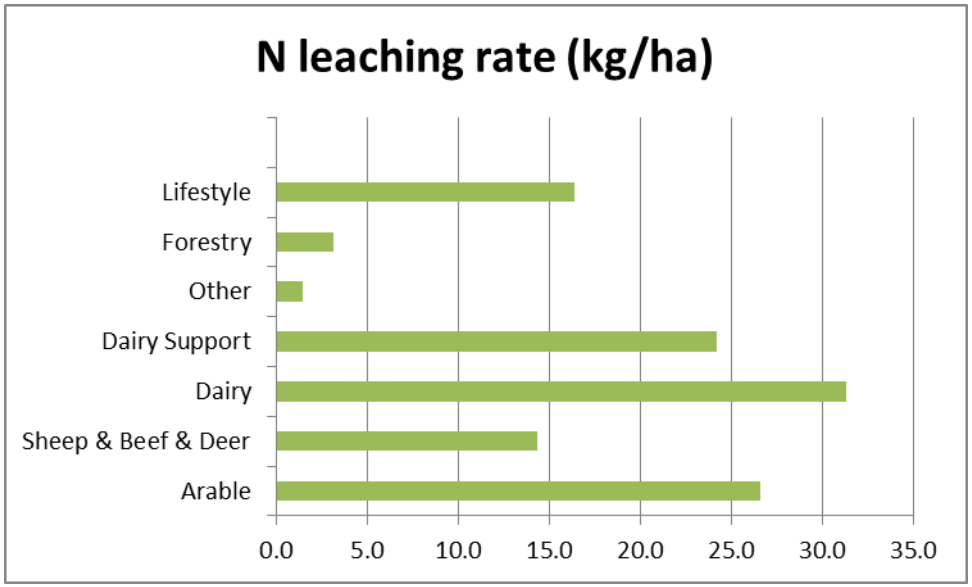
Count of farms and total area within each category of nitrate loss

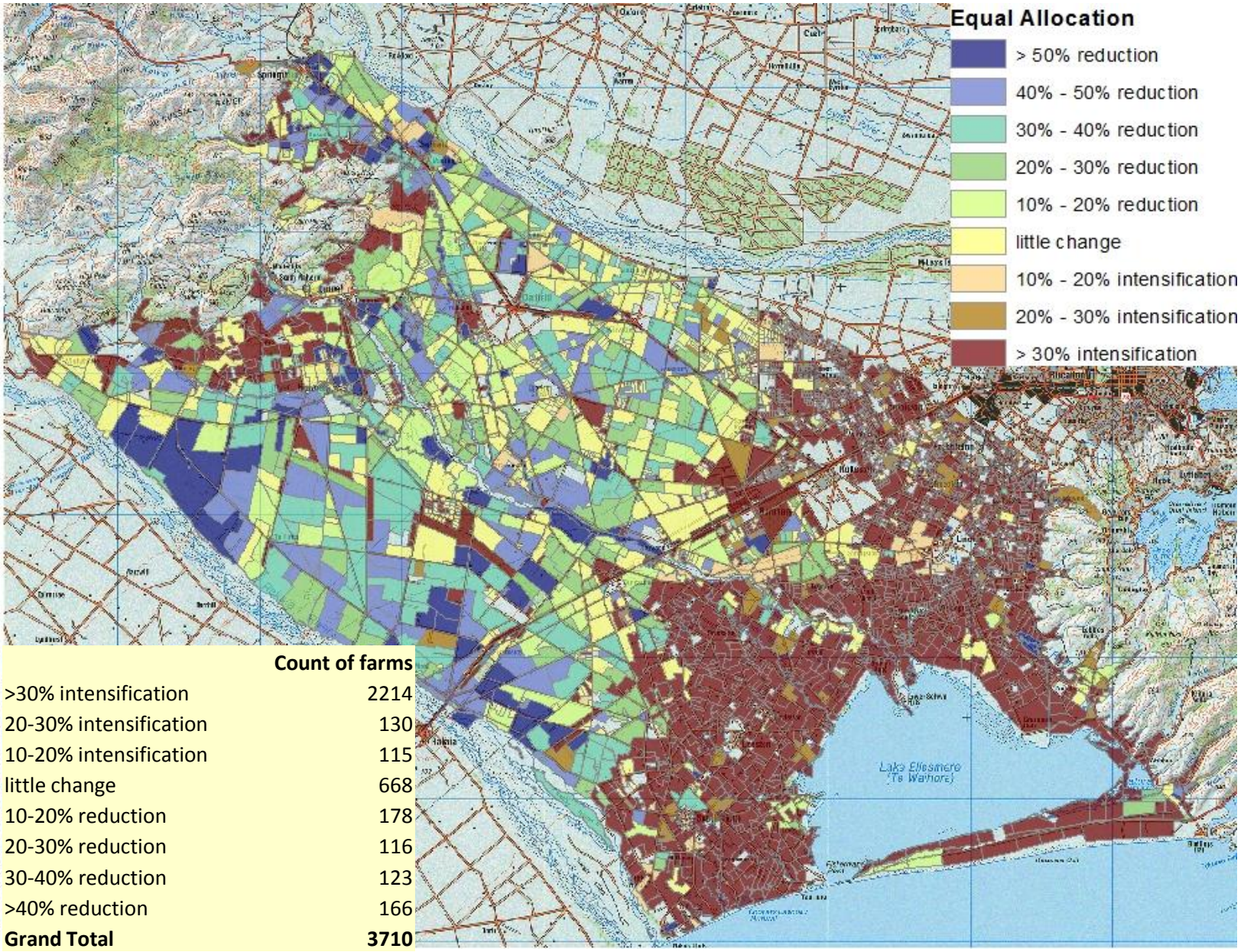
Nitrate loss (kg/ha)	Count	Percent count	Cumulative % count	Area (ha)	Percent area	Cumulative % area
0–5	274	6.3	6.3	28,440	12.5	12.5
5–10	715	16.6	22.9	45,937	20.2	32.7
10–15	940	21.8	44.7	52,403	23.1	55.8
15–20	1186	27.5	72.1	30,319	13.3	69.1
20–25	582	13.5	85.6	22,412	9.9	79.0
25–30	267	6.2	91.8	24,681	10.9	89.8
30–40	69	1.6	93.4	5,412	2.4	92.2
40–50	69	1.6	95.0	15,117	6.7	98.9
50–60	15	0.3	95.3	2,190	1.0	99.8
>60	3	0.1	95.4	376	0.2	100.0
No data	200	4.6	100.0	5	0.0	100.0

Bar plot showing the distribution of mean nitrate lost (kg/ha) from each farm.




Total load (tonnes/yr)
Arable
Sheep & Beef & Deer
Dairy
Dairy Support
Other
Forestry
Lifestyle

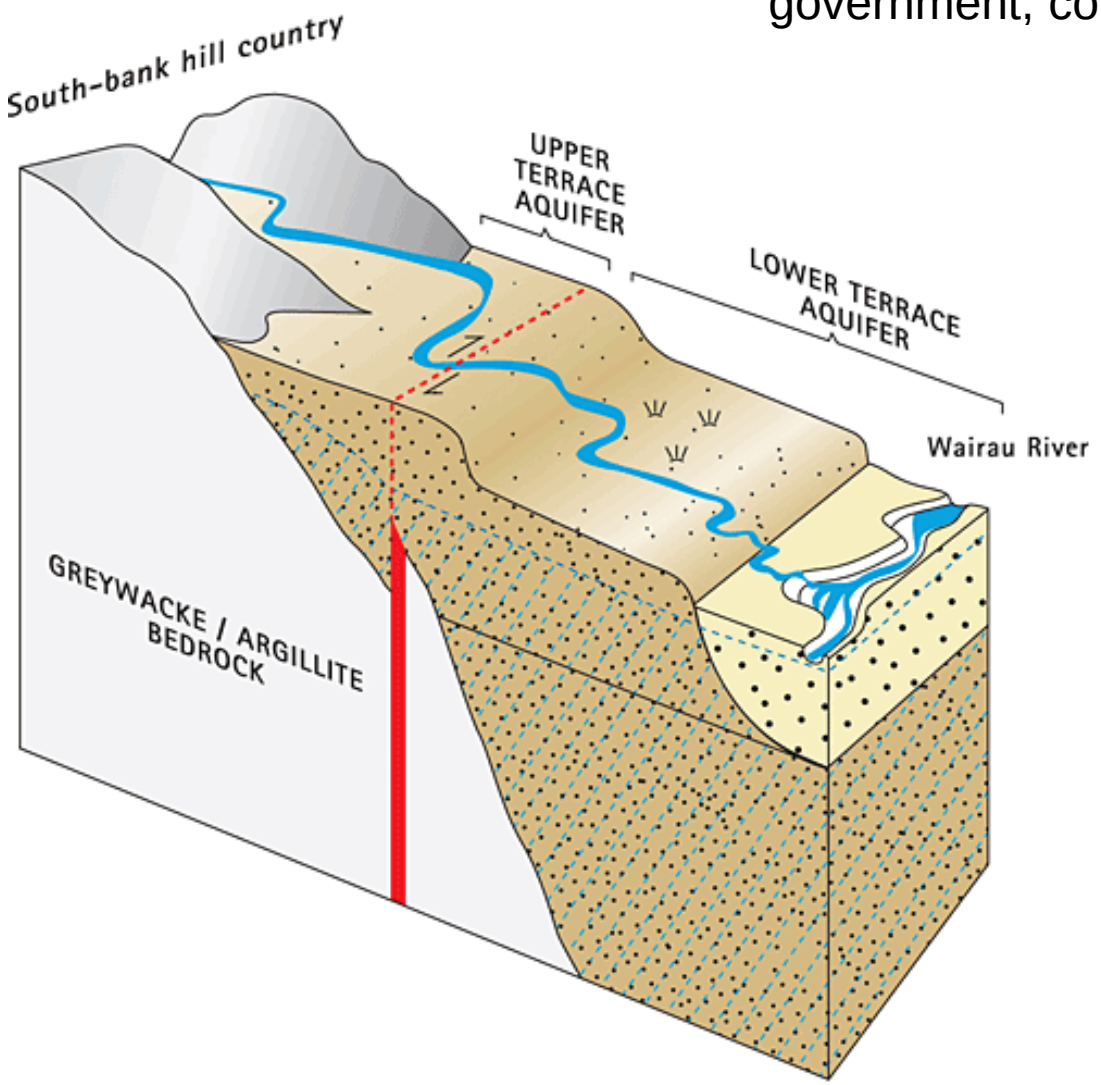

N leaching rate (kg/ha)
Lifestyle
Forestry
Other
Dairy Support
Dairy
Sheep & Beef & Deer
Arable
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0



	Count of farms
>30% intensification	2214
20-30% intensification	130
10-20% intensification	115
little change	668
10-20% reduction	178
20-30% reduction	116
30-40% reduction	123
>40% reduction	166
Grand Total	**3710**

“Good information is necessary if the right decisions are to be made on freshwater quality management, whether by central government, councils or resource users”

Freshwater Reform 2013



Key messages (Under the hood)

- The S-map/NSD linkage demonstrates the potential benefit of coordinated soil data management
- With informatics technology we now have a powerful and flexible soil information system
- Can’t achieve regional water quality outcomes without good soil information

3. Smap in the future

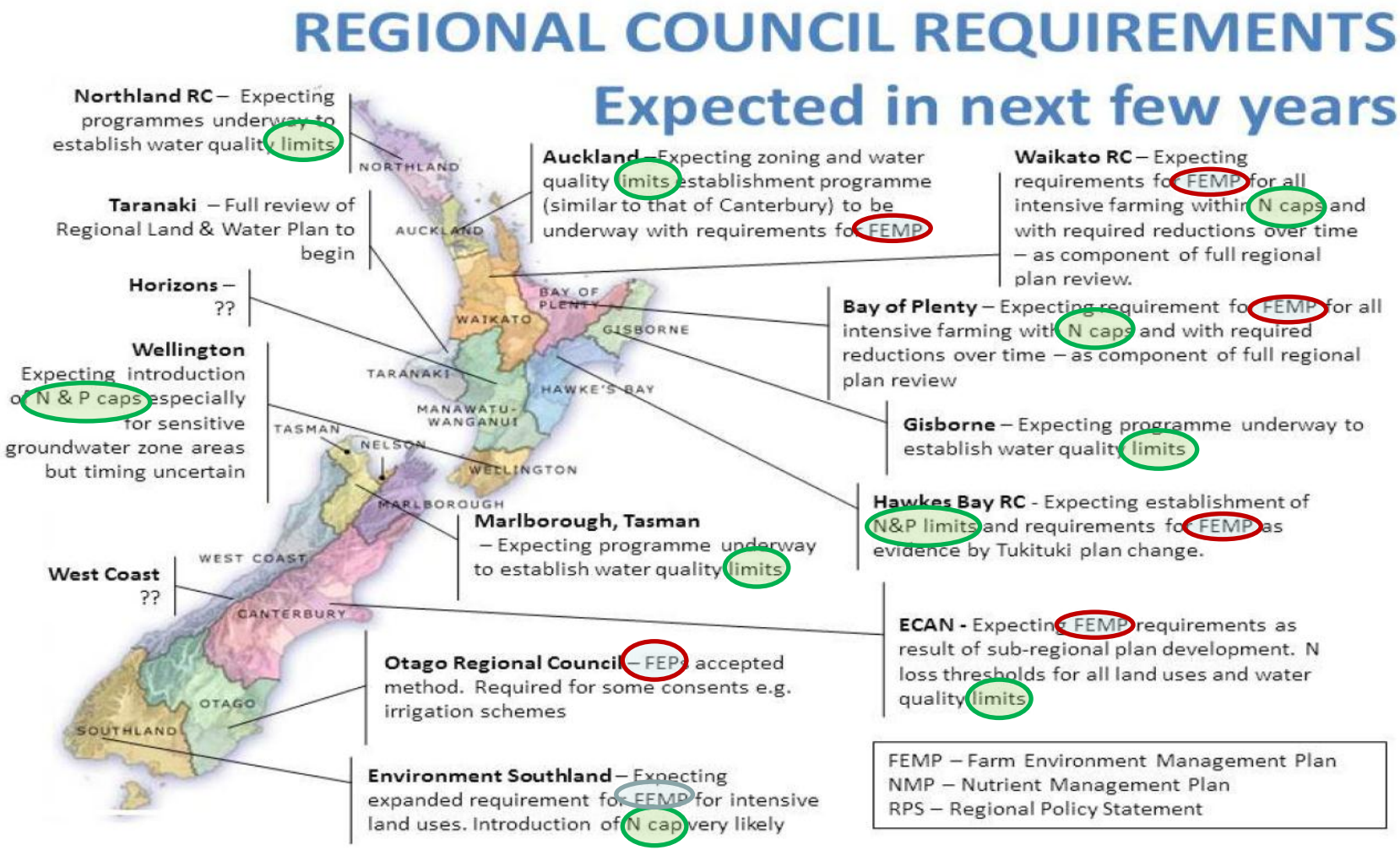


Figure 2: Likely Regional Council Requirements for Farm Environment Plans or Nutrient Management Plans in next few years

ets/Documents/Irrigation-ASM/20130322-IASM-Managing-to-

Policy & regulation drivers = game changer

Success will need quality soil information

Information provision needs to have:

- Clarity (appropriate methods and options for farm scale mapping)
- Certainty (in the accuracy, reliability and acceptability of the data) to those investing
- Auditable (equitable and consistent outcomes)
- Consistency (to allow integration across scales, farm data to catchment-level modelling)

Sources of soil information

- LUC/LRI maps
- Electro-magnetic induction survey
- Field observations (e.g., morphology)
- Lab analysed physical samples (biological, chemical and physical properties)
- Continual measurements (lysimeters, soil moisture meters)
- Soil survey
- Digital soil modelling
- Precision agriculture records

Features of a protocol

- Simple organisation (hierarchy)
- Underpinned by referenced standards
- Produce consistent, auditable outcomes

But…

- Different in key land environments

  (e.g. multiple use, semi-intensive rolling / hill, steeplands)
- Flexible to accommodate new issues, science and technology

An example protocol: intensively farmed plains

Level	Soil map	Base soil attribute data	Temporally dynamic attributes	Indicative cost (e.g. 200 ha farm)
Poor	Fundamental soil layer	Fundamental soil layer	----------	Free
Basic	S-map online	S-map fact sheets	On-farm observations + model defaults	Free
Good	Low variability: S-map High variability: Farm mapping	S-map fact sheets	On-farm observations	$1000 - $10,000
Premium	Farm / paddock mapping	S-map fact sheets upgraded with on-farm data		$10,000+

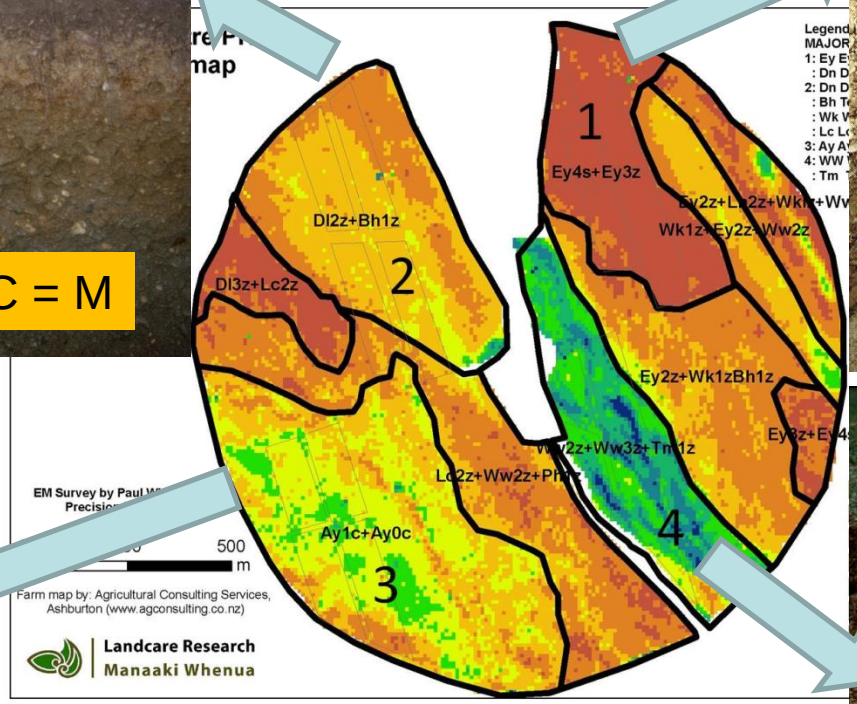
The great farm scale challenge !!

AWC = MH

AWC = M

AWC = VL

AWC = H



AWC = L?

Factsheets to support farm plans

Landcare Research
Manaaki Whenua

S-map Soil Report

Report generated: 12-Dec-2013 from http://smap.landcareresearch.co.nz

This information sheet describes the typical average properties of the specified soil to a depth of 1 metre, and should not be the primary source of data when making land use decisions on individual farms and paddocks.

Lismoref — **Pallic Firm Brown Soil**

S-map ref: Lismore_1.1 — Lism3z (80% of the mapunit at location (5171933, 1539342), Confidence: Medium)

Key physical properties

Irrigation

Depth class (diggability		Shallow (20 - 45 cm)
Texture profile		Silty Loam
Potential rooting depth		Unlimited
Rooting barrier		No significant barrier within 1 m
Topsoil stoniness		Slightly stony
Topsoil clay range		15 - 25 %
Drainage class		Well drained
Aeration in root zone		Unlimited
Permeability profile		Moderate Over Rapid
Depth to slowly permeable horizon		No slowly permeable horizon
Permeability of slowest horizon		Moderate (4 - 72 mm/h)
Profile available water	(0 - 100cm or root barrier)	Moderate (100 mm)
	(0 - 60cm or root barrier)	Moderate (88 mm)
	(0 - 30cm or root barrier)	High (60 mm)
Dry bulk density, topsoil		1.09 (g/cm3)
Dry bulk density, subsoil		1.42 (g/cm3)
Depth to hard rock		No hard rock within 1 m
Depth to soft rock		No soft rock within 1 m
Depth to stony layer class		Shallow

Key chemical properties

Topsoil P retention	Medium (43%)

About this publication

- This information sheet describes the *typical average properties* of the specified soil to a depth of 1 metre.
- For further information on individual soils, contact Landcare Research New Zealand Ltd: www.landcareresearch.co.nz
- Advice should be sought from soil and land use experts before making decisions on individual farms and paddocks.
- The information has been derived from numerous sources. It may not be complete, correct or up to date.
- This information sheet is licensed by Landcare Research on an "as is" and "as available" basis and without any warranty of any kind, either express or implied.
- Landcare Research shall not be liable on any legal basis (including without limitation negligence) and expressly excludes all liability for loss or damage howsoever and whenever caused to a user of this factsheet.

Landcare Research
Manaaki Whenua

Identifying where good management practices are needed

Lismoref

Additional facto

Vulnerability classes relate to soil properties only and do not take into account climate or management

Soil structure integrity

Erodibility of soil material	Moderate
Structural vulnerability	Moderate (0.52)
Pugging vulnerability	not available yet

Water management

Water logging vulnerability	Very Low
Drought vulnerability - if not irrigated	Moderate
Bypass flow	Medium
Hydrological soil group	A
Irrigability	Flat to very gently undulating land with good drainage/permeability and soils with moderate PAW

Contaminant management

Farm dairy effluent framework

Bypass flow	Medium
Dairy effluent (FDE) risk category	D

Additional information

Soil classification	Pallic Firm Brown Soils
Family	Lismoref
Sibling number	1
Profile texture group	Silty
Soil profile material	Rounded stony soil
Rock class of stones/rocks	From Hard Sandstone Rock
Rock origin of fine earth	From Hard Sandstone Rock
Parent material origin	Alluvium

Characteristics of functional horizons in order from top to base of profile:

Functional Horizon	Thickness	Stones	Clay*	Sand*
Loamy Weak	15 - 30 cm	0 - 10 %	15 - 25 %	5 - 30 %
Loamy Weak	5 - 25 cm	0 - 10 %	12 - 25 %	5 - 30 %
Very Stony Loamy Compact	0 - 20 cm	35 - 60 %	10 - 22 %	10 - 50 %
Very Stony Loamy Loose	0 - 20 cm	50 - 70 %	6 - 12 %	20 - 70 %
Very Stony Sandy Loose	40 - 55 cm	60 - 75 %	1 - 4 %	85 - 95 %

* clay and sand percent values are for the mineral fines (excludes stones). Silt = 100 - (clay + sand)

Landcare Research
Manaaki Whenua

We recommend …

- Pan agency national farm-scale soil information protocol working group
- Consistent NZ wide training
- Simple farm mapping support tools, e.g.
  - soil mapping & description guide,
  - online soil factsheet builder

Key messages (S-map in the future)

- We are now focussing on supporting farm scale soil information
- Key to this is a national soil information protocol
- Big challenge is closing the loop between consistency in farm plans and catchment outcomes