



Landcare Research
Manaaki Whenua



MAXIMISING THE VALUE
OF IRRIGATION
Landcare Research & Plant and Food Research led MBE Project

Maximising the value of irrigation: *new technologies for precision management*

Carolyn Hedley & Pierre Roudier

Wellington LINK seminar, 18 March 2014



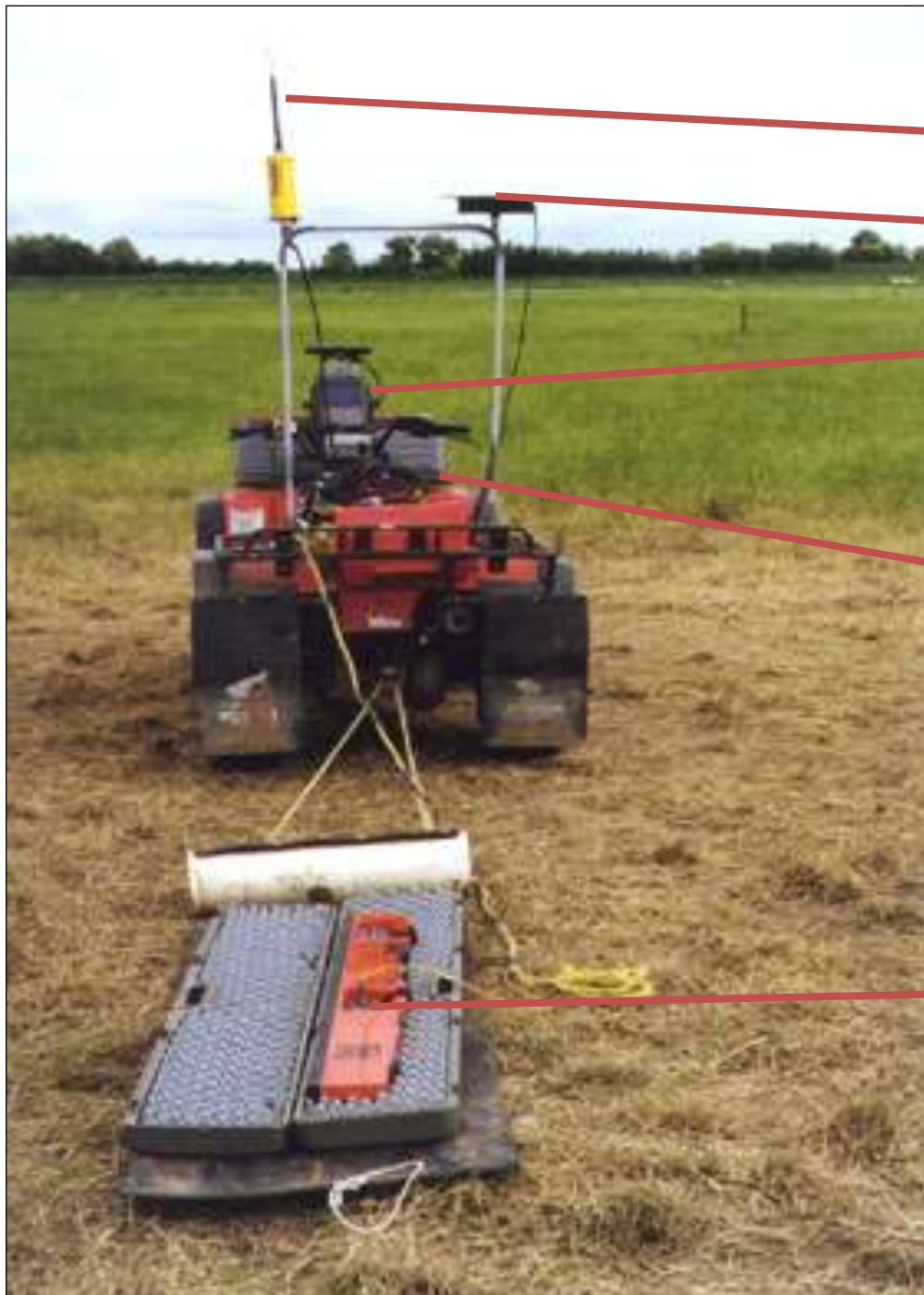
Talk overview

1. New sensor technologies = data-rich
2. The rise of information technologies supporting high resolution sensor data
3. A precision irrigation case study
4. New opportunities (Varigate, MBIE irrigation programme, S-map)

Sensor technologies

- Provide high resolution soil data = better information
- We need to rethink how we handle soil data
- An example is EM mapping (geophysical measure responding to important soil properties such as salinity, texture, CEC and water content)
- Useful to assess spatial variability

EM mapping



GPS radio

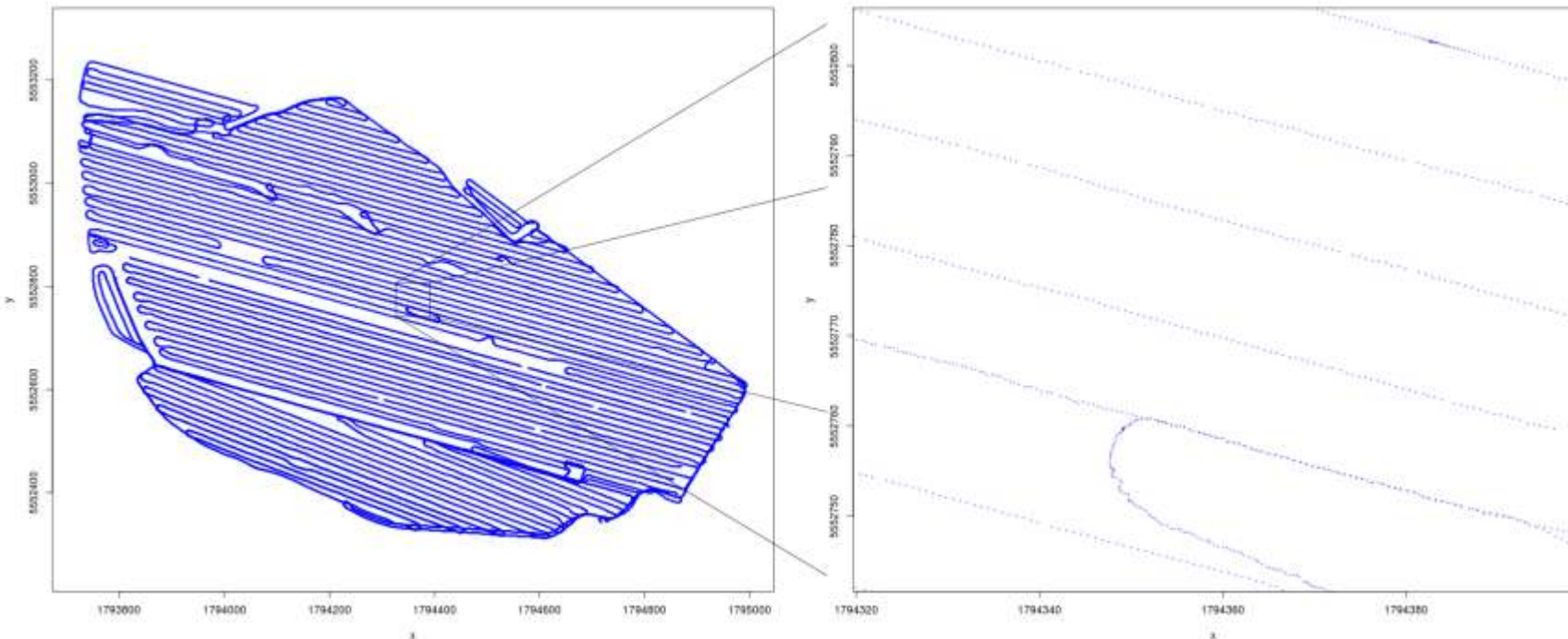
Trimble Ag214
(RTK)-GPS antenna

Trimble Ag170
field computer

Polycorder 600
data logging system

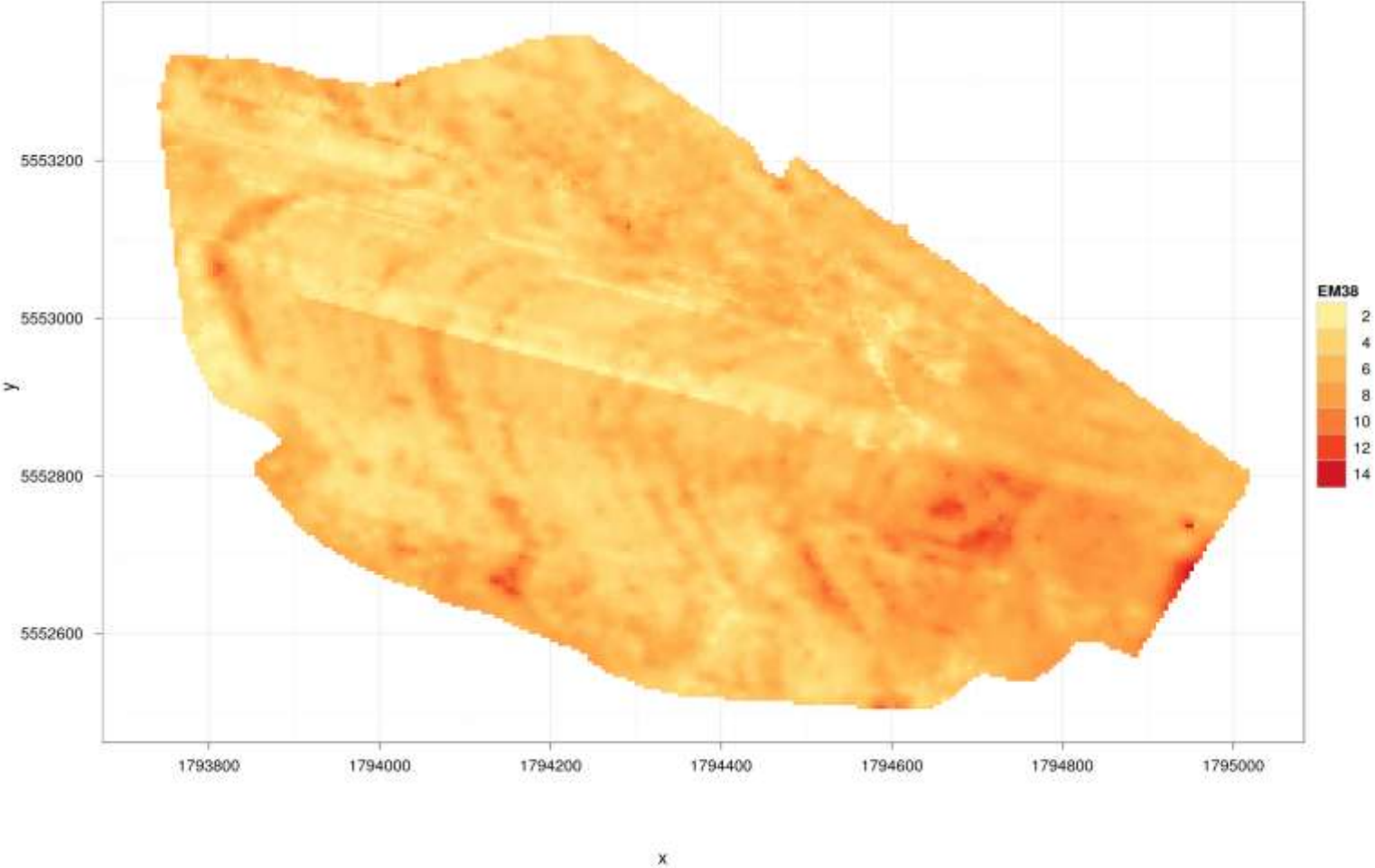
Geonics EM38 soil
electrical conductivity
sensor

The EM sensor collects one georeferenced data point every second

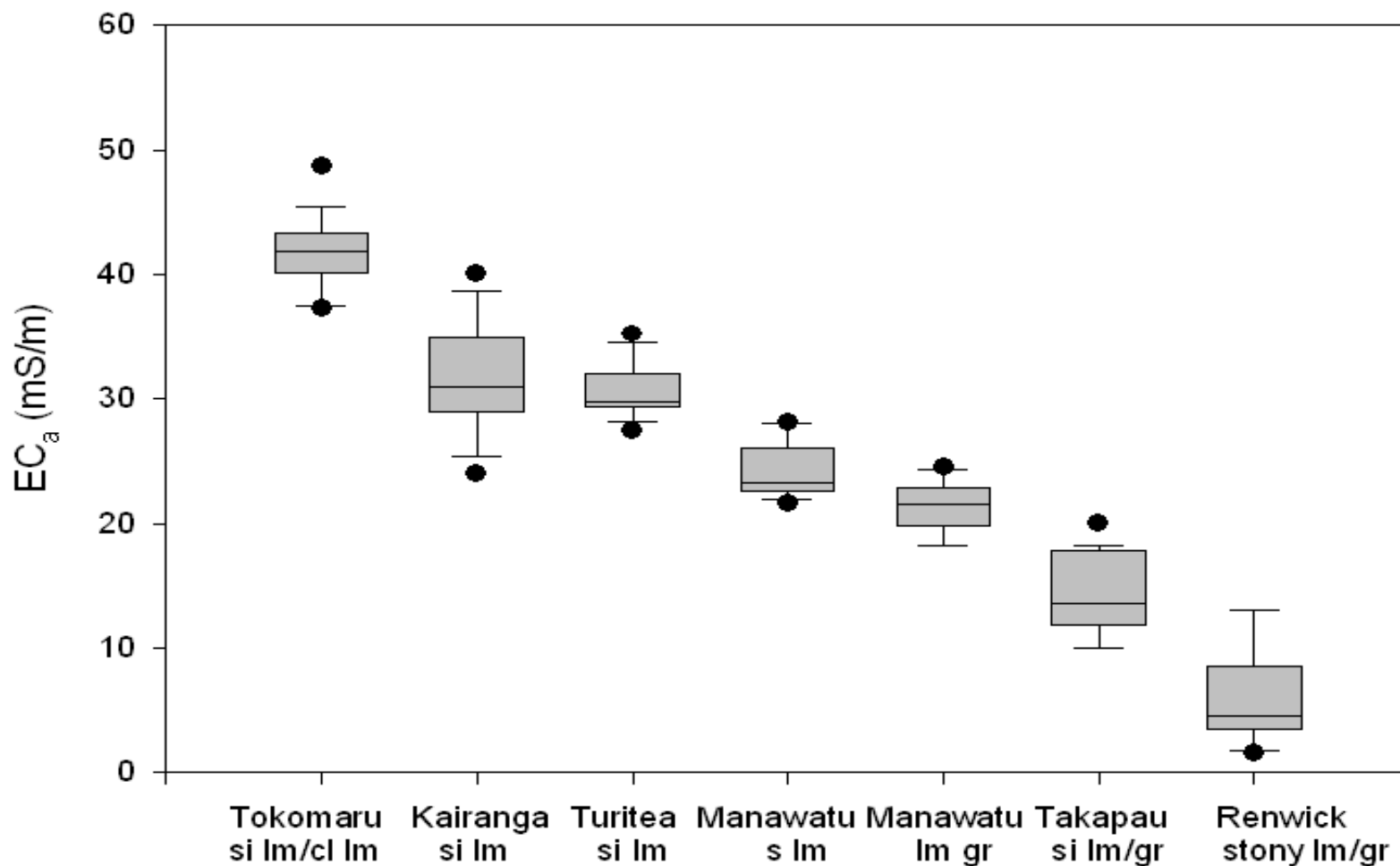


122.000+ points
1500+ points per ha

The EM map

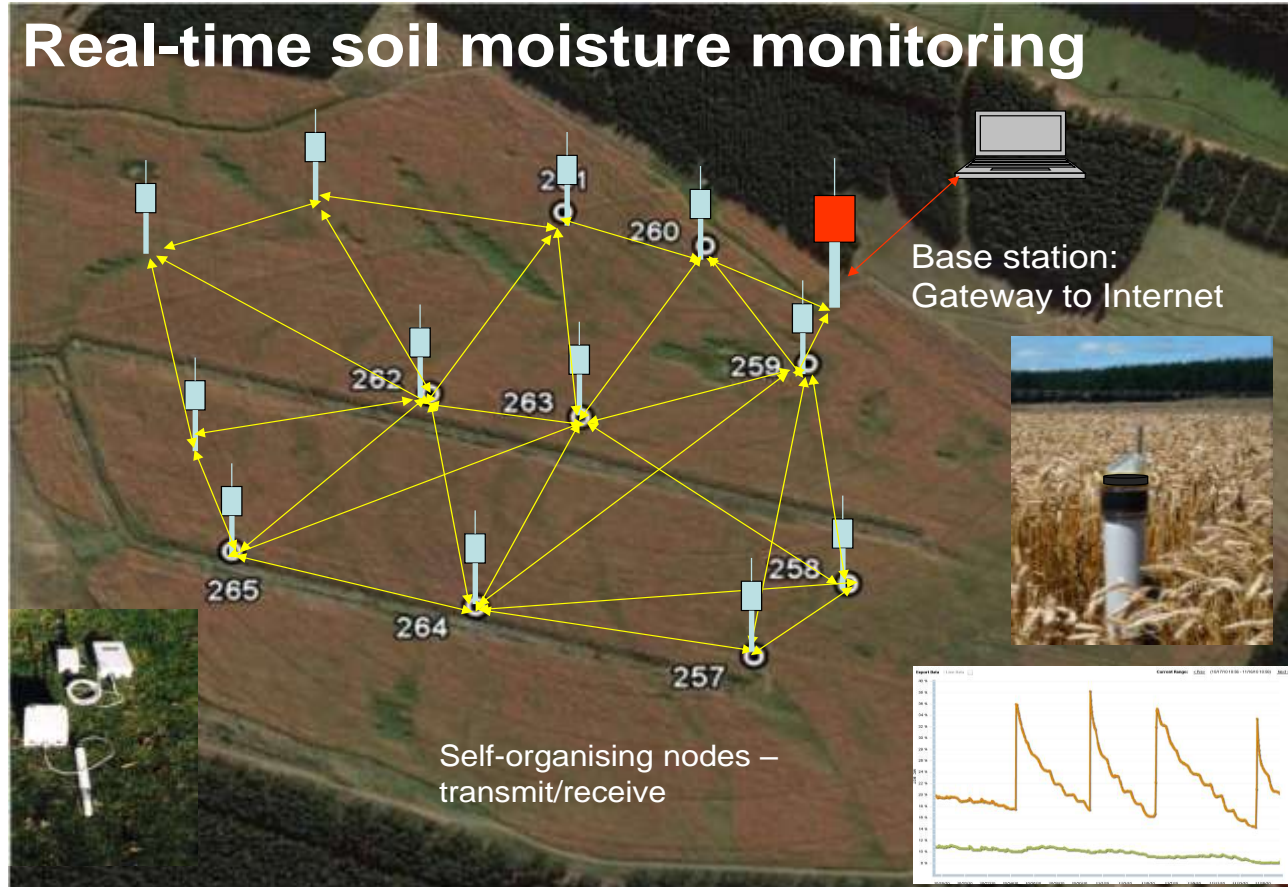


Apparent soil electrical conductivity (mS/m) for a textural range of New Zealand soils



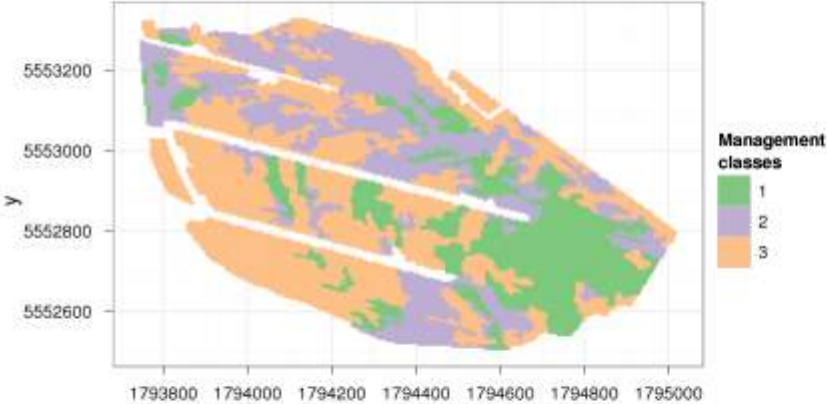
decreasing textural fineness

Wireless sensor networks (WSNs)

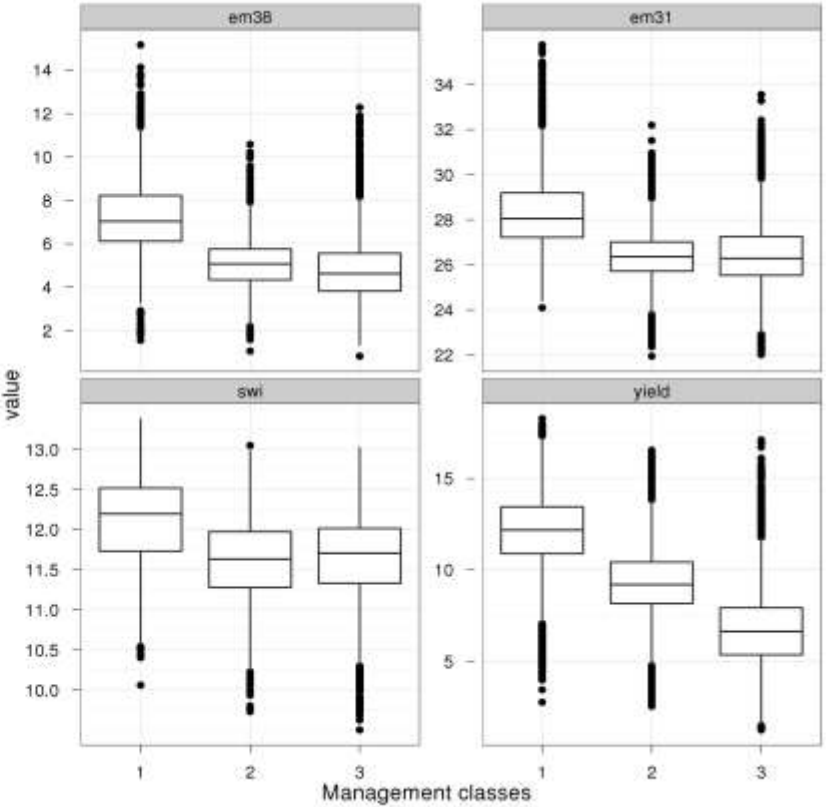


- High temporal resolution
- Dynamic mapping of e.g. water tables

Statistical analysis of datalayers to derive three management classes



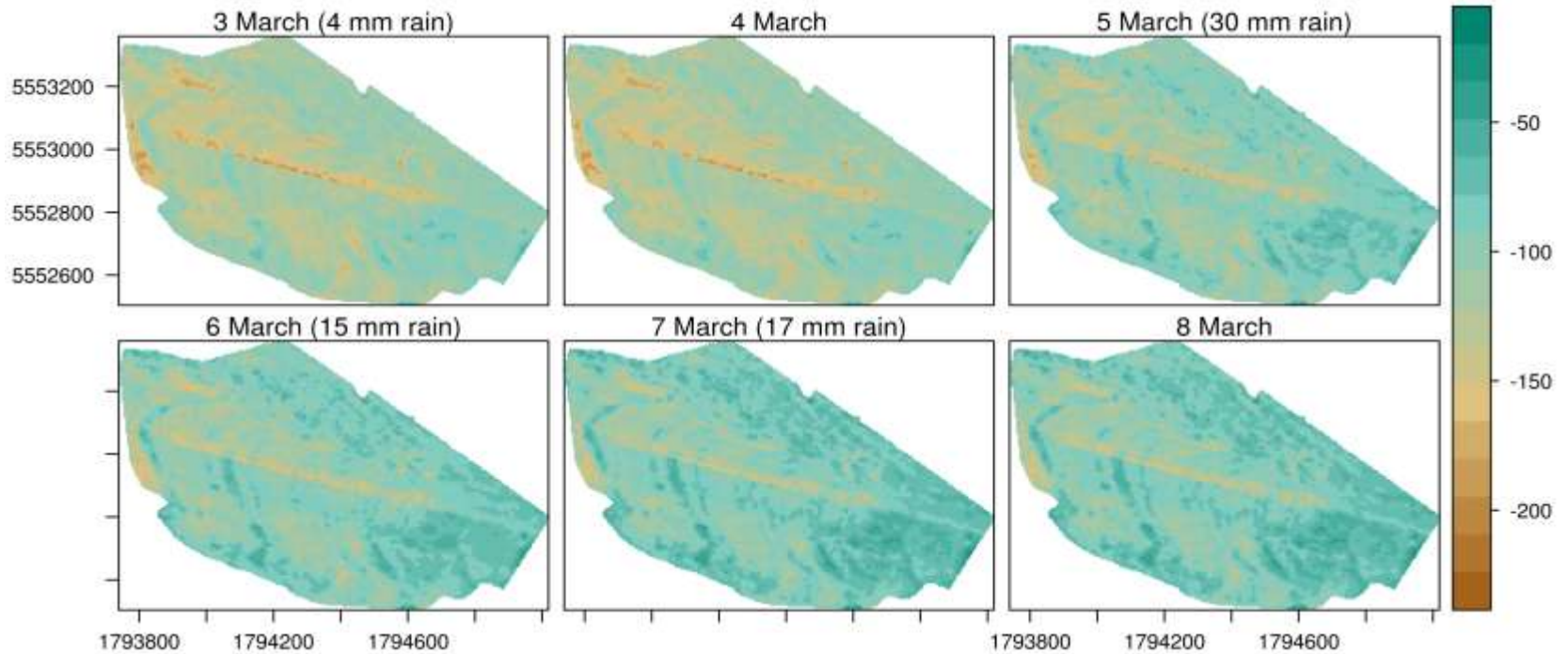
x



WSN nodes are positioned into the three management classes

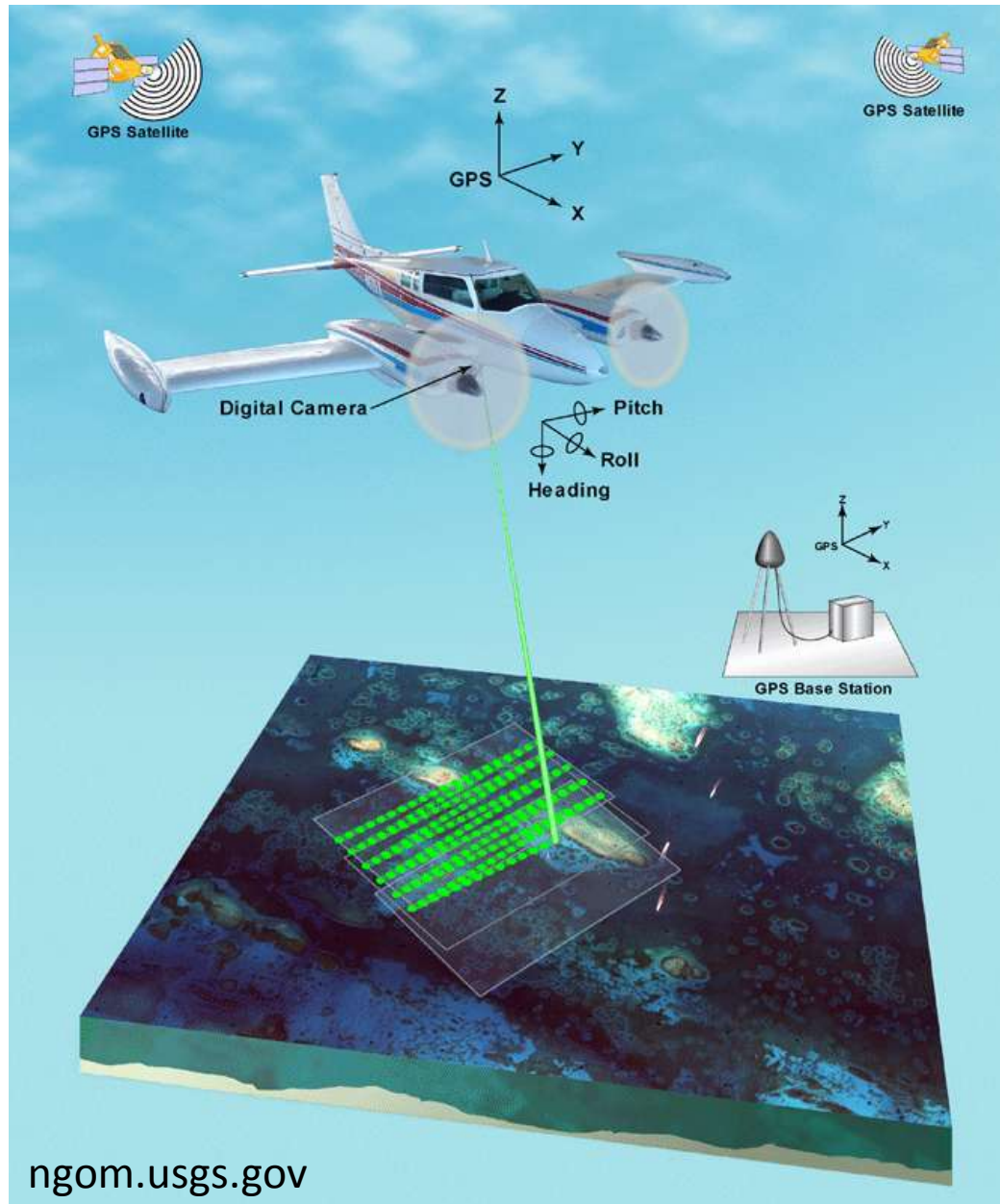


Water table modelling

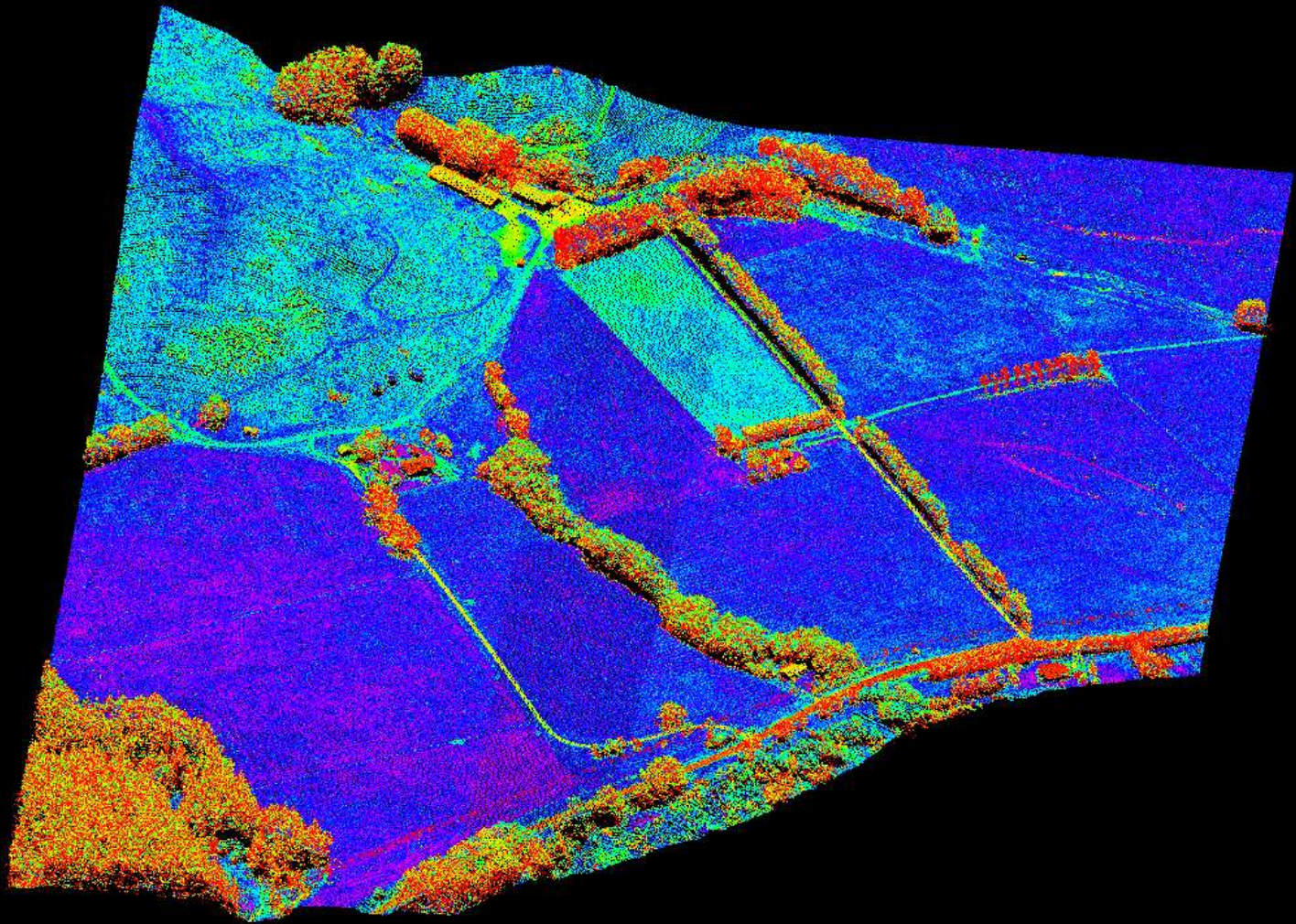


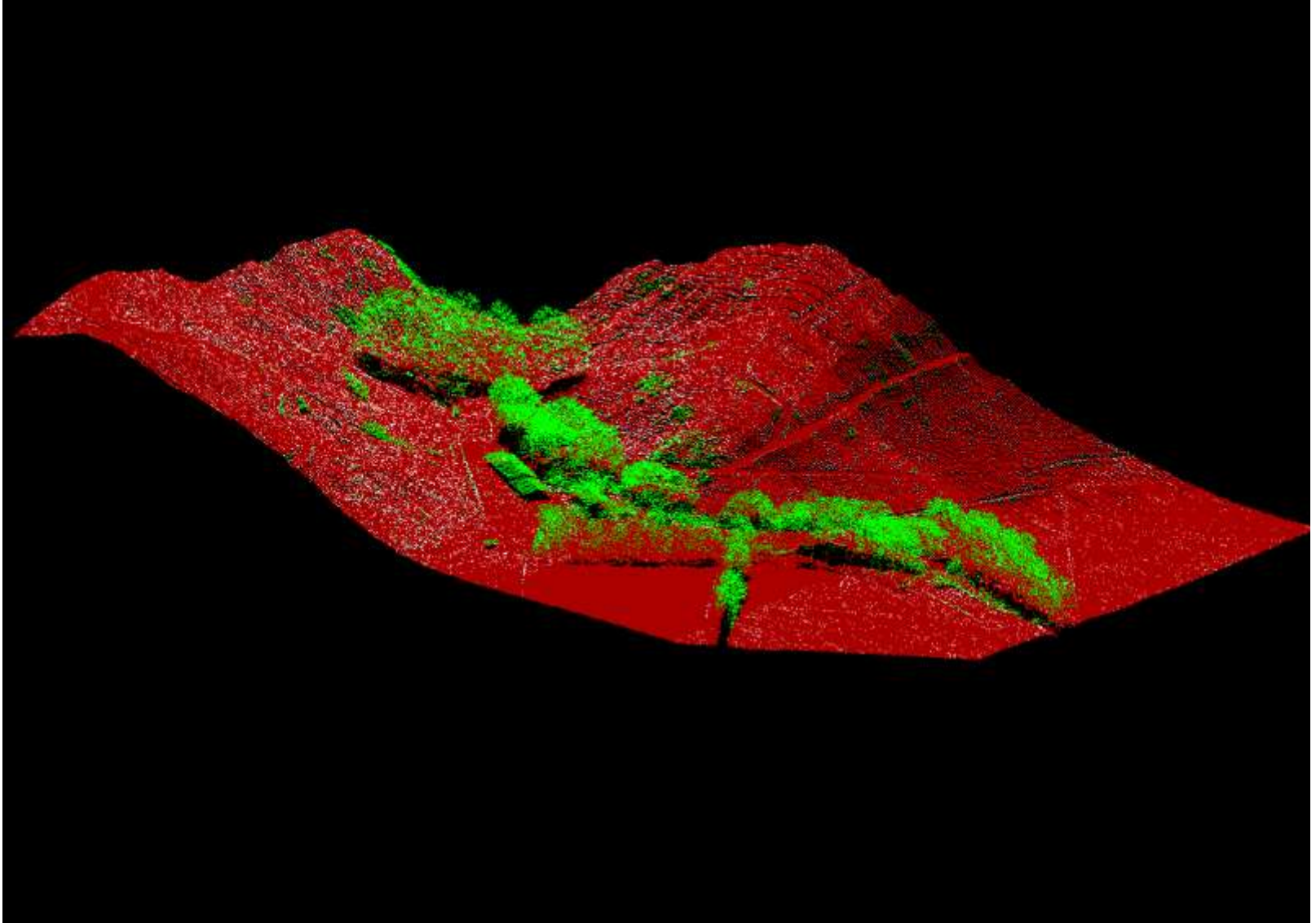
(Hedley et al., 2013, *Geoderma* 199, 22-29)

LiDAR

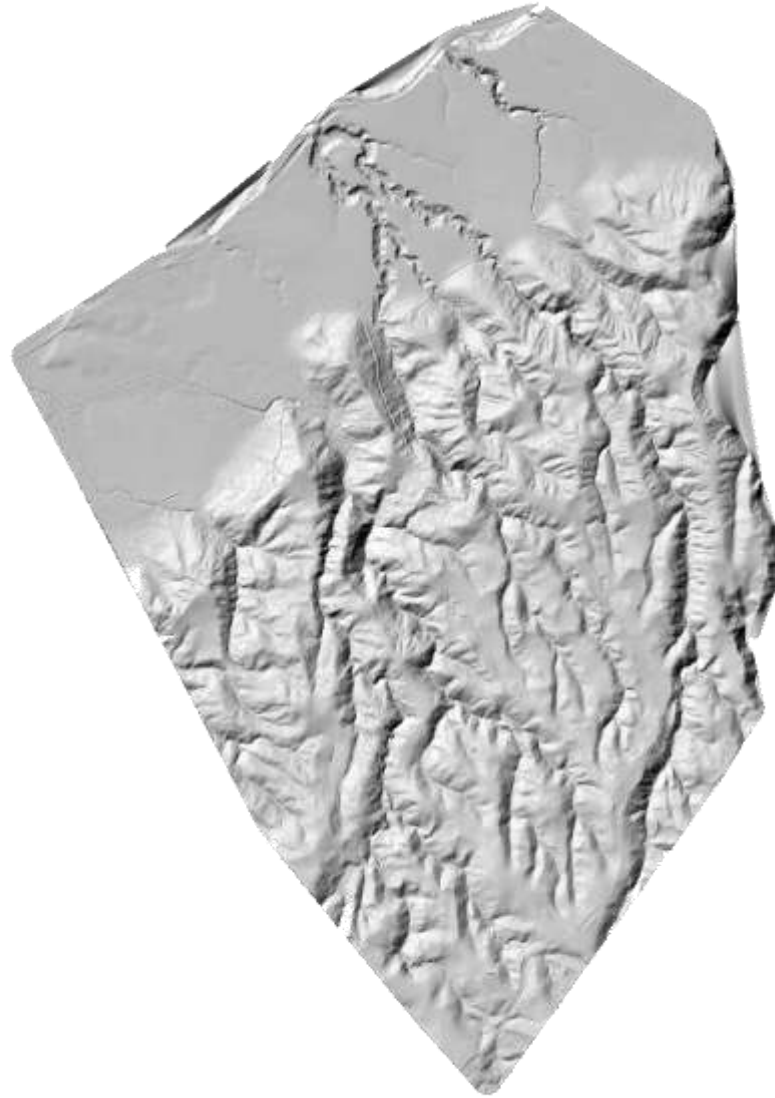


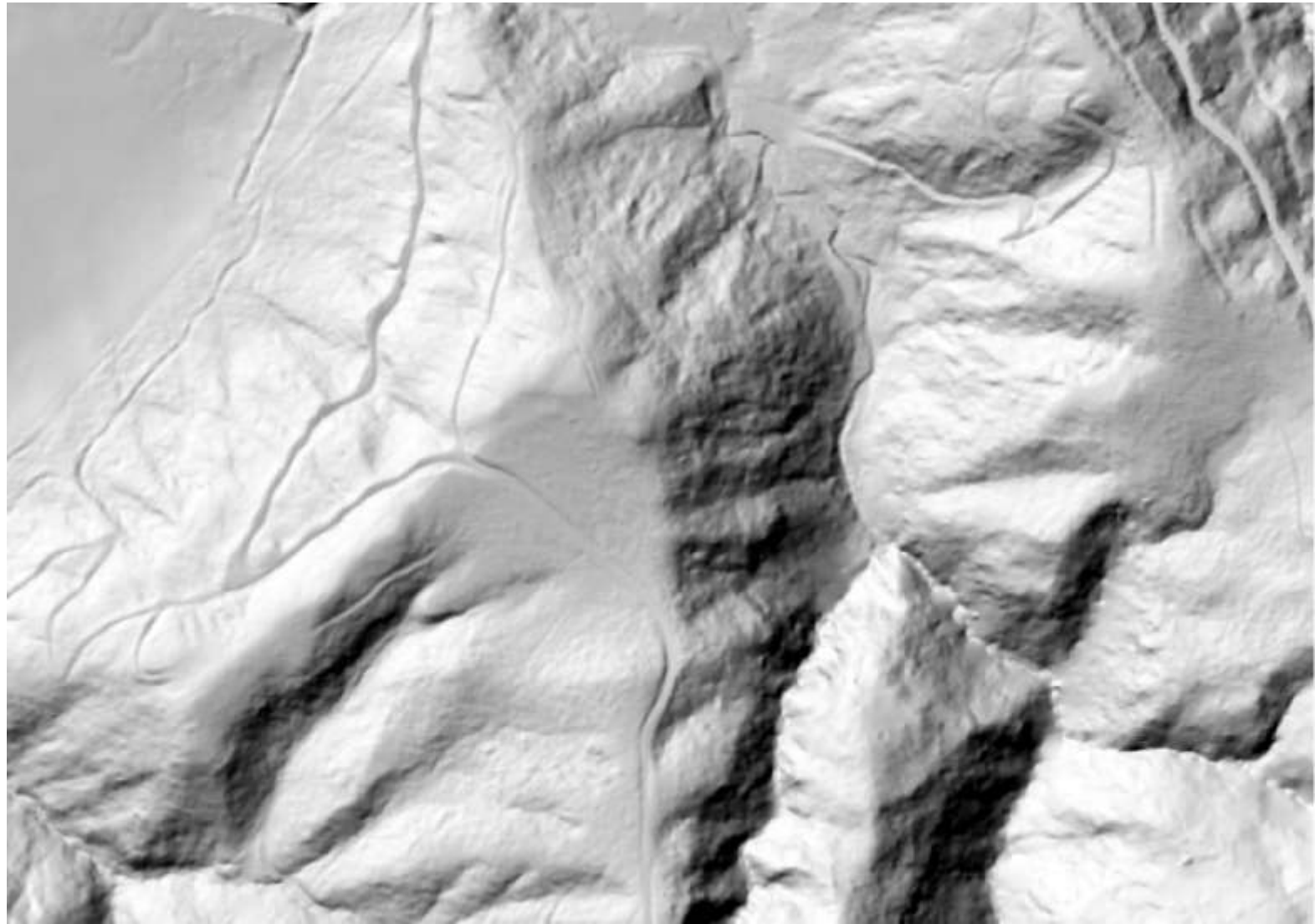
Raw point cloud



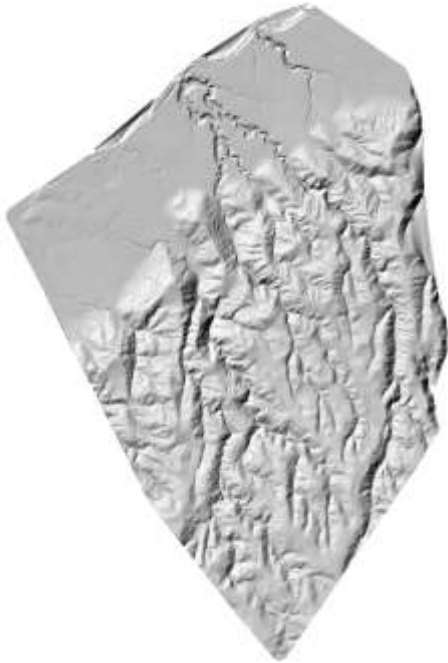


Hillshade visualisation of Massey University Tuapaka farm,
derived from the digital elevation map

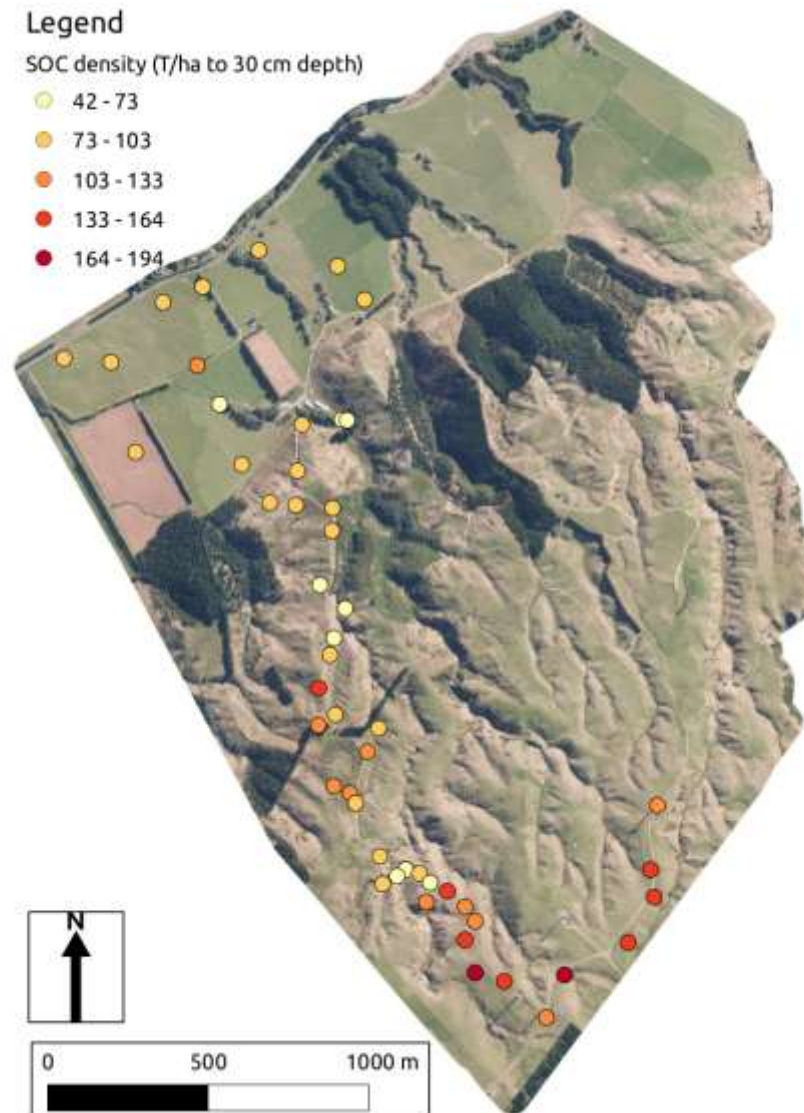




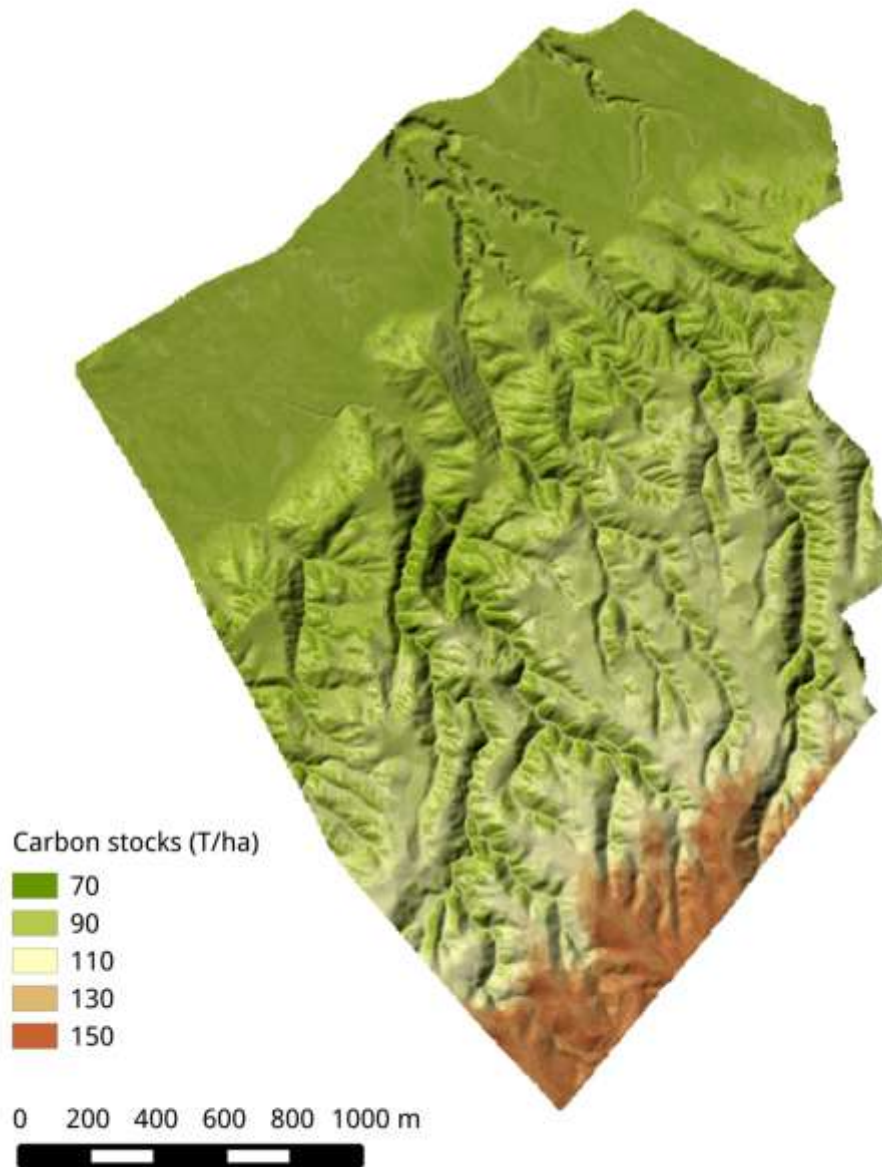
The DEM compliments the legacy soil map to refine our understanding of soil pattern



Stratified sampling by statistical analysis of the datalayers




Soil organic carbon map



(Valette, 2013)

(2) Information technologies

- Tackling the data challenge
- Performance
- Data curation
- The web is the platform

An aerial photograph of a precision irrigation system. The system consists of a grid of parallel pipes supported by a series of circular wheels. The pipes are arranged in a regular pattern, and the wheels are spaced evenly along the length of the system. The background is a light-colored, possibly sandy or dry, field.

**A
precision irrigation
case study**

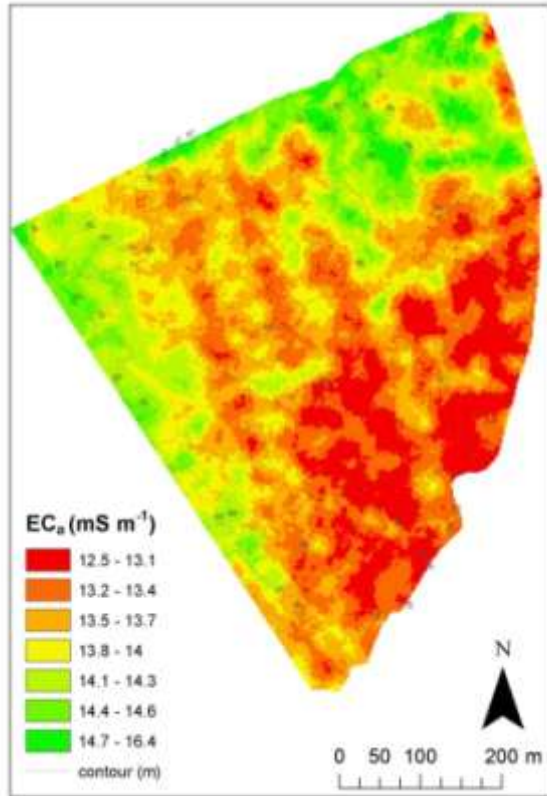
Case study – Fairlie dairy farm

- 3 pivots modified for precision control, irrigating 306 ha = \$130,000
- 50 L/s water saved
- 28% of irrigation saved (17% soil zones; 11% tracks, swamps etc)
- Diverted to other areas via 3 rotorainers
- Paid back in one year

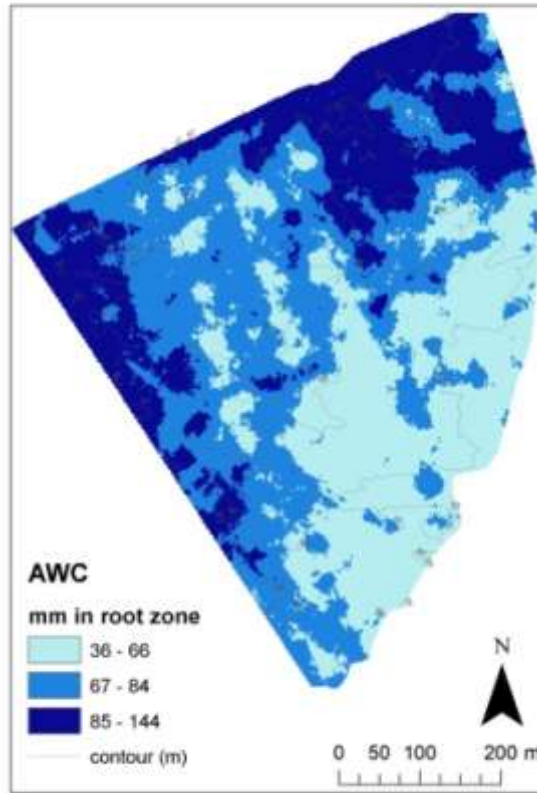


PRECISION IRRIGATION

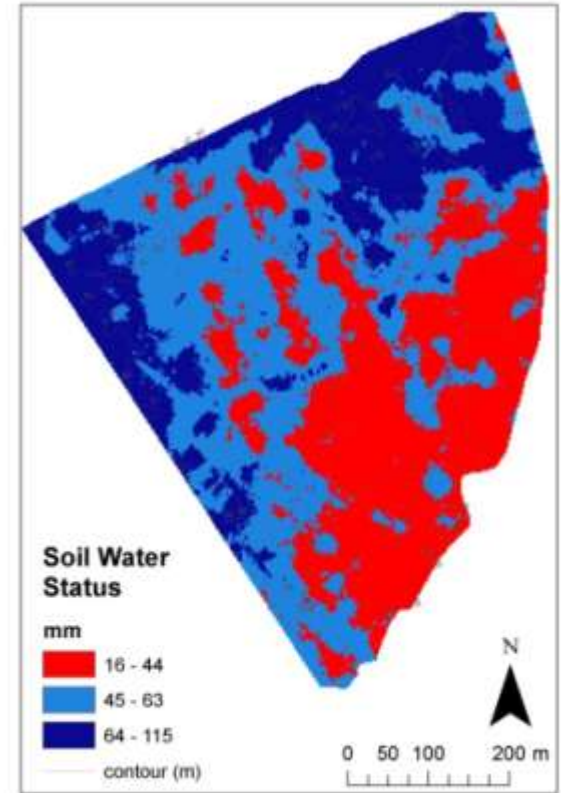
Soil EM map



Plant Available Water

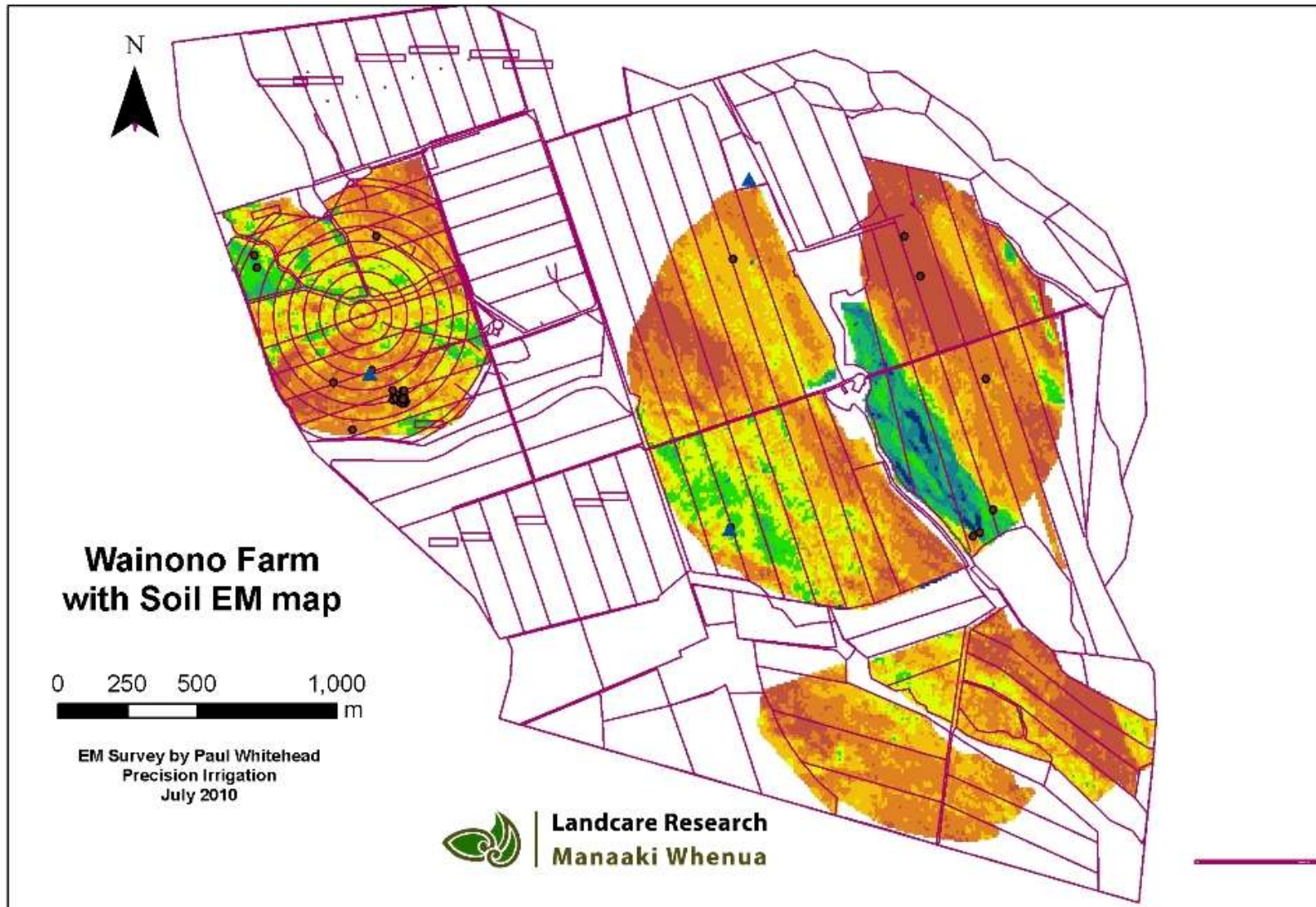


Soil Water Status Map



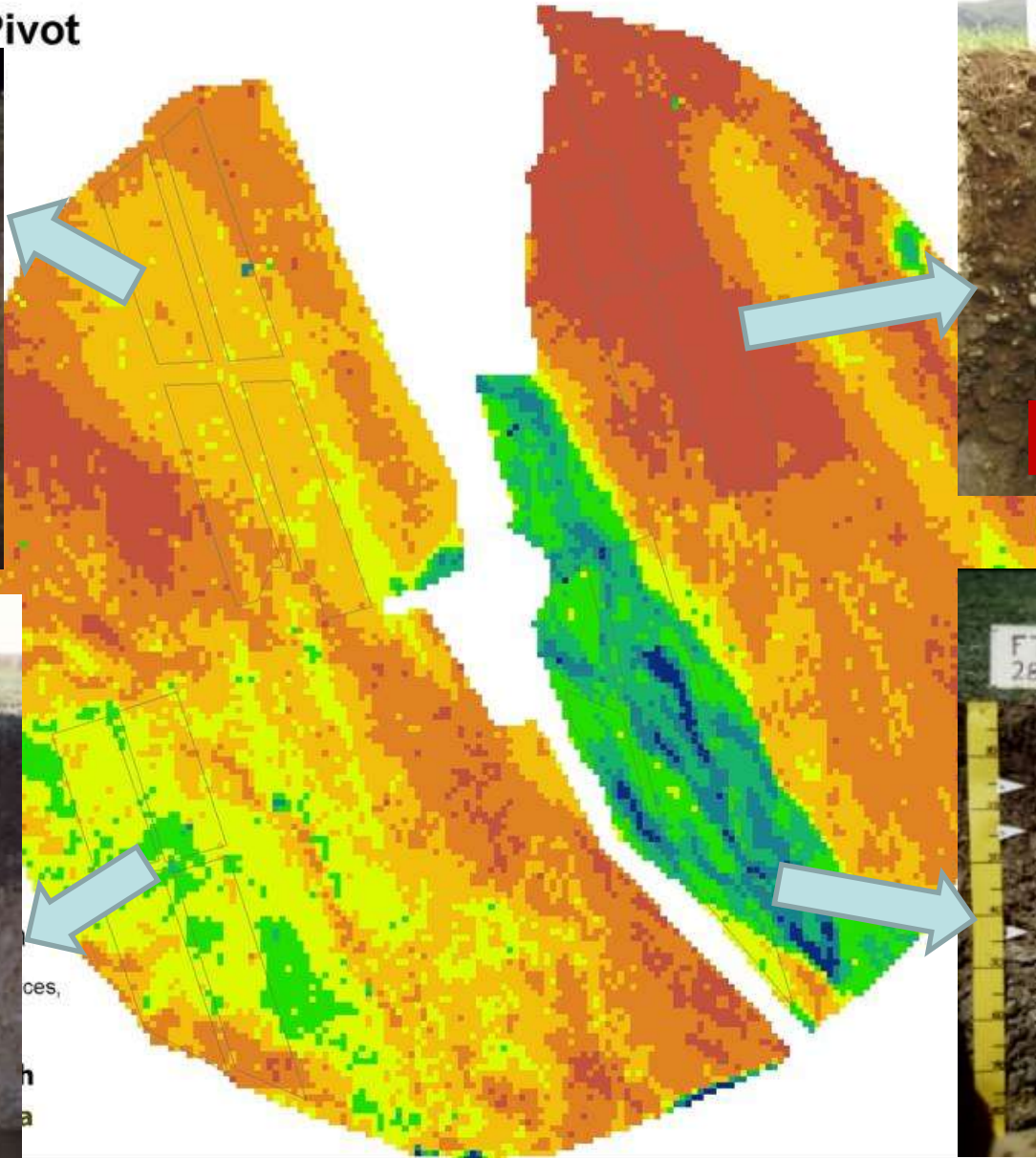
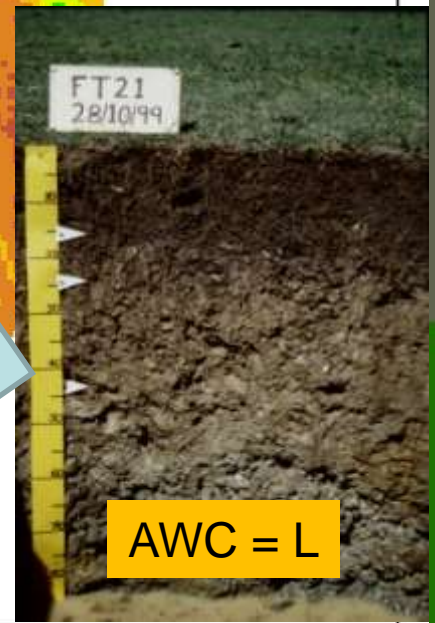
EM mapping and soil survey

MAF SFF Project



Soil & EM map

Wainono Centre Pivot



EM map – 4 management zones

Wainono Centre Pivot & Soil EM map



EM Survey by Paul Whitehead
Precision Irrigation
July 2010

0 125 250 500
m

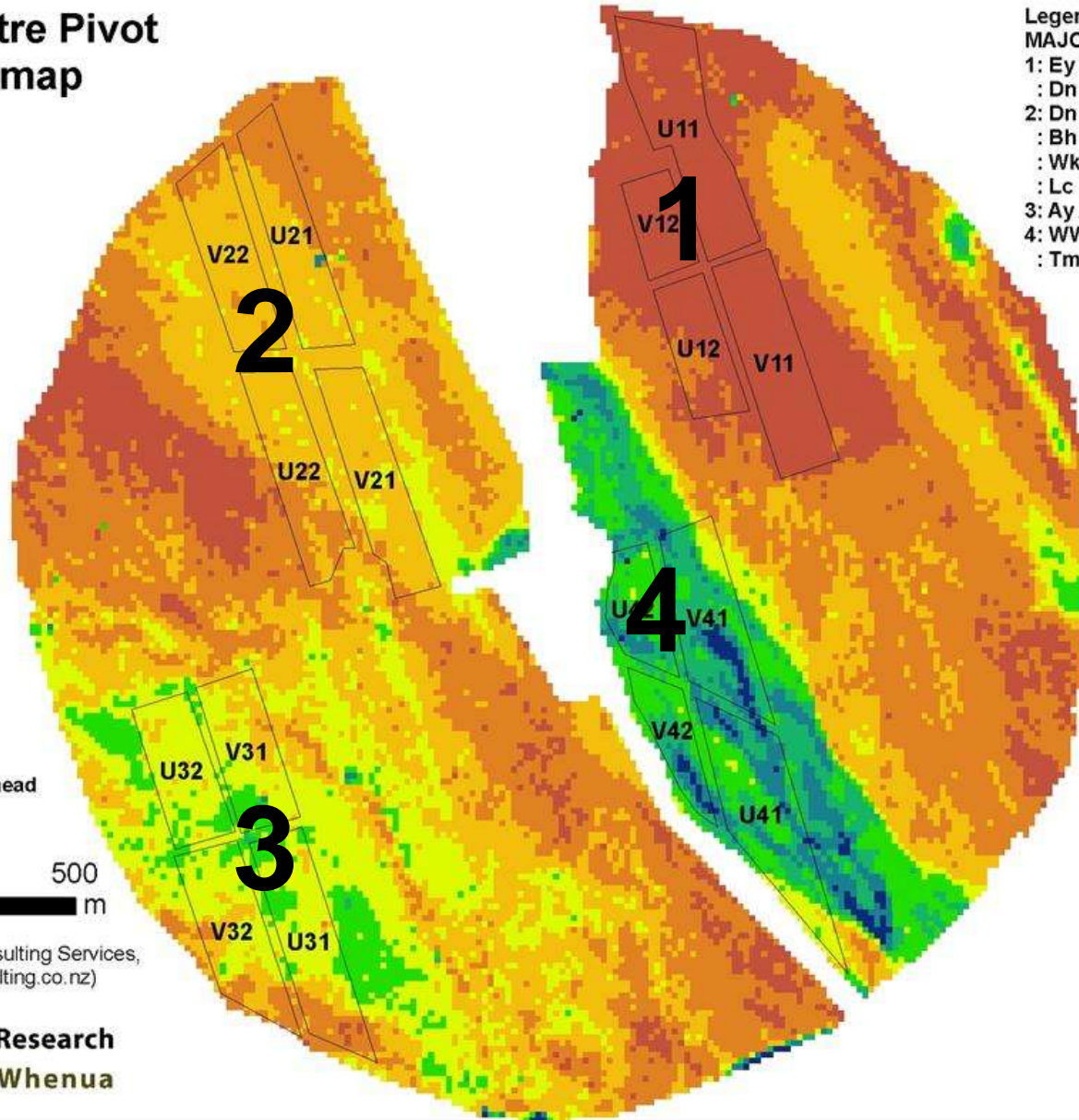
Farm map by: Agricultural Consulting Services,
Ashburton (www.agconsulting.co.nz)



Legend MAJOR SOIL TYPES OF ZONES

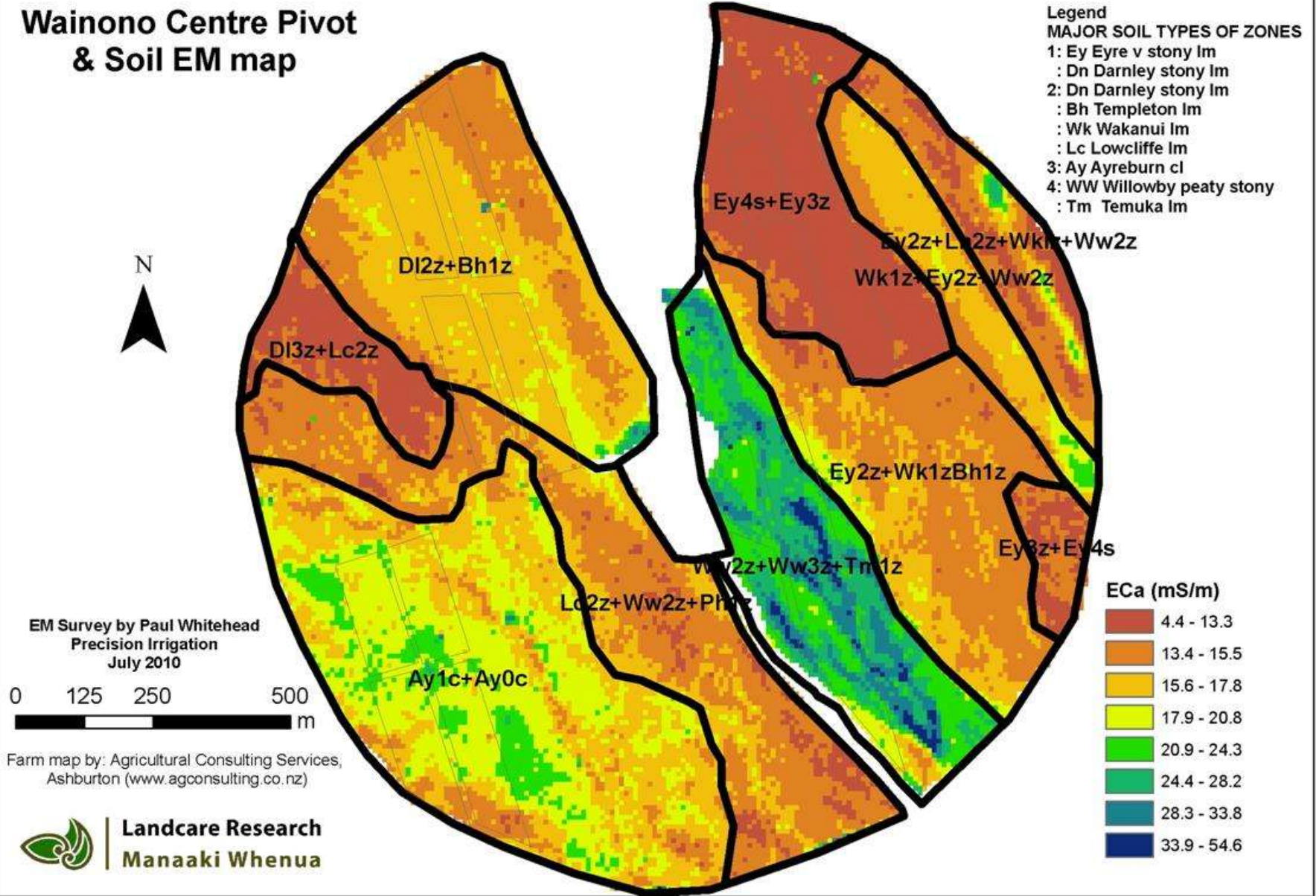
- 1: Ey Eyre v stony lm
: Dn Darnley stony lm
: Bh Templeton lm
: Wk Wakanui lm
: Lc Lowcliffe lm
- 2: Ay Ayreburn cl
- 3: WW Willowby peaty stony
: Tm Temuka lm

ECa (mS/m)



Soil & EM map

Wainono Centre Pivot & Soil EM map



Legend MAJOR SOIL TYPES OF ZONES

- 1: Ey Eyre v stony lm
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: Lc Lowcliffe lm
- 3: Ay Ayreburn cl
- 4: WW Willowby peaty stony
: Tm Temuka lm

ECa (mS/m)

- 4.4 - 13.3
- 13.4 - 15.5
- 15.6 - 17.8
- 17.9 - 20.8
- 20.9 - 24.3
- 24.4 - 28.2
- 28.3 - 33.8
- 33.9 - 54.6

EM Survey by Paul Whitehead
Precision Irrigation
July 2010

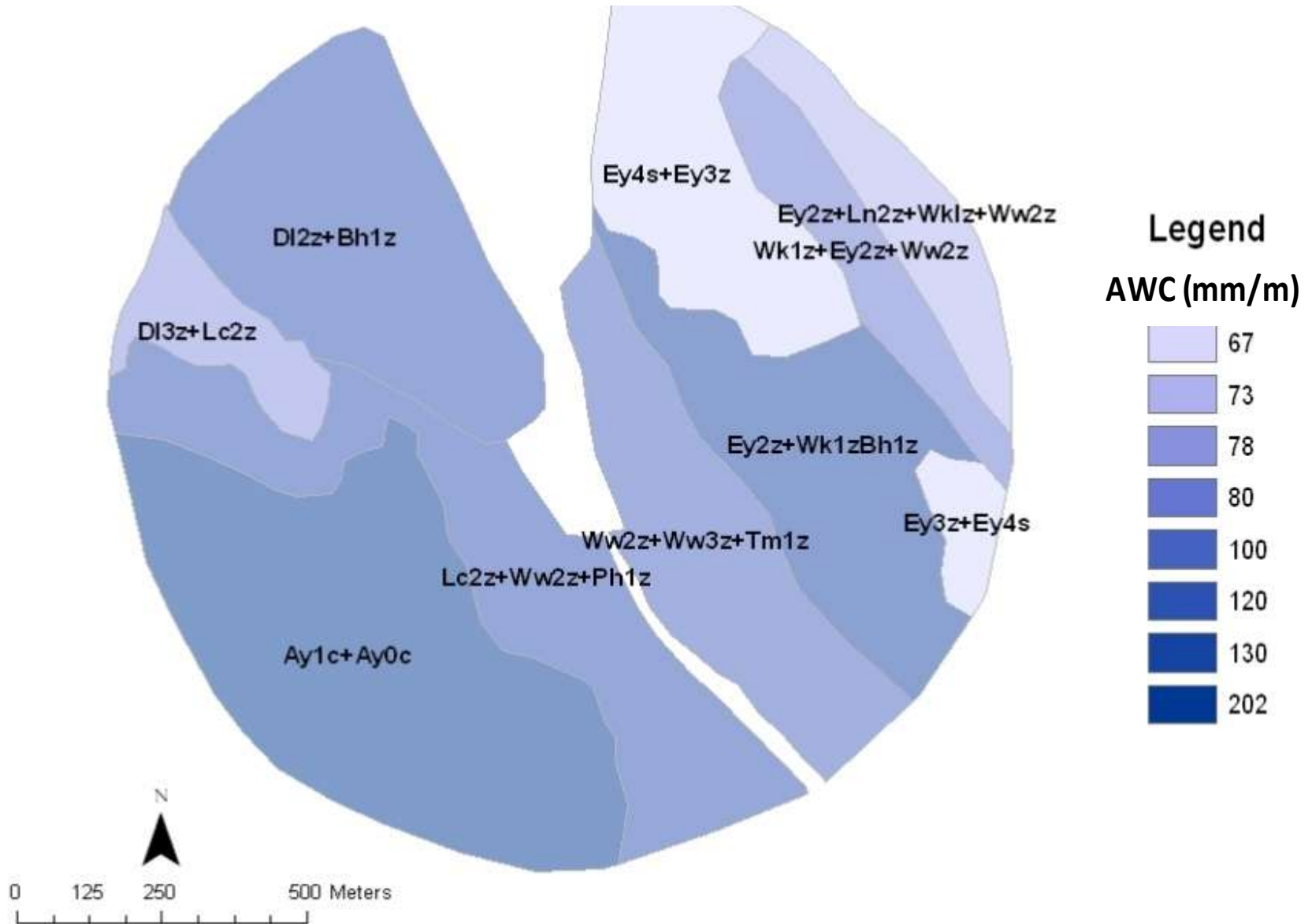
0 125 250 500
m

Farm map by: Agricultural Consulting Services,
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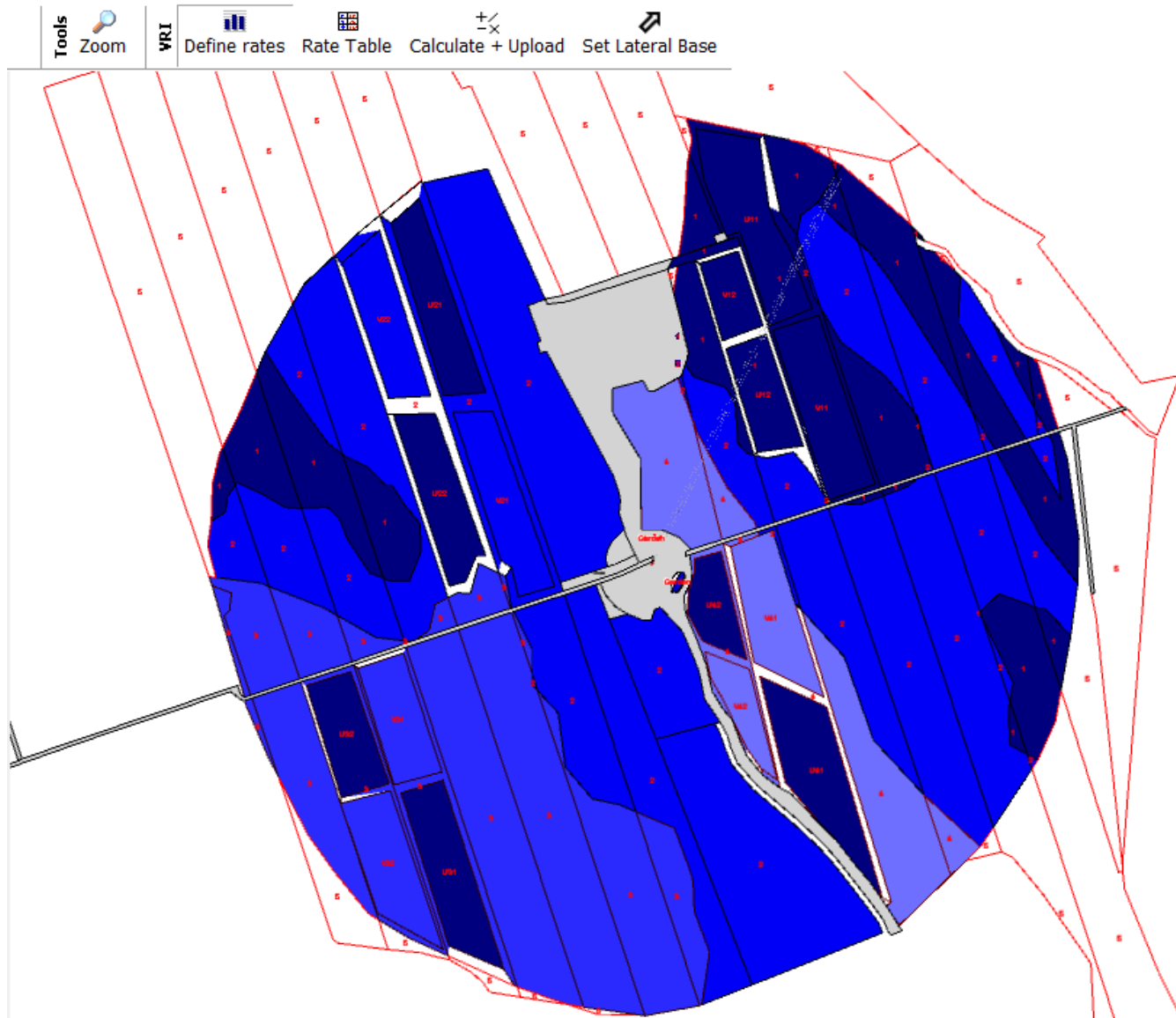


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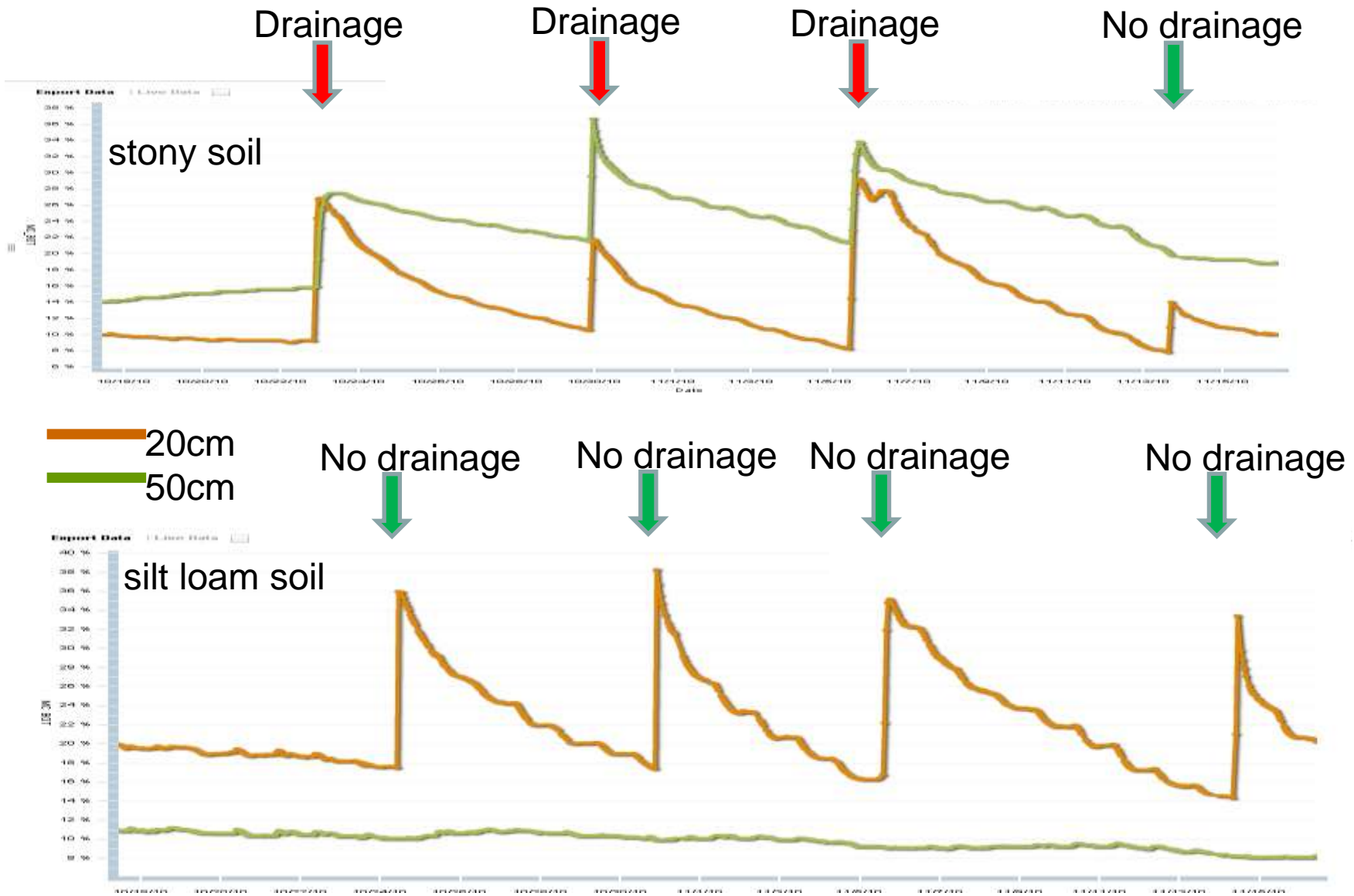
Map of Plant Available Water



Customised VRI software



Real-time monitoring



Precision irrigation = modification of the pivot + precision scheduling



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PRECISION
irrigation

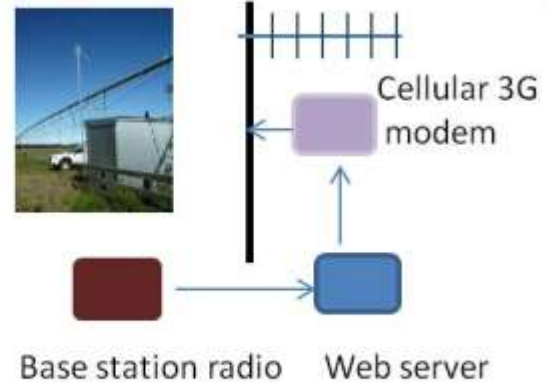
- > 100 systems sold in first 2 years (www.precisionirrigation.co.nz)
- Water savings 8 - 40%, reduced drainage & nutrient loss
- Return on investment 1-5 years

Closing the automation loop

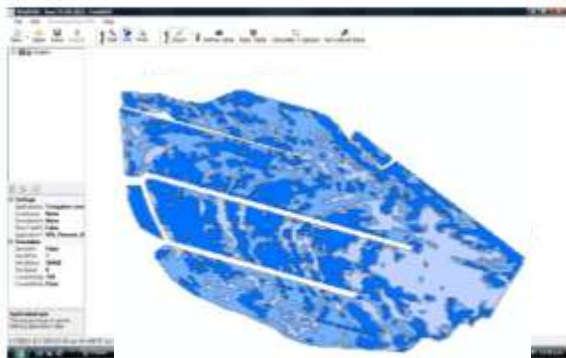
(1) Wireless in-field nodes with sensors attached



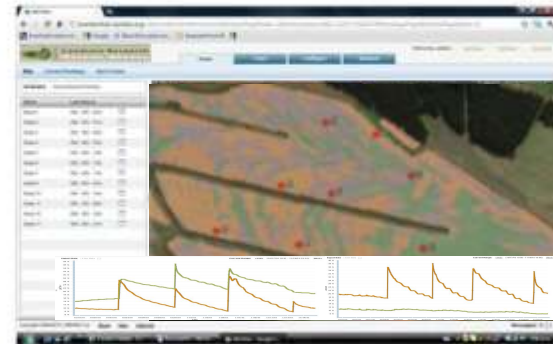
(2) Base station at pivot



(4) Pivot control - soil zones

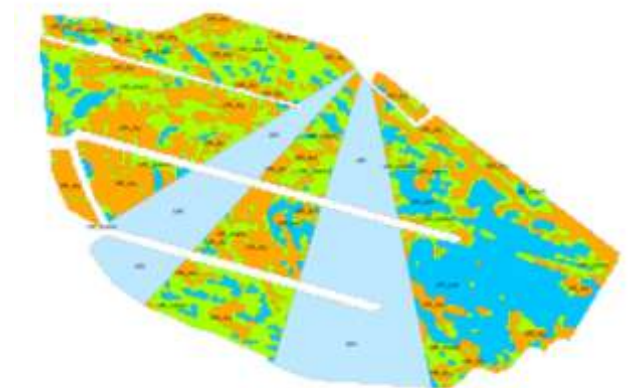
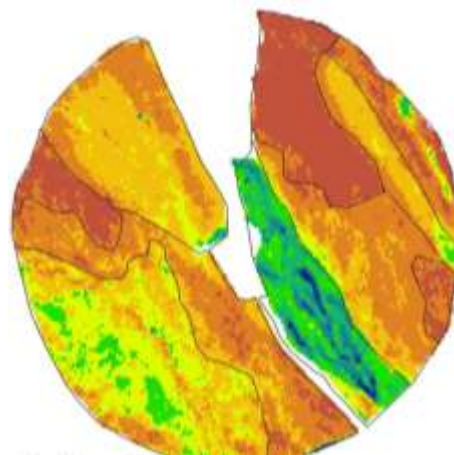
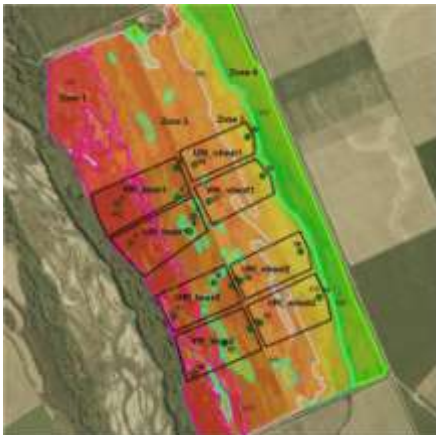


(3) Standard web browser



SUMMARY VRI Trial Results 2010-2012

Farm	Water use efficiency		% water saved by VRI
	Uniform rate irrigation	Variable rate irrigation	
	kg/mm	kg/mm	%
Ashburton –arable	12.9	13.4	15
Fairlie – dairy	41.4	47.8	27
Manawatu - arable	14.1	17.4	21



(4) Realising new opportunities

(1)

Varigate.co.nz



HOME

ABOUT

PRODUCT

NEWS&PRESS

CAREERS

CONTACT US

VARIGATE IS THE WORLD'S MOST ADVANCED IRRIGATION SOFTWARE SERVICE, DELIVERING DRAMATIC WATER COST SAVINGS AND INCREASED CROP & DAIRY YIELD.

GET STARTED TODAY



(2)



MAXIMISING THE VALUE OF IRRIGATION

Landcare Research & Plant and Food Research led MBIE Project

The team

Landcare Research
Plant & Food Research
Foundation for Arable Research
Lincoln AgriTech
Massey University
&
University of Southern Queensland

The supporters

Foundation for Arable Research
Vegetable Research & innovation Board
Hawkes Bay Regional Council
Environment Canterbury
Irrigation New Zealand



MAXIMISING THE VALUE OF IRRIGATION

Landcare Research & Plant and Food Research led MBIE Project

- Technologies that fine-tune irrigation water management
- Advanced control systems
- Effective audited self management
- Recommendations and demonstrations to farmers and growers

Impact Statement

- \$225 million p.a. increase in agricultural exports
 - Greater return on investment in irrigation infrastructure
- Abstracted water irrigates 40,000ha more land that it would with current efficiency
 - Competitive advantage maintained through reduced environmental footprint

Impact Statement

On-farm Outcomes

- Less water applied/ha → Reducing costs
- Less water stress → Increased yields
 - Reduced drainage and nutrient loss
- Simple audited self nutrient management

Impact Statement

On-farm Outcomes

Projects Technical Outcomes

New
irrigation
hardware
matched to
farm
circumstances

Placement of
irrigation
where and
when it is
needed

Effective
audited self
management
of irrigated
systems

Soils and
crops
managed to
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Impact Statement

On-farm Outcomes

Projects Technical Outcomes

New irrigation hardware matched to farm circumstances

Placement of irrigation where and when it is needed

Effective audited self management of irrigated systems

Soils and crops managed to reduce water losses

Implementation Pathway

Information integration and development of tools

MBIE Project

Spatial Information

Crop Monitoring

Soil Management

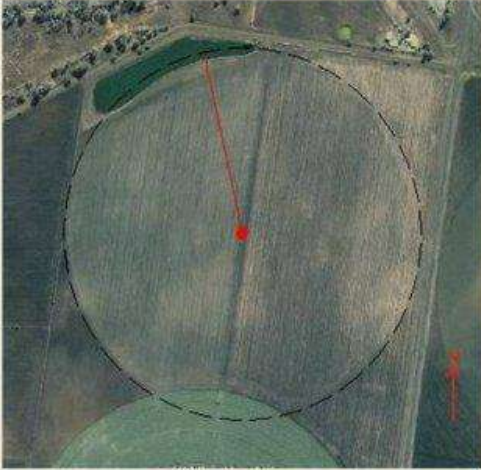

International collaborators: University of Southern Queensland



**Infra-red sensors assess canopy temperature
Machine vision for crop stage and crop health**

Variwise – crop model based

Irrigation valve control LogMeta - Remote Session

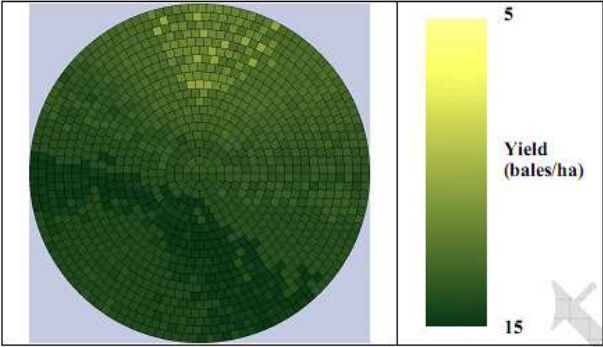
Servo	Open	Closed	Flow rate
1	120	150	0.323
2	107	148	0.403
3	100	148	0.376
4	95	152	0.363
5	105	160	0.37
6	114	145	0.345
7	126	156	0.393
8	105	150	0.375
9	105	160	0.435
10	105	151	0.463
11	105	146	0.412
12	95	144	0.431
13	106	153	0.526
14	120	151	0.4
15	119	153	0.37

All valve details

Add Edit Copy Delete Current location: -27.392621458°S, 151.60634491°E, at bearing 347.2° Backup

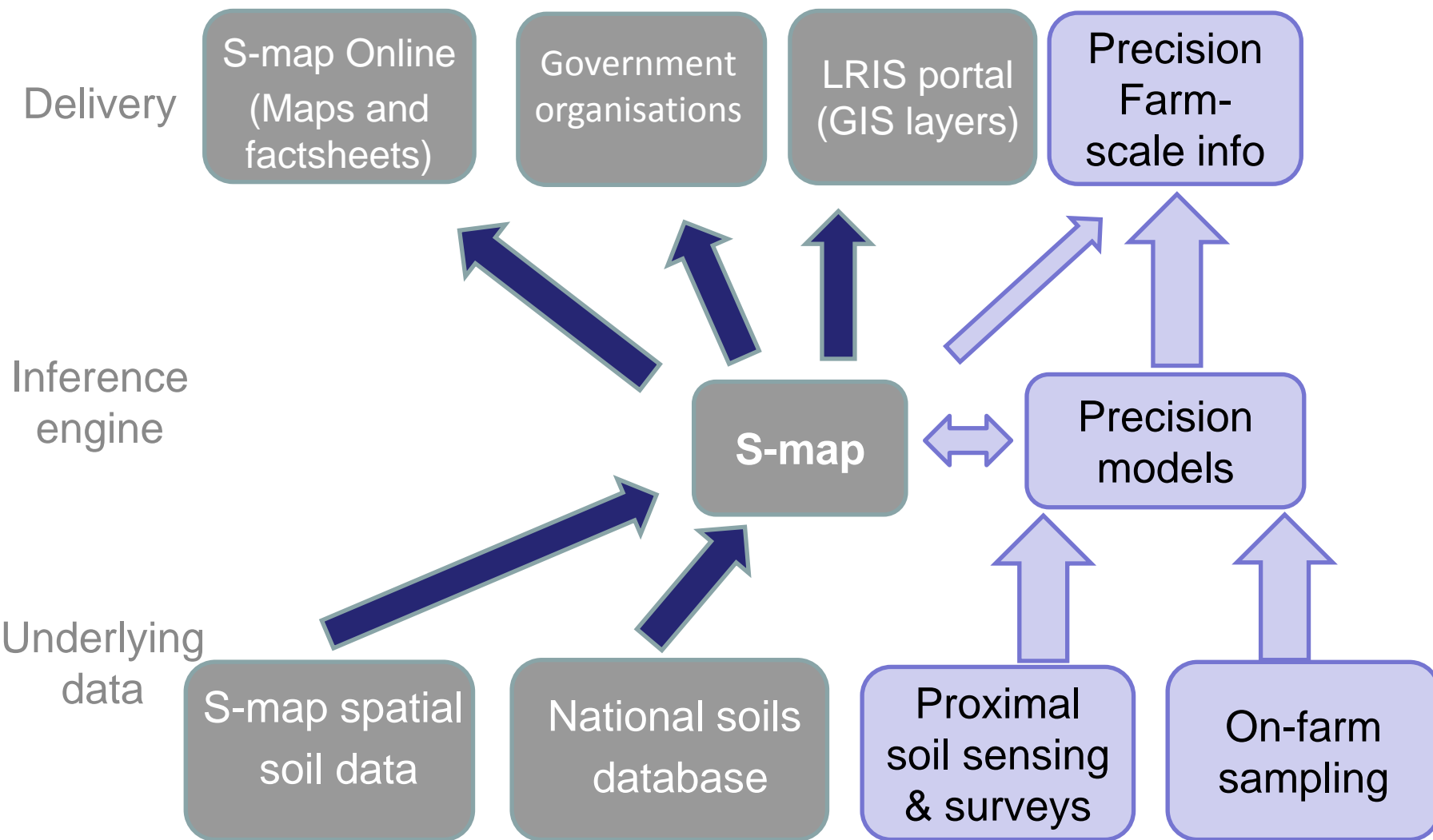
Bearing	Latitude	Longitude	Direction	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
228	-27.5560	151.91716	CW	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
240	-27.5560	151.91716	CW	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
252	-27.5560	151.91716	CW	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
264	-27.5560	151.91716	CW	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
276	-27.5560	151.91716	CW	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
288	-27.5560	151.91716	CW	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
300	-27.5560	151.91716	CW	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
312	-27.5560	151.91716	CW	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
324	-27.5560	151.91716	CW	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80
336	-27.5560	151.91716	CW	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
348	-27.5560	151.91716	CW	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75

Update servos



(3)

Supporting S-map





***Acknowledgements : Precision Irrigation-Lindsay Corporation;
MPI; MBIE; FAR; DairyNZ; Massey University; HydroServices;
Waterforce & all participating farmers***