Landcare Research
Manaaki Whenua

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

Maximising the value of irrigation:
new technologies for precision management

Carolyn Hedley & Pierre Roudier

Wellington LINK seminar, 18 March 2014

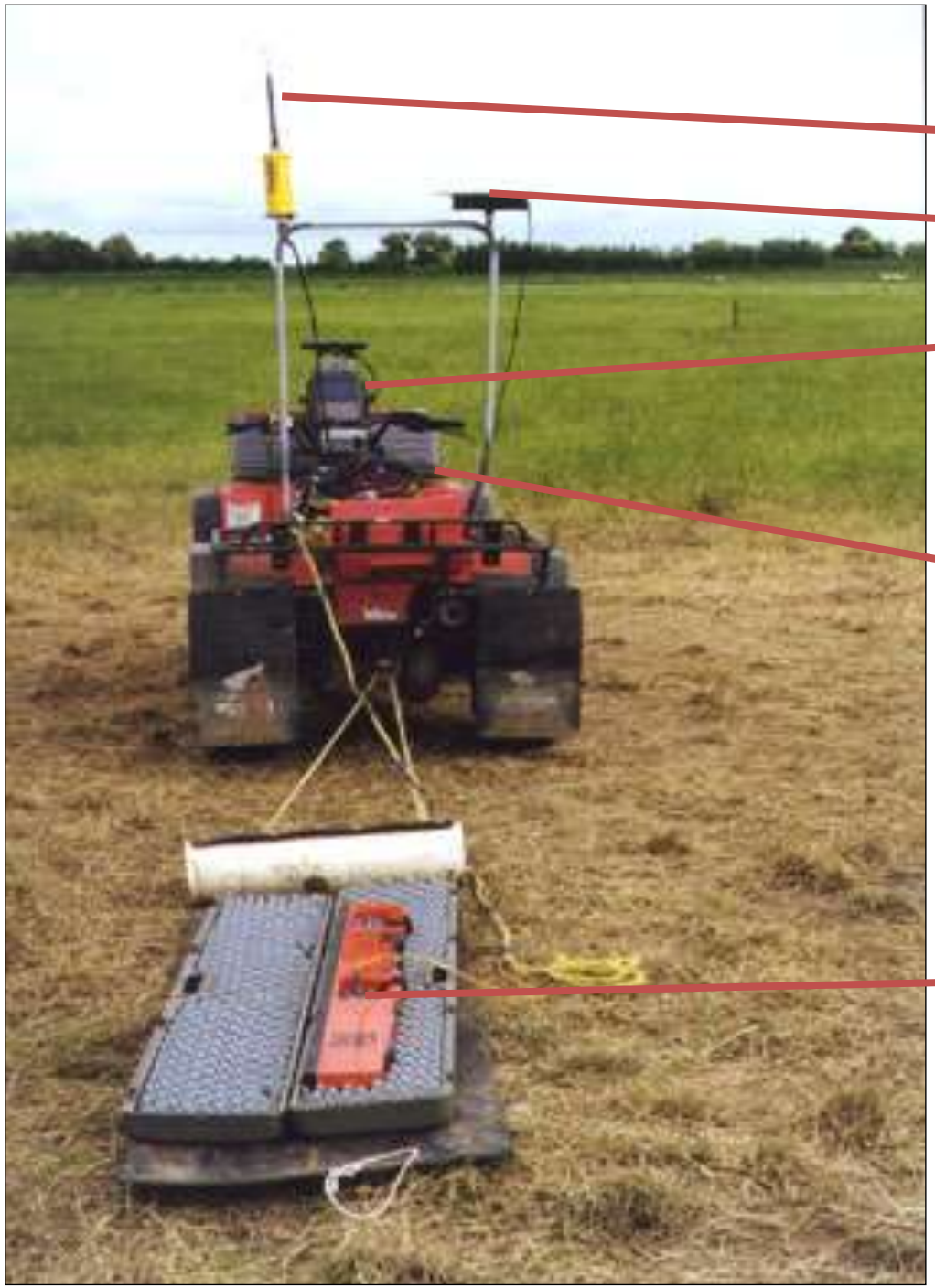
Talk overview

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

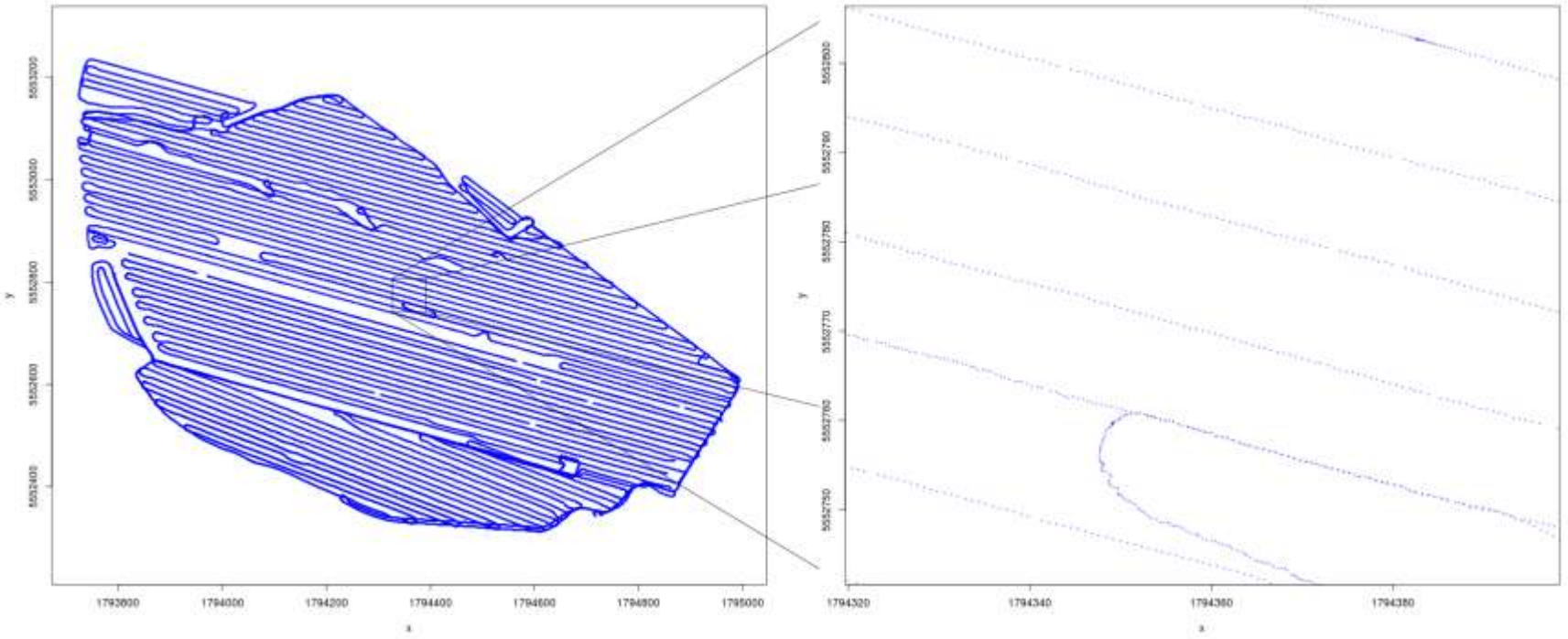
Trimble Ag214
(RTK)-GPS antenna

Trimble Ag170
field computer

Polycorder 600
data logging system

Geonics EM38 soil
electrical conductivity
sensor

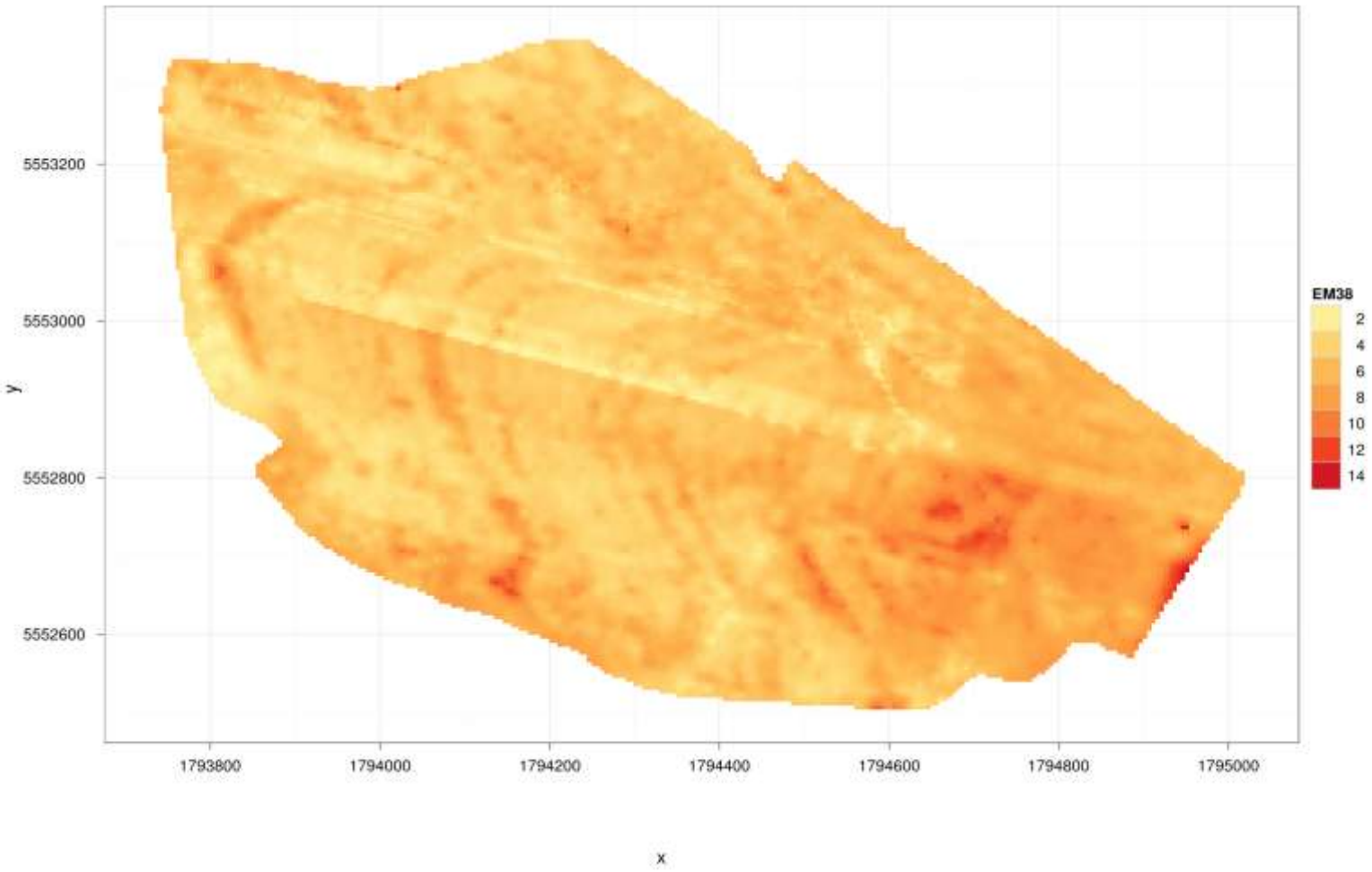
The EM sensor collects one georeferenced data point every second



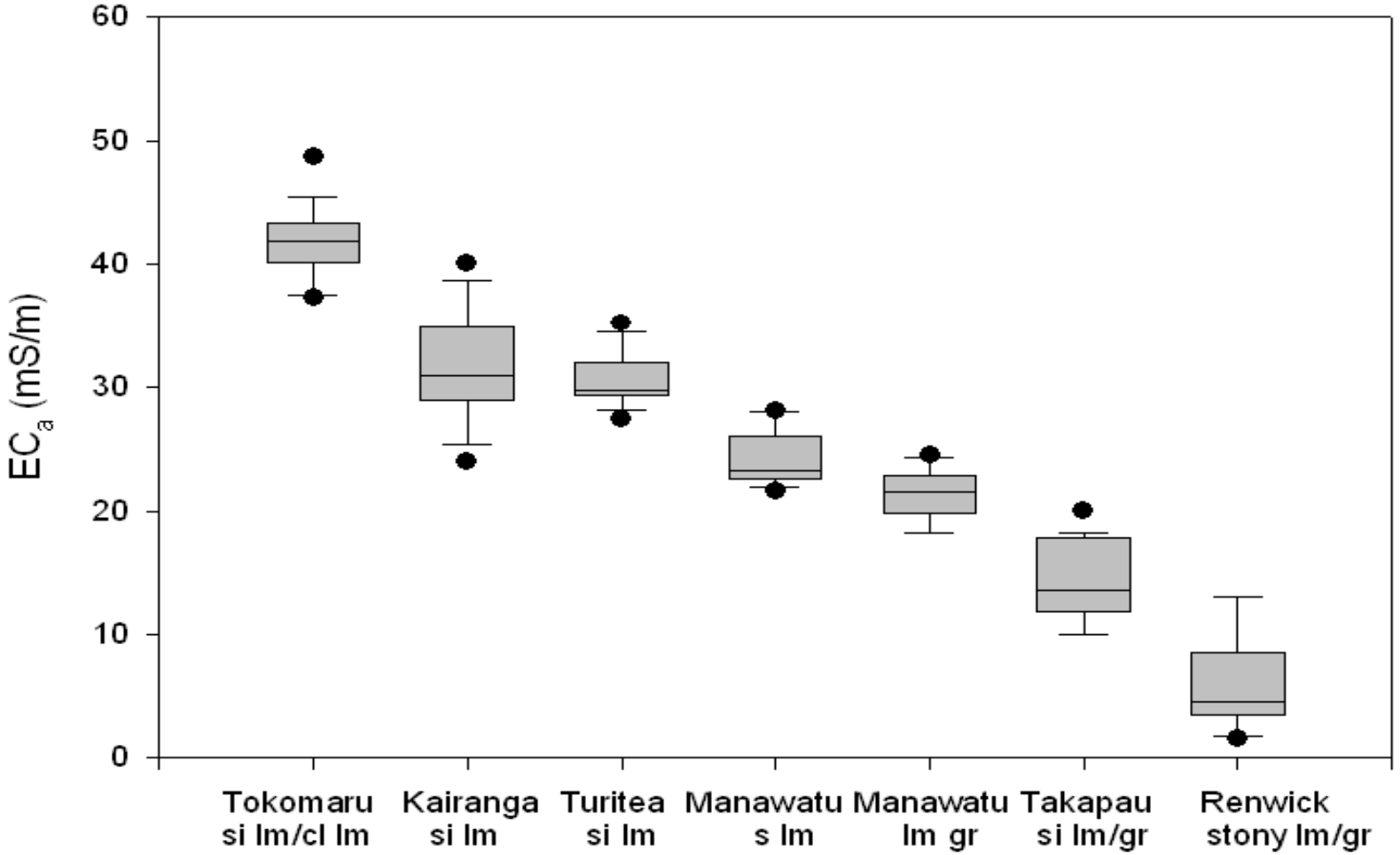
122.000+ points

1500+ points per ha

The EM map

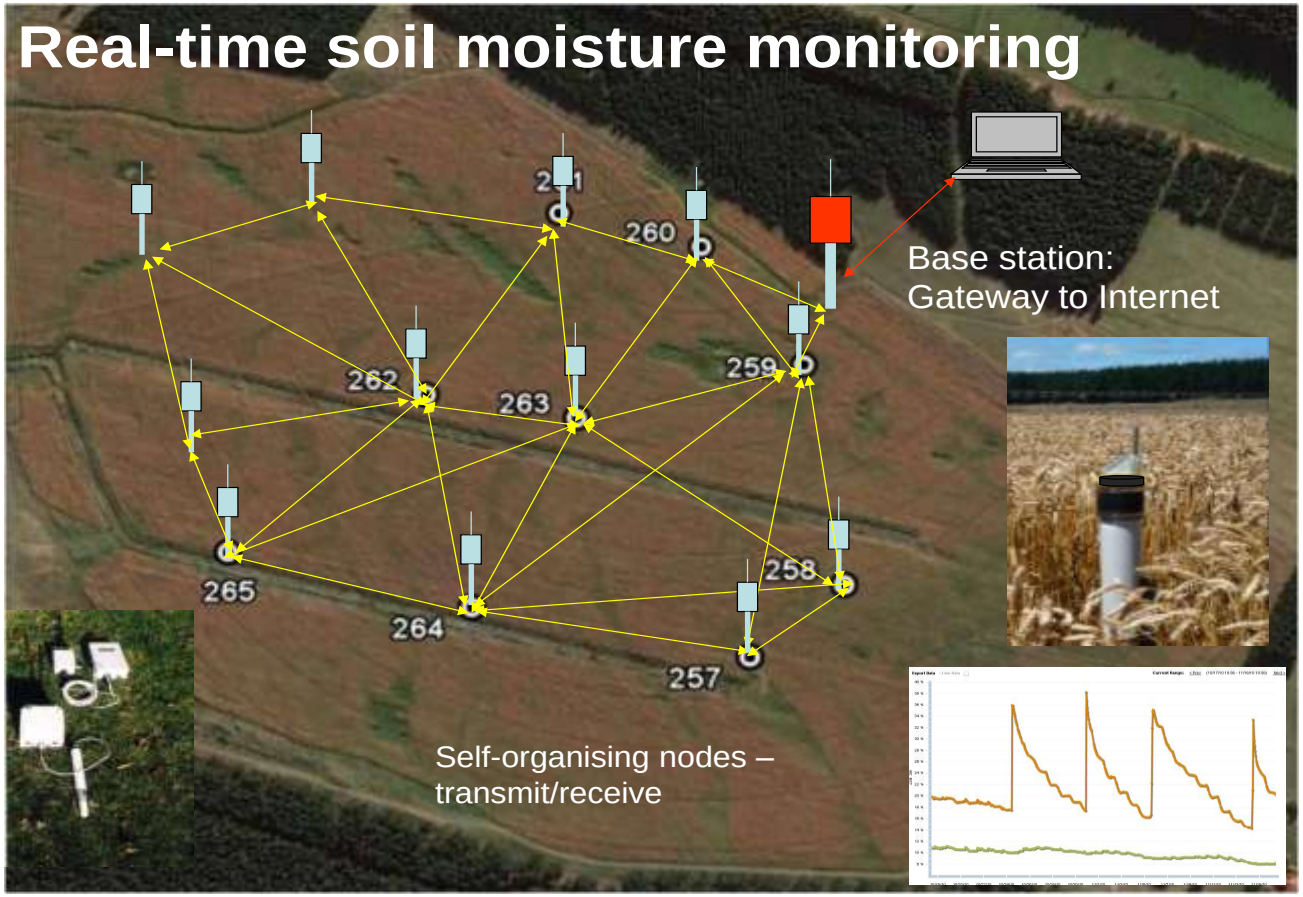

5553200
5553000
5552800
5552600
y
1793800
1794000
1794200
1794400
1794600
1794800
1795000
x
EM38
2
4
6
8
10
12
14

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



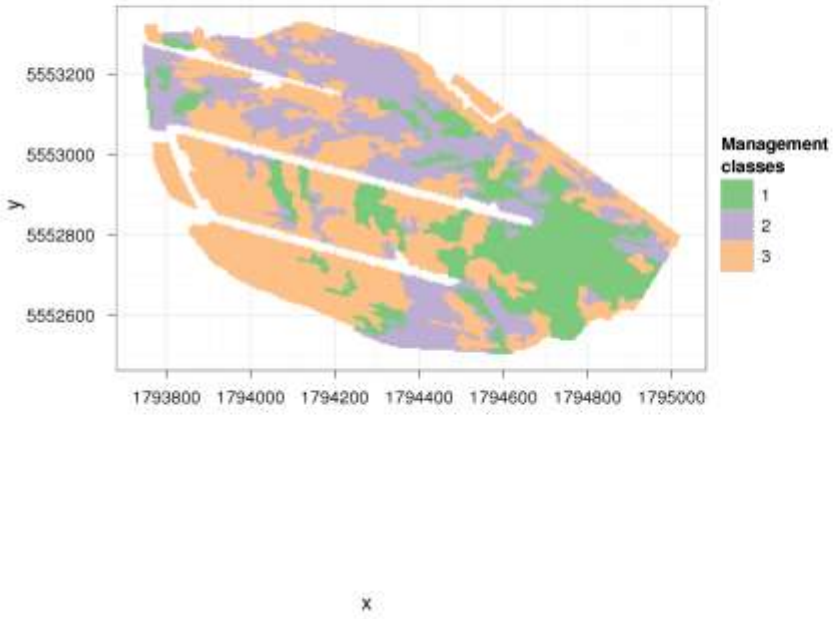
decreasing textural fineness

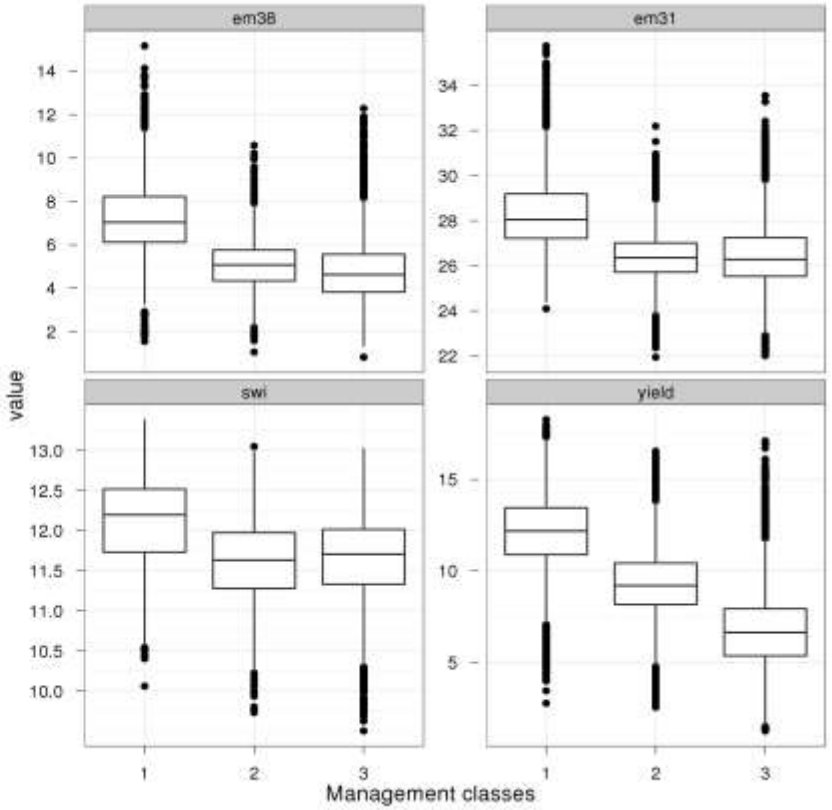
Wireless sensor networks (WSNs)



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

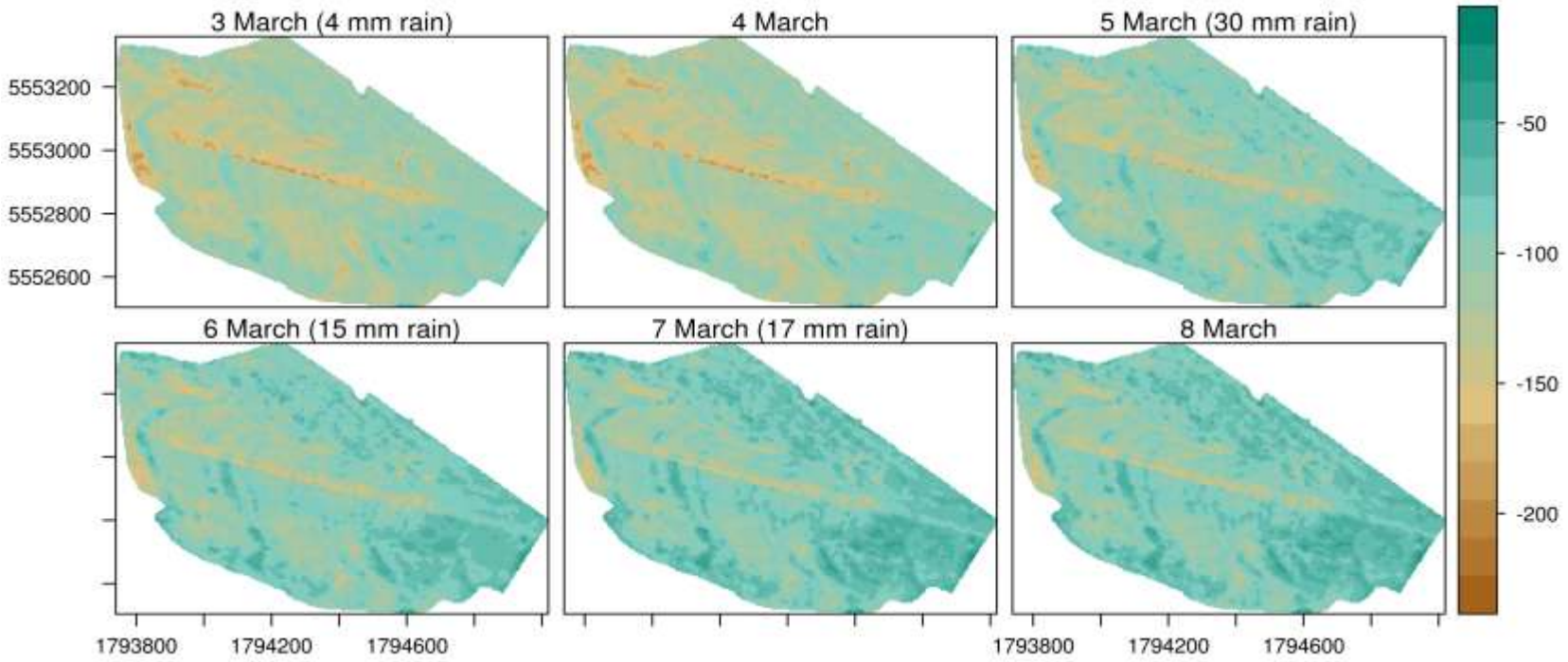
Statistical analysis of datalayers to derive three management classes





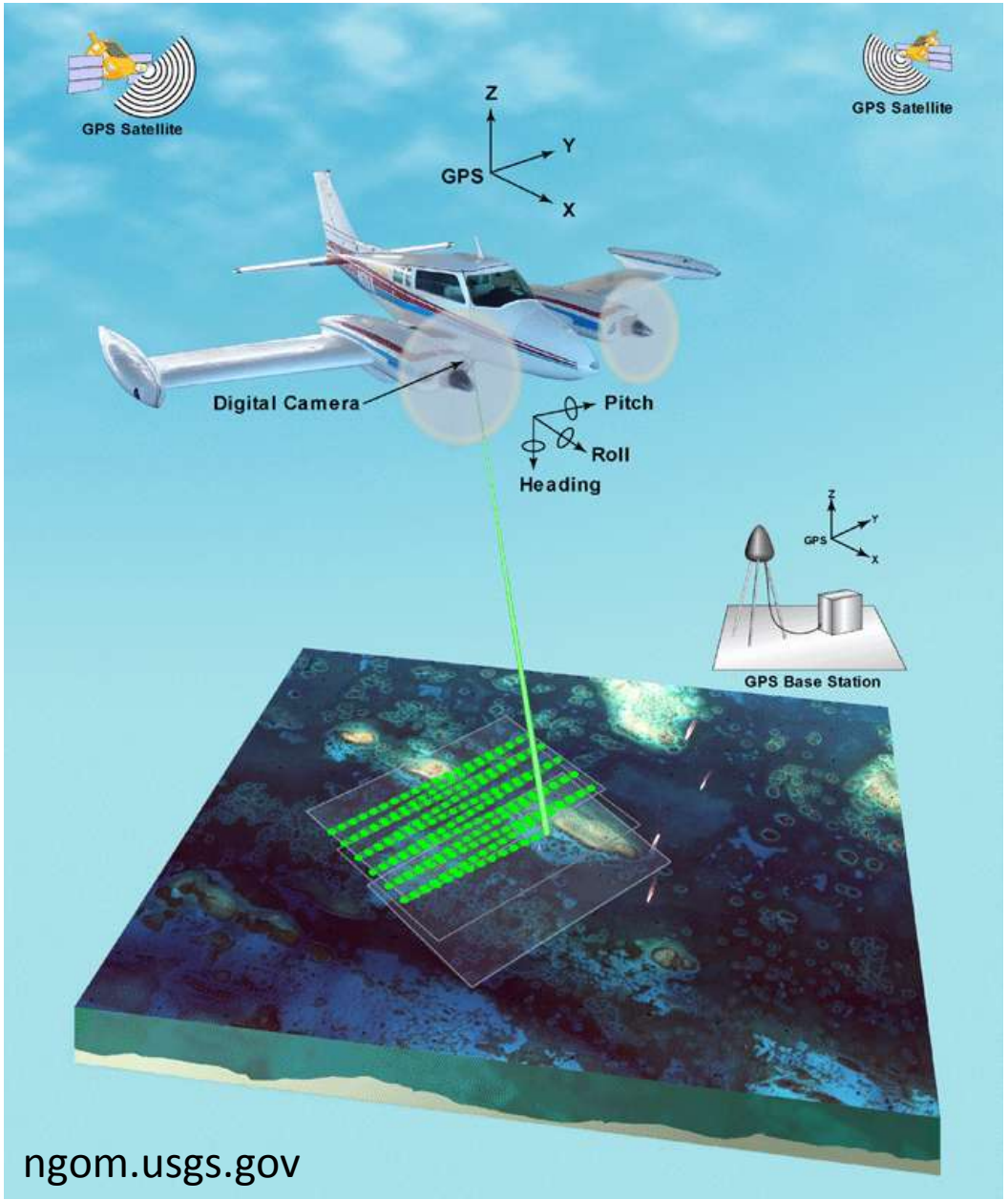
WSN nodes are positioned into the three management classes

Water table modelling

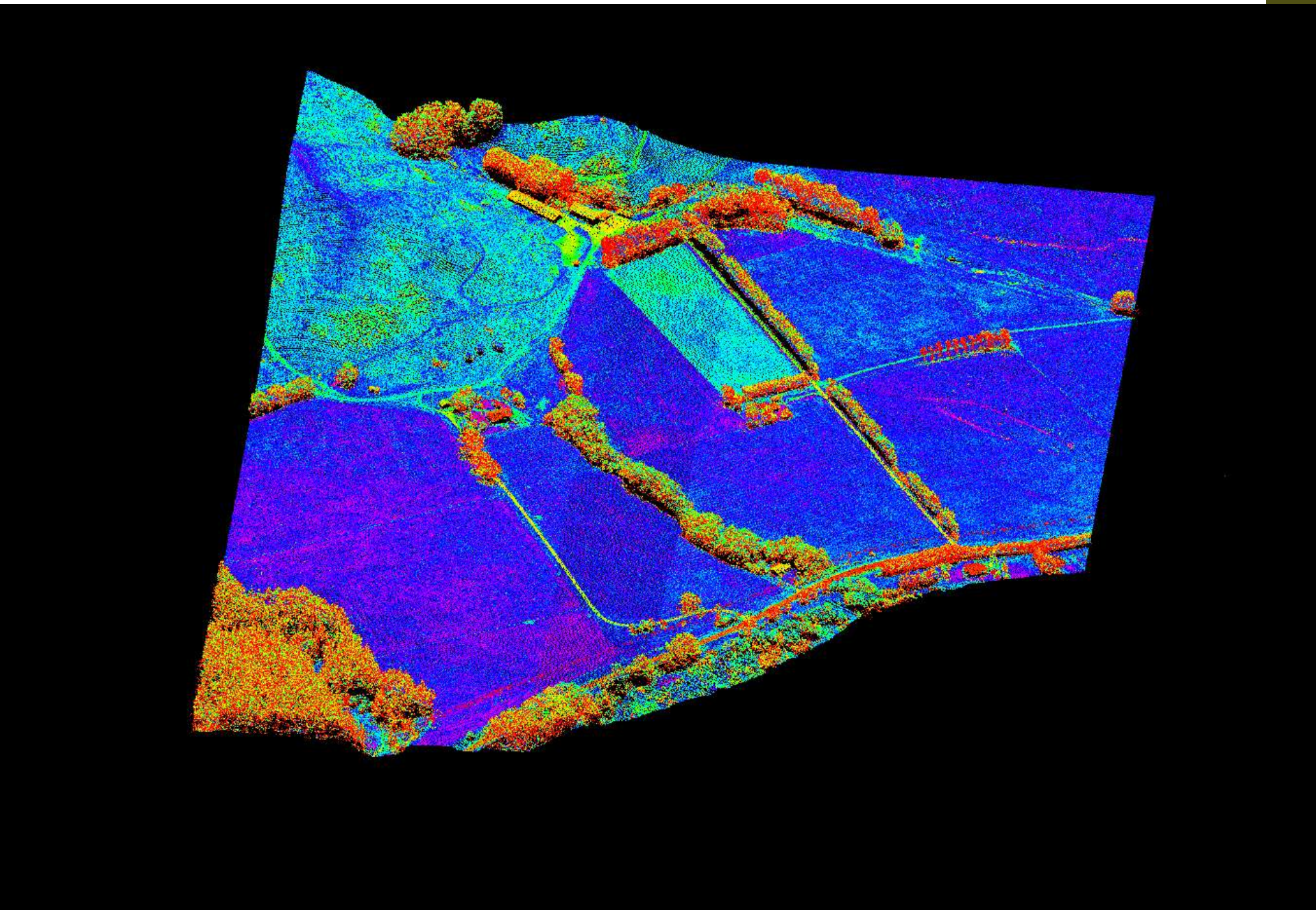


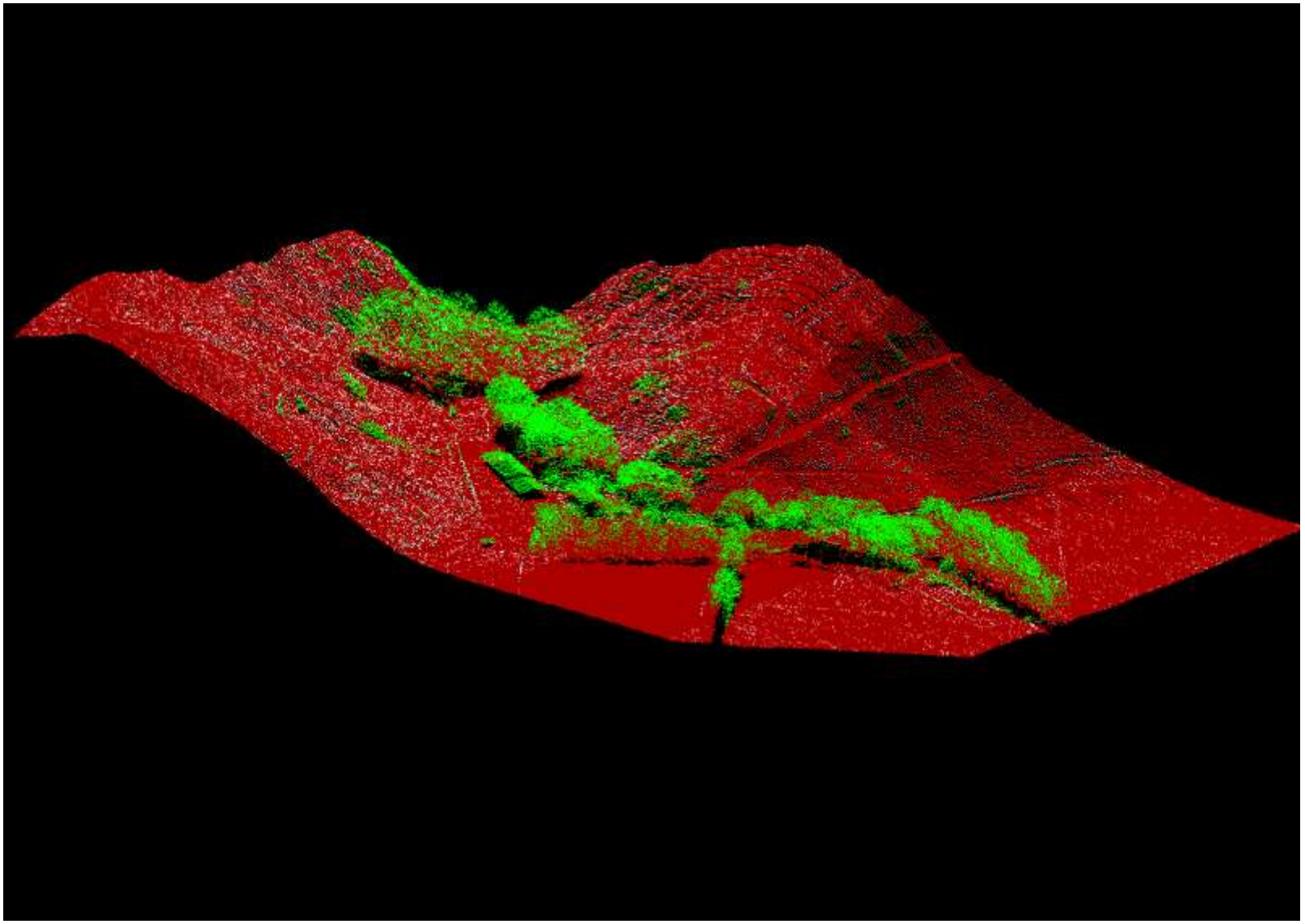
(Hedley et al., 2013, Geoderma 199, 22-29)

LiDAR

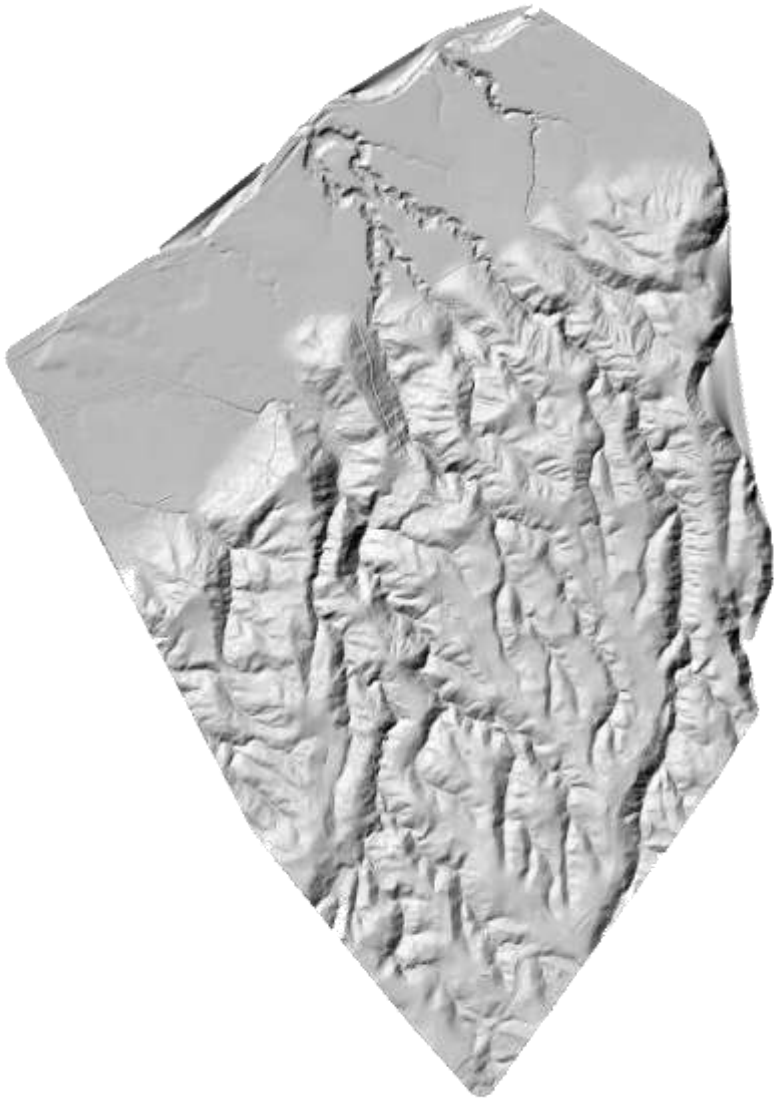

GPS Satellite
GPS Satellite
Z
Y
GPS
X
Digital Camera
Pitch
Roll
Heading
GPS Base Station
ngom.usgs.gov

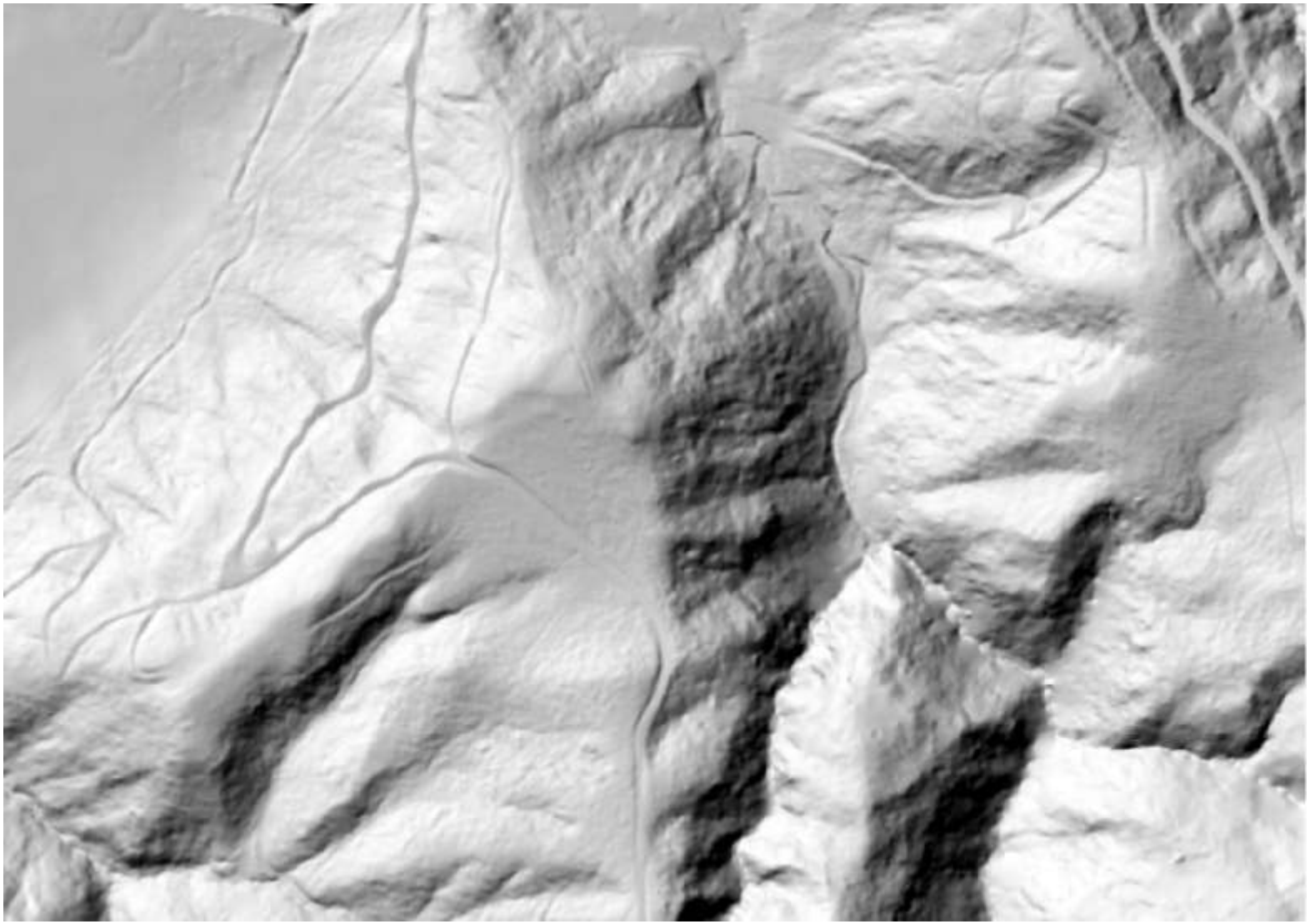
Raw point cloud





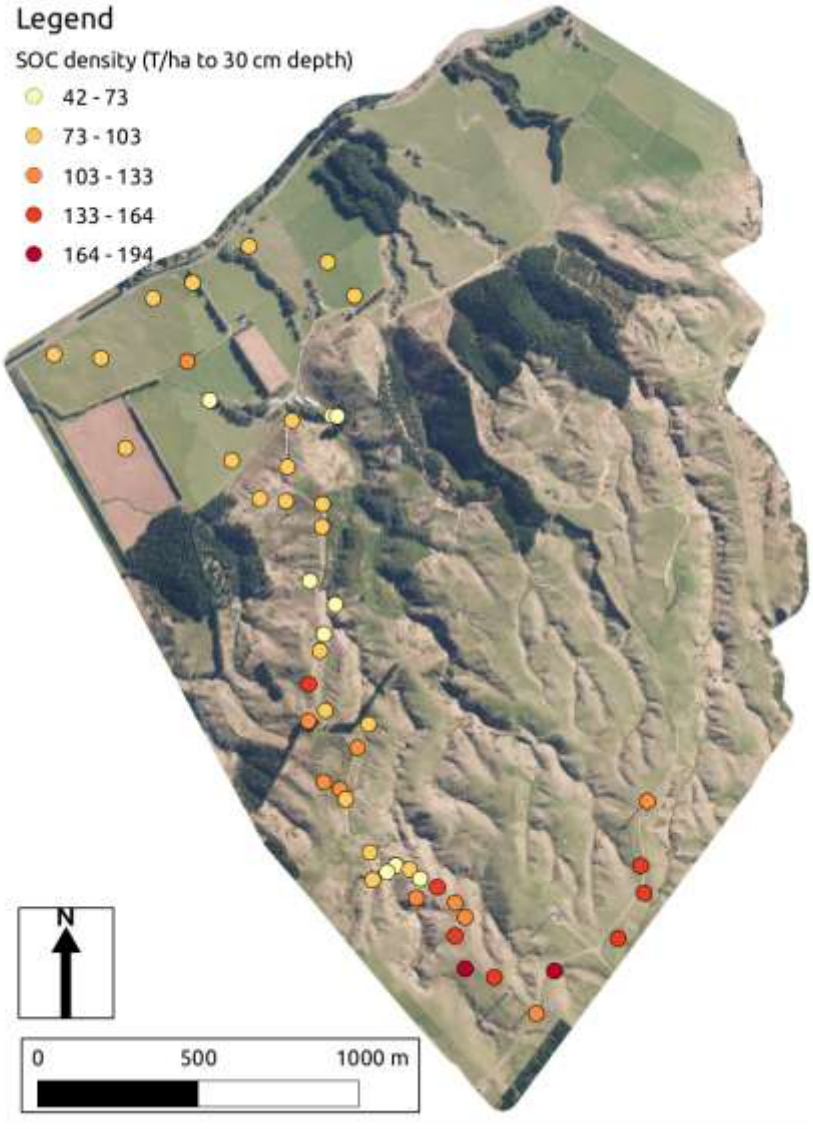
Hillshade visualisation of Massey University Tuapaka farm, derived from the digital elevation map



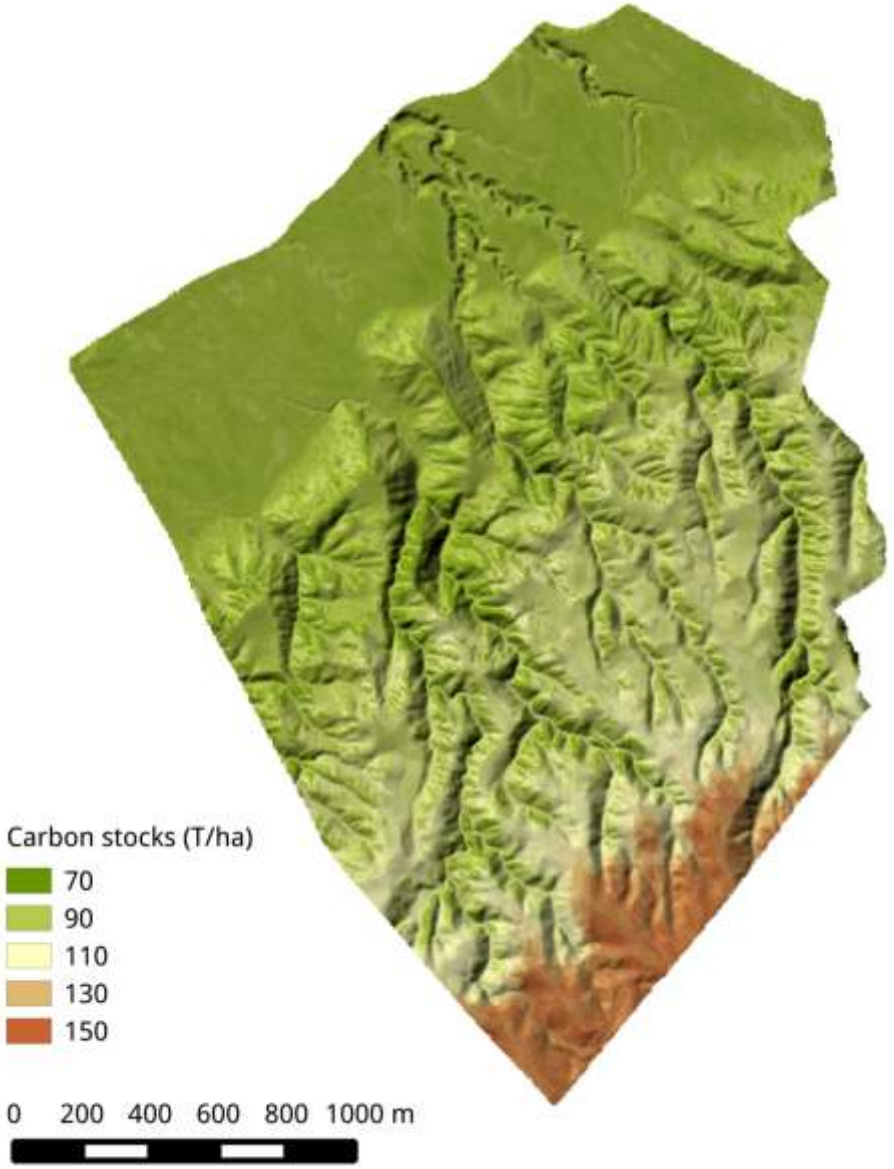


The DEM compliments the legacy soil map to refine our understanding of soil pattern

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

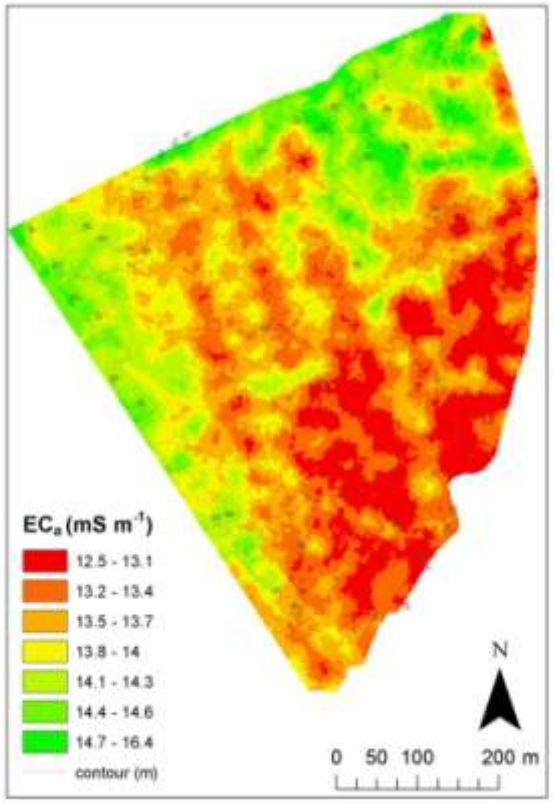
A precision irrigation case study

Case study – Fairlie dairy farm

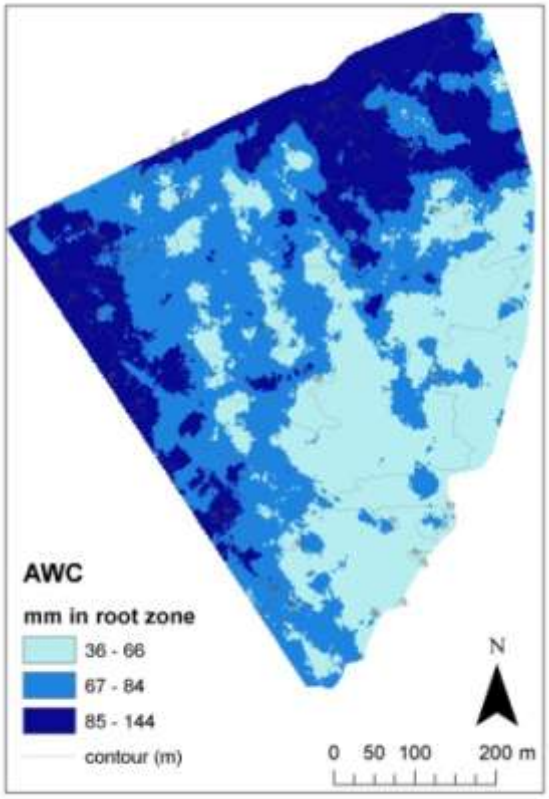
- 3 pivots modified for precision control, irrigating 306 ha = $130,000
- 50 L/s water saved
- 28% of irrigation saved (17% soil zones; 11% tracks, swamps etc)
- Diverted to other areas via 3 rotorainers
- Paid back in one year

PRECISION IRRIGATION

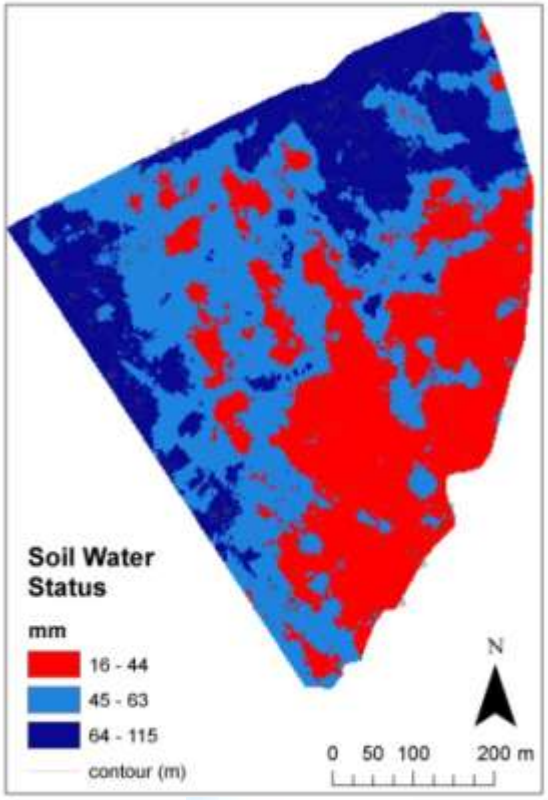
Soil EM map



Plant Available Water

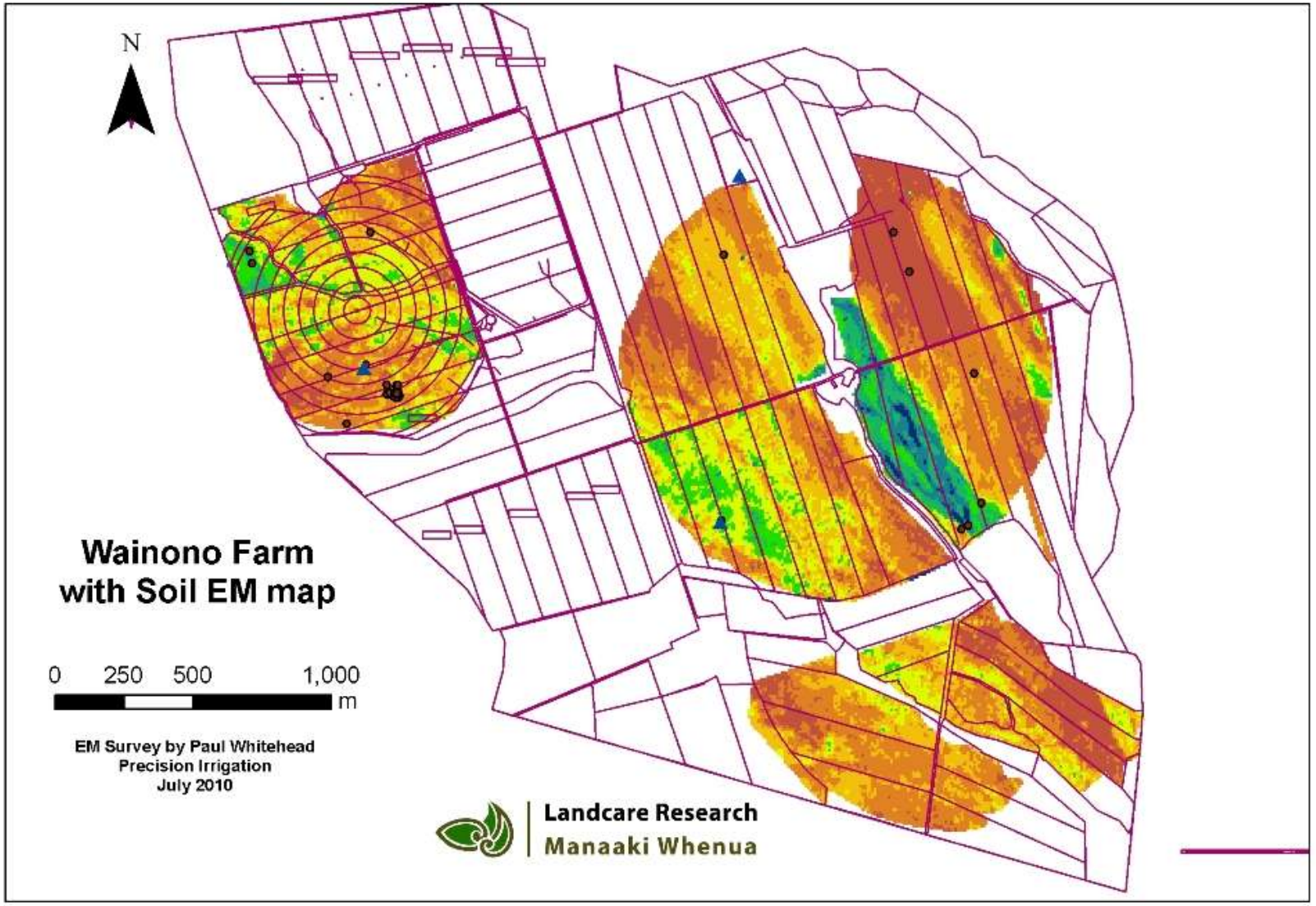


Soil Water Status Map

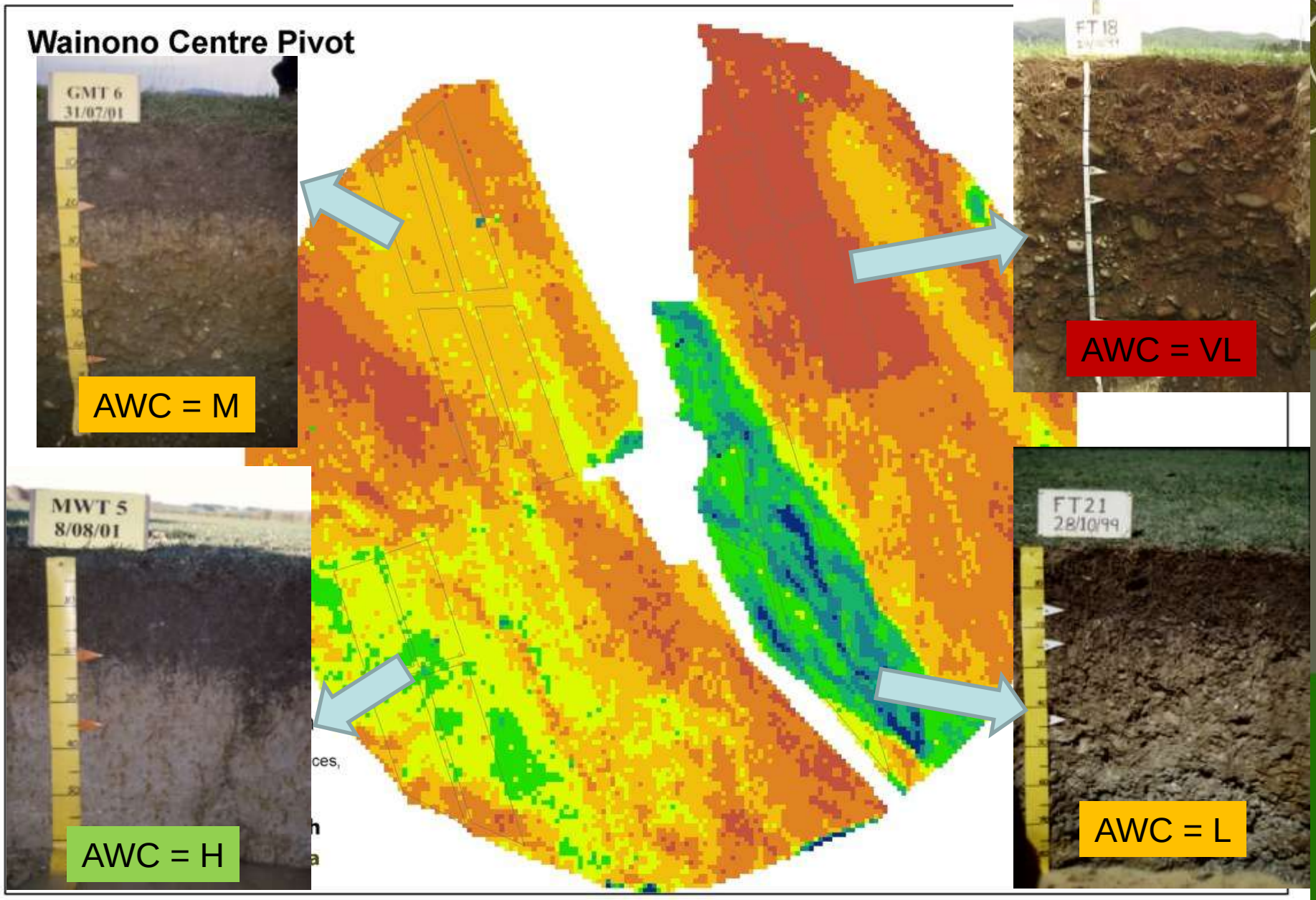


EM mapping and soil survey

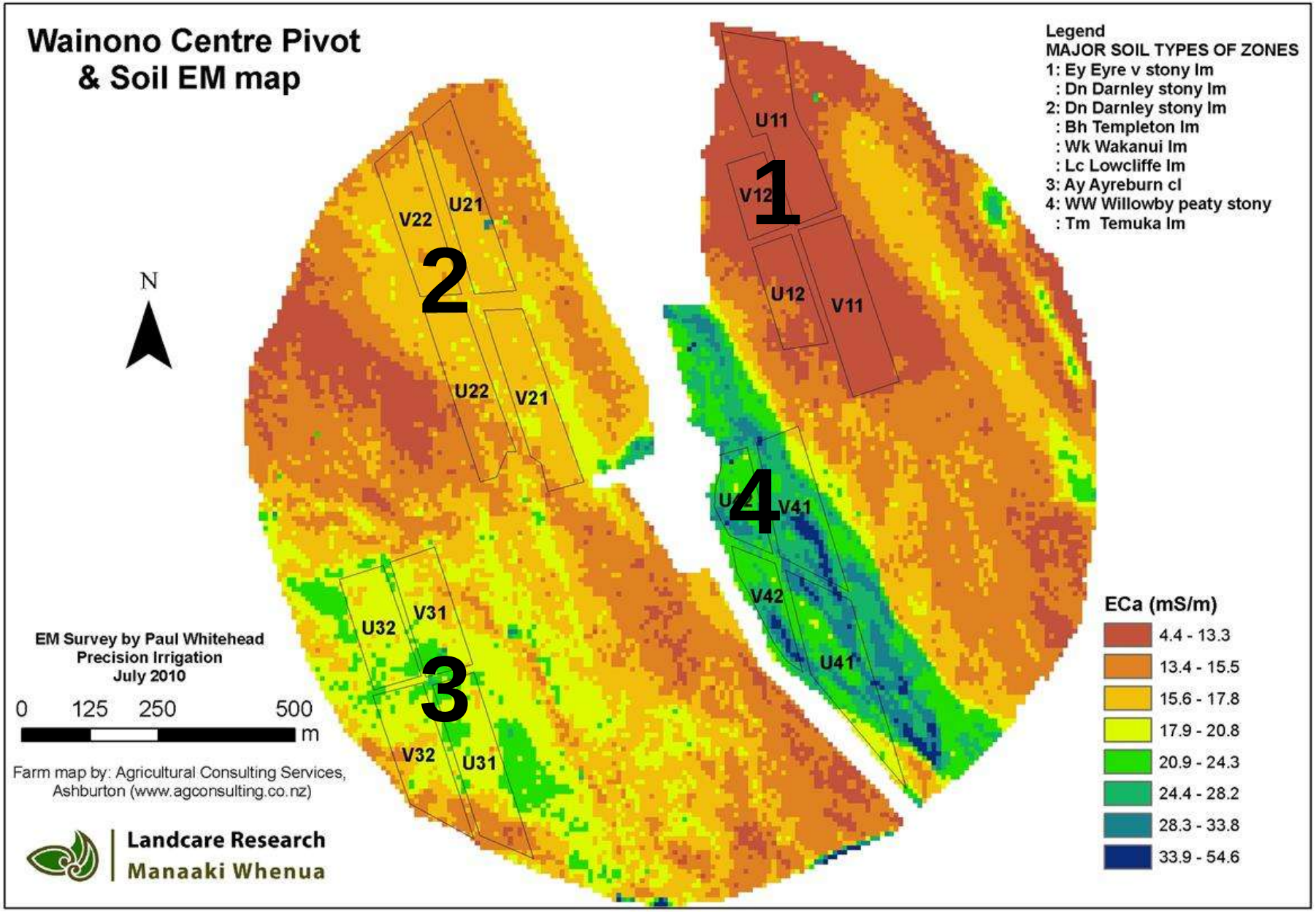
MAF SFF Project



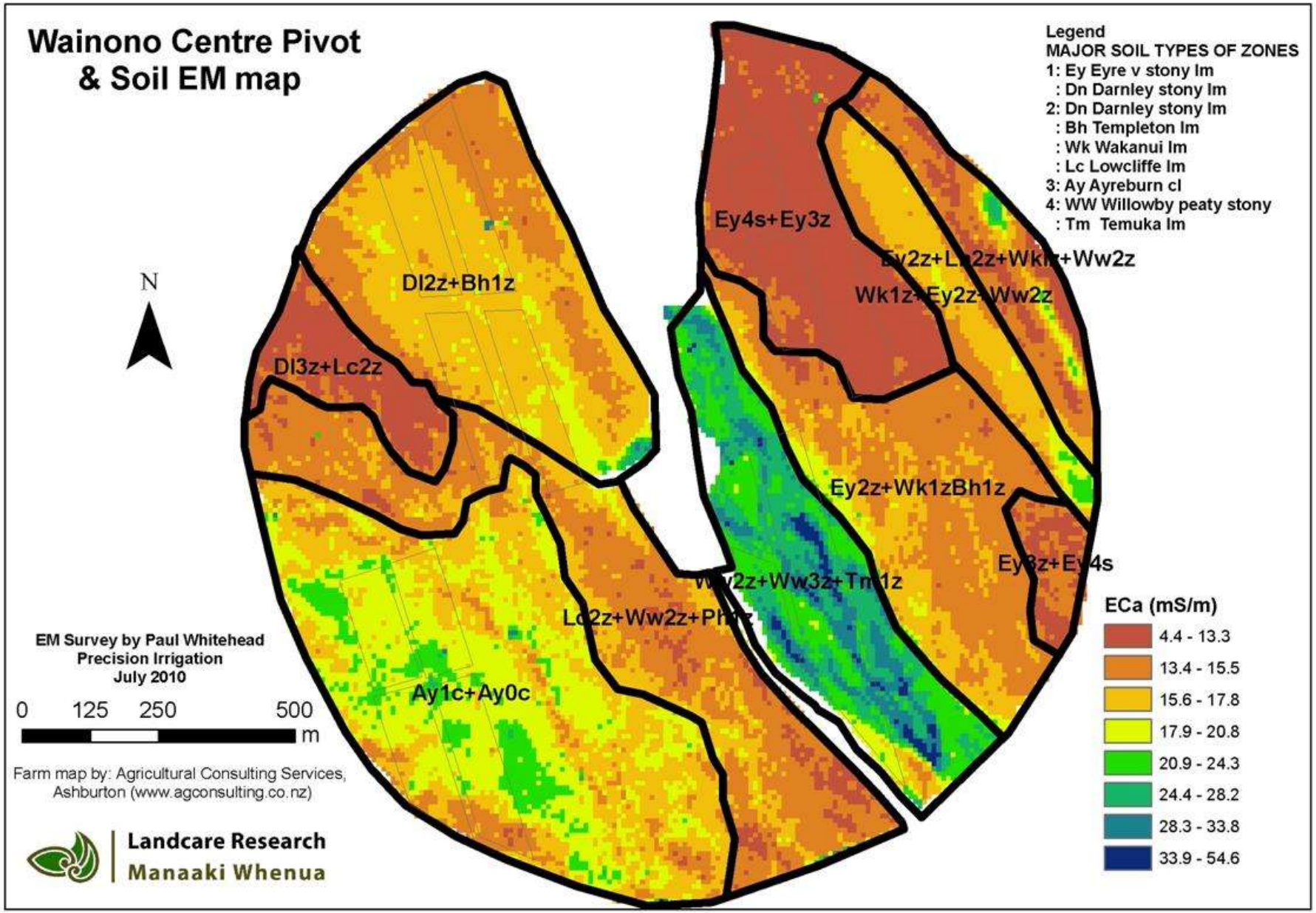
Soil & EM map


Wainono Centre Pivot
GMT 6
31/07/01
AWC = M
FT 18
AWC = VL
MWT 5
8/08/01
AWC = H
FT 21
28/10/99
AWC = L

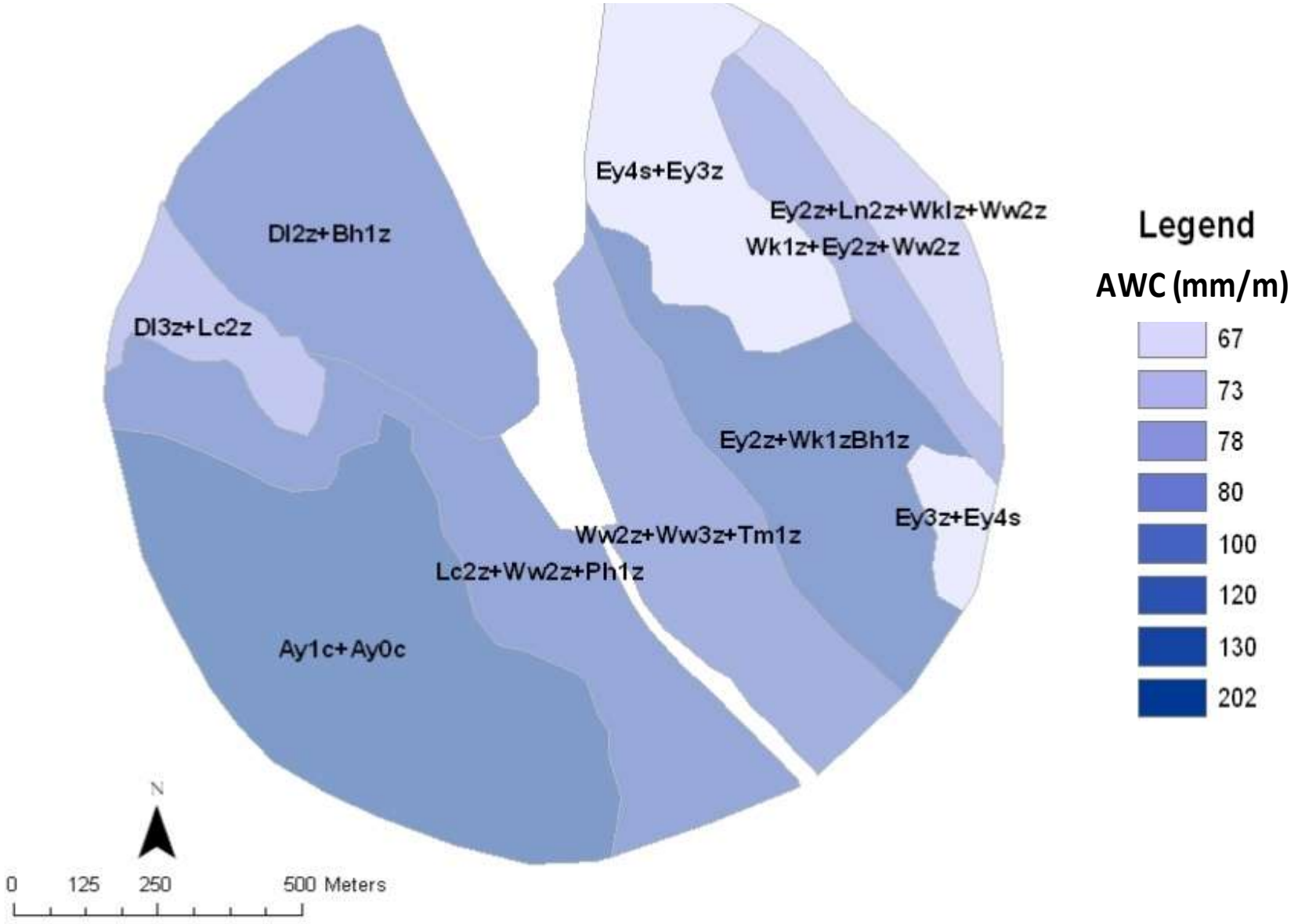
EM map – 4 management zones



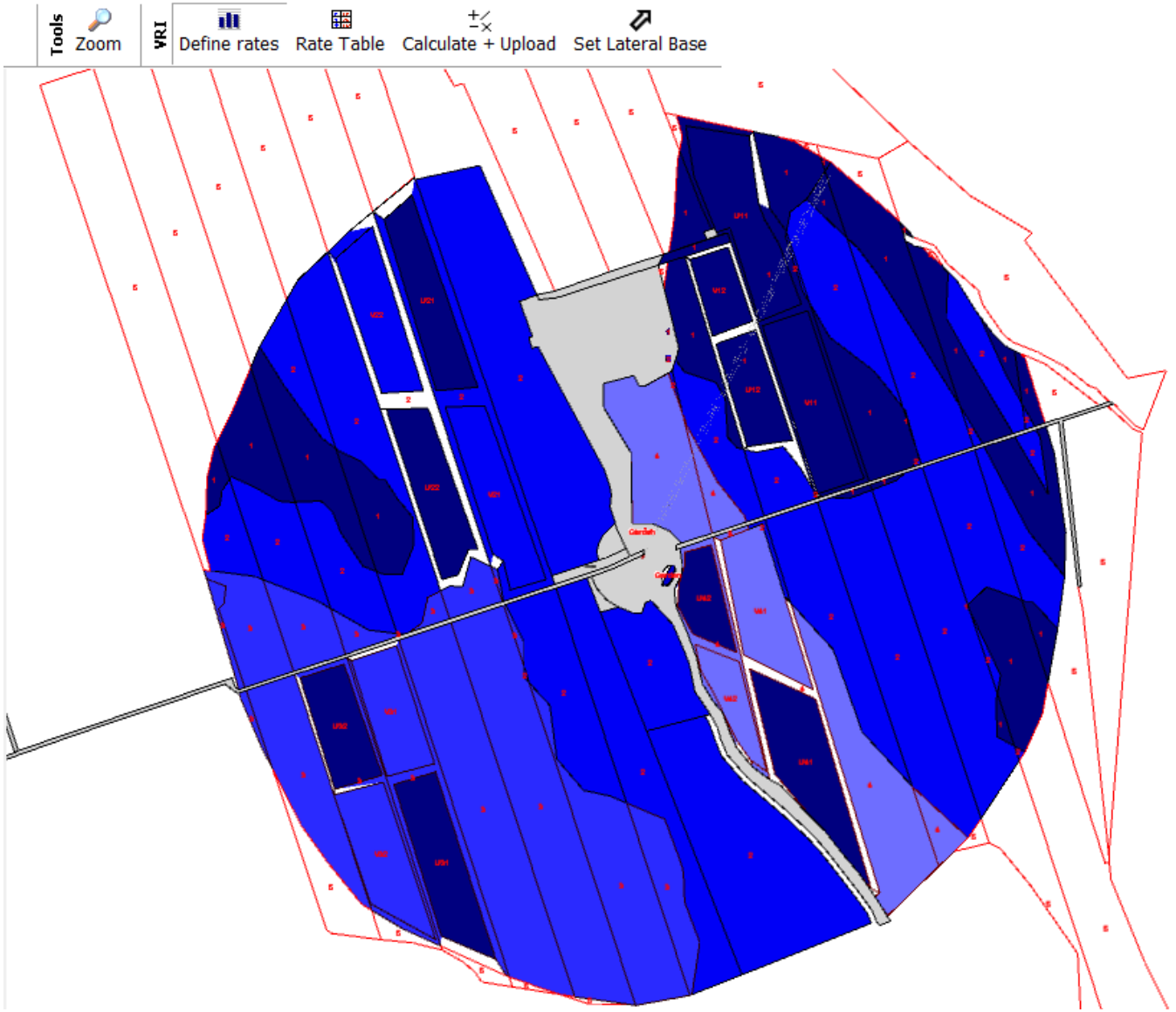
Soil & EM map


Wainono Centre Pivot
& Soil EM map
Legend
MAJOR SOIL TYPES OF ZONES
1: Ey Eyre v stony lm
: Dn Darnley stony lm
2: Dn Darnley stony lm
: Bh Templeton lm
: Wk Wakanui lm
: Lc Lowcliffe lm
3: Ay Ayreburn cl
4: WW Willowby peaty stony
: Tm Temuka lm
N
Dl2z+Bh1z
Dl3z+Lc2z
Ey4s+Ey3z
Ey2z+Wk1z+Ww2z
Ey2z+Wk1zBh1z
Ey3z+Ey4s
Lc2z+Ww2z+Ph1z
Ay1c+Ay0c
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)
Landcare Research
Manaaki Whenua
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

Map of Plant Available Water

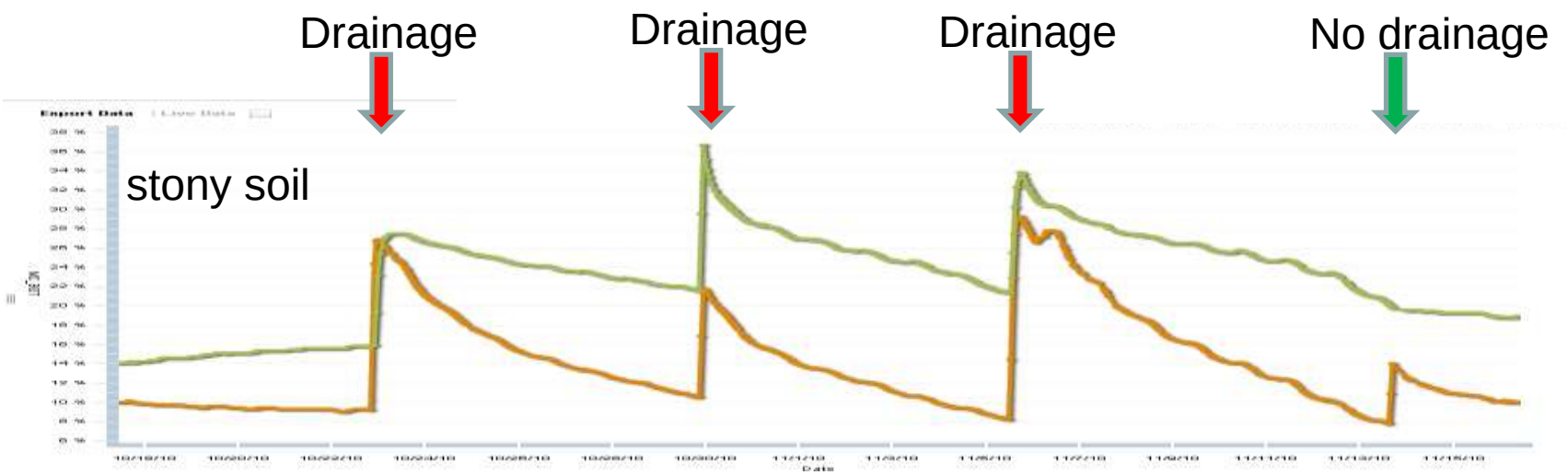


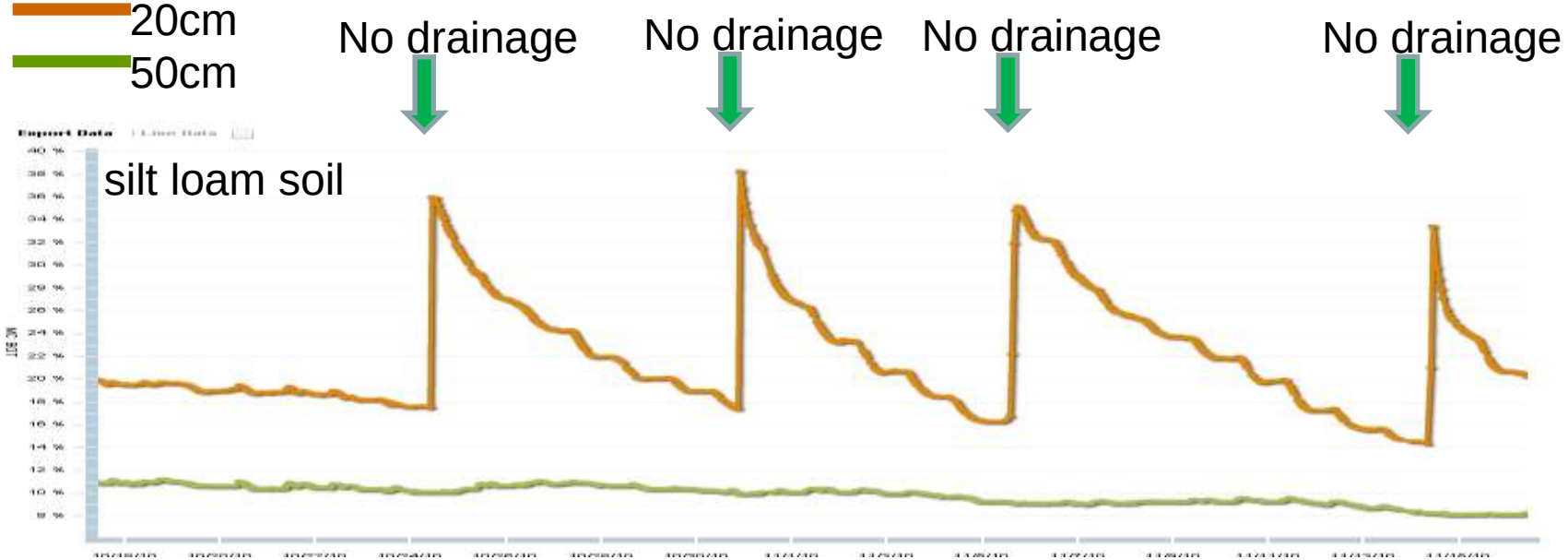
Customised VRI software



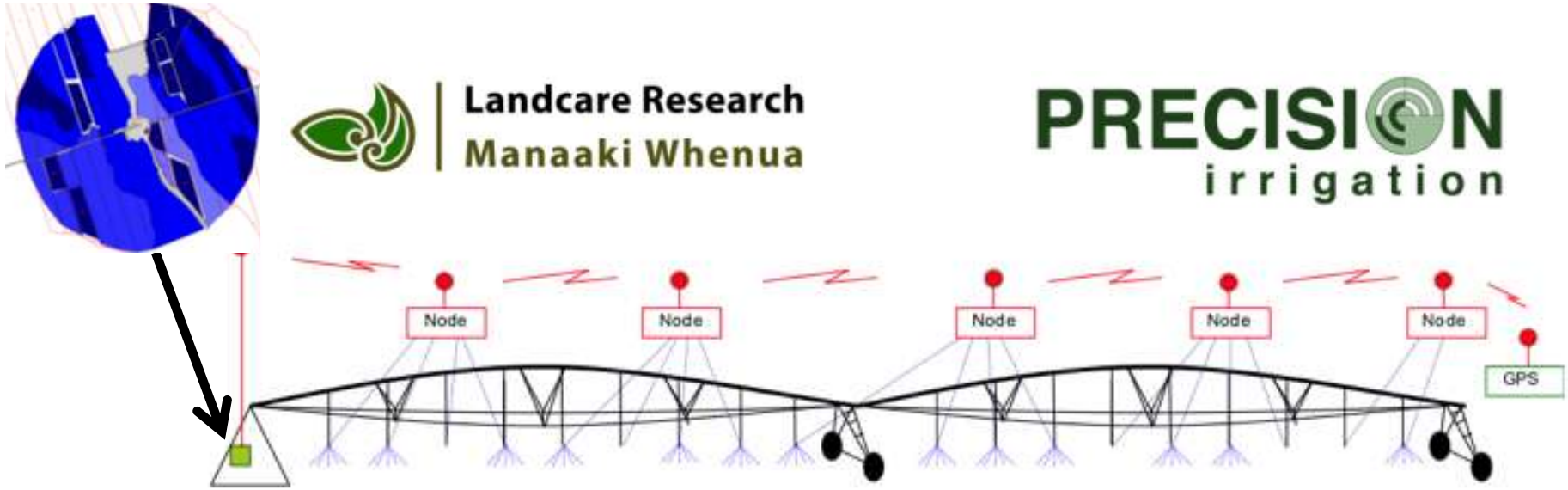
www.precisionirrigation.co.nz

Real-time monitoring





Precision irrigation = modification of the pivot + precision scheduling

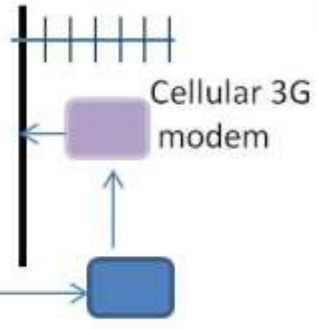


- **> 100 systems sold in first 2 years** **(www.precisionirrigation.co.nz)**
- **Water savings 8 - 40%, reduced drainage & nutrient loss**
- **Return on investment 1-5 years**

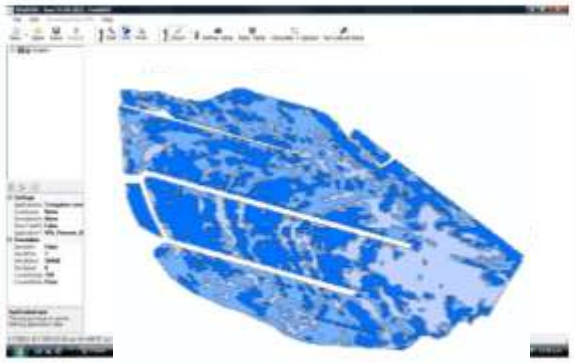
Closing the automation loop

(1) Wireless in-field nodes with sensors attached

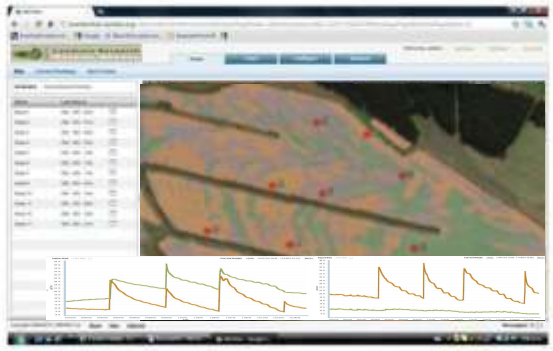
(2) Base station at pivot



(4) Pivot control - soil zones

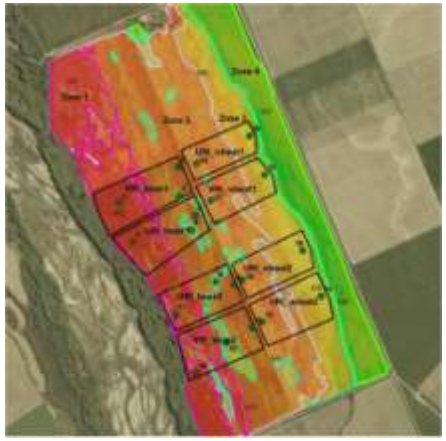


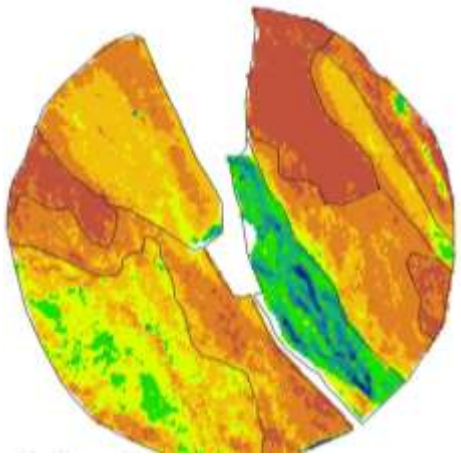
(3) Standard web browser

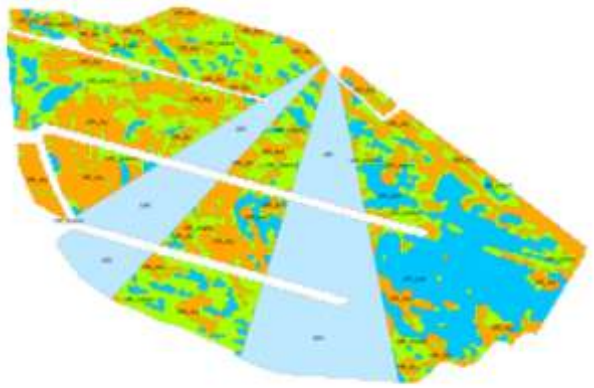


SUMMARY VRI Trial Results 2010-2012

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

(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

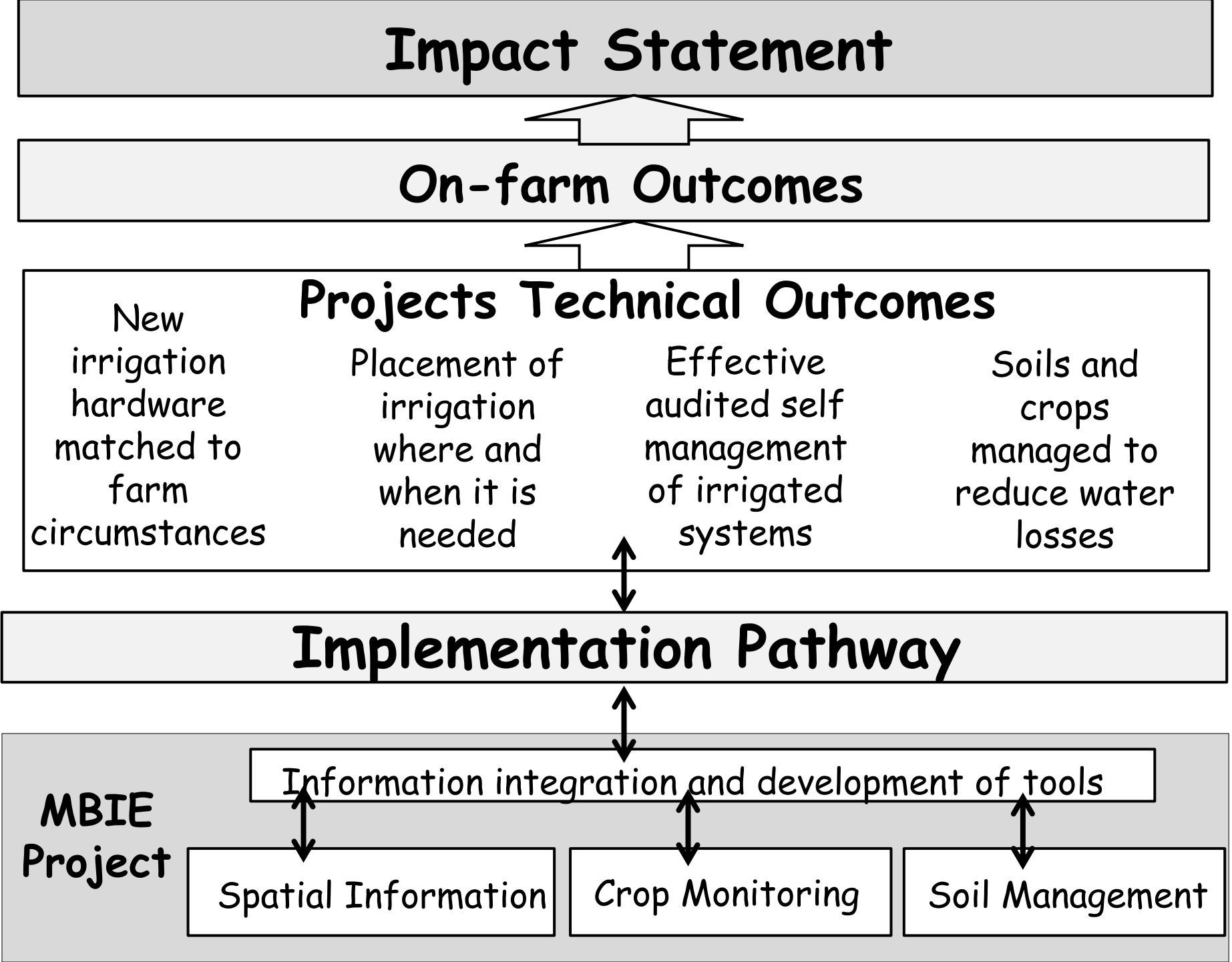
Projects Technical Outcomes

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 reduce water losses


Impact Statement
On-farm Outcomes
Projects Technical Outcomes
New irrigation hardware matched to farm circumstances
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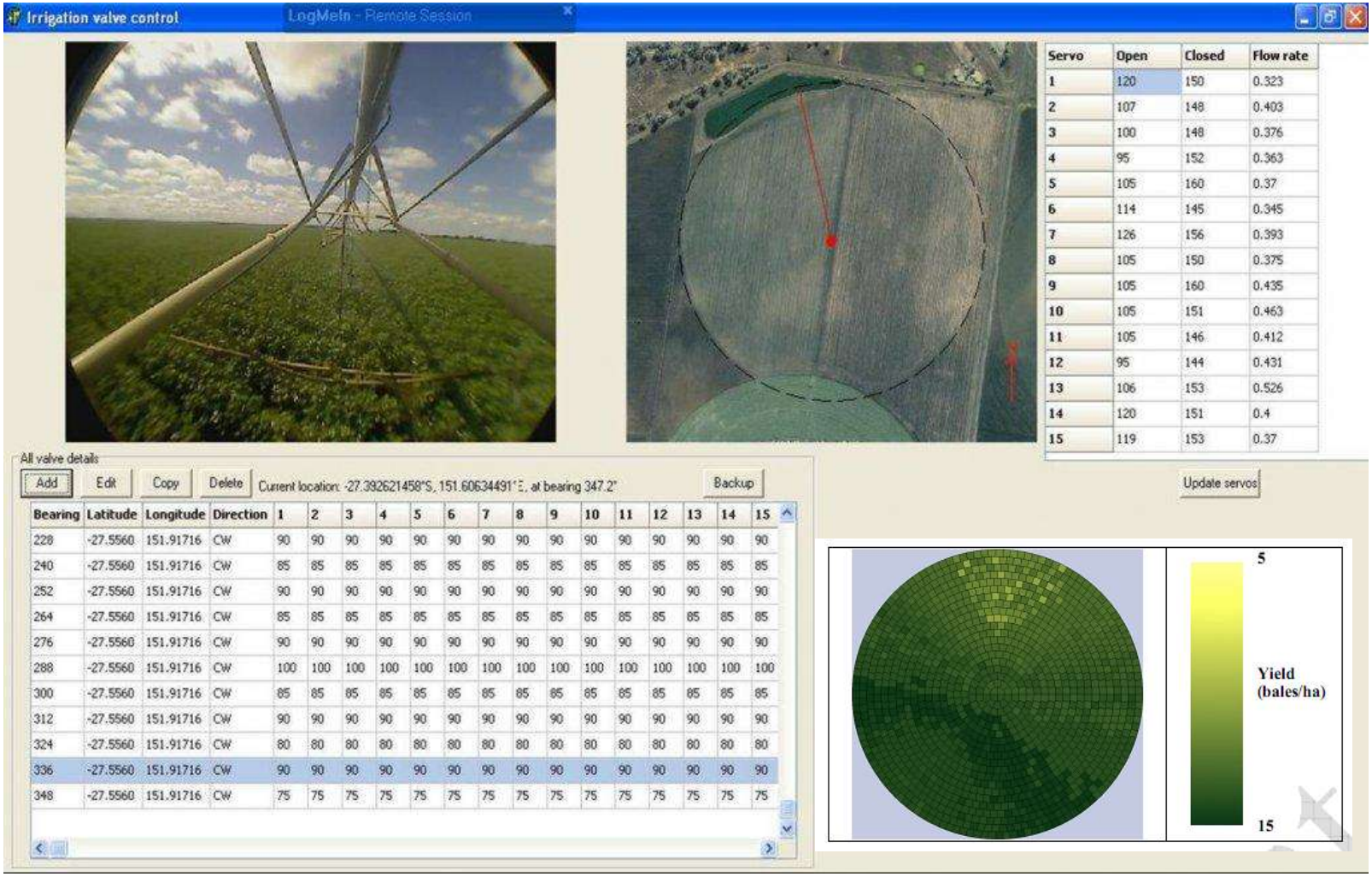
Effective audited self management of irrigated systems
Soils and crops managed to reduce water losses
Implementation Pathway
MBIE Project
Information integration and development of tools
Spatial Information
Crop Monitoring
Soil Management

International collaborators: University of Southern Queensland

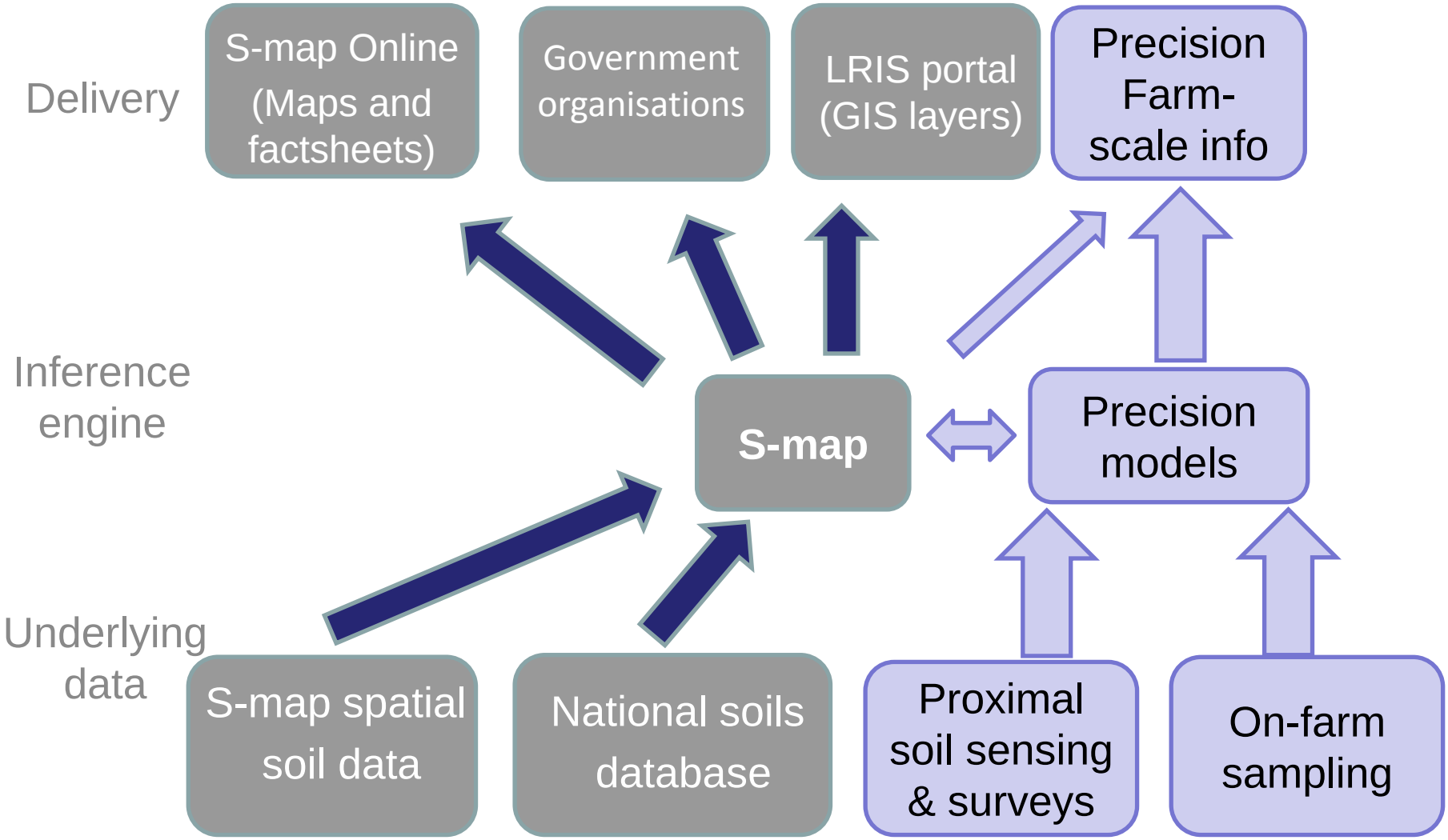
Variwise – crop model based



McCarthy, Hancock and Raine, 2014, University of Southern Queensland

(3)

Supporting S-map



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