Landcare Research
Manaaki Whenua

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# Hill Country Irrigation Project: North Otago Field Trials

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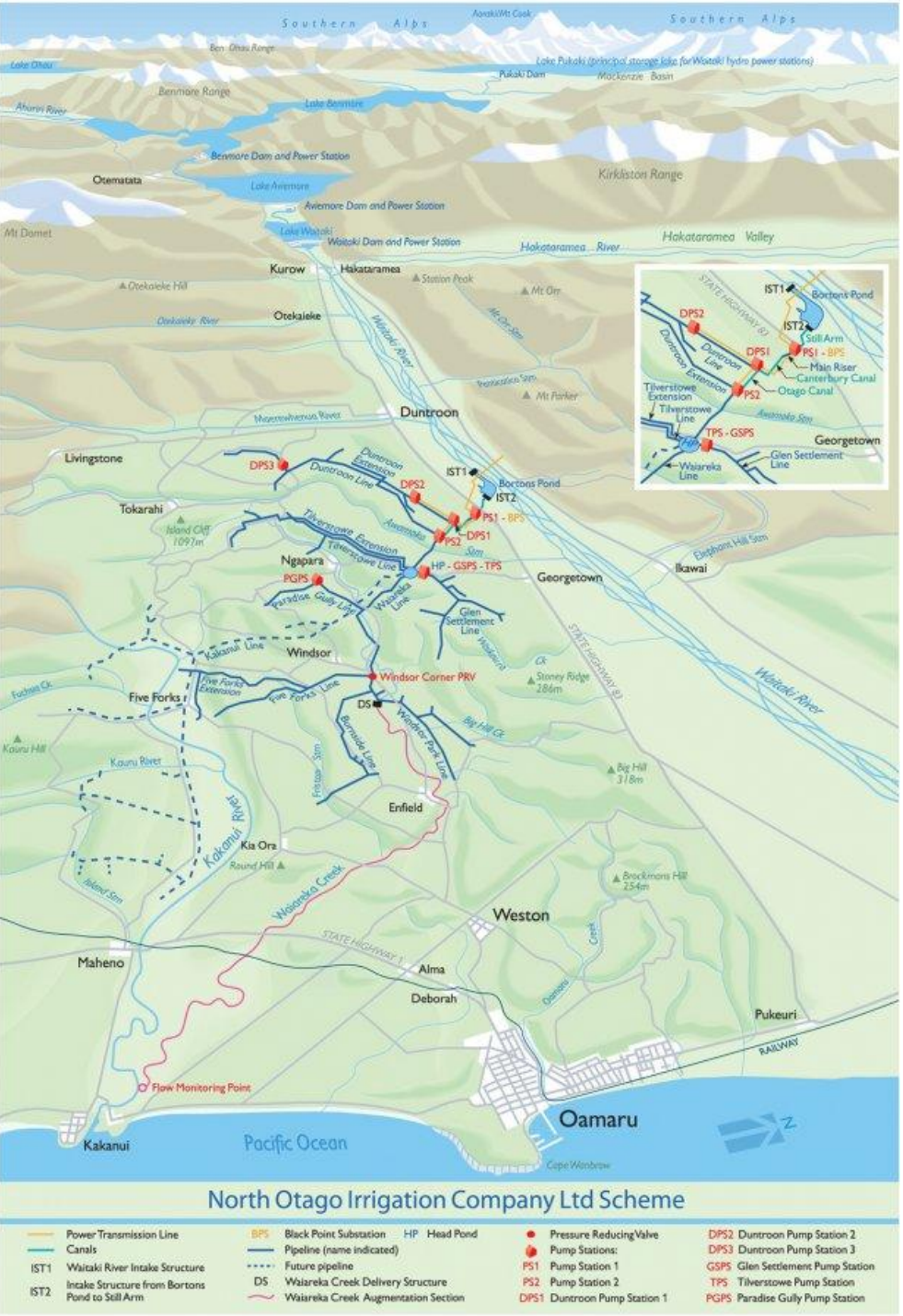
*collaborating with*

AQUALINC

North Otago Irrigation Company
Delivering Opportunities Together

IRRIGATION NEW ZEALAND




# NOIC scheme

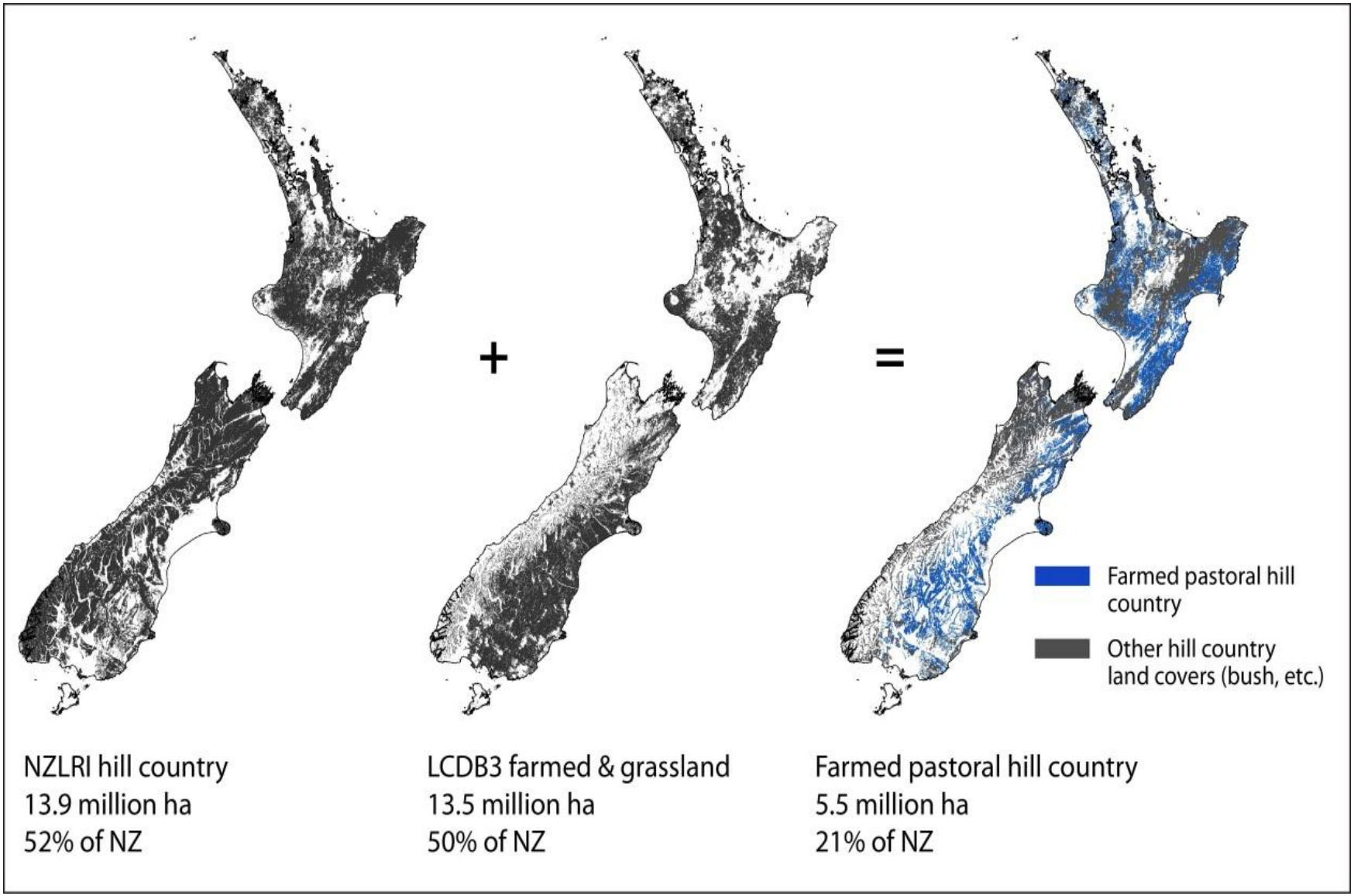
- Opened in 2006
- Series of pump stations, canals, pipes and a natural waterway
- Scheme delivers Waitaki River water to > 10,000 ha of productive farmland
- Pressurised water to the on-farm off-take
- Projected 300% increase in gross revenue output
- 60% under dairying, with sig. conversion from sheep/beef
- 3.5 mm/ha/day

(www.noic.co.nz)

# Hill Country Irrigation Project

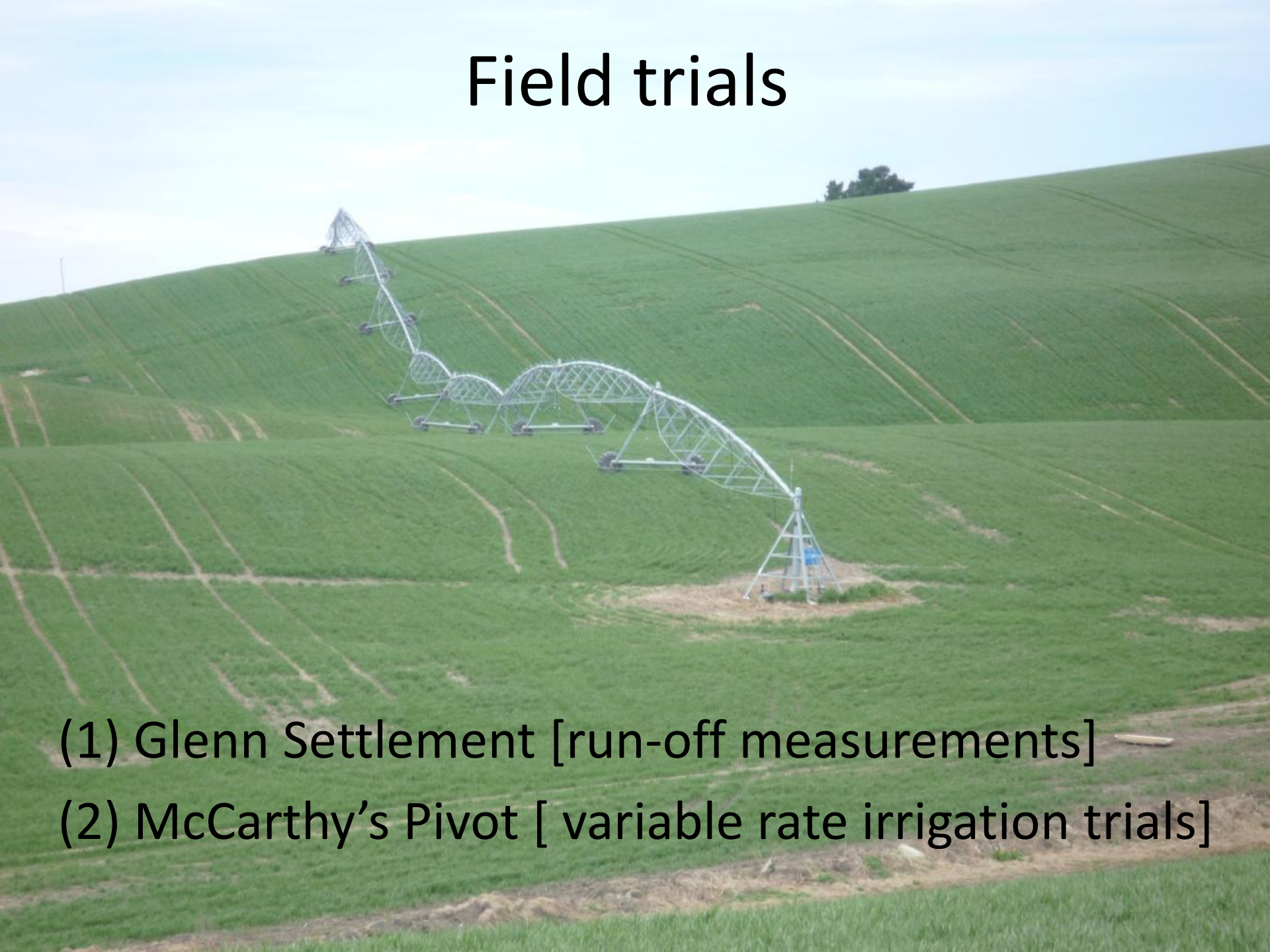
- 3-yr SFF project led by Irrigation NZ, with inputs from North Otago Irrigation Company, Aqualinc, AgResearch, Landcare Research
- Setting Good Management Practice Guidelines to Assist Hill Country Irrigation Performance
- Literature review, field trials and a final report
- “Hill country” is estimated at 13.9 million hectares, or 52% of NZ’s  land area (NZLRI)

Farmed pastoral hill country based on NZLRI hill country and LCDB3 land cover.




(Manderson, 2010)

# Field trials



(1) Glenn Settlement [run-off measurements]

(2) McCarthy's Pivot [ variable rate irrigation trials]

# Glenn Settlement
# field trials

# Land Use Intensification

**Traditionally drought prone region**

**Surface water quality major issue**

**Need to fine tune irrigation**

1) **minimise water and nutrient losses**

2) **maintain productivity**

**Timaru Silt Loam (Pallic soils)**

- **Shallow (approx. 200-500 mm)**
- **Free-draining topsoil on imperfectly drained subsoil**

# North Otago Rolling Downlands

**Glenn Settlement**

**catchment (~1.5 ha)**

**Pivot – uniform rate irrigation**

**Measurements**

- **Irrigation depth**
- **run-off volumes**
- **depth of soil profile saturation**

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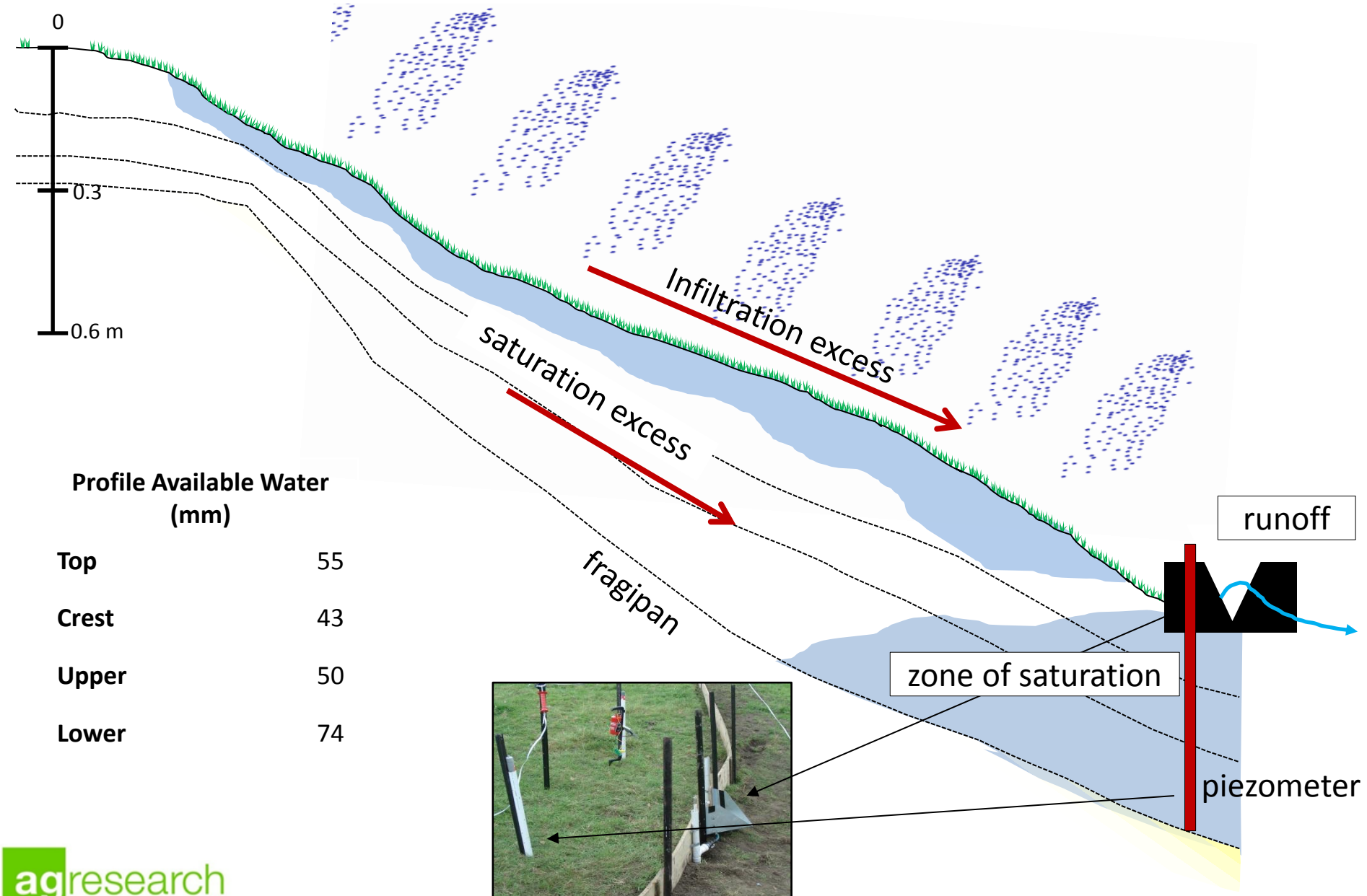
# Slope characteristics




| Profile Available Water (mm) | |
|---|---|
| **Top** | 55 |
| **Crest** | 43 |
| **Upper** | 50 |
| **Lower** | 74 |



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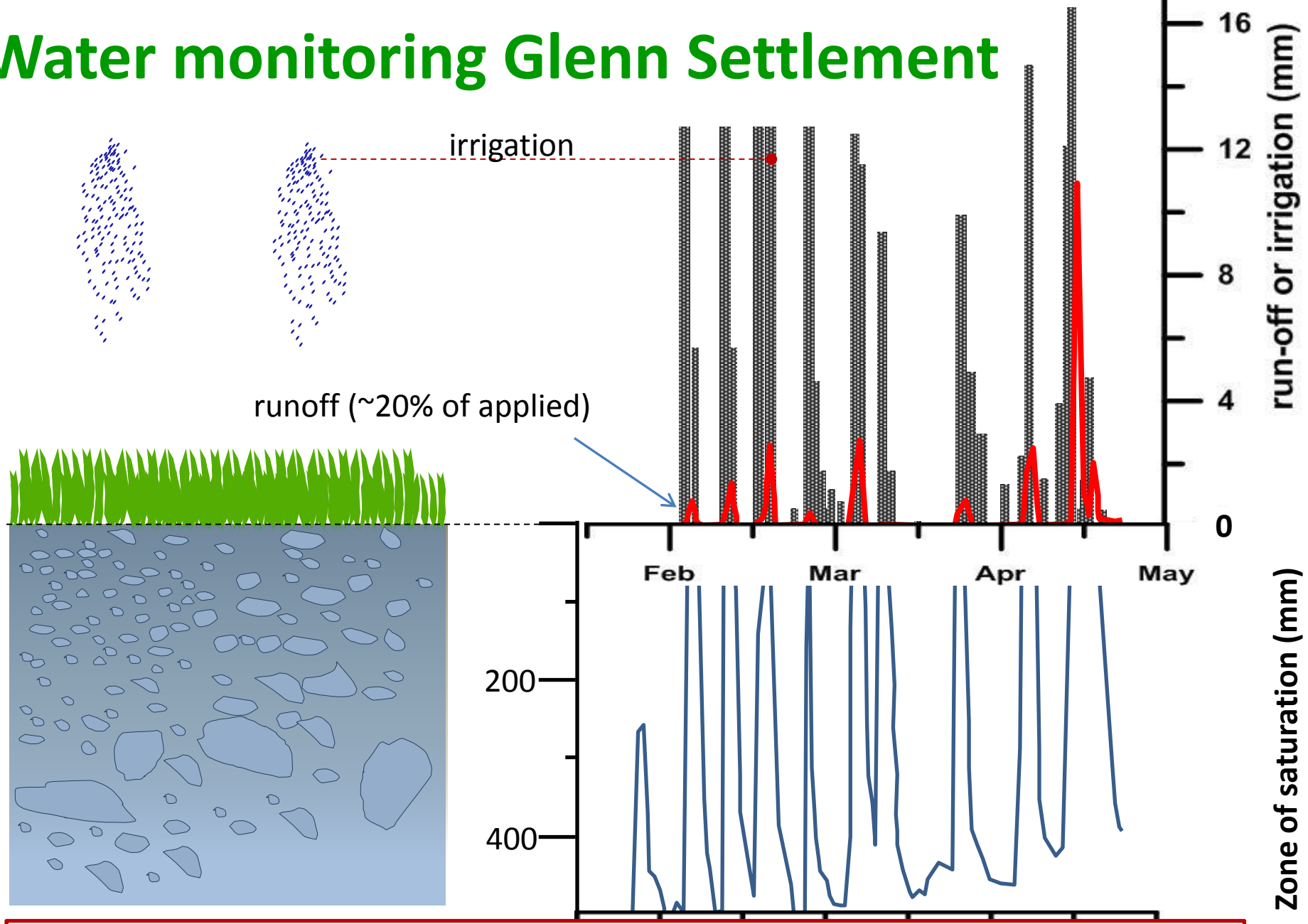
# Water monitoring Glenn Settlement

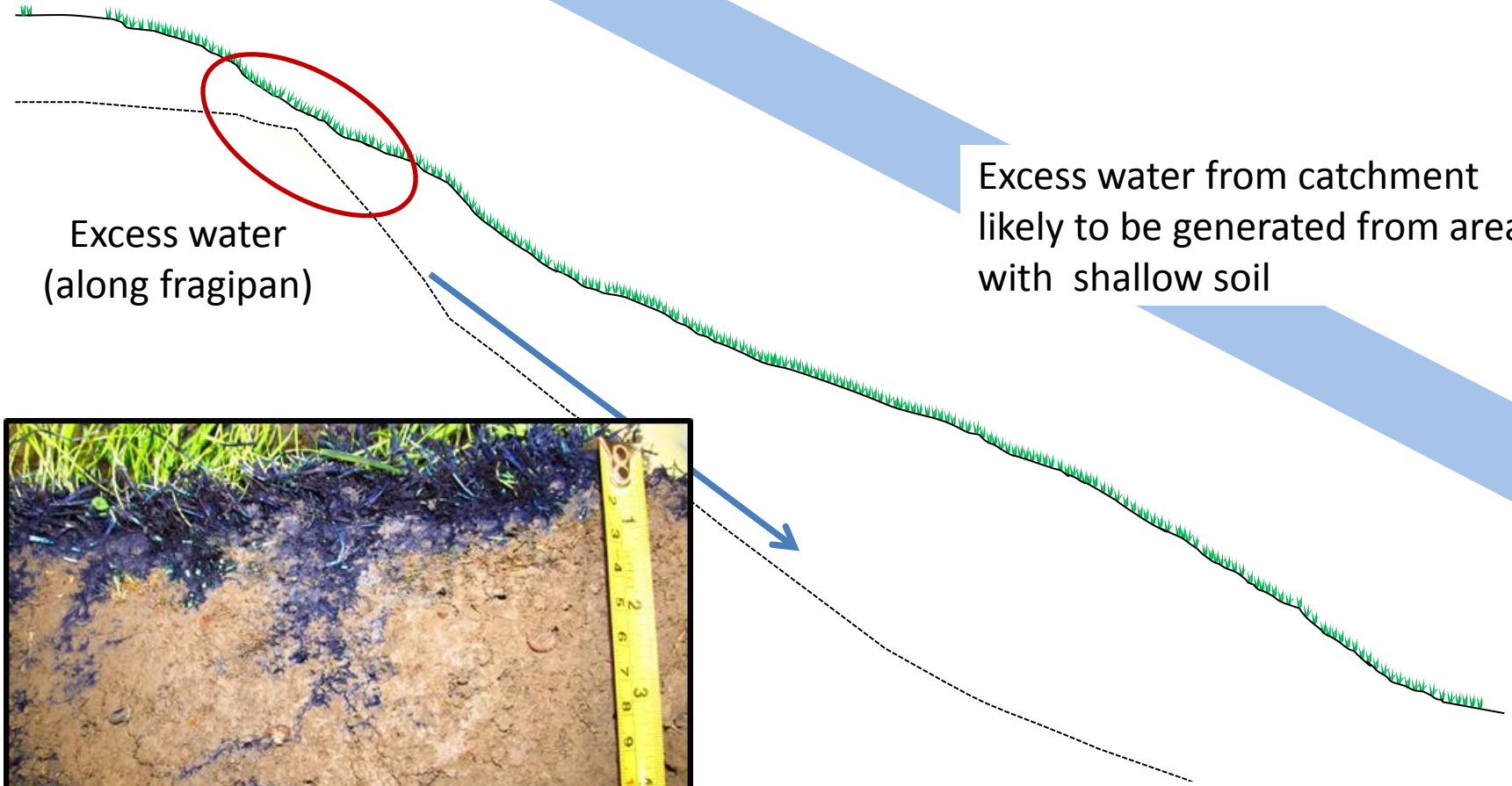



**Runoff – a result of saturation excess conditions at base of slope**

# Potential reasons for saturation excess

Saturation excess conditions somewhere along the slope

Variation in soil depth increases risk of over watering






Intact monoliths 20 mm irrigation applied

Blue dye indicates high probability of preferential flow

# McCarthy's Variable Rate Centre Pivot

# Case Study: Variable Rate Irrigation

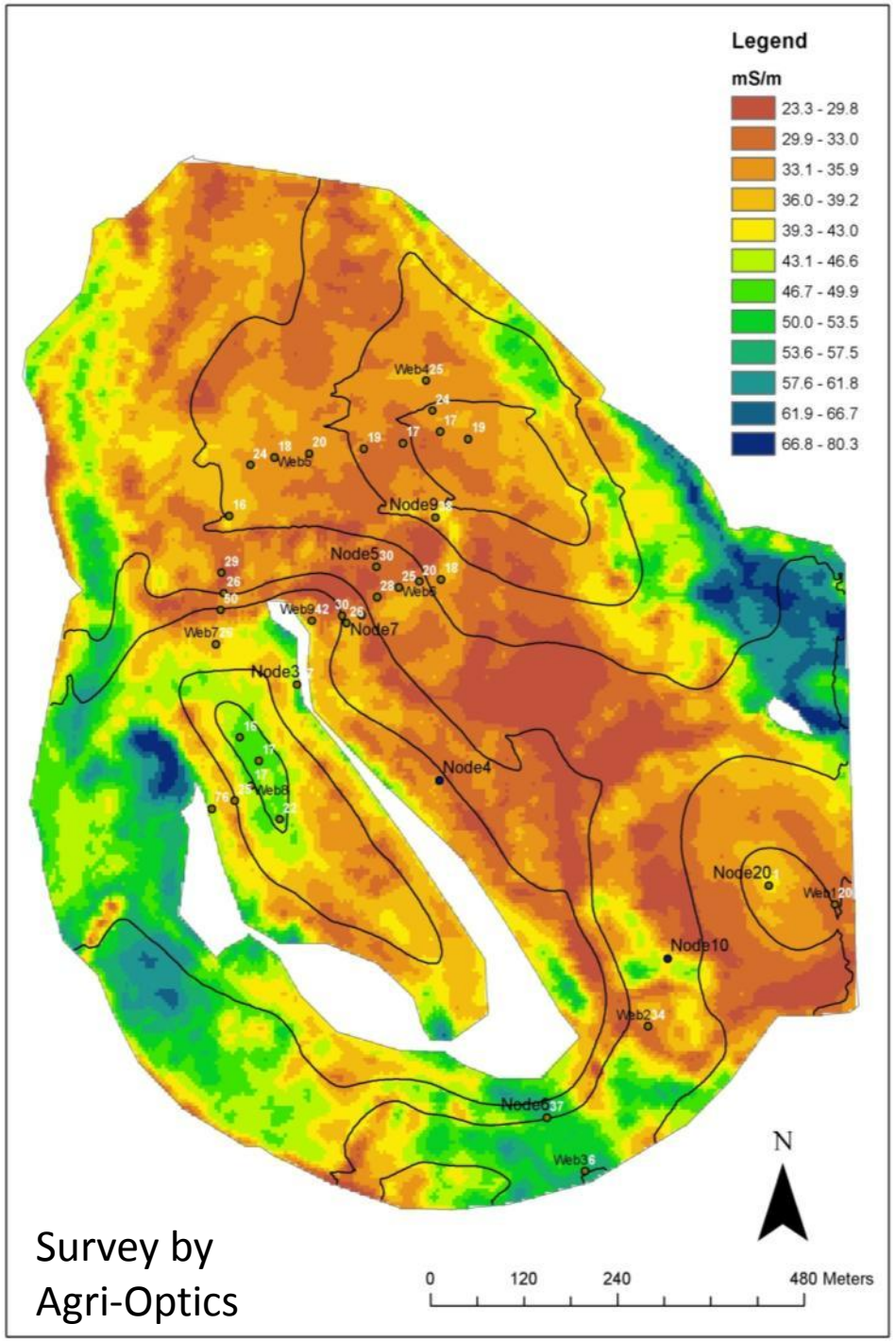
- 490 m pivot, with variable rate modification
- Waiareka clay loams – strongly structured soils
- Electromagnetic (EM) soil survey
- Available Water-holding Capacity Map
- Soil moisture monitoring
- Precision scheduling to avoid drainage and run-off

MAP

MONITOR

MANAGE


Exclusion area
Treschemakers Rd
Fortification Rd
Taipo Rd

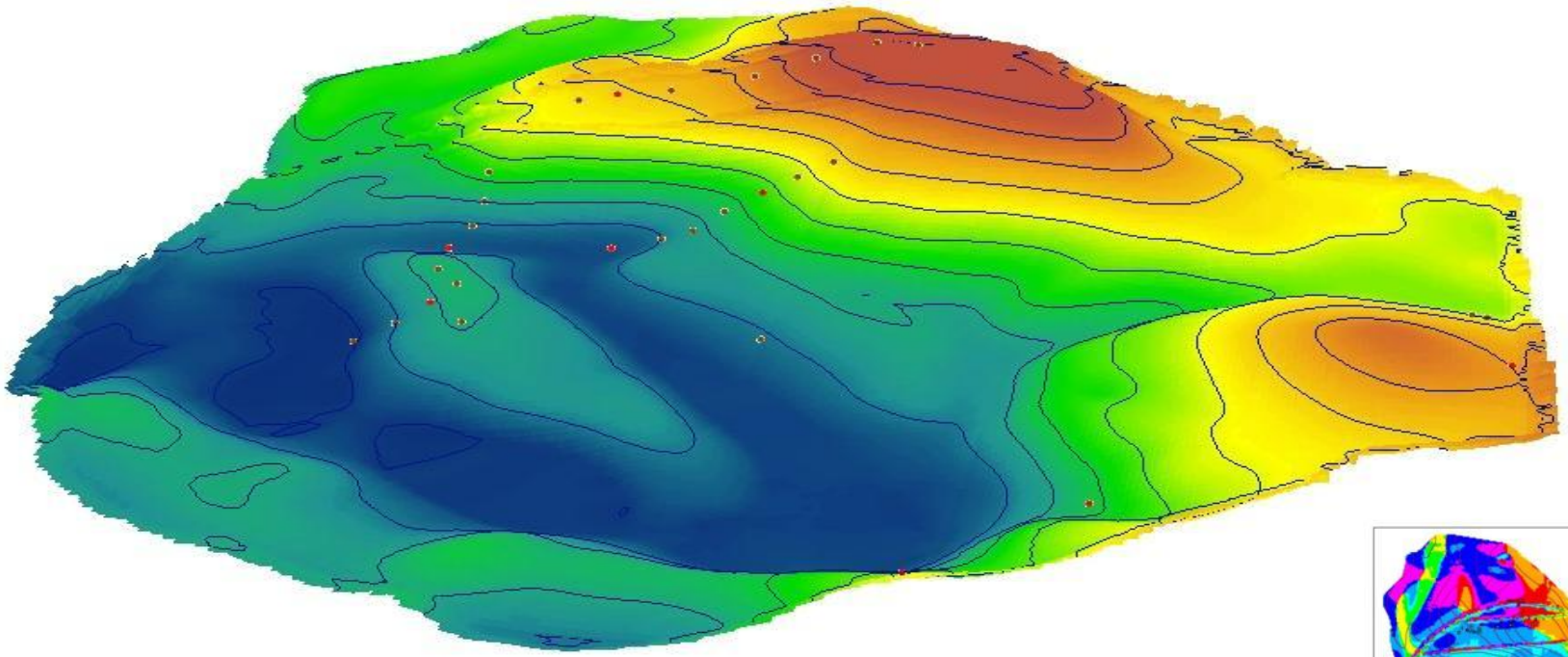



Survey by Agri-Optics

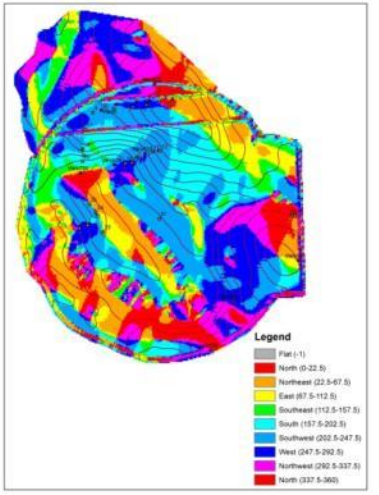
## Electromagnetic (EM) soil survey

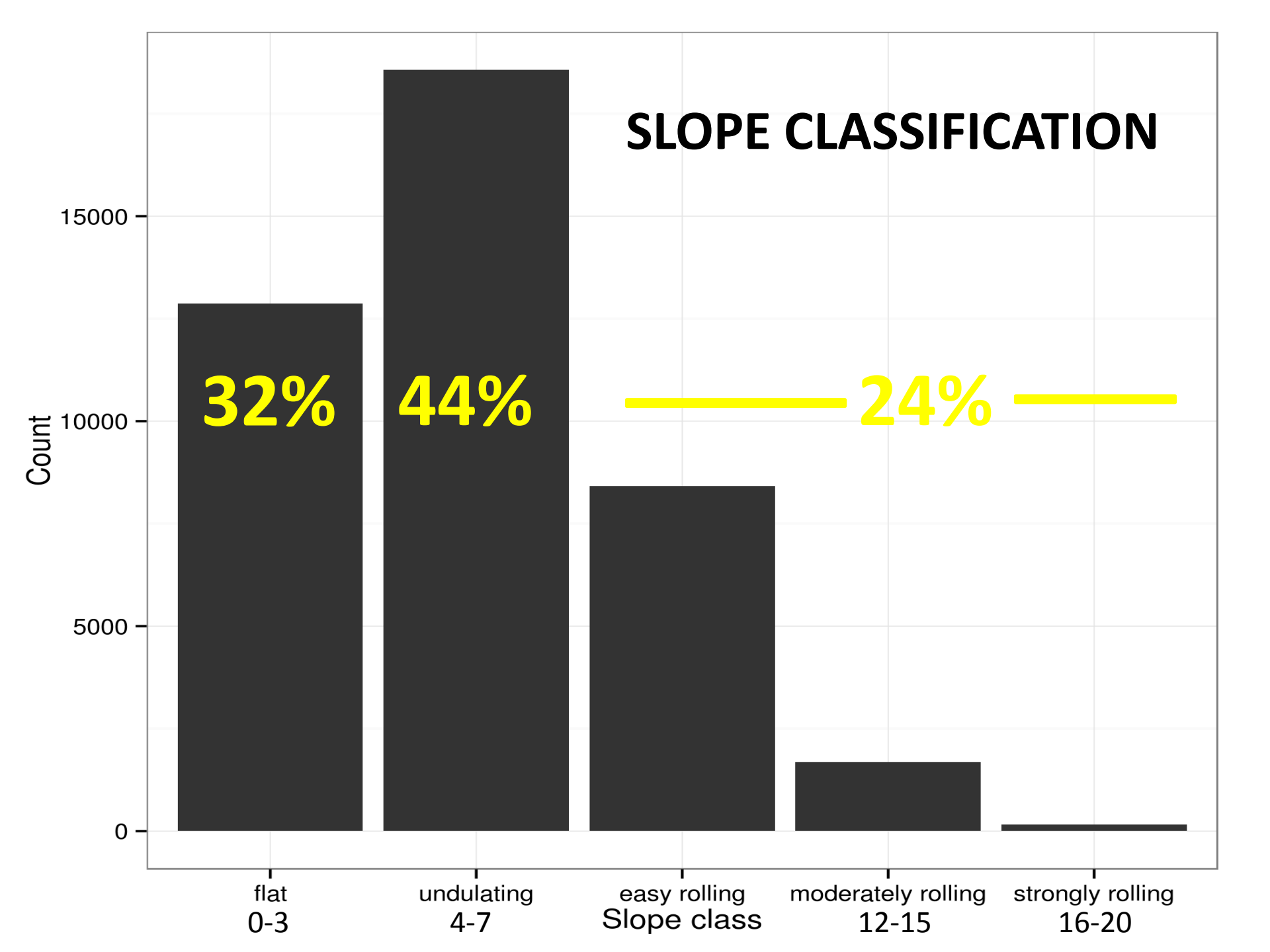
- delineates soil texture and moisture differences
- used to define sampling positions
- Used for spatial modelling of topsoil depth and available water-holding capacity
- Used to define management zones

# Digital elevation map derived from the EM soil survey

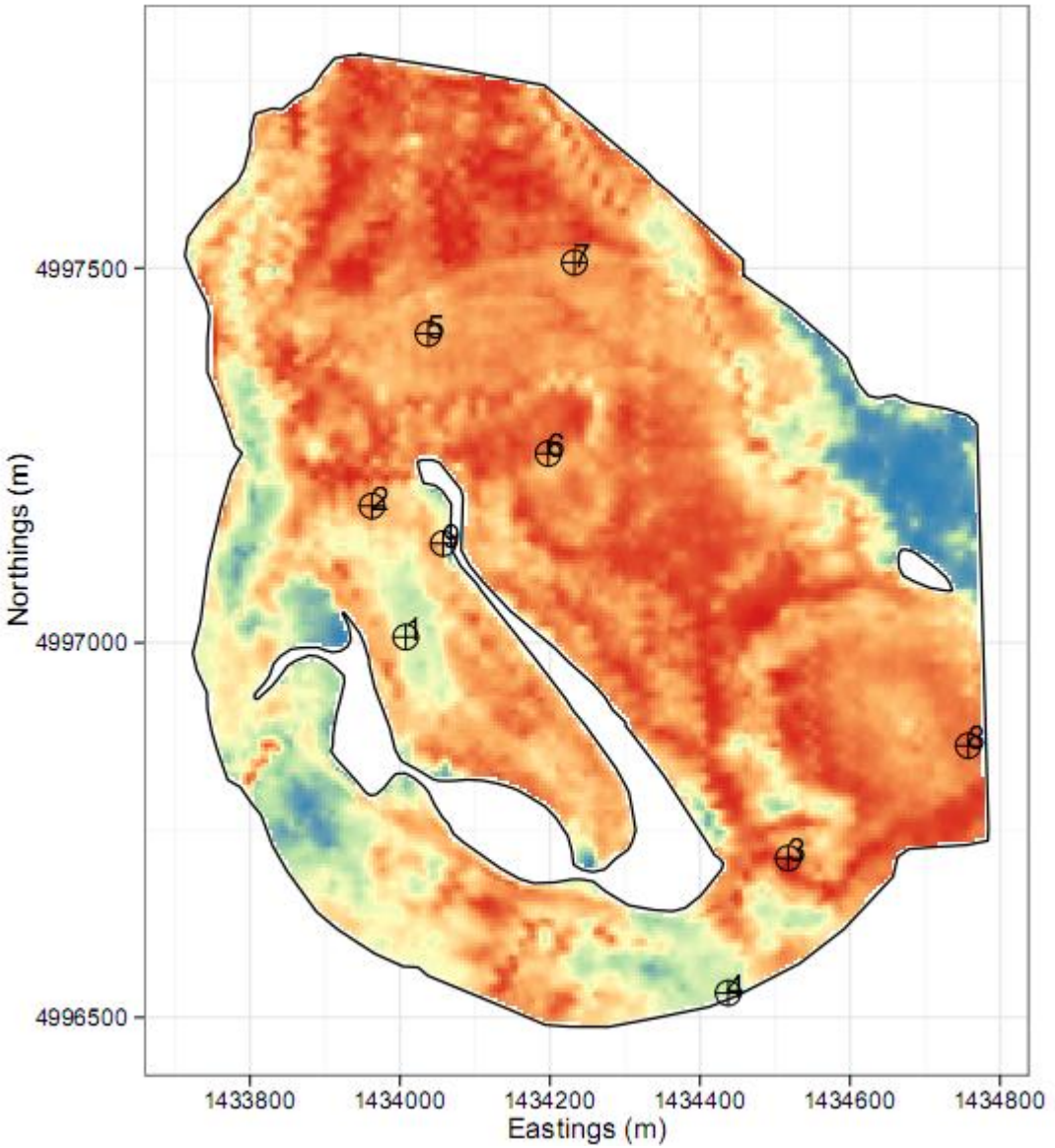


- Extracted slope, aspect and a wetness index

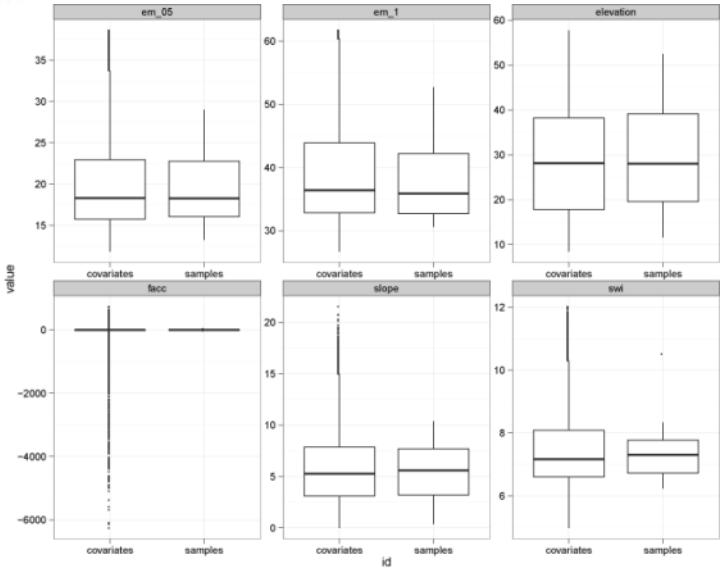



SLOPE CLASSIFICATION
32%
44%
24%
Count
15000
10000
5000
0
flat
0-3
undulating
4-7
easy rolling
moderately rolling
12-15
strongly rolling
16-20
Slope class

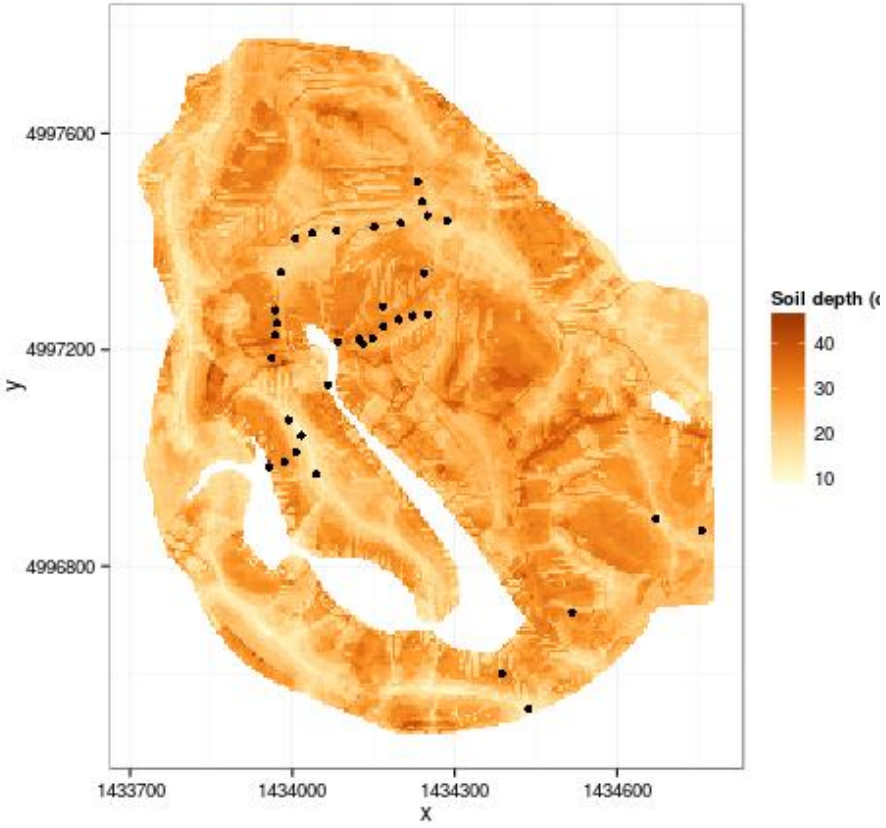
# Sampling positions derived from the covariate datalayers



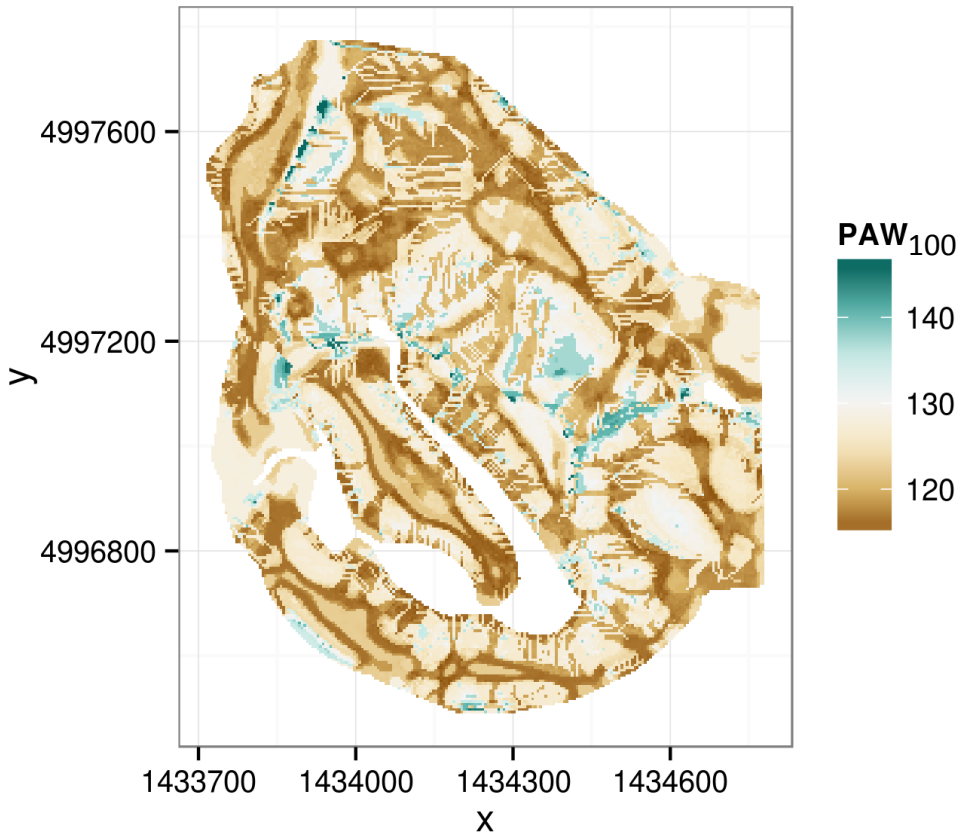

- EM 1m
- EM 0.5m
- Elevation
- Flow pathways
- Slope
- Wetness index



# Topsoil depth




# Available water




**TOPSOIL DEPTH (cm)**

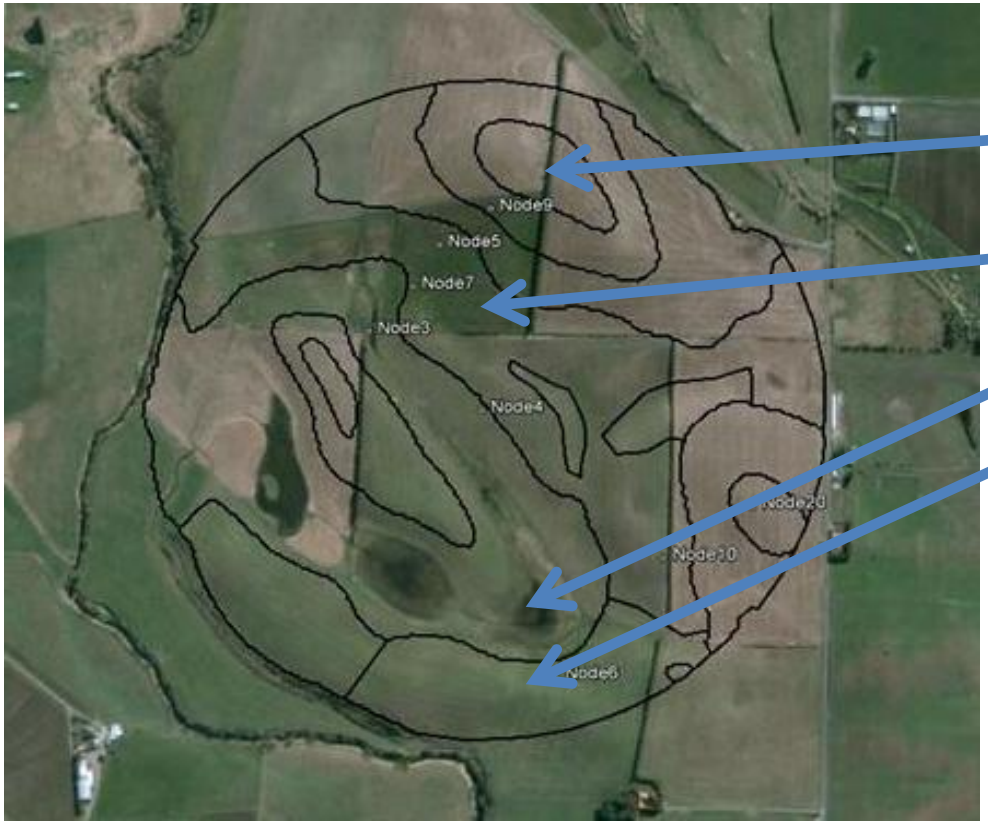
| | |
|---|---|
| Top | 14 |
| Midslope | 28 |
| Toeslope | 38 |
| Bottom | 43 |

**Scheduling guided by monitoring SOIL MOISTURE STATUS**

**PAW_60 (mm)**

| | |
|---|---|
| Top | 80 |
| Midslope | 78 |
| Toeslope | 80 |
| Bottom | 114 |

# Soil moisture monitoring



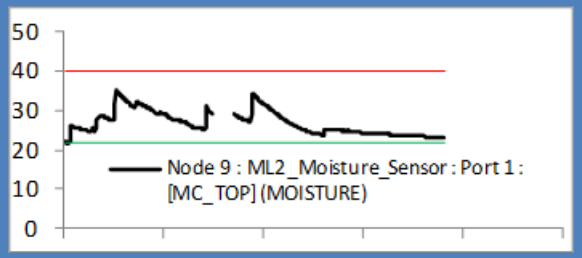

**SUMMIT**

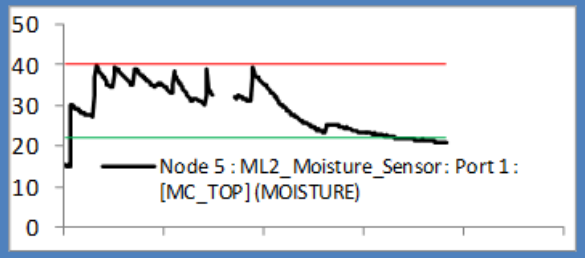
**SOUTH FACING**

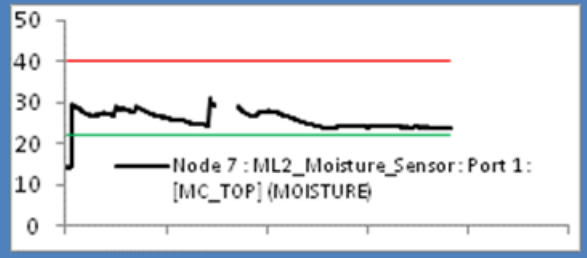
**VALLEY FLOOR**

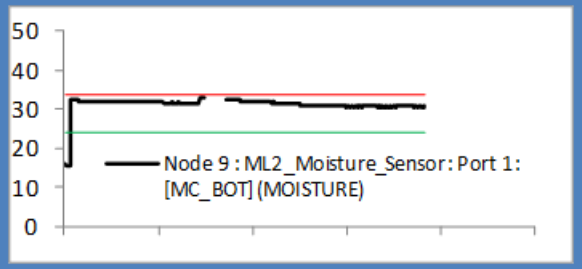
**NORTH FACING**

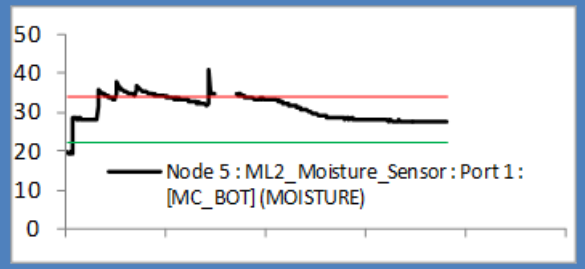
- Soil moisture sensors installed into management zones
- Wireless nodes transmit soil moisture data in real-time to a web browser
- Information guides irrigation scheduling, aiming to maintain soil moisture in the optimum range

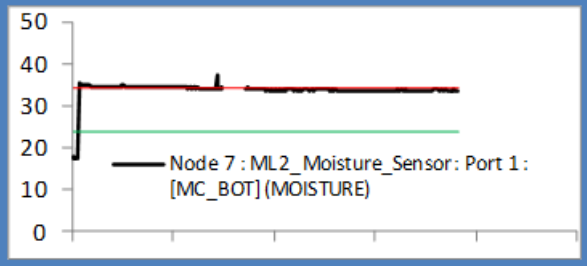


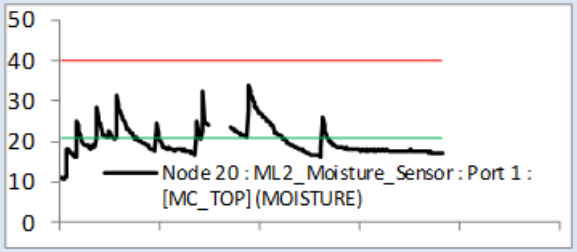



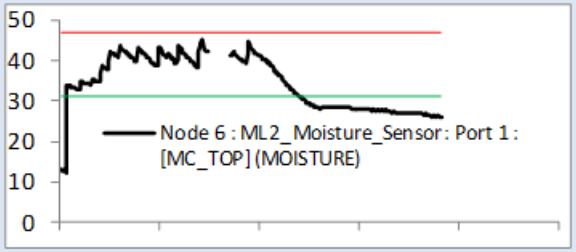



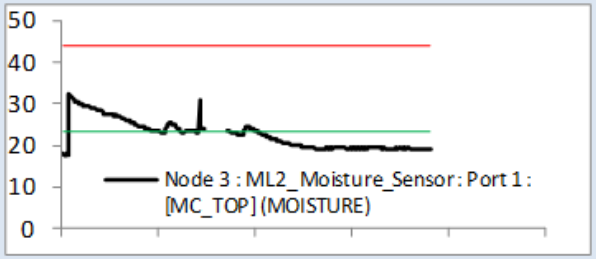



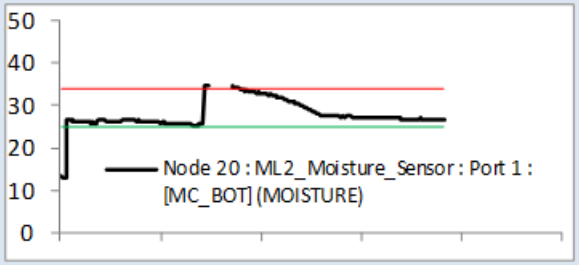

**upper slope** **mid slope** **lower slope**

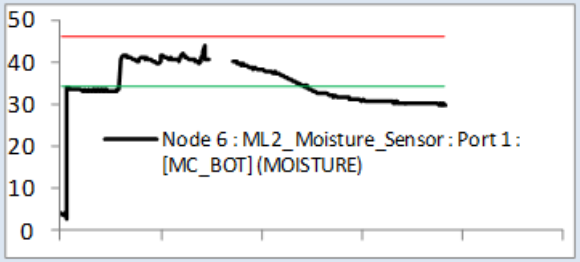
**----------south facing----------**

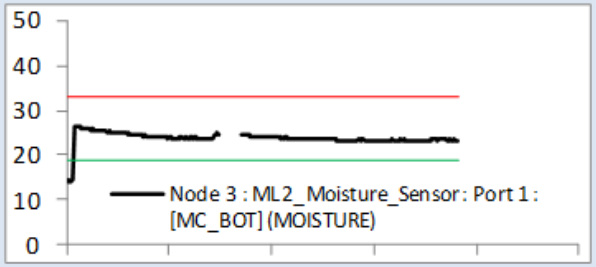



**summit** **north facing - midslope** **valley floor**

# Results of trials

- Irrigation scheduled to maintain soil moisture between FC and RP, with little to no run-off or drainage
- Irrigation reduced to south-facing slopes, hill-tops and excluded from swampy valley floors = 27% water saving
- 30L/s reduced to 24L/s sometimes 11L/s
- Savings ~$18,000 for pivot area in first year (pay-back on VRI is 3-5 years)
- Improved soil condition, pivot did not get stuck in boggy area, likely yield increases, although not measured or included in calculations

# Management options to reduce excess water

- Where system allows - identify and vary irrigation to land management units (e.g. crests, slopes, swampy valley floors)
- Avoid over-watering, i.e. reduce depth of irrigation and increase frequency of return
- Monitor soil moisture, and maintain in the optimum range
- Manage to minimise surface compaction (e.g. restrict grazing on wet soils )
- Hillslopes require some different management strategies to flat land – topography sometimes overrides soil differences
- Water runs downhill (overland and through the soil)!