

Landcare Research
Manaaki Whenua

NEW ZEALAND CENTRE FOR
PRECISION AGRICULTURE

PRECISION
Irrigation

SOIL WATER STATUS AND WATER TABLE MODELLING USING EM SURVEYS FOR PRECISION IRRIGATION SCHEDULING

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2nd Proximal Soil Sensing Global Workshop, May 15-18, 2011, Montreal, Canada

Talk content

- Precision irrigation defined
- Case study
 - EM map → Irrigation prescription map
- Data analysis
 - Wireless Sensor Network (WSN) - monitoring moisture content (mc) and depth to water table (WT)
 - **Measurement : high temporal resolution**
 - Prediction variates: EM31, EM38, DEM, rain
 - **Modelling: high spatial resolution**
 - Spatio-temporal model of soil moisture content (mc) and depth to water table (WT)
- Summary

Precision Irrigation

High resolution (~10m) irrigation placement for soil, crop and landscape differences

(Bradbury, 2009)

Water saved (%)

AWC Range under one irrigation system (mm/root zone)

$y = 8.38 \ln(x) - 25.11$
 $R^2 = 0.99$

EM38 mapping – irrigation management zones

- 75 ha maize grain field
- Variable rate irrigator
- Undulating sandy soils variably influenced by a high water table (~0.3-2.0m)
- EM38Mk2 and EM31 surveys conducted - ground truthing – prescription map
- Wireless mesh sensor network installed for irrigation season
- Irrigation season 16 Dec - 21 March; URI=380mm; VRI=329mm/season

Wireless sensor network (WSN) – real-time soil moisture and water table monitoring

BASE STATION

Node + sensors

Base station

Internet

REAL-TIME SOIL MOISTURE AND WATER TABLE MONITORING

- volumetric soil moisture (20 cm)
- matric potential (cbar) (20 cm)
- volumetric soil moisture (50 cm)
- depth to water table

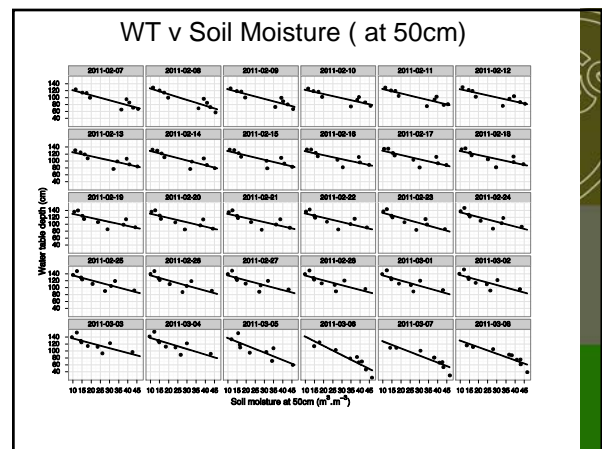
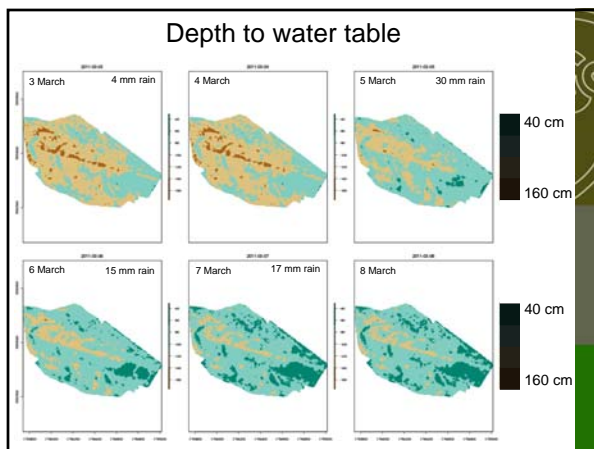
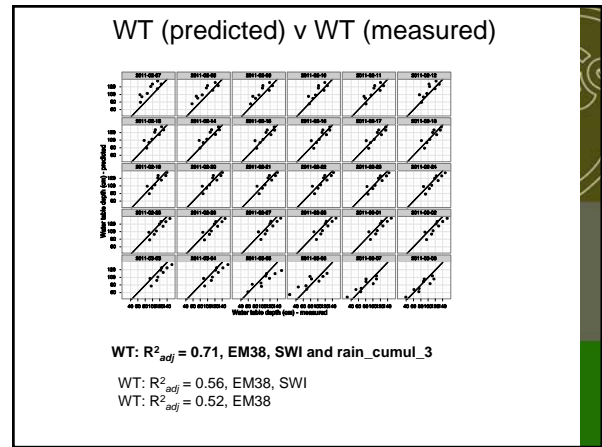
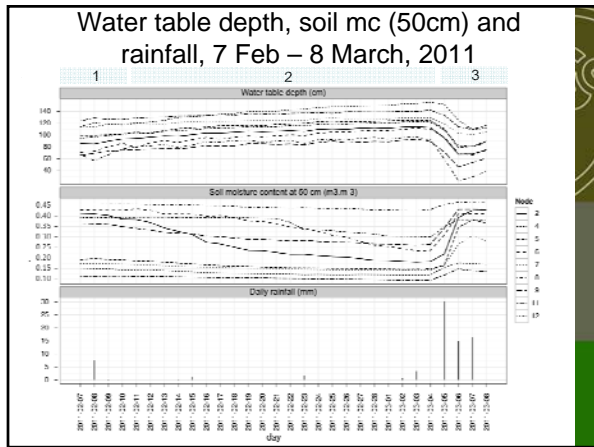
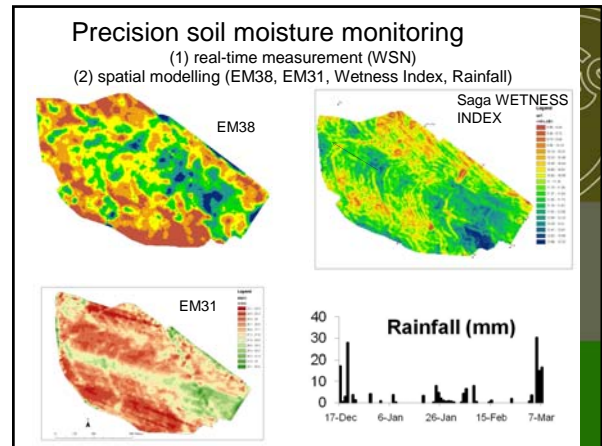
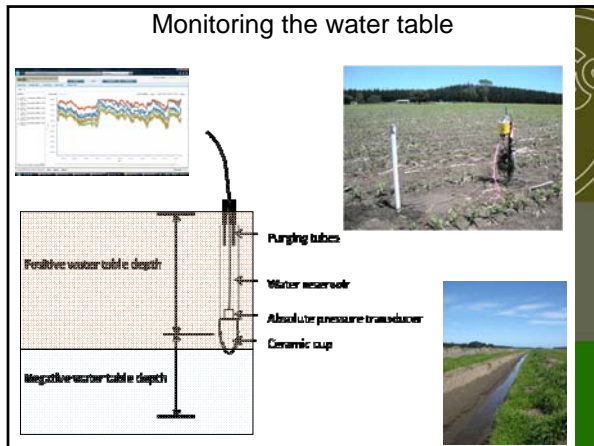
Soil moisture

mc_v refill

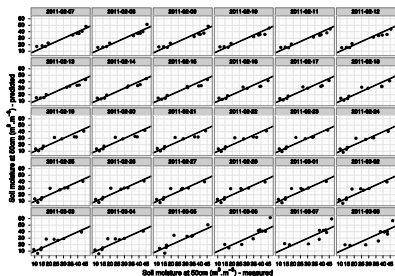
DRY ZONE

WET ZONE

ZONE	Depth	0	5	10	50	100	1500	AWC	RAW	
	cm	-----kPa					mm/m			
DRY	0-20	52	25	16	12	10	4	120	70	
	20-40	40	11	8	4	3	2	60	50	
	40-60	41	12	9	3	2	2	70	60	
WET	0-20	55	42	39	31	27	7	320	120	
	20-40	40	16	13	5	4	2	110	90	
	40-60	39	18	15	4	3	2	140	120	

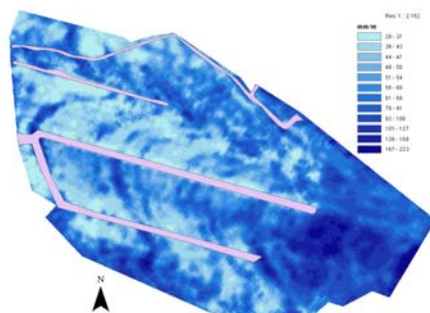


Soil moisture (predicted) v soil moisture (measured)



$R^2_{adj} = 0.87$, EM38, SWI, WT
 $R^2_{adj} = 0.77$, EM38, SWI, R_cum_3
 $R^2_{adj} = 0.72$, EM38, SWI
 $R^2_{adj} = 0.69$, EM38

Soil moisture map (mm/m)



SUMMARY

- Soil moisture and water table depth predicted using EM38 survey data plus rainfall
- Rainfall provides a dynamic temporal component to the model
- EM31 data did not improve predictions of WT [which occurs within ~1.5m of surface]
- Soil moisture is strongly influenced by WT (soil water balance problems)
- Proximal soil sensor data has been used for spatio-temporal modelling
- **Future directions: link strategic site specific measurements real-time to a spatio-temporal model for precision irrigation scheduling**

