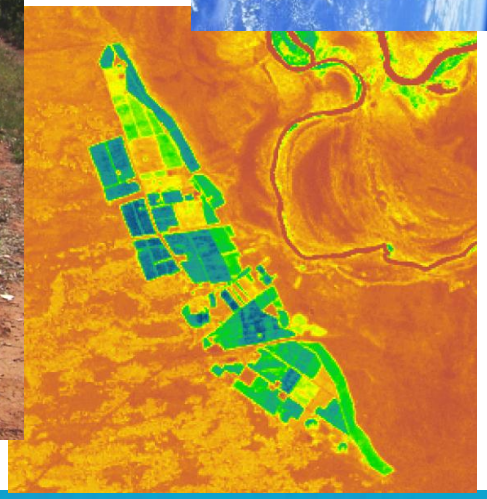

IrriSAT - an Irrigation management and crop water use benchmarking system

John Hornbuckle, Richard Soppe, Evan Christen, CSIRO Land and Water, Griffith, NSW, Australia

Janelle Montgomery NSW I&I, Moore, NSW, Australia

www.csiro.au

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Outline

- Overview of the IrriSAT system - main components
- Science behind IrriSAT - background
- Experience with IrriSAT in Cotton and viticulture irrigated systems
- Future directions R&D

Aims / Goals / Approach

- Aim - to overcome the costs and complexities of irrigation scheduling
- Driving Goal - capturing the bulk of the 'market' and providing them with a tool for assisting irrigation decisions to deliver real water savings or efficiency improvements
- The Approach – use emerging technologies* –
  - Satellite Remote Sensing (a world wide sensor system)
  - SMS (a world wide information delivery platform)

* 1st SMS message was sent in 1992 (20 years ago)
Landsat 5 satellite launched in 1984 (28 years ago)

Overview of IrriSATSMS

Satellite Measurements

Satellite images used to determine plant performance of an irrigators crop

Incorporates management/soil/water/salinity constraints

Determination of a crop coefficient (Kc) from satellite image

Representing Individual Paddocks

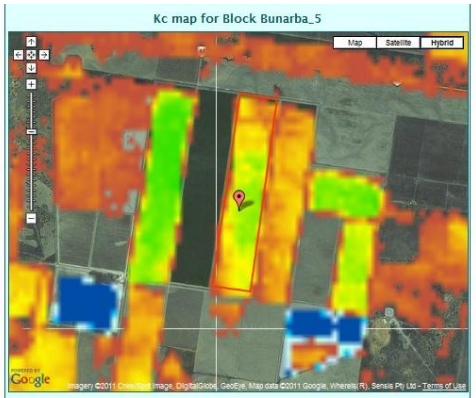
On Ground

ETo from Weather Station and ETo forecast

Potential Evaporation based on Atmospheric Demand

ETc = ETo X Kc

Crop water use determined and irrigation requirement



Daily irrigation scheduling information delivered to irrigators

How does IrriSAT help me irrigate ?

- Using the FAO 56 approach

Actual water use of crop

Reference water use – weather station or 7 day forecast

Crop Coefficient – relates your crop to the reference crop

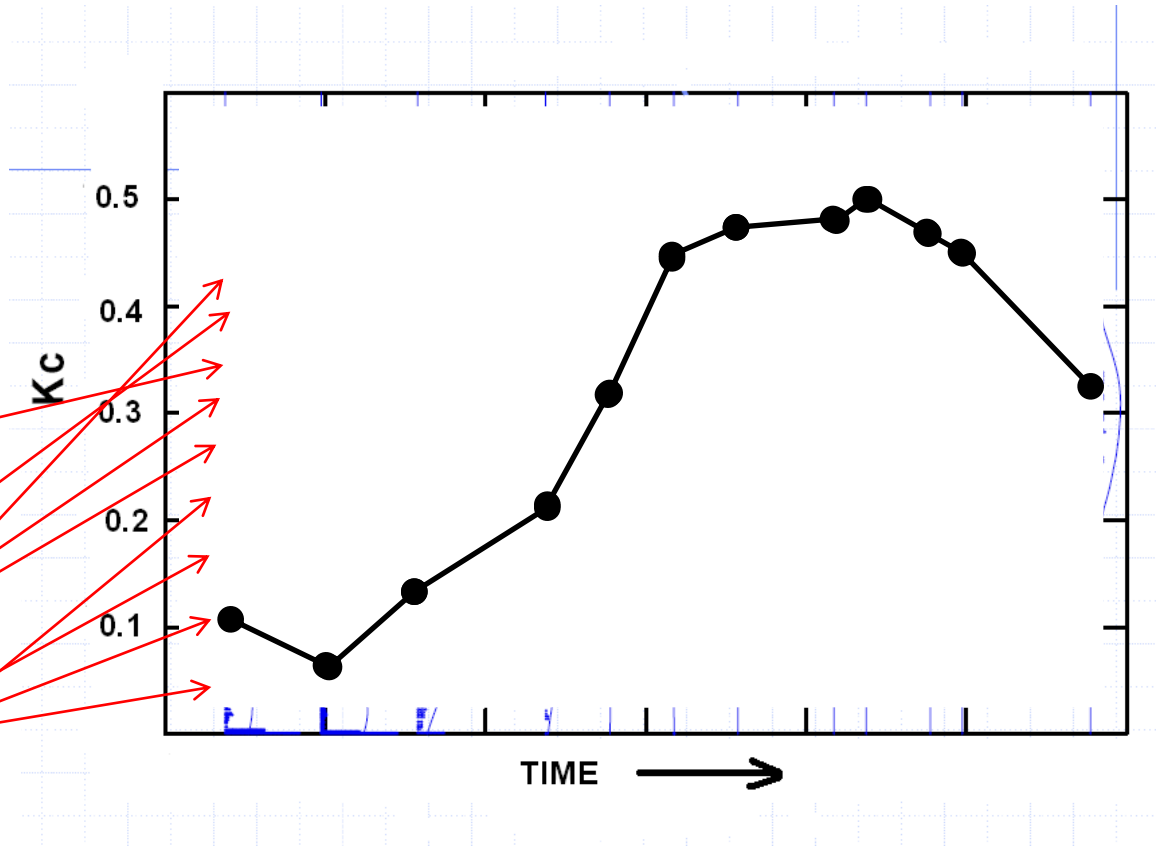
$$ETc = ETo \times Kc$$

=

x Kc ?

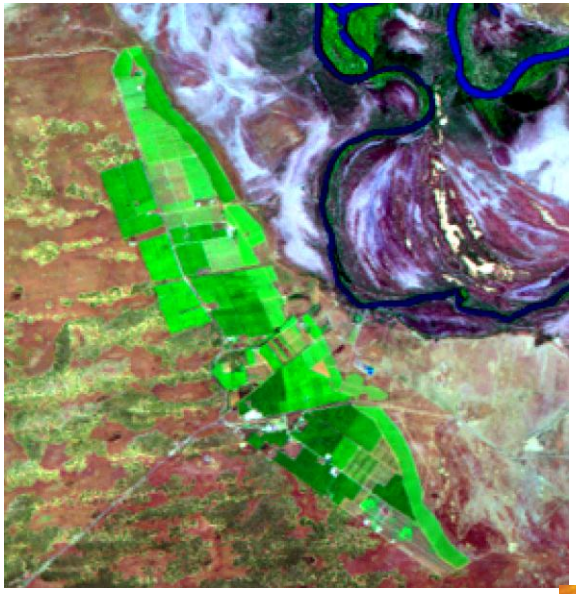
Previously getting site specific crop coefficients has been difficult – RS overcomes this

Limitations of traditional kc approaches



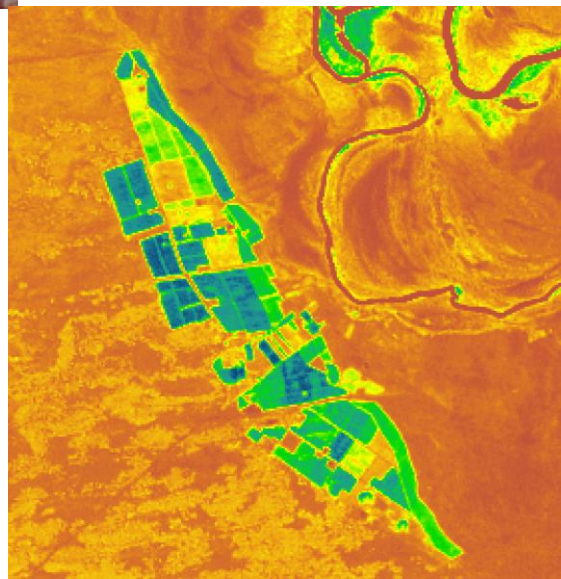
Gaining individual crop coefficients

- Multi-spectral satellites overpass every 8 -16 days
- Images of everyone's individual crop is taken with a 30x30m resolution
- This information can be used for gaining site and management specific crop coefficients



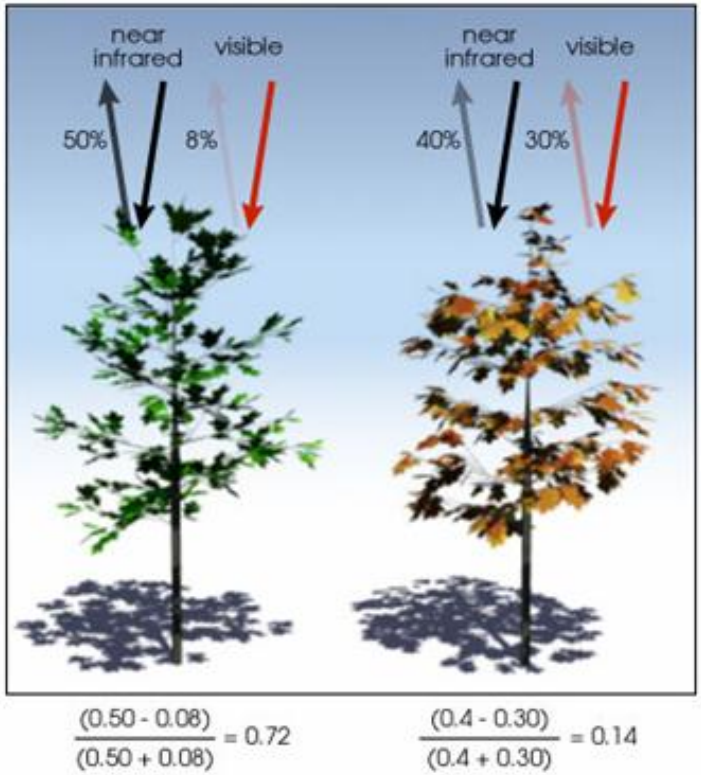
Visible light

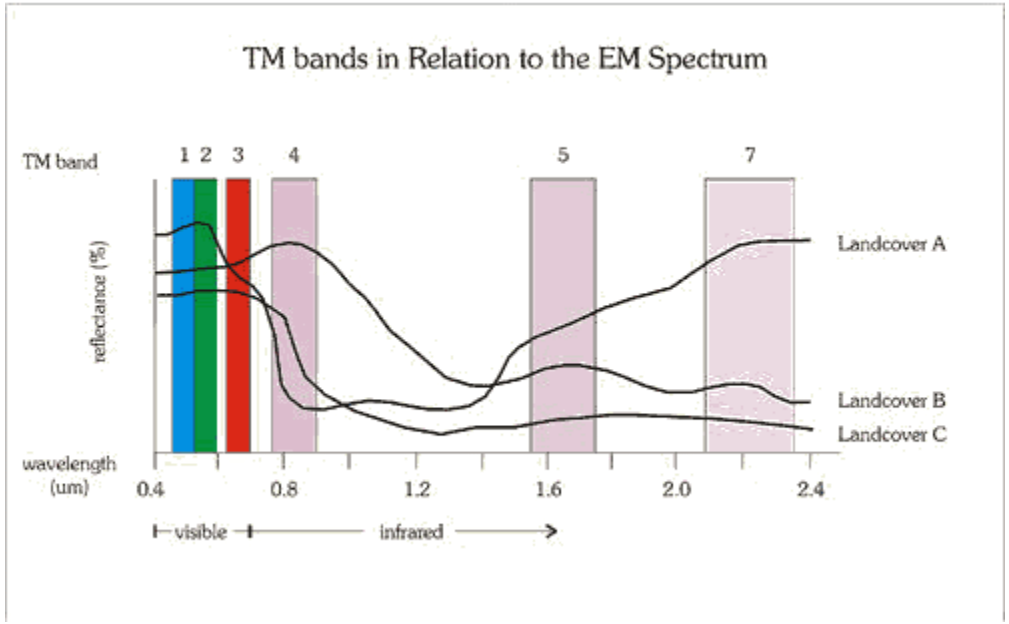
Calculated NDVI



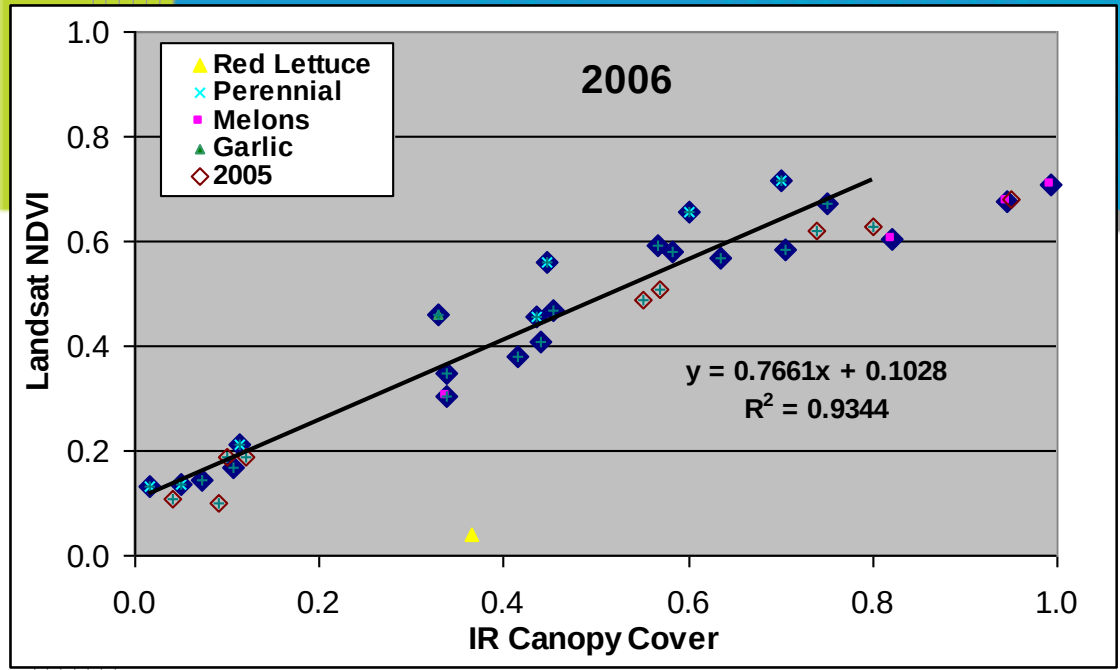
NDVI

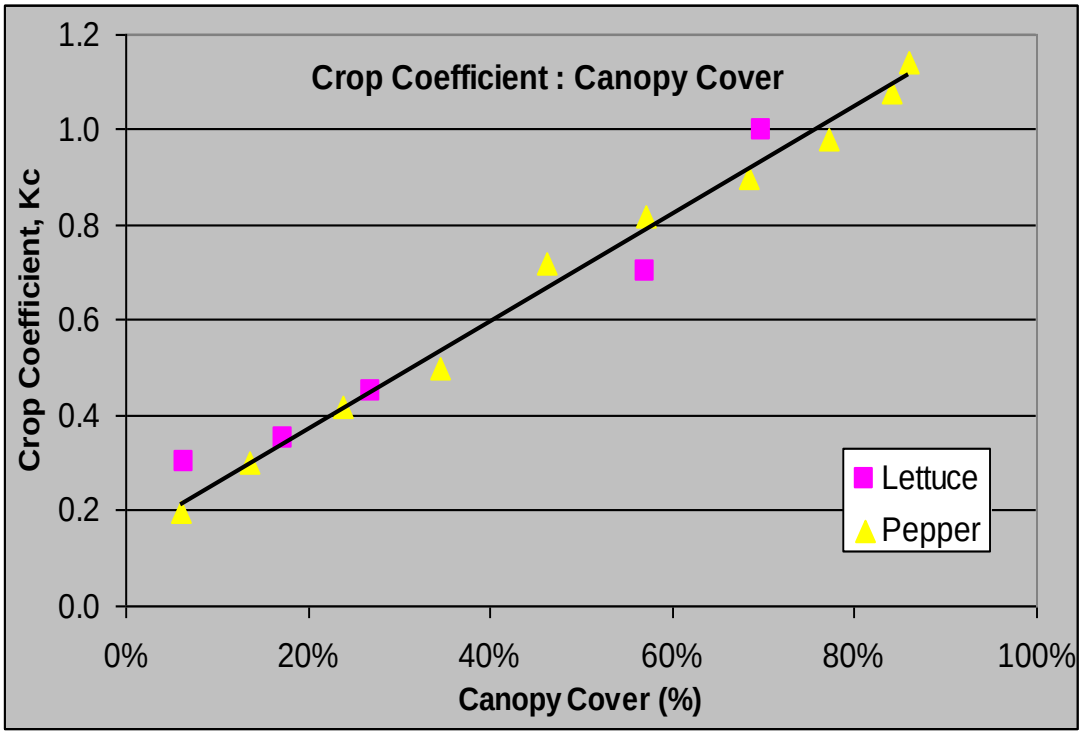
- $NDVI = (R_{NIR} - R_{red}) / (R_{NIR} + R_{red})$





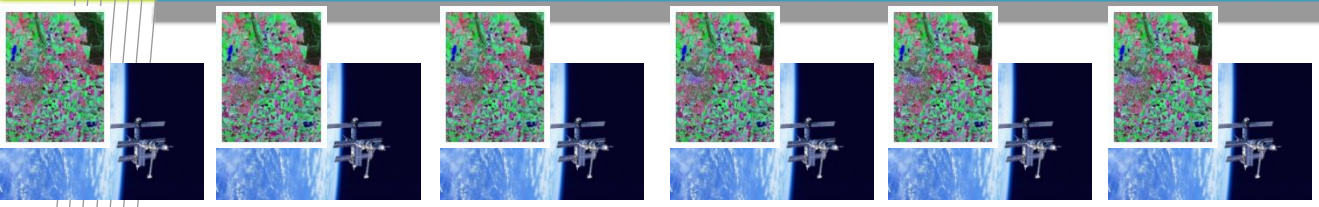
NDVI = (Band 4 - Band 3) / (Band 4 + Band 3)

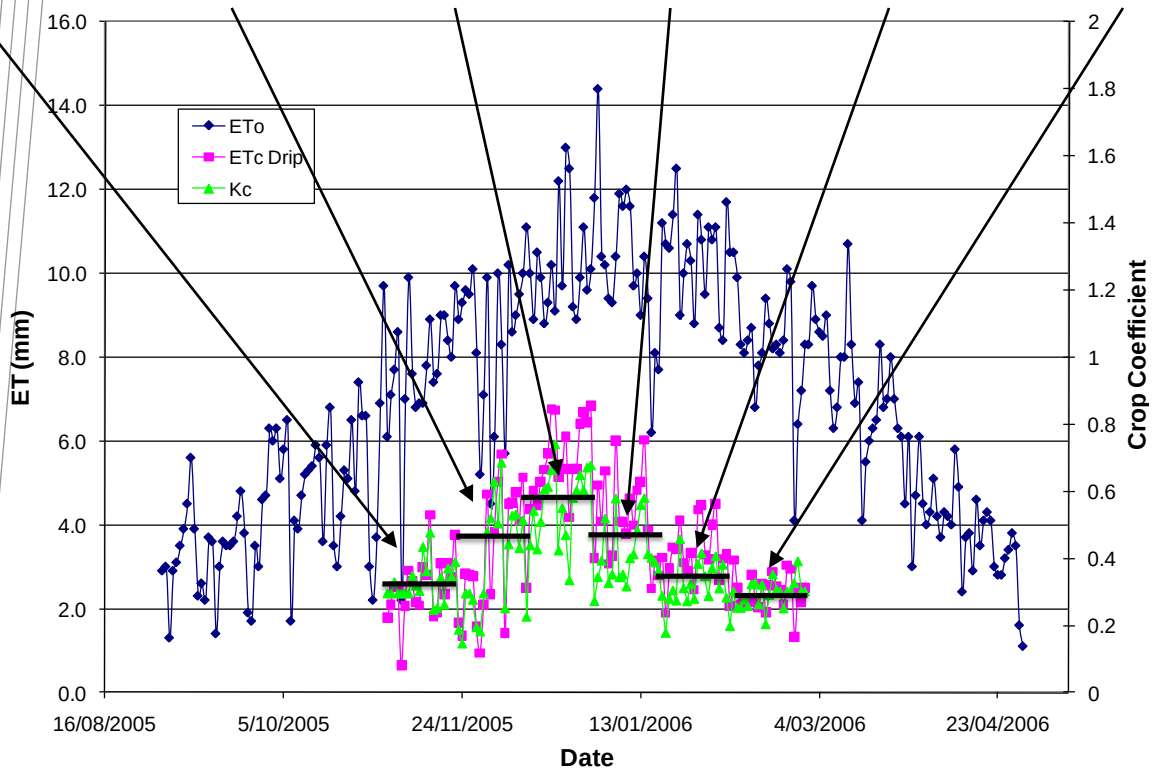

2006
Red Lettuce
Perennial
Melons
Garlic
2005
y = 0.7661x + 0.1028
R2 = 0.9344
Landsat NDVI
IR Canopy Cover
0.0
0.2
0.4
0.6
0.8
1.0

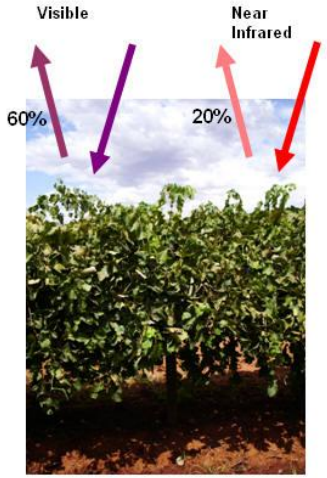

Crop Coefficient : Canopy Cover
Crop Coefficient, Kc
Canopy Cover (%)
Lettuce
Pepper
0.0
0.2
0.4
0.6
0.8
1.0
1.2
0%
20%
40%
60%
80%
100%

USDA

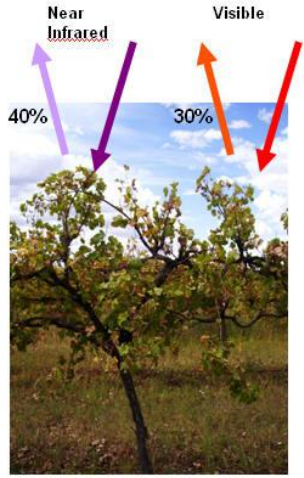
Determining Kc from NDVI - grapevines







$$NDVI = \frac{R_{NIR} - R_{red}}{R_{NIR} + R_{red}} = \frac{0.6 - 0.2}{0.6 + 0.2} = 0.5$$



$$NDVI = \frac{R_{NIR} - R_{red}}{R_{NIR} + R_{red}} = \frac{0.4 - 0.3}{0.4 + 0.3} = 0.14$$

$$Kc = f\,(NDVI)$$

Kc http://www.irrigateway.net/kcmap/

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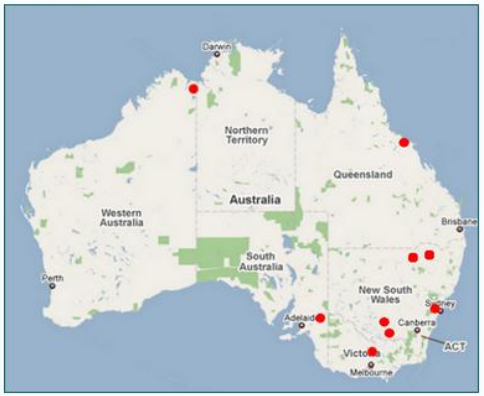
K_c Maps Home | Methodologies and FAQ

K_c Maps for irrigation districts *(prototype)*

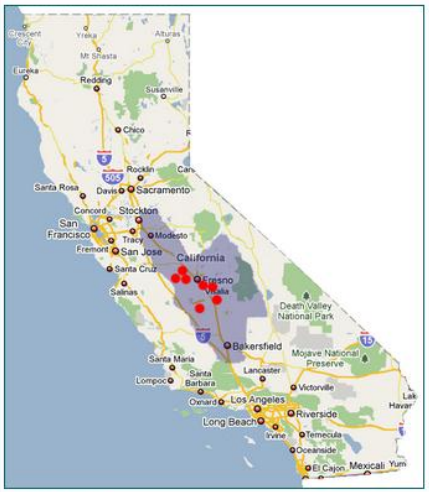
Choose from the locations marked on the maps below.

Australia



- Burdekin
- Coleambally
- Goulburn-Murray Water:
  - Central Goulburn
  - Murray Valley
  - Rochester-Campaspe
  - Shepparton
- Gwydir
- Hawkesbury-Nepean
- Murrumbidgee
- Namoi
- Ord
- SA Lower Murray

California



- San Joaquin, California:
  - Alta Irrigation
  - Consolidated Irrigation
  - Kaweah Delta
  - Tulare Lake Basin
  - Broadview
  - Firebaugh Canal
  - Panoche

Important Disclaimer

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Namoi *(prototype)*

Choose a map by date: 2010 01 27 Load

Legend: 1.1 0.3

You are viewing the K_c map for 27/01/2010

Australia:

- Burdekin
- Coleambally
- Goulburn-Murray Water:
  - Central Goulburn
  - Murray Valley
  - Rochester-Campaspe
  - Shepparton
- Gwydir
- Hawkesbury-Nepean
- Murrumbidgee
- Namoi
- Ord
- SA Lower Murray

California:

- Alta Irrigation
- Consolidated Irrigation
- Kaweah Delta
- Tulare Lake Basin
- Broadview
- Firebaugh Canal
- Panoche

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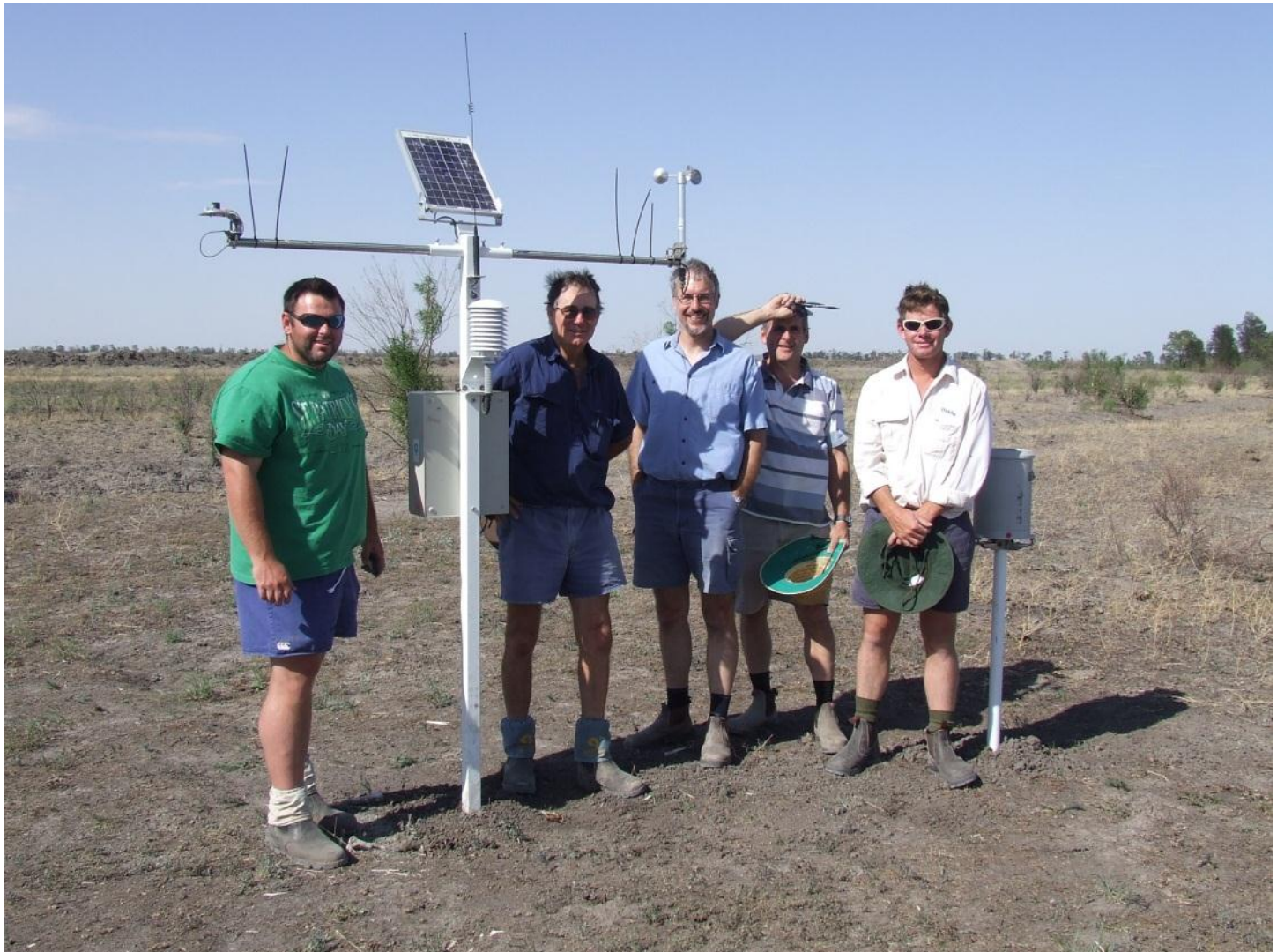
ETo

- Weather data used to calculate reference crop water use (ETo)



ETo -http://www.irrigateway.net/weatherstations

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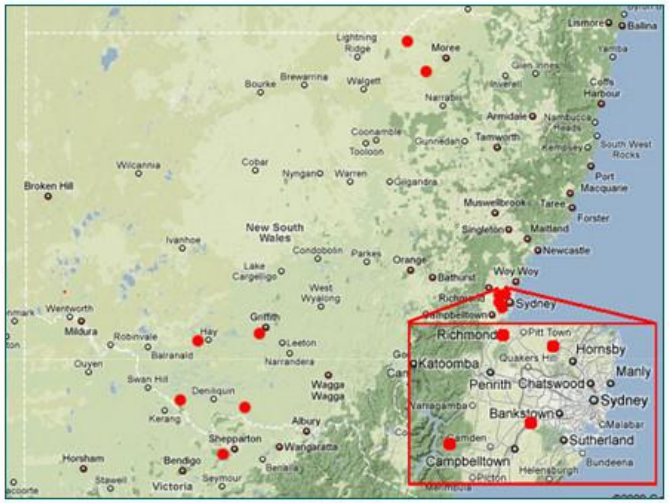
irriGATEWAY Weatherstations

Weatherstations

- Riverina
  - Griffith
  - Hay
  - Finley
  - Tullakool
- Hawkesbury-Nepean
  - Richmond
  - Dural
  - Leppington
  - Oakdale
- Gwydir
  - Keytah
  - Weemalah
- Murray
  - Tatura

Choose a weatherstation to view in full



Lastest Hour's Average readings from all weatherstations

Time format: AEST

Station Name	Latest reading	Air Temp (°C)	Rel. Humidity (%)	Wind Speed (km/hr)	Rain (mm)	Solar Rad (MJ/m^2)
Dural	22:00	9.83	92.8	2.05	0	0
Finley	22:00	14.72	58.3	13.51	0	0
Griffith	22:00	14.11	57.28	8.37	0	0
Hay	22:00	16.52	48.16	13.99	0	0
Keytah	22:00	16.03	48.2	8.73	0	0
Leppington	22:00	7.54	92.8	1.78	0	0
Oakdale	22:00	8.56	95.7	1.6	0	0
Richmond	22:00	8.24	95.2	1.6	0	0
Tatura	22:00	15.27	63.21	16.51	0	0
Tullakool	22:00	16.63	51.38	13.79	0	0
Weemalah	22:00	15.93	55.27	7.23	0	0

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Weatherstations

- Riverina
  - Griffith
  - Hay
  - Finley
  - Tullakool
- Hawkesbury-Nepean
  - Richmond
  - Dural
  - Leppington
  - Oakdale
- Gwydir
  - Keytah
  - Weemalah
- Murray
  - Tatura

Weemalah

Summary | Today | Yesterday | 7 Days | 14 Days | 7 Day forecast | Data Download

7 Day's data for Weemalah

Date	Air T Avg °C	Air T Max °C	Air T Min °C	RH Avg %	RH Max %	RH Min %	Wind Avg km/hr	Wind Max km/hr	Sol Rad MJ/m^2	Dew Point °C	Rain mm	ET_{ref_s} mm	ET_{ref_t} mm
21/2	27.2	33.5	23	52.3	85.4	18.6	11.8	26.2	24.11	16.6	0	6.6	8.9
22/2	25.5	34	16.5	45.5	77.7	28.6	8.8	21.1	25.37	12.9	0	6.3	8.3
23/2	23.5	30.3	16.2	48.7	77.7	25.3	7.8	21.7	27.94	12.1	0	6	7.6
24/2	24.3	32.5	16.6	49.7	82.5	21.1	5.7	15.3	25.84	13.1	0	5.4	6.7
25/2	25.3	33.7	18.5	50.2	78.6	21.1	8.5	24.4	23.4	14.2	0	5.8	7.5
26/2	26.6	36	18	47.3	78.2	19	7.4	19.1	22.98	14.5	0	5.8	7.5
27/2	28	37.1	20.2	44.5	67	19.1	10.2	20.8	24.64	14.8	0	6.9	9.3

Download this table as a CSV file: download

Figure 5: Last 7 day's air temperatures for Weemalah (deg C per day)

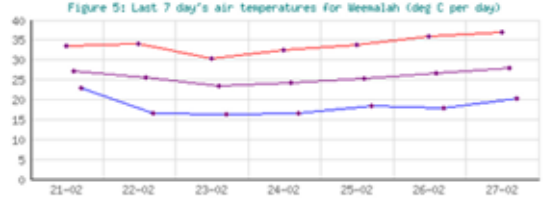


Figure 6: Last 7 day's rain for Weemalah (mm per day)

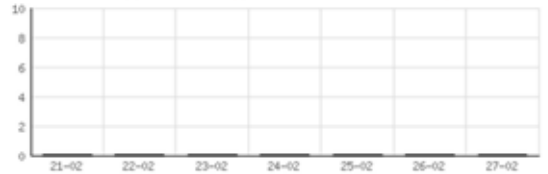
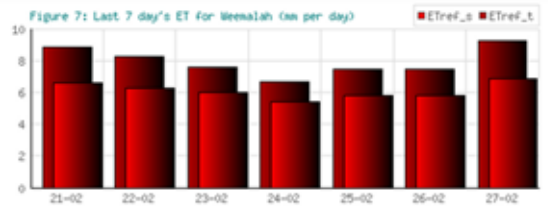


Figure 7: Last 7 day's ET for Weemalah (mm per day)



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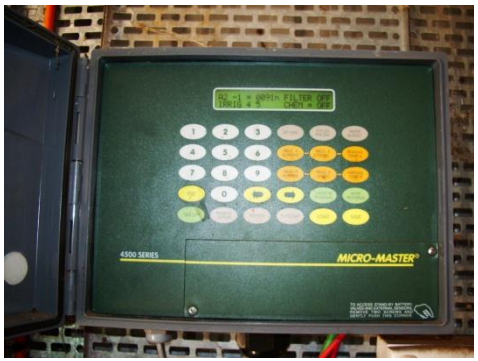
How does the IrriSAT schedule ?

Actual water use of crop

$ETc = ETo \times Kc$

.. But still in a format that's not much use for irrigators! (mm/day)

..Need to convert to a pump run time



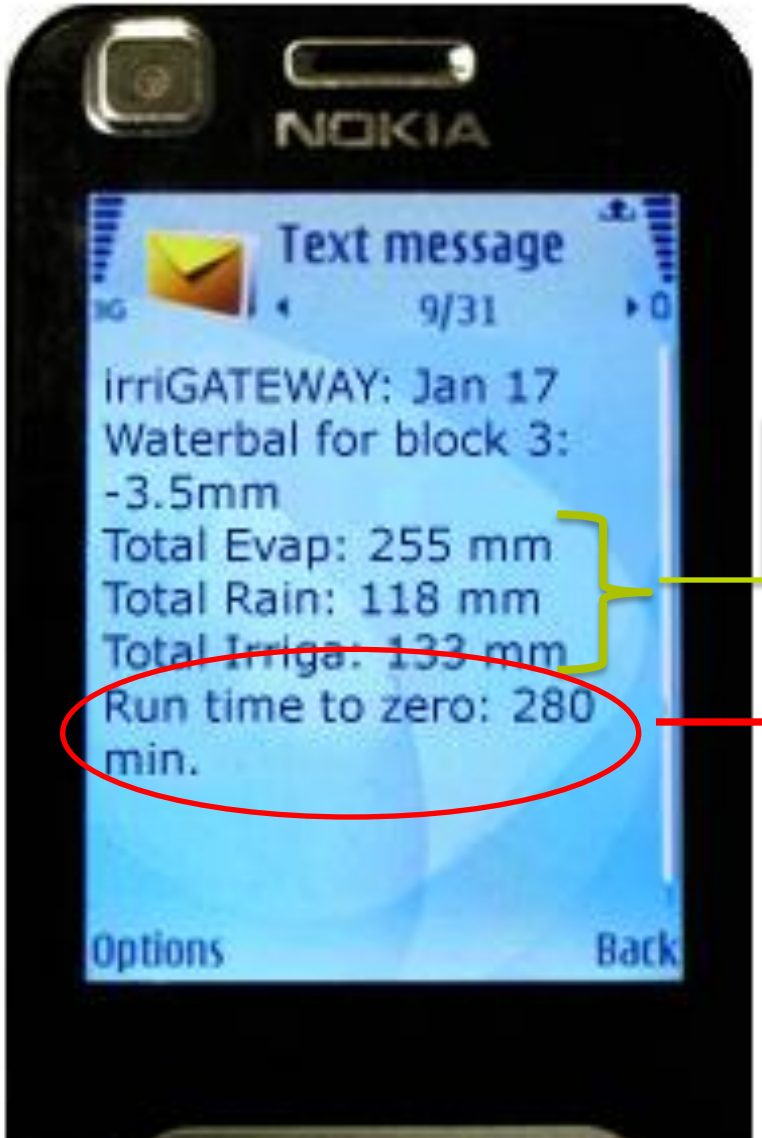
IrriSATSMS

IrriSATSMS Making the scheduling information useful

Irrigation

Rainfall

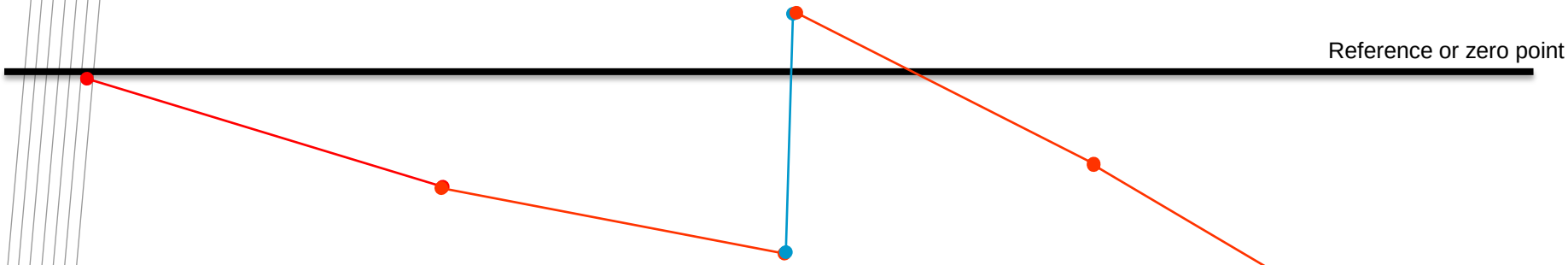
Daily SMS delivery of irrigation scheduling information



Seasonal water balance information

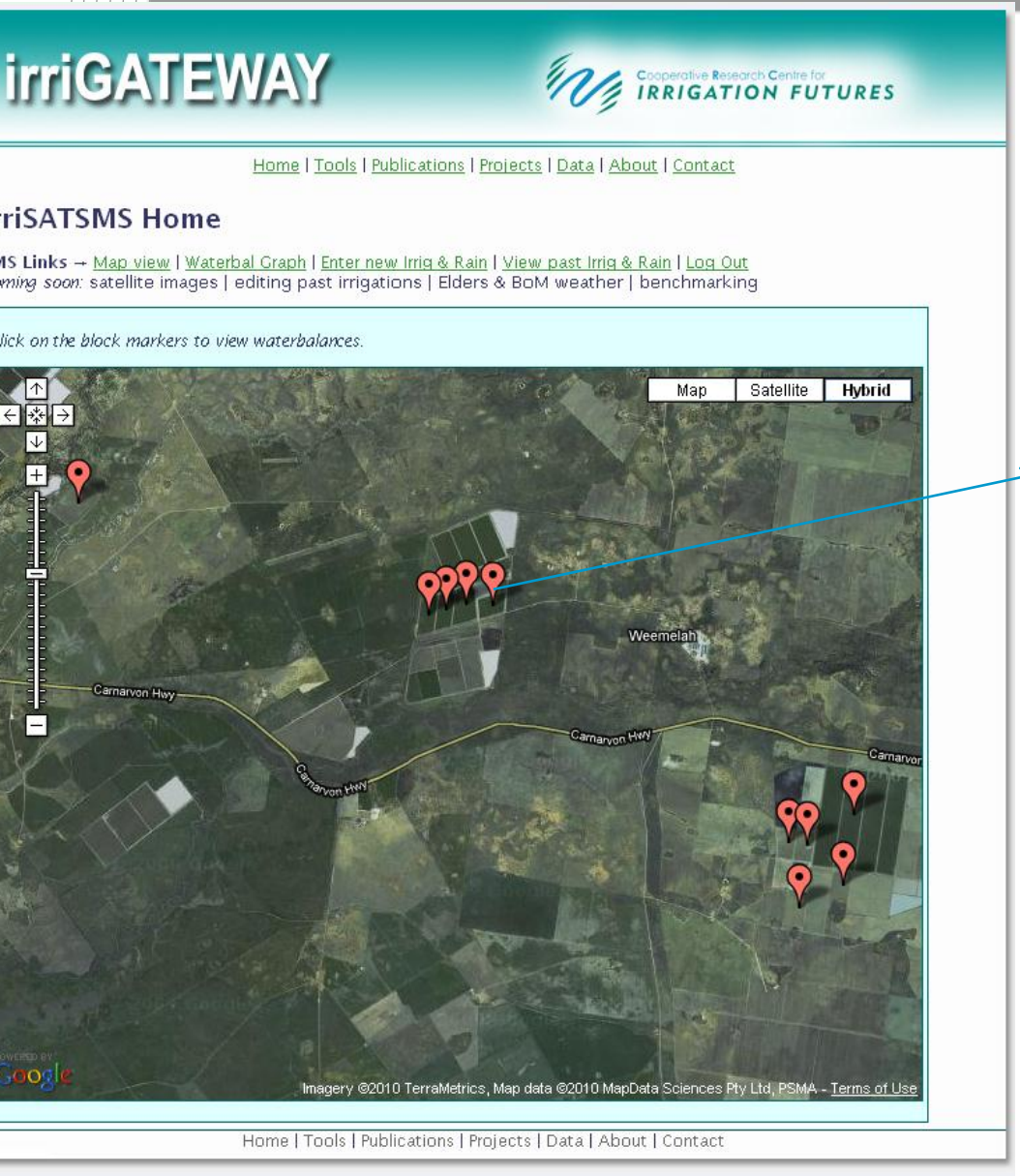
Pump/dripper run time to replace ET since last irrigation or rainfall

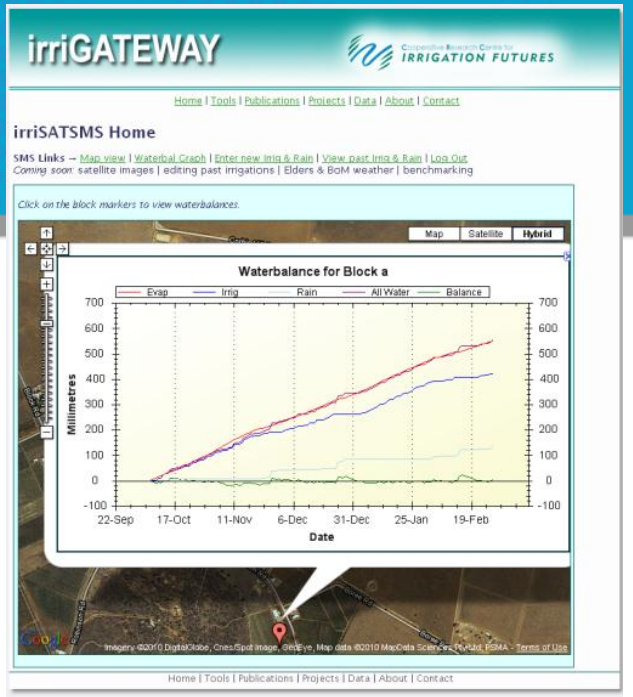
Example of daily SMS sequence

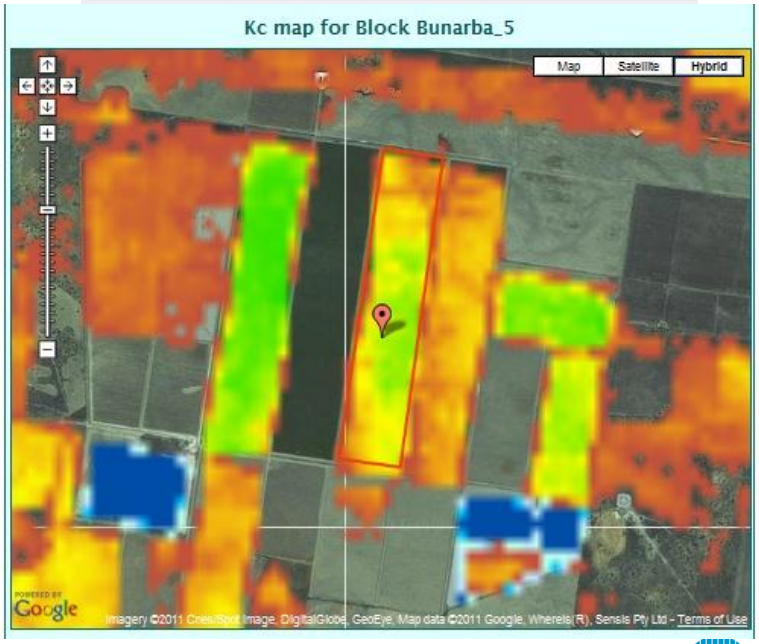


IrriSAT

Spatial Irrigation scheduling / water management information







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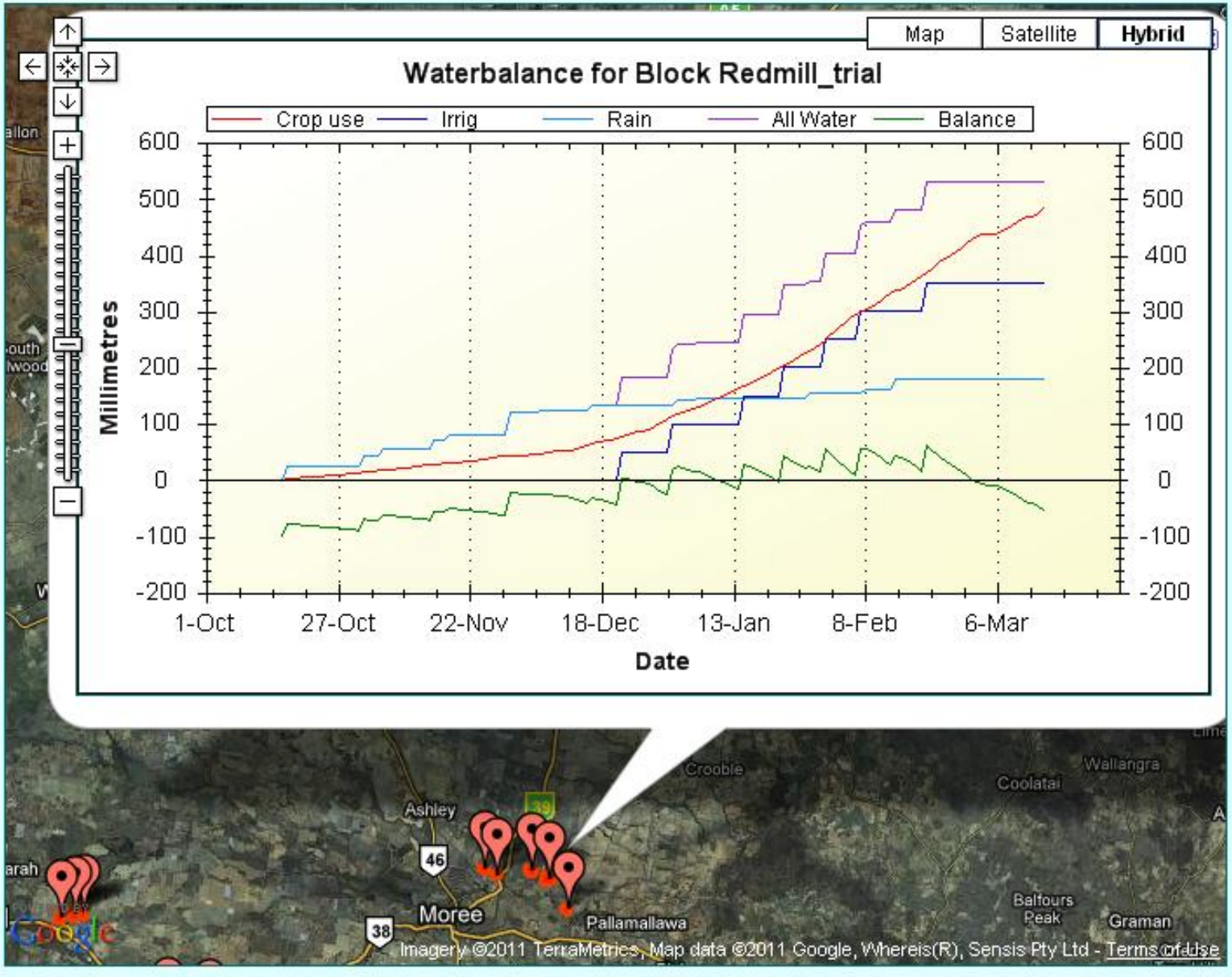
Cotton - Crop Variability

Cotton – Furrow



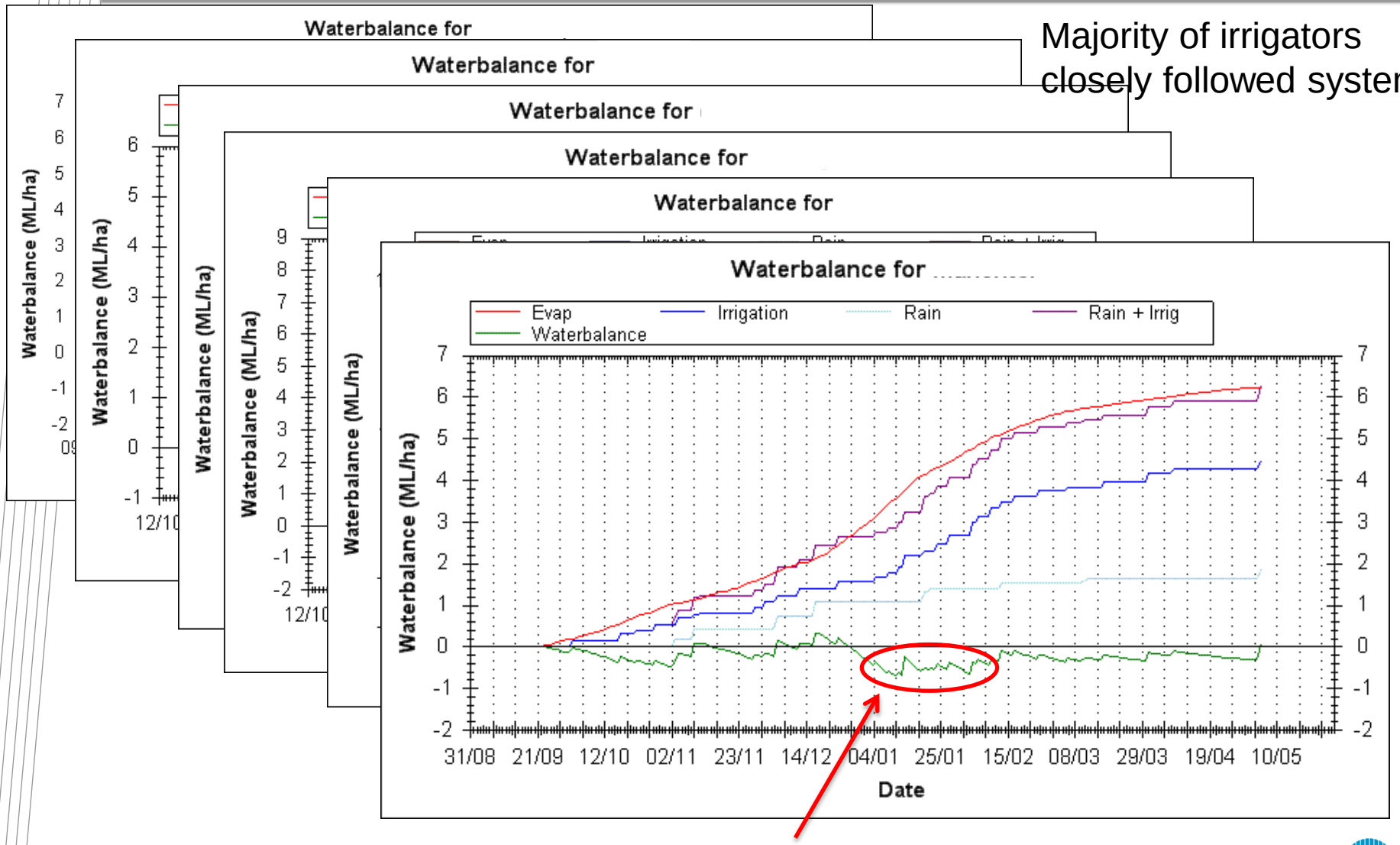
Waterbalances - MIA 2008/09 season

Percentage of Irrigators within water balance group

Group	Percentage (%)
Within +-0.2 ML/ha	50%
With +- 0.5 ML/ha	25%
More 0.5 ML/ha	5%
Less 0.5 Ml/ha	10%
Stopped	10%

Waterbalance traces – MIA 2008/09 season

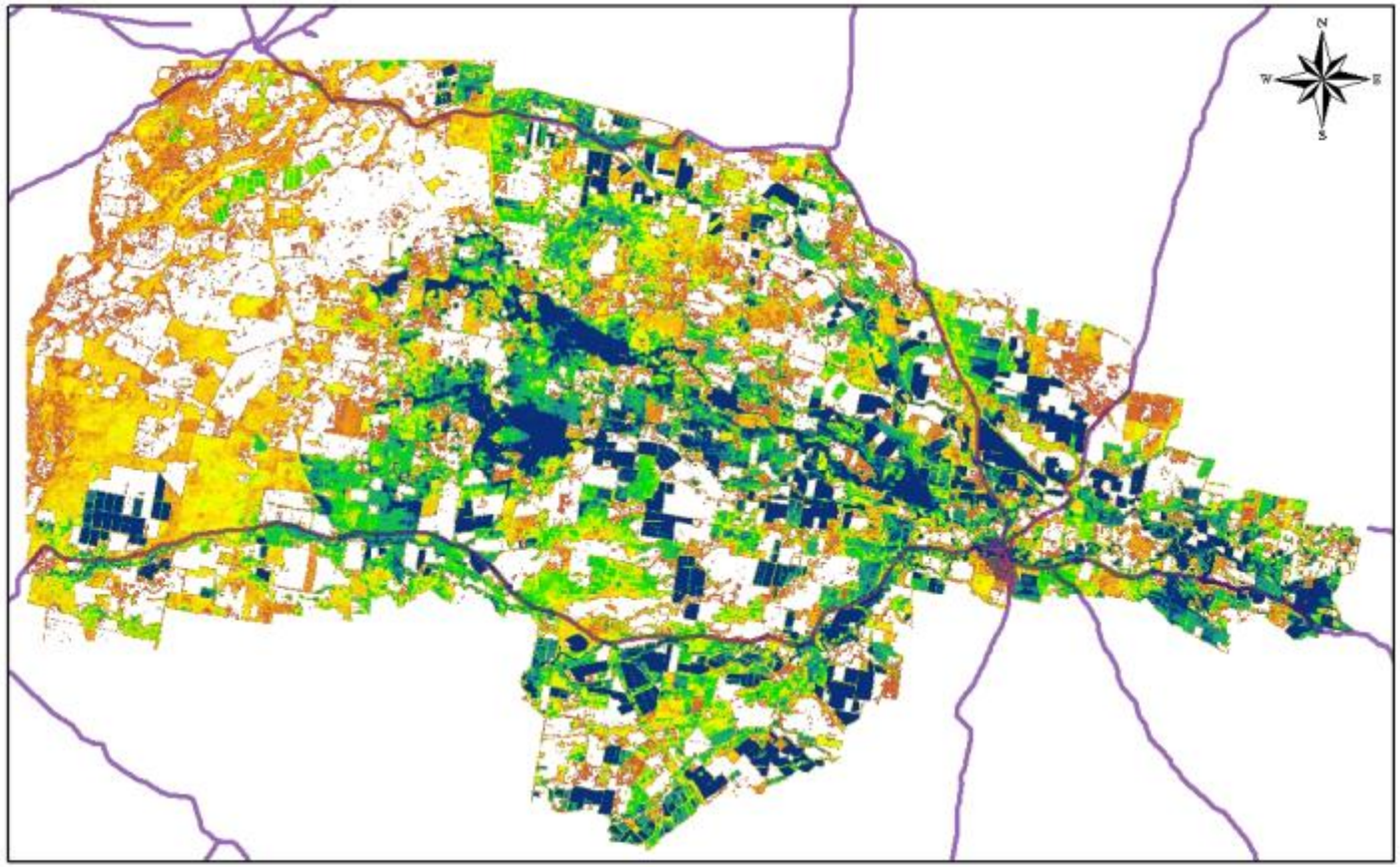
Majority of irrigators closely followed system



Two week period of high ETc

IrriSAT - Benchmarking

Regional Crop Water Use



Legend

0 5 10 20 30 40
Kilometers

Total seasonal crop water consumption

ML/ha/season

8.6

< 0.5

Season based on period from
15-Oct-2010 until 15-April-2011

Data projection UTM38-WSG84

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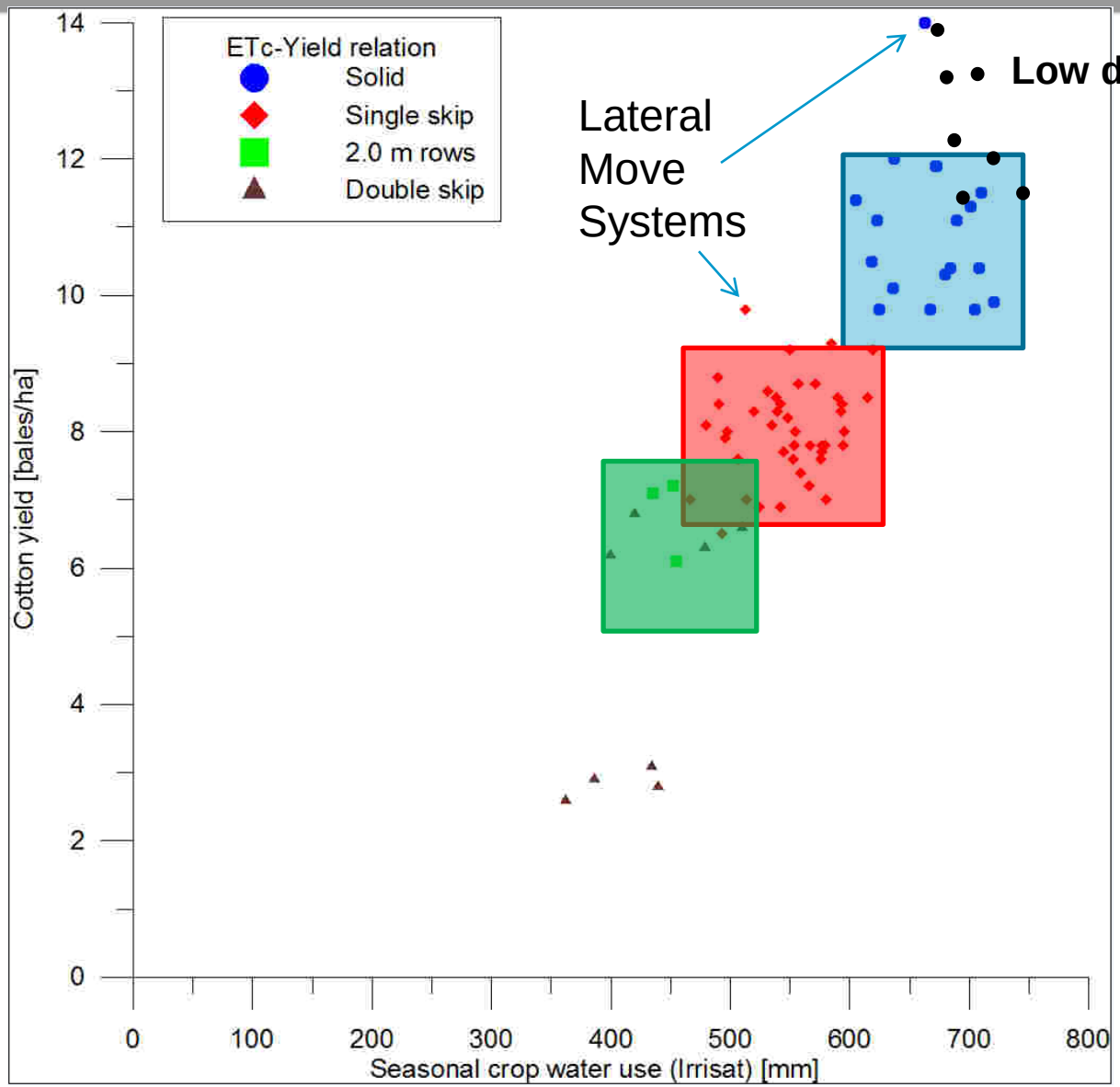
Yield/production/water use relationships



IrriSATSMS/IrriSATWEB Nodes

- Current Areas (2011-2012 irrigation season)
  - Murrumbidgee (Grapes and Citrus)
  - Hawkesbury-Nepean (Turf, Pasture, Citrus, Stone fruit)
  - Gwydir/Namoi/ Walgett (Cotton)
  - Goulburn Valley (Grapes)
  - Mildura (Grapes and Citrus)
- International Nodes being established
  - Cambodia
  - Iraq

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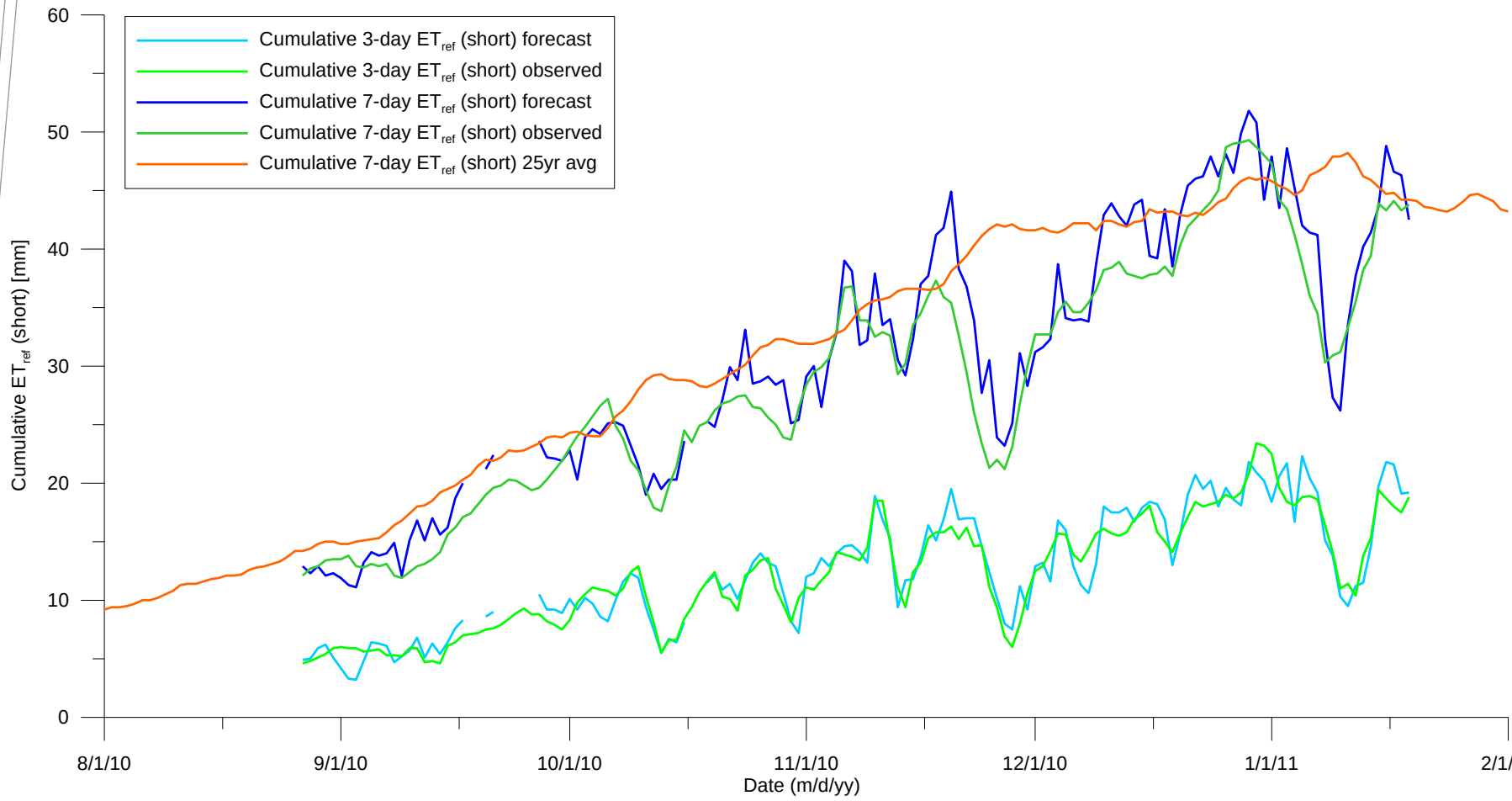
Future directions R&D

Future directions

- Establishing IrriSAT nodes in developing countries – Iraq and Cambodia
- Incorporating thermal band for stress determination in wine grape production
- Finding alternatives for Landsat
- Whole of irrigation area water ordering/demand management from large storage dams
    - Murrumbidgee Irrigation Area – 200 000 irrigated hectares – 1300 GL allocation
    - 7 days travel time from dam release to off-take in Irrigation Area
    - 24 hr water availability for customers
    - Over/under order losses are financially costly for the Irrigation company

Cumulative 3 & 7 day ET_{ref} forecast



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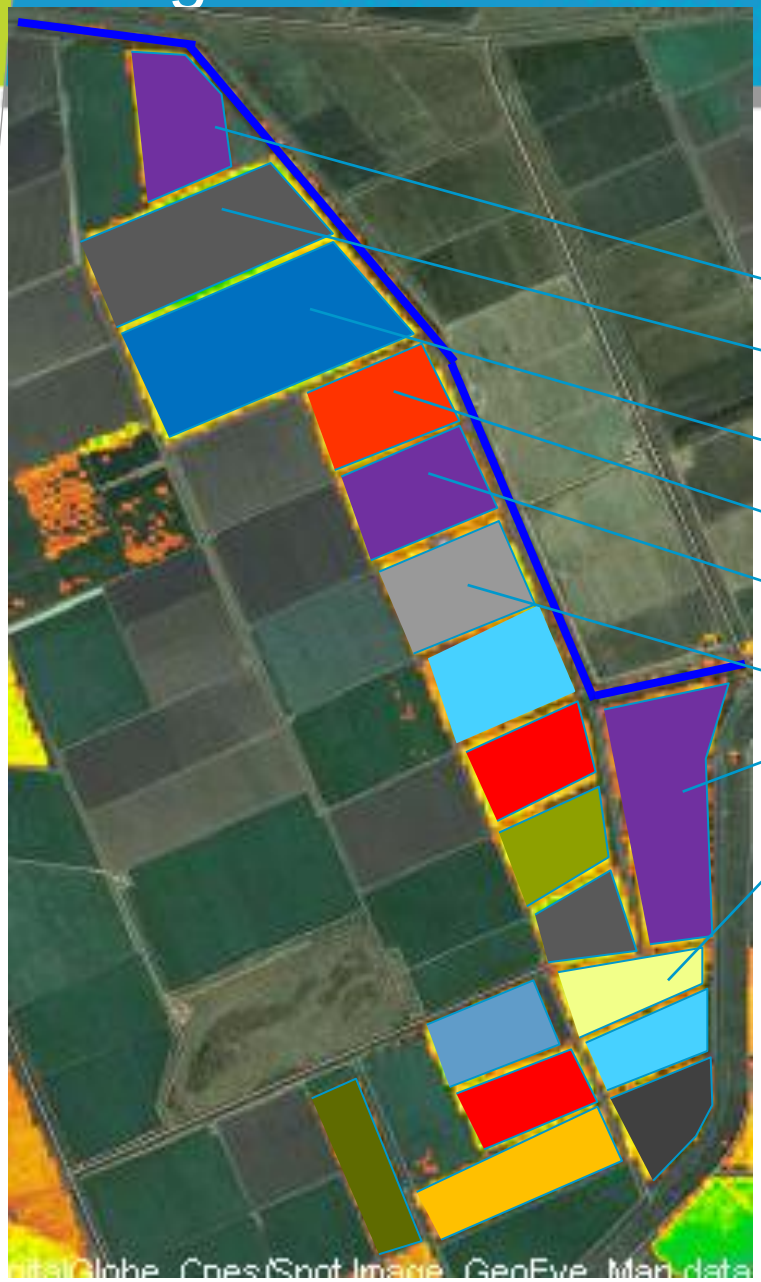
Irrigation Demand Management



Farm No.	Kc	CSIRO Forecast Eto (Next 7 days)	Forecast Water Demand (Next 7 days)
1045	0.5	65	28 ML
1085	0.9	65	39 ML
144	0.95	65	27 ML
784	0.21	65	82 ML
108	0.22	65	74 ML
1478	0.35	65	56 ML
221	0.7	65	10 ML
2658	0.18	65	11 ML
Total Demand Forecast For this off-take			327 ML

Conclusions

- IrriSAT provides useful real time information on crop water use across large areas at low cost – validated with actual irrigators across the major production areas in Australia

- IrriSAT when combined with yield data provides detailed information on benchmarking the performance of irrigation/row configurations and effects on irrigation decisions on yield

- The system is scalable and provides useful information for individual farmers. It also scales from the farm to the irrigation system level for water ordering.

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Further Information

- Download IrriSATSMS technical report
  - http://www.irrigationfutures.org.au/imagesDB/news/irrisatsms_v_60_finalwAppendix.pdf

- Visit the IrriGATEWAY website www.irrigateway.net