TESTING CROP COEFFICIENT CORRECTNESS WITH SAPWAT3 VER. 2

P S van Heerden, PICWAT
S Walker, UFS
LJ van Rensburg, UFS

SANCID, 2012

T: 051 401 9111 info@ufs.ac.za **www.ufs.ac.za**

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA

UFS·UV
NATURAL AND AGRICULTURAL SCIENCES
NATUUR- EN LANDBOUWETENSKAPPE

INTRODUCTION

- Estimation of irrigation requirements for planning comes a long way.
- Started through direct measurement and extrapolation
- Relating evaporation to crop irrigation requirement:
  - Class A pan
- Relating crop growth and development to weather data:
  - Penman-Monteith

INTRODUCTION

- Estimation or prediction of crop irrigation requirements are faced with a problem of credibility:
  - Green book – A-pan:
    - As long as calibrated and correctly placed;
    - Furthermore:
      - Heat exchange between pan and soil
      - Underground pans sensitive to environment
      - Maintain edge can cause wind break
      - Convective flows during night
  - Penman-Monteith:
    - Crop coefficients

- (Du Plessis & Wittwer, 1991; Green, 1985; Tanner, 1987; Riou, 1985; Doorenbos & Pruitt, 1977)

THEORETICAL BACKGROUND

- Growing plants contain about 90% water by weight.
- Transpires much more.
  - Maize plant contain 2l (2 kg) of water at maturity
    - 100000 plants/ha = 200 t/ha
    - Transpire 6000 t/ha during growing period.
- Water requirement need to be carefully planned and managed to ensure sustainability

- (Allen et al., 1998; Alois, 2007; DWA, 2004; Fairweather et al.,, undated)

THEORETICAL BACKGROUND

- FAO 56 crop coefficients based on semi-humid areas with warm summers
- Recent study found discrepancies between FAO 56 and crop coefficients.
  - -20% for citrus in Morocco
  - +20% for apples grown in cool, humid climate
- Crop coefficients used can vary significantly from actual observed data
  - Lysimeter, eddy covariance, soil and water balance, plant physiological
  - High air temperature and water deficit could lead to stomatal closure
    - lower than expected crop coefficients
- Some crops well researched:
  - Beans, cabbage, citrus, cotton, maize, onion, peas, peppers, potatoes, sugar cane, sunflower, wheat
- Some crops less well researched:
  - Berries, canola, gourds, granadillas, mangoes, papaws

- Need exists for continuous verification of crop coefficients

- (Lazarra & Rana, 2012; Allen, 2008; Raes, et al., 2009)

THEORETICAL BACKGROUND

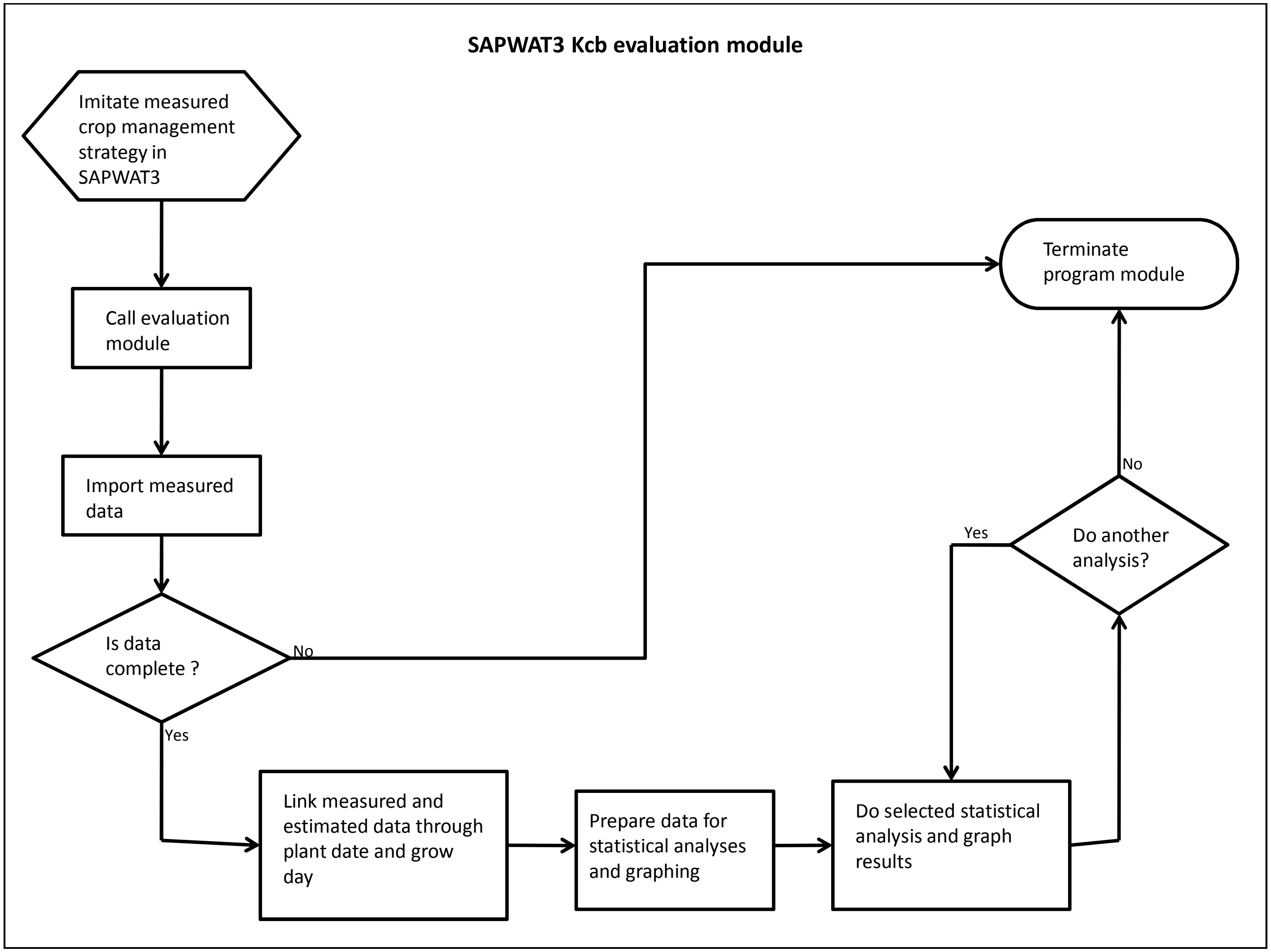
- Existing models do not have built-in routines for testing crop coefficient correctness
- Shorter grass surface loses the similarity in aerodynamic exchange found in taller plants – lucerne (alfalfa) could be better
- Accepting default coefficients without considering influence of climate, planting data, cultivar characteristics, agronomic practices is wrong
- SAPWAT3 with 104 main crops and 2835 subgroups need to continuously update crop characteristics / coefficients
- Routine to verify crop coefficients has been built into SAPWAT3 version 2

- (Smith, 1992; Raes, et al., 2009; Allen, et al., 1998; Smith, 1994; Van Heerden, et al., 2001; Doorenbos & Kassam, 1986; Van Heerden, et al., 2008)

METHODOLOGY

- The approach to solving the problem for SAPWAT3
  - Crop observed ETc = SAPWAT3 estimated ETc
  - ETc is related to Kcb
  - Therefore:
    - If Crop observed ETc # SAPWAT3 estimated ETc
    - SAPWAT3 crop coefficient need to be adjusted
    - Adjustment within limits

- Allen, et al., 1998


SAPWAT3 Kcb evaluation module
Imitate measured crop management strategy in SAPWAT3
Call evaluation module
Import measured data
Is data complete ?
No
Yes
Link measured and estimated data through plant date and grow day
Prepare data for statistical analyses and graphing
Do selected statistical analysis and graph results
Do another analysis?
Yes
No
Terminate program module

METHODOLOGY

- ETc calculated with the soil water balance equation
- Calculate Kcb – basal crop coefficient
  - Kcb = Kc – Ke

- Display results supported by statistical analyses
  - SAPWAT3 ETc compared to observed ETc
  - SAPWAT3 cumulative ETc compared to observed cumulative ETc
  - SAPWAT3 Kcb compared to observed Kcb
  - SAPWAT3 Kcb curve compared to observed Kcb data

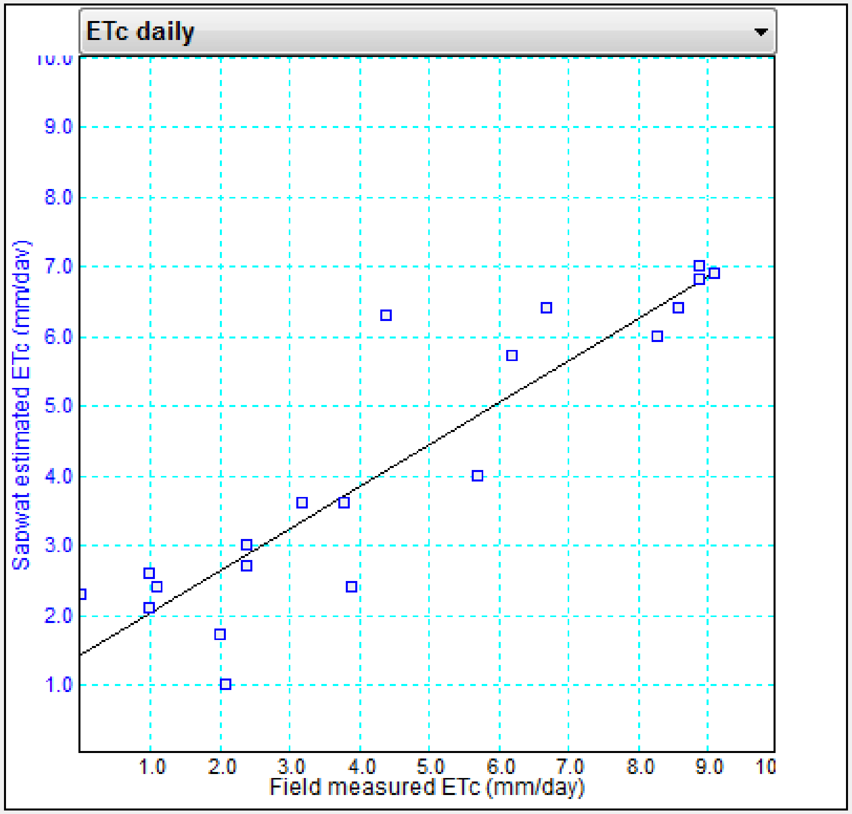
METHODOLOGY

- Three case studies:
  - Lysimeter at Bainsvlei (salinity project: control)
    - Wheat, planted mid June 2003
    - Centre pivot on sandy loam
    - Neutron probe about weekly
  - Lysimeter at Bainsvlei (water table project: control)
    - Wheat, planted mid June 1998
    - Centre pivot on sandy loam
    - Neutron probe about weekly
  - Field observed data near Hertzogville, NW (scheduling service)
    - Maize, planted End December 2008
    - Centre pivot on sandy loam
    - Decagon EC-20 probe, about daily
    - Percolation-Runoff not measured
    - "Good rain year"

ETC DAILY: LYSIMETER 1

Sapwat3

SAPWAT estimation accuracy



Date	Day	S_ETc	M_ETc	M_ETc_cur	S_ETc_cum
26/08/2003	54	1.7	2.0	83	107
02/09/2003	61	3.0	2.4	99	128
08/09/2003	67	3.6	3.2	118	149
16/09/2003	75	3.6	3.8	148	177
22/09/2003	81	4.0	5.7	182	201
30/09/2003	89	5.7	6.2	231	246
07/10/2003	96	6.4	6.7	277	291
14/10/2003	103	6.4	8.6	337	335
21/10/2003	110	6.0	8.3	395	376
28/10/2003	117	6.8	8.9	457	423
04/11/2003	124	6.9	9.1	520	471

S_ = SAPWAT data; M_ = Measured data

Regression equation:	Y = 1.44 + 0.60X
Coefficient of determination (r^2):	0.91
Number and Averages (n); (S_); (M_):	20 / 4.15 / 4.49
Mean error (ME):	-0.34
Root mean square error (RMSE):	1.50
Root mean sq. error: sys. (RMSEs):	1.24
Root mean sq. error: unsys. (RMSEu):	0.84
Index of agreement (d):	0.91

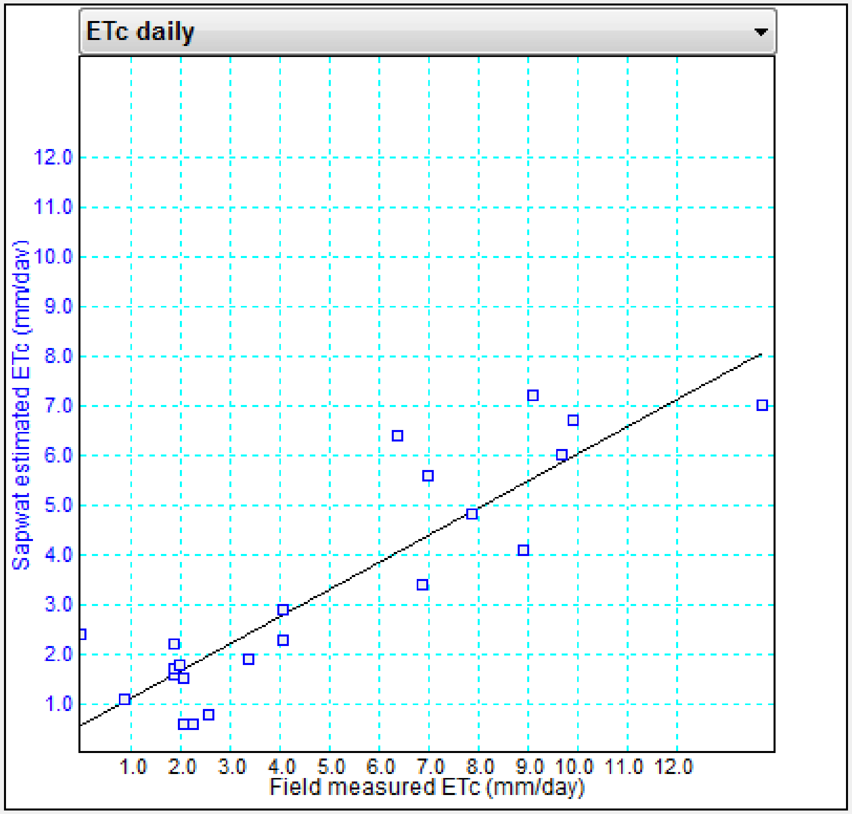
Set-up | Results | Readme

UFS
UV

ETC DAILY: LYSIMETER 2

Sapwat3

SAPWAT estimation accuracy



Date	Day	S_ETc	M_ETc	M_ETc_cur	S_ETc_cum
31/07/2000	55	1.1	0.9	105	71
07/08/2000	62	1.5	2.1	119	81
14/08/2000	69	1.9	3.4	142	94
21/08/2000	76	2.3	4.1	170	110
28/08/2000	83	2.9	4.1	198	130
04/09/2000	90	3.4	6.9	246	154
11/09/2000	97	4.1	8.9	308	182
19/09/2000	105	4.8	7.9	371	220
25/09/2000	111	5.6	7.0	413	253
02/10/2000	118	6.0	9.7	480	295
09/10/2000	125	6.4	6.4	524	339

S_ = SAPWAT data; M_ = Measured data

Regression equation:	Y = 0.60 + 0.55X
Coefficient of determination (r²):	0.89
Number and Averages (n); (S_); (M_):	22 / 3.30 / 4.95
Mean error (ME):	-1.65
Root mean square error (RMSE):	2.53
Root mean sq. error: sys. (RMSEs):	2.32
Root mean sq. error: unsys. (RMSEu):	1.01
Index of agreement (d):	0.82

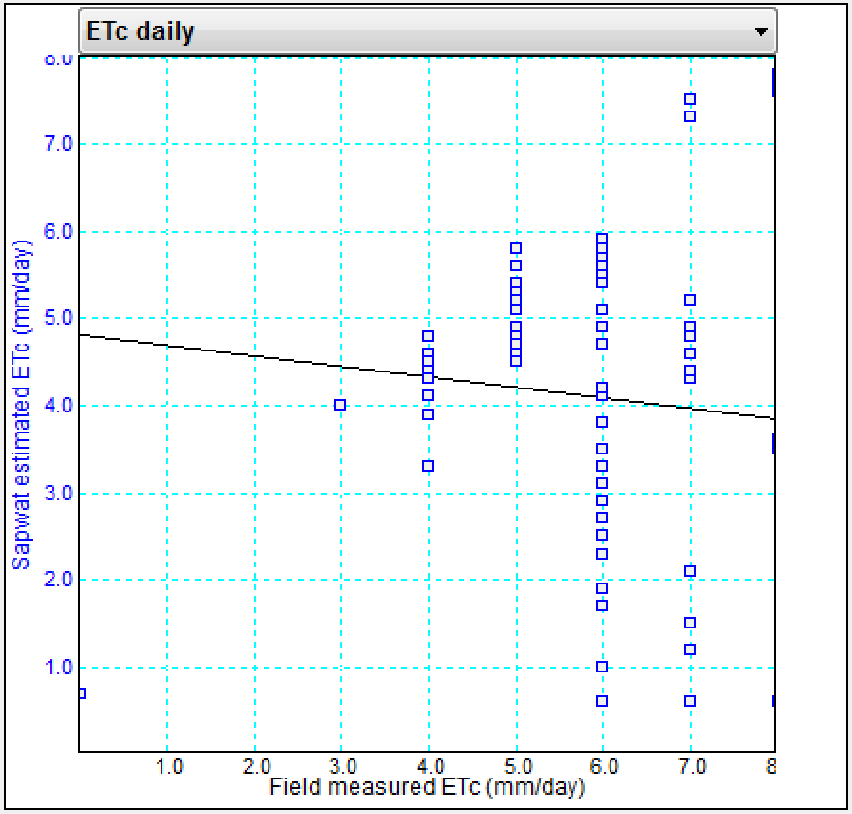
Set-up | Results | Readme

UFS UV

ETC DAILY: FIELD DATA

Sapwat3

SAPWAT estimation accuracy



Date	Day	S_ETc	M_ETc	M_ETc_cur	S_ETc_cum
02/03/2009	54	5.5	6.0	356	180
03/03/2009	55	5.5	6.0	362	185
04/03/2009	56	5.5	6.0	368	190
05/03/2009	57	5.4	5.0	373	195
06/03/2009	58	5.4	6.0	379	200
07/03/2009	59	5.4	5.0	384	205
08/03/2009	60	5.3	5.0	389	210
09/03/2009	61	5.3	5.0	394	215
10/03/2009	62	5.2	5.0	399	220
12/03/2009	64	5.2	5.0	409	230
13/03/2009	65	5.1	5.0	414	235

S_ = SAPWAT data; M_ = Measured data

Regression equation:	Y = 4.80 + -0.12X
Coefficient of determination (r^2):	-0.09
Number and Averages (n); (S_); (M_):	86 / 4.12 / 5.78
Mean error (ME):	-1.66
Root mean square error (RMSE):	2.92
Root mean sq. error: sys. (RMSEs):	2.29
Root mean sq. error: unsys. (RMSEu):	1.82
Index of agreement (d):	0.34

Set-up | Results | Readme

UFS UV

ETC DAILY RESULTS: DISCUSSION

- "Practical" acceptable slope 0.7 – 1.3
  - Lysimeter 1 is closest with slope = 0.6
  - Field observed data shows negative slope – no use
- Graph interpretation:
  - Lysimeter 1 = slope low;
  - Lysimeter 2 = slope too low;
    - Observed data substantially higher than estimated data;
  - Field data = not usable
    - Observed data rounded to nearest integer could have influence, but will not solve the problem
    - High observed data values at beginning of growth due to excessive water – lost through percolation but not picked up

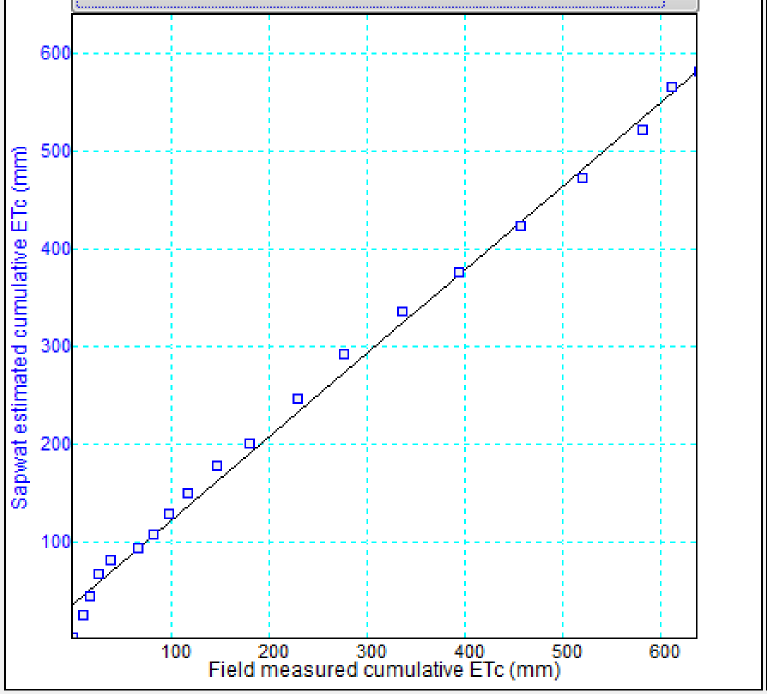
- Snedecor & Cochran, 1991; Wilmot, 1981

UFS UV

ETC CUMULATIVE: LYSIMETER 1

Sapwat3

SAPWAT estimation accuracy



Date	Day	M_ETc_cur	S_ETc_cum	S_Kcb	M_Kcb
26/08/2003	54	83	107	0.48	0.57
02/09/2003	61	99	128	0.61	0.49
08/09/2003	67	118	149	0.72	0.64
16/09/2003	75	148	177	0.84	0.88
22/09/2003	81	182	201	0.96	1.33
30/09/2003	89	231	246	1.09	1.13
07/10/2003	96	277	291	1.15	1.12
14/10/2003	103	337	335	1.15	1.43
21/10/2003	110	395	376	1.15	1.54
28/10/2003	117	457	423	1.15	1.35
04/11/2003	124	520	471	1.15	1.36

S_ = SAPWAT data; M_ = Measured data

Regression equation:	Y = 36.97 + 0.86X		
Coefficient of determination (r^2):	1.00		
Number and Averages (n); (S_); (M_):	20	244.20	242.25
Mean error (ME):	1.95		
Root mean square error (RMSE):	33.52		
Root mean sq. error: sys. (RMSEs):	31.06		
Root mean sq. error: unsys. (RMSEu):	12.59		
Index of agreement (d):	0.99		

Set-up | Results | Readme

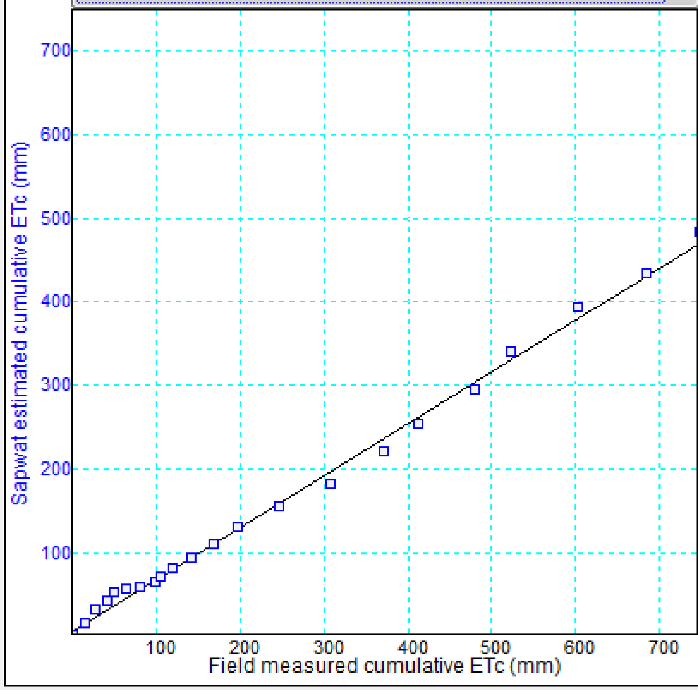
UFS UV

ETC CUMULATIVE: LYSIMETER 2

Sapwat3

SAPWAT estimation accuracy

ETc cumulative



Date	Day	M_ETc_cur	S_ETc_cum	S_Kcb	M_Kcb
31/07/2000	55	105	71	0.42	0.13
07/08/2000	62	119	81	0.50	0.35
14/08/2000	69	142	94	0.59	0.60
21/08/2000	76	170	110	0.68	0.76
28/08/2000	83	198	130	0.77	0.79
04/09/2000	90	246	154	0.86	1.35
11/09/2000	97	308	182	0.95	1.78
19/09/2000	105	371	220	1.04	1.63
25/09/2000	111	413	253	1.13	1.40
02/10/2000	118	480	295	1.15	1.87
09/10/2000	125	524	339	1.15	1.16

S_ = SAPWAT data; M_ = Measured data

Regression equation:	Y = 7.07 + 0.62X		
Coefficient of determination (r^2):	1.00		
Number and Averages (n); (S_); (M_):	22	161.82	249.64
Mean error (ME):	-87.82		
Root mean square error (RMSE):	123.28		
Root mean sq. error: sys. (RMSEs):	123.00		
Root mean sq. error: unsys. (RMSEu):	8.42		
Index of agreement (d):	0.89		

Set-up | Results | Readme

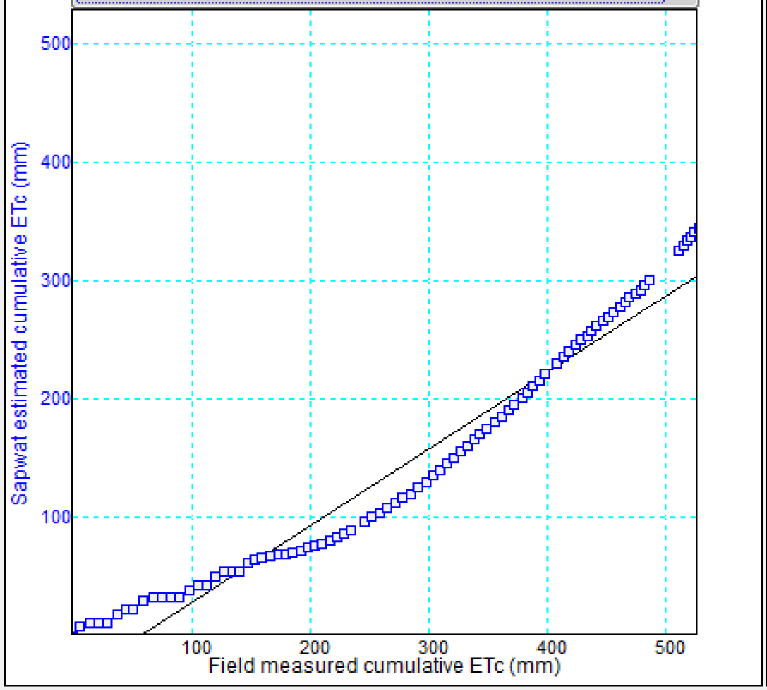
UFS UV

ETC CUMULATIVE: FIELD DATA

Sapwat3

SAPWAT estimation accuracy

ETc cumulative



	Date	Day	M_ETc_cur	S_ETc_cun	S_Kcb	M_Kcb
	26/02/2009	50	334	160	1.15	1.20
	27/02/2009	51	339	165	1.15	1.00
	28/02/2009	52	344	170	1.15	1.02
	01/03/2009	53	350	175	1.15	1.22
	02/03/2009	54	356	180	1.15	1.25
	03/03/2009	55	362	185	1.15	1.25
	04/03/2009	56	368	190	1.15	1.25
	05/03/2009	57	373	195	1.15	1.06
	06/03/2009	58	379	200	1.15	1.28
	07/03/2009	59	384	205	1.15	1.06
	08/03/2009	60	389	210	1.15	1.09

S_ = SAPWAT data; M_ = Measured data

Regression equation:	Y = -34.87 + 0.65X
Coefficient of determination (r^2):	0.98
Number and Averages (n); (S_); (M_):	86	147.83	282.78
Mean error (ME):	-134.95
Root mean square error (RMSE):	146.92
Root mean sq. error: sys. (RMSEs):	145.43
Root mean sq. error: unsys. (RMSEu):	20.85
Index of agreement (d):	0.76

Set-up | Results | Readme

UFS UV

ETC CUMULATIVE RESULTS: DISCUSSION

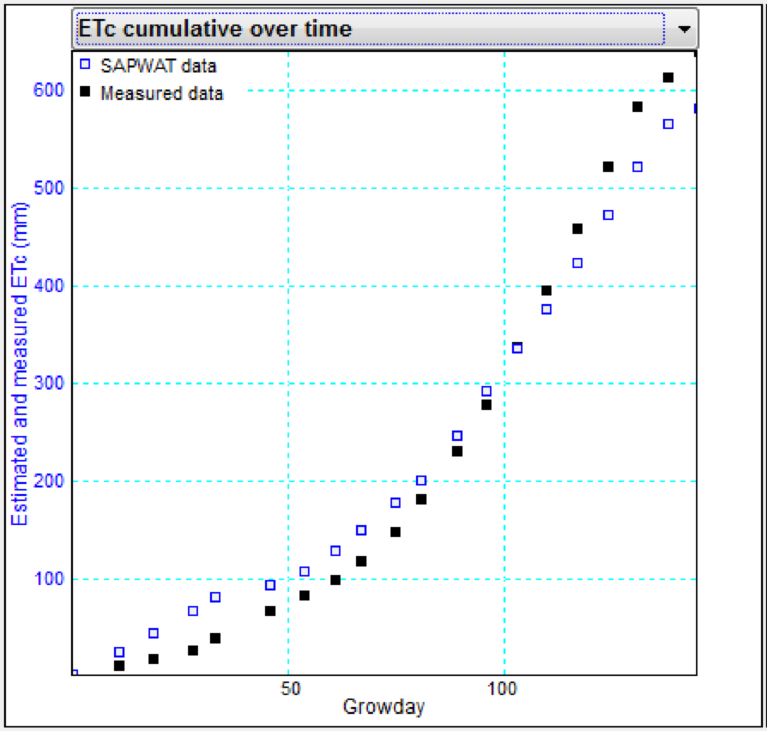
- Lysimeter 1 shows a slope within acceptable values range at 0.86
- Slope of lysimeter 2 is too shallow at 0.62,
  - Observed cumulative ETc of 700 compared to 450 for estimated cumulative ETc
- Slope of field data 16 too shallow at 0.65,
  - Observed cumulative ETc of 500 compared to 300 for estimated cumulative ETc
  - Excessive rain with no measurement of percolation could be the cause
- Graph interpretation:
  - Lysimeter 1 = good;
  - lysimeter 2 = predicted and observed data on line, slope too shallow,
  - field data = predicted and observed data approximately on line, slope too shallow

- Snedecor & Cochran, 1991; Wilmot, 1981

ETC OVER TIME: LYSIMETER 1

Sapwat3

SAPWAT estimation accuracy



Date	Day	M_ETc_cur	S_ETc_cun	S_Kcb	M_Kcb
26/08/2003	54	83	107	0.48	0.57
02/09/2003	61	99	128	0.61	0.49
08/09/2003	67	118	149	0.72	0.64
16/09/2003	75	148	177	0.84	0.88
22/09/2003	81	182	201	0.96	1.33
30/09/2003	89	231	246	1.09	1.13
07/10/2003	96	277	291	1.15	1.12
14/10/2003	103	337	335	1.15	1.43
21/10/2003	110	395	376	1.15	1.54
28/10/2003	117	457	423	1.15	1.35
04/11/2003	124	520	471	1.15	1.36
11/11/2003	131	582	520	1.15	1.31
18/11/2003	138	612	564	0.94	0.63
25/11/2003	145	639	580	0.45	0.71

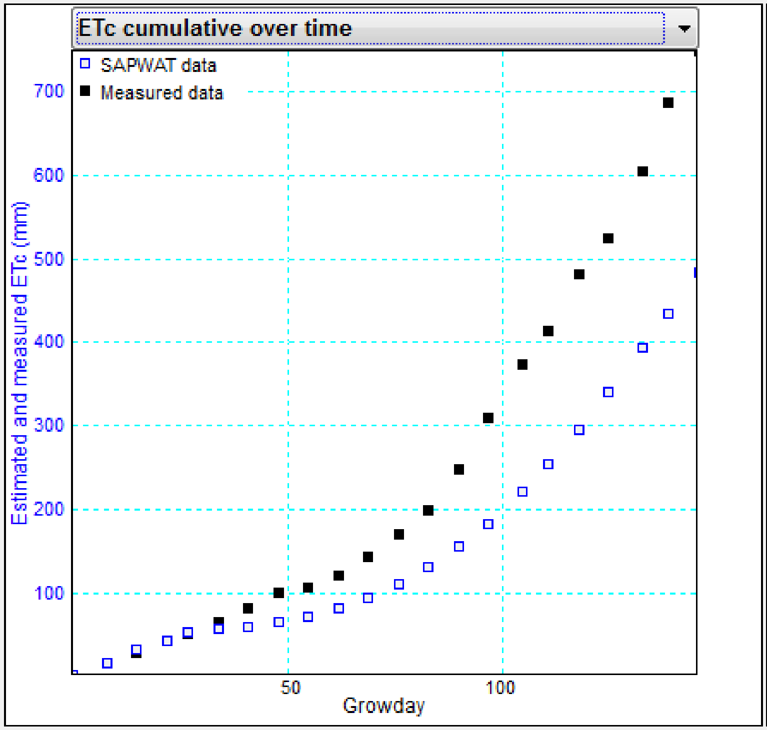
S_ = SAPWAT data; M_ = Measured data

Set-up | Results | Readme

ETC OVER TIME: LYSIMETER 2

Sapwat3

SAPWAT estimation accuracy



Date	Day	M_ETc_cur	S_ETc_cun	S_Kcb	M_Kcb
17/07/2000	41	81	59	0.24	0.25
24/07/2000	48	99	64	0.33	0.34
31/07/2000	55	105	71	0.42	0.13
07/08/2000	62	119	81	0.50	0.35
14/08/2000	69	142	94	0.59	0.60
21/08/2000	76	170	110	0.68	0.76
28/08/2000	83	198	130	0.77	0.79
04/09/2000	90	246	154	0.86	1.35
11/09/2000	97	308	182	0.95	1.78
19/09/2000	105	371	220	1.04	1.63
25/09/2000	111	413	253	1.13	1.40
02/10/2000	118	480	295	1.15	1.87
09/10/2000	125	524	339	1.15	1.16
17/10/2000	133	603	392	1.15	1.71
23/10/2000	139	685	433	1.15	2.25
30/10/2000	146	748	483	1.15	1.44

S_ = SAPWAT data; M_ = Measured data

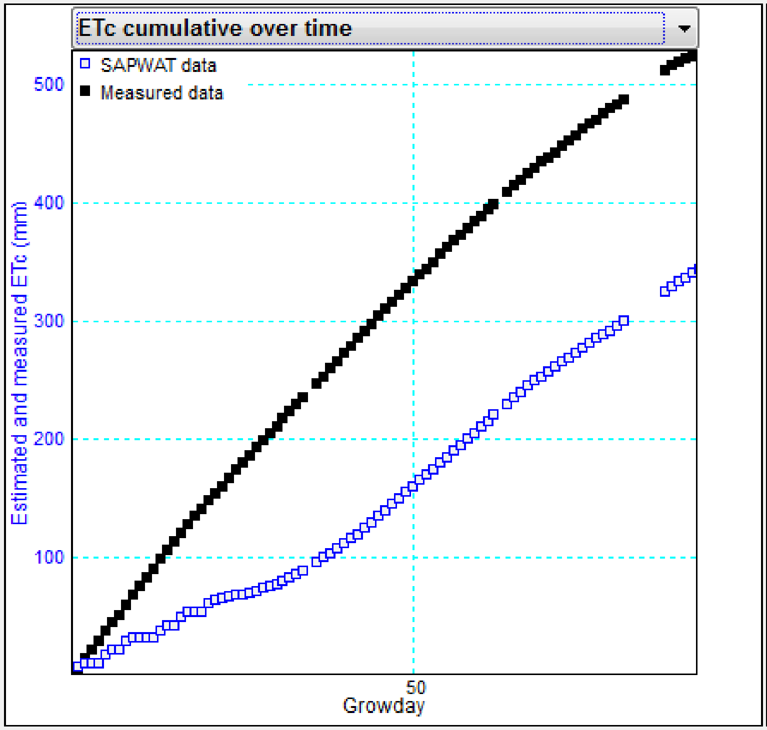
Set-up | Results | Readme

UFS UV

ETC OVER TIME : FIELD DATA

Sapwat3

SAPWAT estimation accuracy



Date	Day	S_ETc	M_ETc	M_ETc_cum	S_ETc_cum
07/01/2009	0	0.7	0.0	0	0
08/01/2009	1	4.3	7.0	7	8
09/01/2009	2	3.6	8.0	15	11
10/01/2009	3	0.6	8.0	23	11
11/01/2009	4	0.6	7.0	30	11
12/01/2009	5	7.8	8.0	38	18
13/01/2009	6	4.9	7.0	45	22
14/01/2009	7	0.6	7.0	52	22
15/01/2009	8	7.7	8.0	60	29
16/01/2009	9	3.5	8.0	68	32
17/01/2009	10	0.6	8.0	76	32
18/01/2009	11	0.6	7.0	83	32
19/01/2009	12	0.6	8.0	91	32
20/01/2009	13	7.6	8.0	99	39
21/01/2009	14	4.8	7.0	106	43
22/01/2009	15	0.6	8.0	114	43

S_ = SAPWAT data; M_ = Measured data

Set-up | Results | Readme

UFS UV

ETC OVER TIME RESULTS: DISCUSSION

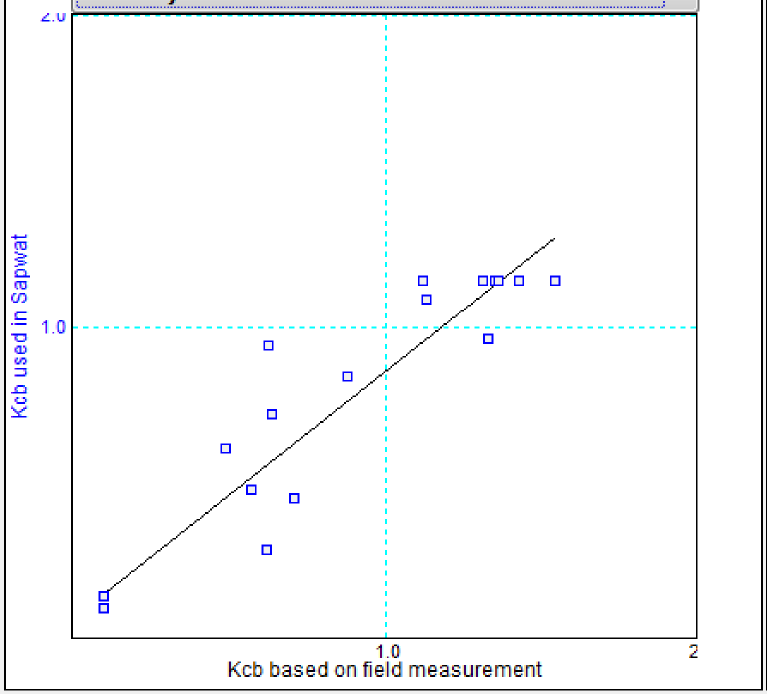
- In Lysimeter 1 the cumulative ETc curves of estimated and observed data follow a similar line – indicating an acceptable degree of similarity
- The estimated and observed curves of lysimeter 2 is divergent
  - Excessive observed ETc?
  - Under-estimation of cumulative ETc?
- The estimated and observed curves of field data is very divergent
  - Excessive observed ETc?
  - Under-estimation of cumulative ETc?

KCB DAILY: LYSIMETER 1

Sapwat3

SAPWAT estimation accuracy

Kcb daily



	Date	Day	S_Kcb	M_Kcb	S_Kc	M_Kc	Kcmax	S_
	26/08/2003	54	0.48	0.57	0.48	0.57	1.26	3
	02/09/2003	61	0.61	0.49	0.61	0.49	1.26	4
	08/09/2003	67	0.72	0.64	0.72	0.64	1.28	5
	16/09/2003	75	0.84	0.88	0.84	0.88	1.25	4
	22/09/2003	81	0.96	1.33	0.96	1.33	1.25	4
	30/09/2003	89	1.09	1.13	1.09	1.13	1.27	5
	07/10/2003	96	1.15	1.12	1.15	1.12	1.27	6
	14/10/2003	103	1.15	1.43	1.15	1.43	1.28	6
	21/10/2003	110	1.15	1.54	1.15	1.54	1.28	5
	28/10/2003	117	1.15	1.35	1.15	1.35	1.28	6
	04/11/2003	124	1.15	1.36	1.15	1.36	1.28	6

S_ = SAPWAT data; M_ = Measured data

Regression equation:	Y = 0.07 + 0.79X		
Coefficient of determination (r^2):	0.94		
Number and Averages (n); (S_); (M_):	20	0.69	0.78
Mean error (ME):	-0.09		
Root mean square error (RMSE):	0.20		
Root mean sq. error: sys. (RMSEs):	0.93		
Root mean sq. error: unsys. (RMSEu):	0.14		
Index of agreement (d):	0.95		

Set-up | Results | Readme

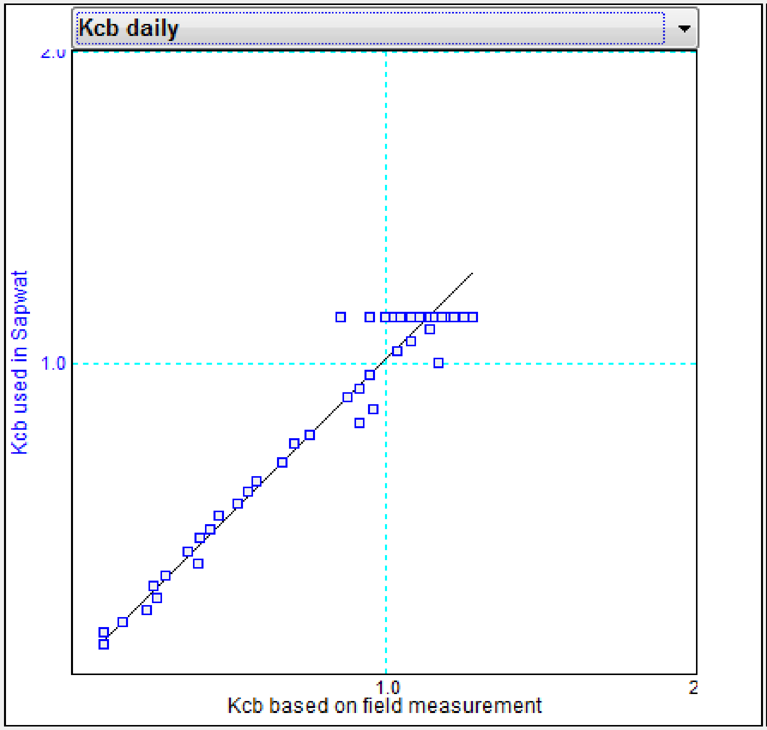
UFS UV

KCB DAILY: FIELD DATA

Sapwat3

SAPWAT estimation accuracy

Kcb daily



Date	Day	S_Kcb	M_Kcb	S_Kc	M_Kc	Kcmax	S_
26/02/2009	50	1.15	1.20	1.15	1.20	1.27	5
27/02/2009	51	1.15	1.00	1.15	1.00	1.27	5
28/02/2009	52	1.15	1.02	1.15	1.02	1.27	4
01/03/2009	53	1.15	1.22	1.15	1.22	1.25	4
02/03/2009	54	1.15	1.25	1.15	1.25	1.25	4
03/03/2009	55	1.15	1.25	1.15	1.25	1.25	4
04/03/2009	56	1.15	1.25	1.15	1.25	1.25	4
05/03/2009	57	1.15	1.06	1.15	1.06	1.25	4
06/03/2009	58	1.15	1.28	1.15	1.28	1.25	4
07/03/2009	59	1.15	1.06	1.15	1.06	1.25	4
08/03/2009	60	1.15	1.09	1.15	1.09	1.25	4

S_ = SAPWAT data; M_ = Measured data

Regression equation:	Y = 0.02 + 0.99X		
Coefficient of determination (r²):	0.98		
Number and Averages (n); (S_); (M_):	86	0.73	0.72
Mean error (ME):	0.02		
Root mean square error (RMSE):	0.09		
Root mean sq. error: sys. (RMSEs):	0.85		
Root mean sq. error: unsys. (RMSEu):	0.09		
Index of agreement (d):	0.99		

Set-up | Results | Readme

UFS UV

KCB DAILY RESULTS: DISCUSSION

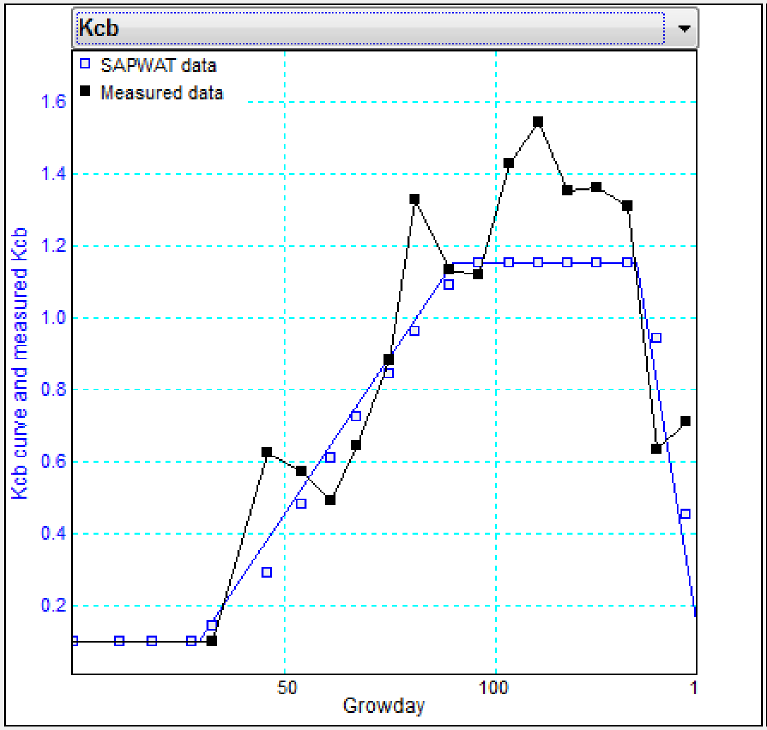
- Acceptable slope 0.7 – 1.3
  - Lysimeter 1 and field data is within the acceptable range with slopes of 0.79 and 0.99 respectively
- Graph interpretation:
  - Lysimeter 1 = acceptable
  - field data = acceptable

- Snedecor & Cochran, 1991; Wilmot, 1981

KCB CURVE: LYSIMETER 1

Sapwat3

SAPWAT estimation accuracy



Date	Day	S_Kcb	M_Kcb	S_Kc	M_Kc	Kcmax	S_
05/08/2003	33	0.14	0.10	0.80	0.71	1.24	3
18/08/2003	46	0.29	0.62	0.29	0.62	1.24	3
26/08/2003	54	0.48	0.57	0.48	0.57	1.26	3
02/09/2003	61	0.61	0.49	0.61	0.49	1.26	4
08/09/2003	67	0.72	0.64	0.72	0.64	1.28	5
16/09/2003	75	0.84	0.88	0.84	0.88	1.25	4
22/09/2003	81	0.96	1.33	0.96	1.33	1.25	4
30/09/2003	89	1.09	1.13	1.09	1.13	1.27	5
07/10/2003	96	1.15	1.12	1.15	1.12	1.27	6
14/10/2003	103	1.15	1.43	1.15	1.43	1.28	6
21/10/2003	110	1.15	1.54	1.15	1.54	1.28	5
28/10/2003	117	1.15	1.35	1.15	1.35	1.28	6
04/11/2003	124	1.15	1.36	1.15	1.36	1.28	6
11/11/2003	131	1.15	1.31	1.15	1.31	1.27	6
18/11/2003	138	0.94	0.63	0.94	0.63	1.27	7
25/11/2003	145	0.45	0.71	0.45	0.71	1.21	5

S_ = SAPWAT data; M_ = Measured data

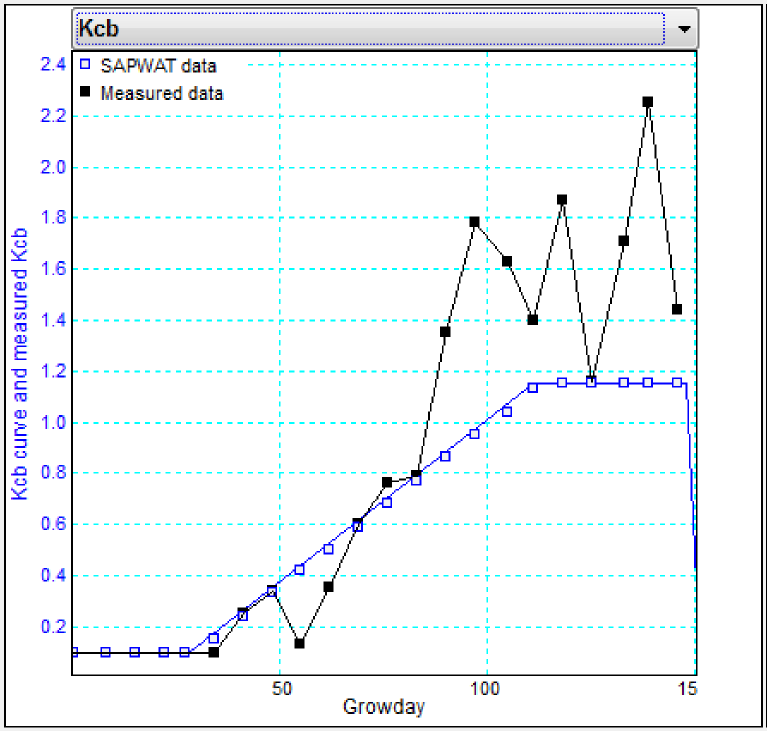
Set-up Results Readme

UFS
UV

KCB CURVE: LYSIMETER 2

Sapwat3

SAPWAT estimation accuracy



Date	Day	S_Kcb	M_Kcb	S_Kc	M_Kc	Kcmax	S_
17/07/2000	41	0.24	0.25	0.24	0.25	1.23	2
24/07/2000	48	0.33	0.34	0.33	0.34	1.24	2
31/07/2000	55	0.42	0.13	0.42	0.13	1.24	2
07/08/2000	62	0.50	0.35	0.50	0.35	1.26	2
14/08/2000	69	0.59	0.60	0.59	0.60	1.26	3
21/08/2000	76	0.68	0.76	0.68	0.76	1.26	3
28/08/2000	83	0.77	0.79	0.77	0.79	1.27	3
04/09/2000	90	0.86	1.35	0.86	1.35	1.28	4
11/09/2000	97	0.95	1.78	0.95	1.78	1.28	4
19/09/2000	105	1.04	1.63	1.04	1.63	1.29	4
25/09/2000	111	1.13	1.40	1.13	1.40	1.29	5
02/10/2000	118	1.15	1.87	1.15	1.87	1.29	5
09/10/2000	125	1.15	1.16	1.15	1.16	1.28	5
17/10/2000	133	1.15	1.71	1.15	1.71	1.28	5
23/10/2000	139	1.15	2.25	1.15	2.25	1.28	6
30/10/2000	146	1.15	1.44	1.15	1.44	1.28	6

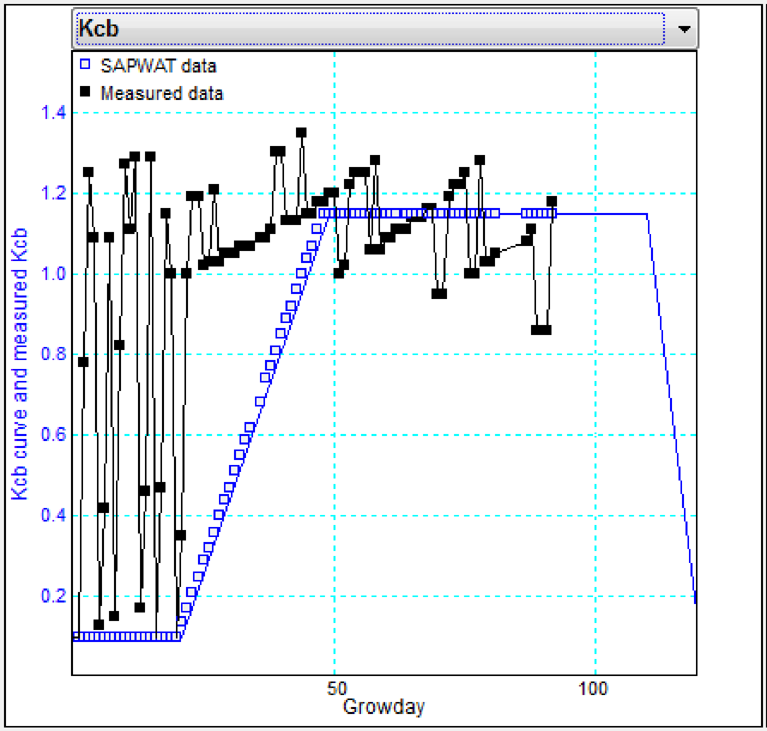
S_ = SAPWAT data; M_ = Measured data

Set-up | Results | Readme

KCB CURVE: FIELD DATA WITHOUT CANOPY DEVELOPMENT

Sapwat3

SAPWAT estimation accuracy



	Date	Day	S_ETc	M_ETc	M_ETc_cur	S_ETc_cum
▶	07/01/2009	0	0.7	0.0		0
	07/01/2009	0	0.7	0.0		0
	08/01/2009	1	7.9	7.0		7
	09/01/2009	2	3.6	8.0		10
	10/01/2009	3	0.6	8.0		10
	11/01/2009	4	0.6	7.0		10
	12/01/2009	5	7.8	8.0		17
	13/01/2009	6	4.9	7.0		21
	14/01/2009	7	0.6	7.0		21
	15/01/2009	8	7.7	8.0		28
	16/01/2009	9	3.5	8.0		31
	17/01/2009	10	0.6	8.0		31
	18/01/2009	11	0.6	7.0		31
	19/01/2009	12	0.6	8.0		31
	20/01/2009	13	7.6	8.0		38
	21/01/2009	14	4.8	7.0		42

S_ = SAPWAT data; M_ = Measured data

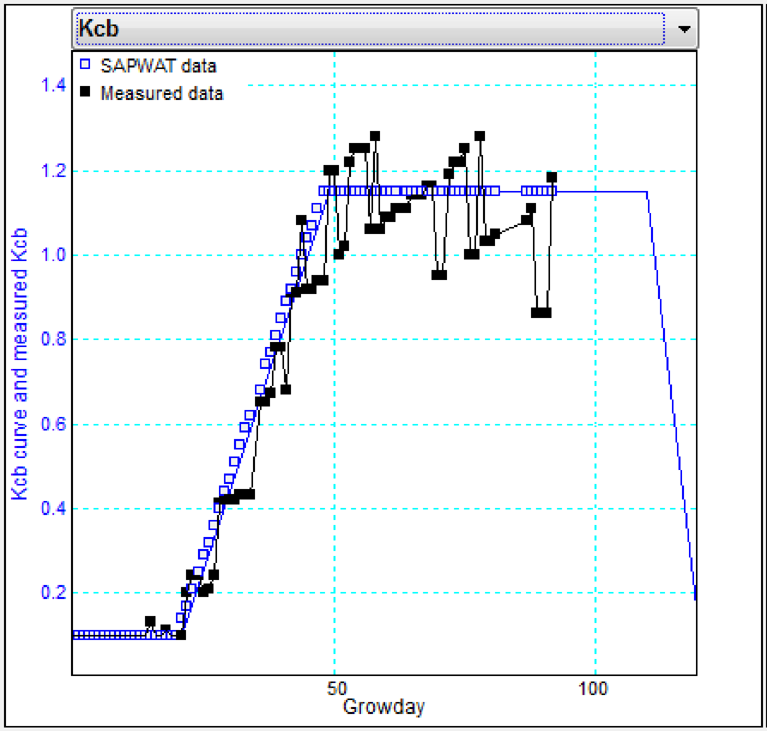
Set-up | Results | Readme

UFS UV

KCB CURVE: FIELD DATA WITH CANOPY DEVELOPMENT

Sapwat3

SAPWAT estimation accuracy



Date	Day	S_Kcb	M_Kcb	S_Kc	M_Kc	Kcmax	S_
26/02/2009	50	1.15	1.20	1.15	1.20	1.27	5
27/02/2009	51	1.15	1.00	1.15	1.00	1.27	5
28/02/2009	52	1.15	1.02	1.15	1.02	1.27	4
01/03/2009	53	1.15	1.22	1.15	1.22	1.25	4
02/03/2009	54	1.15	1.25	1.15	1.25	1.25	4
03/03/2009	55	1.15	1.25	1.15	1.25	1.25	4
04/03/2009	56	1.15	1.25	1.15	1.25	1.25	4
05/03/2009	57	1.15	1.06	1.15	1.06	1.25	4
06/03/2009	58	1.15	1.28	1.15	1.28	1.25	4
07/03/2009	59	1.15	1.06	1.15	1.06	1.25	4
08/03/2009	60	1.15	1.09	1.15	1.09	1.25	4
09/03/2009	61	1.15	1.09	1.15	1.09	1.25	4
10/03/2009	62	1.15	1.11	1.15	1.11	1.25	4
12/03/2009	64	1.15	1.11	1.15	1.11	1.25	4
13/03/2009	65	1.15	1.14	1.15	1.14	1.25	4
14/03/2009	66	1.15	1.14	1.15	1.14	1.25	4

S_ = SAPWAT data; M_ = Measured data

Set-up | Results | Readme

UFS UV

KCB CURVE RESULTS: DISCUSSION

- Lysimeter 1
  - Predicted and observed Kcb values follow a similar curve
    - Good comparison, though observed values are higher for mid-season stage
- Lysimeter 2
  - Predicted and observed Kcb values follow a similar curve
    - Not a good comparison, observed values are much higher for mid-season stage
    - Observed Kcb values beyond 1.5 – 1.6 for grass reference are unexpected
- Field data
  - Too high values for initial and development stages, even allowing for soil evaporation
  - Mid-season stage values show good comparison
- Field data with incorporation of canopy development
  - Good comparison between observed and predicted values

- Allen, et al., 1998

CONCLUSIONS

- Lysimeter 1
  - Graphs and analyses data show that this case can be used for verification of crop Kcb values.
    - Accurate measurement at all levels required.
- Lysimeter 2
  - Graphs and analyses data show that this case should not be used for verification of crop Kcb values.
    - Analyses gives Kcb values higher than expected maxima.
    - The result: data is skewed at all levels of analyses.
- Field data
  - Graphs and analyses show that the use of this data can only be used if:
    - Rainfall and irrigation is limited so that over-extension of soil water capacity is limited.
    - Canopy development data also be noted and used in the analyses.

- The module could be extended to include observed sap flow data as input.

- The inclusion of remote sensing data in this module need to be investigated.

ACKNOWLEDGEMENT

- To my co-presenters, prof Sue Walker and prof Lean van Rensburg for guidance and for making data available.
- James Kennedy who supplied the concept and data for the original development and testing of the verification module.
- To the Water Research Commission who have funded the development of SAPWAT3.

UFS
UV

- Thank you

Thank You
Dankie

T: 051 401 9111 info@ufs.ac.za **www.ufs.ac.za**

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA

UFS·UV
NATURAL AND AGRICULTURAL SCIENCES
NATUUR- EN LANDBOUWETENSKAPPE