

Supplementary Materials: Scrubbing up: multi-scale investigation of woody encroachment in a southern African savannah

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Table S1. Confusion matrix for the site 1 2002 (QuickBird) land cover classification.

Ground Truthing Data										
Classified Data	Trees	Shrubs	Long Grass	Sparse Grass	Bare	Swamp	Built Up	Water	Row Total	Users Accuracy (%)
Trees	39	3				1			43	90.7
Shrubs		25	2						27	92.6
Long grass		2	38			1			41	92.7
Sparse grass			5	19					24	79.2
Bare			1	5	34		3		43	79.1
Swamp						24			24	100.0
Built up							26		26	100.0
Water								28	28	100.0
Column Total	39	30	46	24	34	26	29	28	256	
Producers Accuracy (%)	100.0	83.3	82.6	79.2	100.0	92.3	89.7	100.0		
Overall Classification Accuracy (%)										91.0
95% confidence interval (error tolerance) of the probability estimate										0.070
Cohen's Kappa coefficient										0.8966

Table S2. Confusion matrix for the site 1 2014 (WorldView-2) land cover classification.

Ground truthing data										
Classified Data	Trees	Shrubs	Long Grass	Sparse Grass	Bare	Swamp	Built Up	Water	Row Total	Users Accuracy (%)
Trees	48					3	1		52	92.3
Shrubs	4	15	2			1			22	68.2
Long grass		2	28			2	1		33	84.9
Sparse grass			1	4					5	80.0
Bare				2	29		1		32	90.6
Swamp						6			6	100.0
Built up							29		29	100.0
Water								26	26	100.0
Column Total	52	17	31	6	29	12	32	26	205	
Producers Accuracy (%)	92.3	88.2	90.3	66.7	100.0	50.0	90.6	100.0		
Overall Classification Accuracy (%)										90.2
95% confidence interval (error tolerance) of the probability estimate										0.073
Cohen's Kappa coefficient										0.8838

Table S3. Confusion matrix for the site 2 2002 (IKONOS) land cover classification.

Ground truthing data											Users Accuracy (%)
Classified data	Trees	Shrubs	Long Grass	Sparse Grass	Bare	Swamp	Built Up	Water	Agriculture	Row Total	
Trees	40	6				1	1		5	53	75.5
Shrubs		21					1			22	95.5
Long grass		3	37				1		1	42	88.1
Sparse grass				26			4			30	86.7
Bare					34		1			35	97.1
Swamp						22				22	100.0
Built up							19			19	100.0
Water								22		22	100.0
Agriculture									11	11	100.0
Column Total	40	30	37	26	34	23	27	22	17	256	
Producers accuracy (%)	100.0	70.0	100.0	100.0	100.0	95.7	70.4	100.0	64.7		
Overall Classification Accuracy (%)											90.6
95% confidence interval (error tolerance) of the probability estimate											0.063
Cohen's Kappa coefficient											0.8932

Table S4. Confusion matrix for the site 2 2014 (IKONOS) land cover classification.

Ground truthing data												
Classified Data	Trees	Shrubs	Long Grass	Sparse Grass	Bare	Swamp	Built Up	Water	Agriculture	Burn Scar	Row Total	Users Accuracy (%)
Trees	33	1				5				1	40	82.5
Shrubs	2	23					1				26	88.7
Long grass		1	30	1					1		33	90.9
Sparse grass				25							25	100.0
Bare					27		3				30	90.0
Swamp						5					5	100.0
Built up							15				15	100.0
Water								20			20	100.0
Agriculture									9		9	100.0
Burn scar							1			24	25	96.0
Column Total	35	25	30	26	27	10	20	20	10	25	228	
Producers accuracy (%)	94.3	92.0	100.0	96.2	100.0	50.0	75.0	100.0	90.0	96.0		
Overall Classification Accuracy (%)												92.5
95% confidence interval (error tolerance) of the probability estimate												0.051
Cohen's Kappa coefficient												0.9158

Table S5. Confusion matrix for the site 3 2001 (IKONOS) land cover classification.

Ground truthing data										Users accuracy (%)
Classified data	Trees	Shrubs	Long grass	Sparse grass	Bare	Swamp	Built up	Water	Row total	
Trees	17	2				2			21	81.0
Shrubs		12				2			14	85.7
Long grass	6	2	27			3			38	71.1
Sparse grass				15					15	100.0
Bare					25				25	100.0
Swamp	3					11			14	78.6
Built up							15		15	100.0
Water								20	20	100.0
Column Total	26	16	27	15	25	18	15	20	162	
Producers accuracy (%)	65.4	75.0	100.0	100.0	100.0	61.1	100.0	100.0		
Overall Classification Accuracy (%)										87.7
95% confidence interval (error tolerance) of the probability estimate										0.081
Cohen's Kappa coefficient										0.8574

Table S6. Confusion matrix for the site 3 2014 (IKONOS) land cover classification.

Ground truthing data										
Classified data	Trees	Shrubs	Long grass	Sparse grass	Bare	Swamp	Built up	Water	Row total	Users accuracy (%)
Trees	29	1				1	1	1	33	87.9
Shrubs	1	24	1			6	1		33	72.7
Long grass		5	30						35	85.7
Sparse grass				23					23	100.0
Bare				1	29				30	96.7
Swamp						14			14	100.0
Built up							10		10	100.0
Water								24	24	100.0
Column Total	30	30	31	24	29	21	12	25	202	
Producers accuracy (%)	96.7	80.0	96.8	95.8	100.0	66.7	83.3	96.0		
Overall Classification Accuracy (%)										90.6
95% confidence interval (error tolerance) of the probability estimate										0.072
Cohen's Kappa coefficient										0.8913

Table S7. Confusion matrix for the sites 1,2 and 3 2002 medium spatial resolution (Landsat ETM+) land cover classification.

Classified data	Ground truthing data									Row total	Users accuracy (%)
	Open woodland	Closed woodland	Continuous grassland	Discontinuous grassland	Agriculture	Bare	Water	Swamp	Built-up		
Open woodland	51	3	2	3		7	3	3	20	92	55.4
Closed woodland	4	38	1			2	1		2	48	79.2
Continuous grassland	1		102	16		7	1	1	5	133	76.7
Discontinuous grassland	11		6	69		7			12	105	65.7
Agriculture					17				2	19	89.5
Bare	2	1	4	1		93	1	7		109	85.3
Water	1	3	1				56	7		68	82.4
Swamp		4				3	7	50		64	78.1
Built-up			1			3	1		30	35	85.7
Column total	70	49	117	89	17	122	70	68	71	673	
Producers accuracy (%)	72.9	77.6	87.2	77.5	100.0	76.2	80.0	73.5	42.3		
Overall Classification Accuracy (%)											75.2
95% confidence interval (error tolerance) of the probability estimate											0.094
Cohen's Kappa coefficient											0.7148

Table S8. Confusion matrix for the sites 1,2 and 3 2014 medium spatial resolution (Landsat OLI) land cover classification.

Classified data	Ground truthing data									Row total	Users accuracy (%)
	Open woodland	Closed woodland	Continuous grassland	Discontinuous grassland	Agriculture	Bare	Water	Swamp	Built-up		
Open woodland	39	8	1	3	1	2	1		14	69	56.5
Closed woodland	11	62	1		1	3	4	2	9	93	66.7
Continuous grassland	2	2	105	9		7			2	127	82.7
Discontinuous grassland	6	1	11	40		3			5	66	60.6
Agriculture					8					8	0.0
Bare	5	3	3	1		79		1	1	93	84.9
Water		1				1	57	4		63	90.5
Swamp	3	6	1				7	36	1	54	66.7
Built-up		3					1		32	36	88.9
Column total	66	86	122	53	10	95	71	43	64	609	
Producers accuracy (%)	59.1	72.1	86.1	75.5	80.0	83.2	80.3	83.7	50.0		
Overall Classification Accuracy (%)											75.2
95% confidence interval (error tolerance) of the probability estimate											0.094
Cohen's Kappa coefficient											0.7125

Table S9. Cross-tabulation results between VHR land cover classifications for sites 1 to 3 combined, illustrating land cover change vectors (as a percentage of total area).

2001/02 classes	2014 classes								
	Trees	Shrubs	Long grass	Sparse grass	Bare	Swamp	Built up	Water	Agriculture
Trees	2.56	9.97	5.70	0.27	0.20	0.06	0.06	0.03	0.19
Shrubs	1.01	8.09	7.57	0.39	0.20	0.03	0.04	0.02	0.02
Long grass	1.59	16.10	34.14	2.37	0.49	0.03	0.11	0.03	0.04
Sparse grass	0.12	0.75	1.86	1.13	0.21	0.01	0.03	0.01	0.00
Bare	0.07	0.18	0.26	0.27	0.98	0.07	0.03	0.03	0.00
Swamp	0.14	0.12	0.15	0.07	0.27	0.24	0.00	0.08	0.00
Built up	0.03	0.07	0.05	0.02	0.01	0.00	0.09	0.00	0.00
Water	0.08	0.13	0.06	0.04	0.22	0.21	0.00	0.49	0.00
Agriculture	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.11

Table S10. Cross-tabulation results between medium resolution land cover classifications for sites 1 to 3 combined, illustrating land cover change vectors (as a percentage of total area).

2002 classes	2014 classes								
	Open woodland	Closed woodland	Continuous grassland	Discontinuous grassland	Agriculture	Bare	Water	Swamp	Built Up
Open woodland	12.36	6.10	1.87	5.11	0.00	0.26	0.06	0.13	0.07
Closed woodland	0.50	1.49	0.06	0.11	0.01	0.12	0.06	0.06	0.02
Continuous grassland	3.63	0.29	14.25	10.51	0.01	0.23	0.01	0.05	0.05
Discontinuous grassland	10.47	1.35	9.69	15.09	0.00	0.21	0.02	0.04	0.08
Agriculture	0.26	0.16	0.01	0.02	0.29	0.00	0.00	0.02	0.00
Bare	0.15	0.10	0.81	0.21	0.00	0.80	0.11	0.17	0.00
Water	0.03	0.10	0.01	0.01	0.00	0.10	0.36	0.13	0.00
Swamp	0.20	0.26	0.11	0.12	0.00	0.29	0.21	0.37	0.00
Built Up	0.02	0.01	0.03	0.03	0.01	0.01	0.00	0.00	0.10