

978 **Supplementary figures and tables**979 **Tables**

980 **Table S1.** Analysis of Variance (ANOVA) results for effects of site age/disturbance class (independent factor)
 981 on forest stem and canopy structure variables.

Stem structure	Model Fit	F-ratio	Degrees of freedom	<i>p</i> value
Stem Density	$r^2 = 0.694$	8.71	5, 12	0.001
Basal Area	$r^2 = 0.941$	55.3	5, 12	<0.001
Height	$r^2 = 0.799$	14.5	5, 12	<0.001
Biomass/Biomass C	$r^2 = 0.893$	29.3	5, 12	<0.001
Volume	$r^2 = 0.931$	47.0	5, 12	<0.001
Canopy structure	Model Fit	F-ratio	Degrees of freedom	<i>p</i> value
PAI (total plant- area index, LAI- 2200 photosensor)	$r^2 = 0.701$	8.98	5, 12	<0.001
Densiometer open- sky canopy fraction	$r^2 = 0.843$	19.2	5, 12	<0.001
Densiometer woody material canopy fraction	$r^2 = 0.730$	10.2	5, 12	<0.001
Densiometer green leaf canopy fraction	$r^2 = 0.238$	2.06	5, 12	0.141

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989 **Table S2.** Tree cover structure model results for a Miombo Woodland landscape in Tabora, Tanzania,
 990 estimated from Landsat 8-derived senesced vegetation and green vegetation land cover metrics. Values show
 991 the percentage of the modeled area (2.47×10^5 ha, 2470 km²) with basal area and biomass ranges within
 992 reported field data for Miombo Woodlands. Z subscripts indicate Z-score (scene-normalization) of land cover
 993 metrics (see Methods).

994	Model type	Basal area 0-35 m ² ha ⁻¹ (% training area)	Biomass 0-150 Mg ha ⁻¹ (% training area)
995	NPV _Z	95.7	97.2
996	VEG _Z	92.7	98.6
997	NDVI _Z	96.5	97.8

998 **Table S3.** Back-comparison of satellite estimates to field-measured aboveground woody biomass for 18 sites in
 999 a Miombo Woodland landscape, Tabora, Tanzania. The data compares Landsat 8 OLI satellite NPV and
 1000 greenness index-based estimates of site-level woody biomass and is reported for all field sites, grouped by
 1001 categories of forest site age, management and disturbance. Summary statistics are group means \pm standard
 1002 errors.

Site category	Site	Field Biomass Mg ha ⁻¹	SMA-NPV-est biomass Mg ha ⁻¹	SMA-GV-est. biomass Mg ha ⁻¹	NDVI-est. biomass Mg ha ⁻¹
Regrowth 3-4 yr	S08	2.6	1.2	1.8	2.2
	S10	0.32	6.2	5.7	5.5
	S13	2.3	9.7	15.8	12.5
	<i>Mean \pm s.e.m.</i>	<i>1.7 \pm 0.7</i>	<i>5.7 \pm 2.5</i>	<i>7.7 \pm 4.2</i>	<i>6.8 \pm 3.0</i>
Regrowth 10-24 yr	S02	9.7	5.0	12	8.4
	S12	11	22	44	35.8
	S18	7.8	14	6.1	6.5
	<i>Mean \pm s.e.m.</i>	<i>9.4 \pm 0.9</i>	<i>14 \pm 5.0</i>	<i>21 \pm 12</i>	<i>17 \pm 10</i>
Regrowth 30-40 yr	S16	38	95	86.7	85
	S17	38	13	14.7	10
	S19	57	52	52.2	41
	<i>Mean \pm s.e.m.</i>	<i>44 \pm 6.2</i>	<i>53 \pm 24</i>	<i>51 \pm 21</i>	<i>46 \pm 22</i>
Mature Village-mgd >100 yr	S07	140	*not modeled	*not modeled	*not modeled
	S14	45	18	14.2	10
	S15	120	113	145	140
	<i>Mean \pm s.e.m.</i>	<i>100 \pm 28</i>	<i>66 \pm 48</i>	<i>80 \pm 65</i>	<i>75 \pm 64</i>
Mature Igombe Reserve >100 yr	S04	94	108	40	48
	S05	66	54	25	27
	S06	68	42	31	31
	<i>Mean \pm s.e.m.</i>	<i>76 \pm 9.0</i>	<i>68 \pm 20</i>	<i>32 \pm 4.4</i>	<i>36 \pm 6.3</i>
Disturbed	S03	2.9	3.0	4.0	3.8
	S09	1.8	3.2	3.3	3.0
	S11	4.2	4.7	5.1	4.9
	<i>Mean \pm s.e.m.</i>	<i>3.0 \pm 0.7</i>	<i>3.6 \pm 0.5</i>	<i>4.1 \pm 0.5</i>	<i>3.9 \pm 0.6</i>

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1004 **Table S4.** Back-comparison of satellite estimates to field-measured aboveground woody biomass for 18 sites in
 1005 a Miombo Woodland landscape, Tabora, Tanzania. Data presented are the absolute values of differences
 1006 between field biomass, and satellite biomass estimates based on NPV and green vegetation metrics, summarized
 1007 by forest age and management classes (means \pm standard errors). Abbreviated, site category-level summaries
 1008 (**bold**) are presented in Table 5.

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Site category	Site	Field – SMA NPV biomass	Field-SMA GV biomass	Field – NDVI biomass
		Mg ha ⁻¹	Mg ha ⁻¹	Mg ha ⁻¹
Regrowth	S08	1.4	0.77	0.31
3-4 yr	S10	5.9	5.4	5.2
	S13	7.5	13.5	10.3
	Mean \pm s.e.m.	4.9 \pm 1.8	6.5 \pm 3.7	5.3 \pm 2.9
Regrowth	S02	4.7	2.5	1.3
10-24 yr	S12	12	33	25
	S18	6.2	1.7	1.3
	Mean \pm s.e.m.	7.5 \pm 2.1	13 \pm 11	9.2 \pm 7.9
Regrowth	S16	57	49	47
30-40 yr	S17	25	23	28
	S19	5.1	4.4	15
	Mean \pm s.e.m.	29 \pm 15	26 \pm 13	30 \pm 9.3
Mature	S07	*not modeled	*not modeled	*not modeled
Village-managed	S14	27	31	35
	S15	5.9	25	19
>100 yr	Mean \pm s.e.m.	16 \pm 11	28 \pm 2.8	27 \pm 7.6
Mature	S04	14	54	46
Igombe Reserve	S05	12	42	39
	S06	27	37	37
>100 yr	Mean \pm s.e.m.	17 \pm 4.6	44 \pm 5.2	41 \pm 2.8
Disturbed	S03	0.1	1.1	0.89
	S09	1.4	1.5	1.2
	S11	0.5	0.91	0.75
	Mean \pm s.e.m.	0.7 \pm 0.4	1.2 \pm 0.2	0.9 \pm 0.1
Overall	Mean \pm s.e.m.	12 \pm 3.5	19 \pm 4.6	18 \pm 4.2

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1038 **Table S5.** Aboveground biomass estimates at image validation sites, modeled with senesced (SMA-NPV) and
 1039 green vegetation (SMA-GV, NDVI) Landsat 8-based land cover indicators, for dense woodland, mbuga and
 1040 cleared tree covert types in national reserve and village-managed Miombo landscape regions of Tabora,
 1041 Tanzania. Validation sites for tree cover types were selected as 3x3 pixel areas from a 14 July 2015 Landsat 8
 1042 OLI image (see Methods). Region numbers correspond with numbered boxes in figure 3(a). Means comparison
 1043 tests (Tukey HSD) for biomass were performed for each management region separately; values not sharing
 1044 letters by region of interest differed significantly in Tukey HSD tests ($p < 0.05$). Accompanies figure 10.

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1046	Region of interest	Model type	Tree Cover Type	N sites	Biomass Mg ha ⁻¹
1047	1.Igombe Forest Reserve National management	Senesced Veg. SMA-NPV	Dense Woodland	38	130 ± 2.8 ^a
1048			Mbuga	40	24 ± 1.7 ^c
1049			Cleared	40	4.2 ± 0.5 ^d
1050		Green Veg. SMA-GV	Dense Woodland	38	115 ± 3.0 ^b
1051			Mbuga	40	8.5 ± 0.7 ^d
1052			Cleared	40	14 ± 2.9 ^d
1053		Green Veg. NDVI	Dense Woodland	38	130 ± 2.7 ^a
1054			Mbuga	40	9.5 ± 1.0 ^d
1055			Cleared	40	7.8 ± 1.2 ^d
1056	2.Millennium Villages Village management	Senesced Veg. SMA-NPV	Dense Woodland	40	88 ± 5.0 ^a
1057			Mbuga	41	23.8 ± 1.8 ^b
1058			Cleared	38	2.0 ± 0.2 ^c
1059		Green Veg. SMA-GV	Dense Woodland	40	91 ± 5.1 ^a
1060			Mbuga	41	6.4 ± 0.5 ^c
1061			Cleared	38	1.9 ± 0.4 ^c
1062		Green Veg. NDVI	Dense Woodland	40	92 ± 5.6 ^a
1063			Mbuga	41	6.9 ± 0.6 ^c
1064			Cleared	38	2.0 ± 0.3 ^c
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1074 **Supplemental figures**

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1090 **Figure S1.** Photos of representative field sites across the forest regrowth chronosequence from which tree
1091 inventory, land and ground cover data were collected in 2014-15. (a) A 3 yr regrowth site, representative of
1092 sites 3-4 yrs. (b) A 10 yr regrowth site, representative of sites 10-24 yrs. (c) A 30 yr regrowth site,
1093 representative of sites 30-40 yrs. (d) A mature forest site (Village area), representative of sites 50 to more than
1094 100 years.

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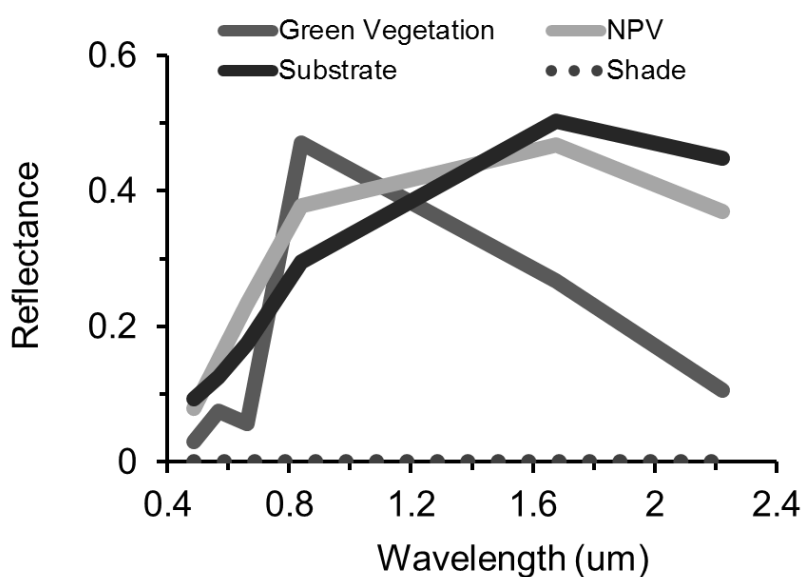
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$$p_b = \sum [F_{EM}P_{EM,B} + E_b]; \sum F_{EM} = 1$$

1119 **Figure S2.** Spectral endmembers used for linear spectral mixture analysis of Landsat data and the governing
 1120 equation for linear SMA analysis with a unit sum constraint. SMA models pixel reflectance (p_b) as
 1121 multiplicative fractions of the reflectance spectra of known land cover materials or mixtures ($F_{em} \cdot p_{em}$) plus an
 1122 error term (E_b), with the constraint that all pixel fractions must sum to unity (1). The endmembers used to
 1123 model green vegetation, non-photosynthetic vegetation (NPV) and substrate are Tabora-specific, selected from
 1124 different time periods (May 2008 (green vegetation spectra) and July 2008 (NPV, substrate)) Landsat 5 data
 1125 from pixels geolocated to calibration field sites with high proportions of these materials comprising ground
 1126 cover (Mayes *et al.* 2015). Spectra were converted to Landsat 8 spectral resolution using the Spectral Library
 1127 Resampling tool in ENVI 4.8 (Harris Geospatial Solutions, Boulder, CO USA).