

Supplementary Material

How and why do rangeland changes and their underlying drivers differ across Namibia's two major land-tenure systems?

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Supplementary Table S1. Accuracy assessment

For accuracy assessment a confusion matrix showing the classified data versus the class values of the inspected validation plot was computed for each classified image. We calculated the reference accuracy (i.e. producers' accuracy, which indicates how well a certain area can be classified), reliability (i.e. users' accuracy, which is the probability that a class on the map represents the category on the ground), and overall accuracy. Furthermore, quantity disagreement (the amount of difference between the reference map and the comparison map based upon mismatch of class proportions) and allocation disagreement (the percentage of classification errors caused by incorrect spatial allocations of pixels in the classification) were used for accuracy assessment as proposed by Pontius and Millones (2011).

The overall accuracy (95-98 %) of the classification results indicated a high accuracy with a quantity disagreement ranging from 1-3.5 % and allocation disagreement ranging from 1-2 %. Most of the classification errors were due to quantity disagreement rather than allocation disagreement.

Table S1. Summary of the accuracy assessment of the land cover classification results in the Greater Waterberg region, Namibia showing the users' accuracy (UA) and the producers' accuracy (PA) for each land cover category.

Land cover class	1965		1972		1986		2001		2011		2020	
	UA (%)	PA (%)	UA (%)	PA (%)	UA (%)	PA (%)	UA (%)	PA (%)	UA (%)	PA (%)	UA (%)	PA (%)
Water	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Barren land	0.500	1.000	1.000	0.900	1.000	0.750	0.500	1.000	0.833	1.000	1.000	1.000
Woodland	1.000	1.000	1.000	0.880	0.920	1.000	0.875	1.000	1.000	0.909	1.000	1.000
Shrubland	0.875	0.962	0.950	0.980	0.980	0.990	0.992	0.947	0.962	0.992	0.992	0.961
Savannah	0.880	0.957	0.960	0.940	0.980	0.950	0.865	0.970	0.957	0.815	0.853	0.967
Overall accuracy (%)		0.954		0.957		0.980		0.954		0.960		0.966
Allocation disagreement (%)		1.163		1.714		1.143		1.143		1.143		1.143
Quantity disagreement (%)		3.229		2.286		1.143		3.429		2.857		2.286

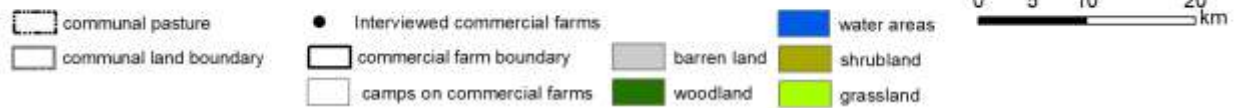
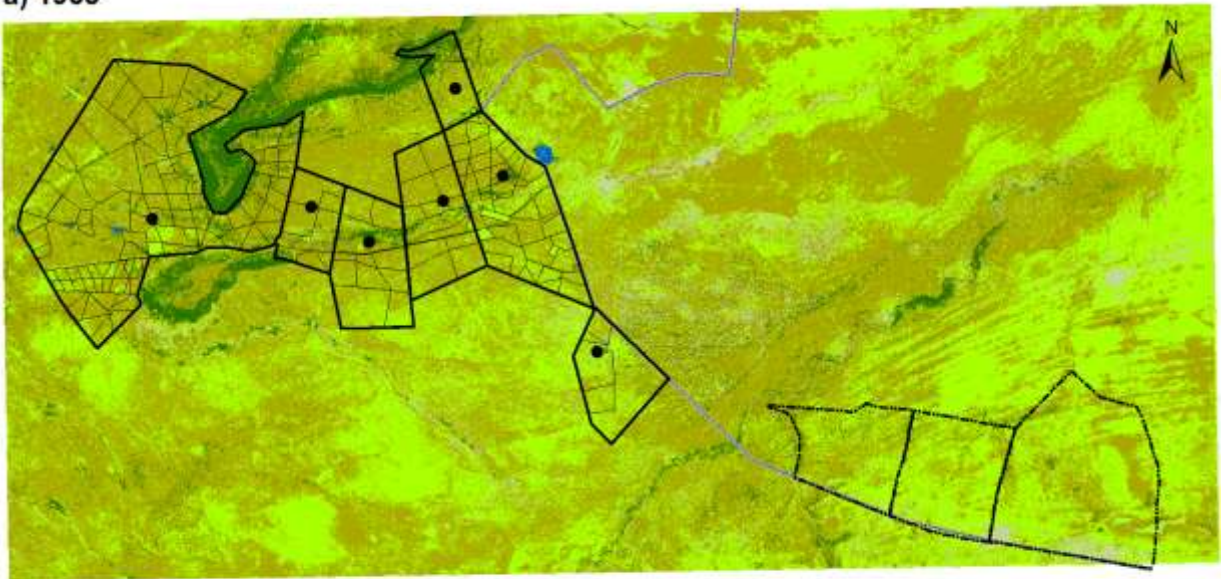
Supplementary Table S2. Annual change rate (%)

Table S2. Rangeland changes (annual rate of change in % for each land cover class) for major trend periods from 1965 to 1986, 1986 to 2011 and 2011 to 2020 in the Greater Waterberg region, Namibia.

	Year	Land cover category (annual rate of change in %)				
		water	barren	woodland	shrubland	savannah
Freehold land	1965-1986	-1.8	-1.6	-0.2	1.5	-2.5
	1986-2011	1.5	2.9	-0.3	0.0	-0.2
	2011-2020	0.7	8.4	-6.0	-0.8	5.7
Communal land	1965-1986	1.2	-0.8	-3.9	1.4	-1.2
	1986-2011	-0.4	-0.2	-2.4	0.9	-1.6
	2011-2020	3.9	14.5	-0.8	-0.7	0.8

Supplementary Fig S1. Land cover maps

a) 1965



b) 2020

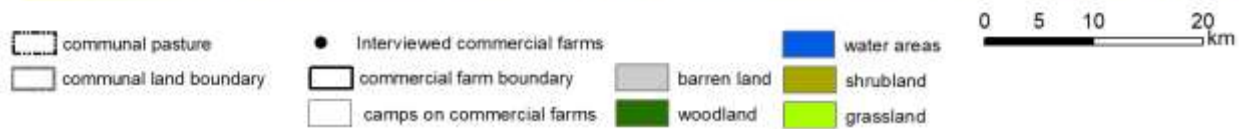
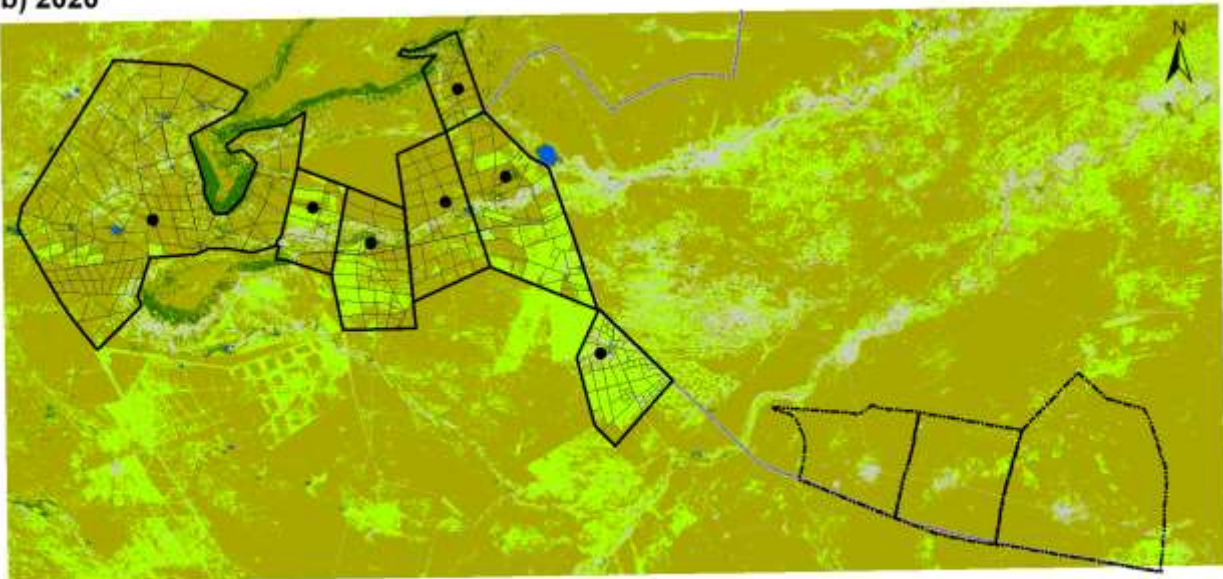


Figure S3. Land cover classification results of 1965 (a) and 2020 (b) with boundaries and camps in the Waterberg region, Namibia.