CHARCOAL PRODUCTION IN LICUATI KEY BIODIVERSITY AREA:
A PARTICIPATORY ASSESSMENT OF FOREST MANAGEMENT AND DEGRADATION

People-and-pixels mixed-methods approach

To determine the intensity and distribution of the charcoal production in Djabula, a rural village representative of the southernmost region of Mozambique and of the Sand Forest ecosystem

I– Ground assessment

I.1 of the production system, descriptive (operations, costs, actors, historical records) and quantitative (biophysical data)

I.2 Participatory mapping of all village's relevant limits external perimeter and internal partitions

II– Remote sensing

. Land cover changes in a 30 years series 1990-2020 to which ground assessment findings were transposed for interpretation

Main finding:

Tree cuttings are selective and restricted by communitarian rule

CHARCOAL PRODUCTION

. Human scale

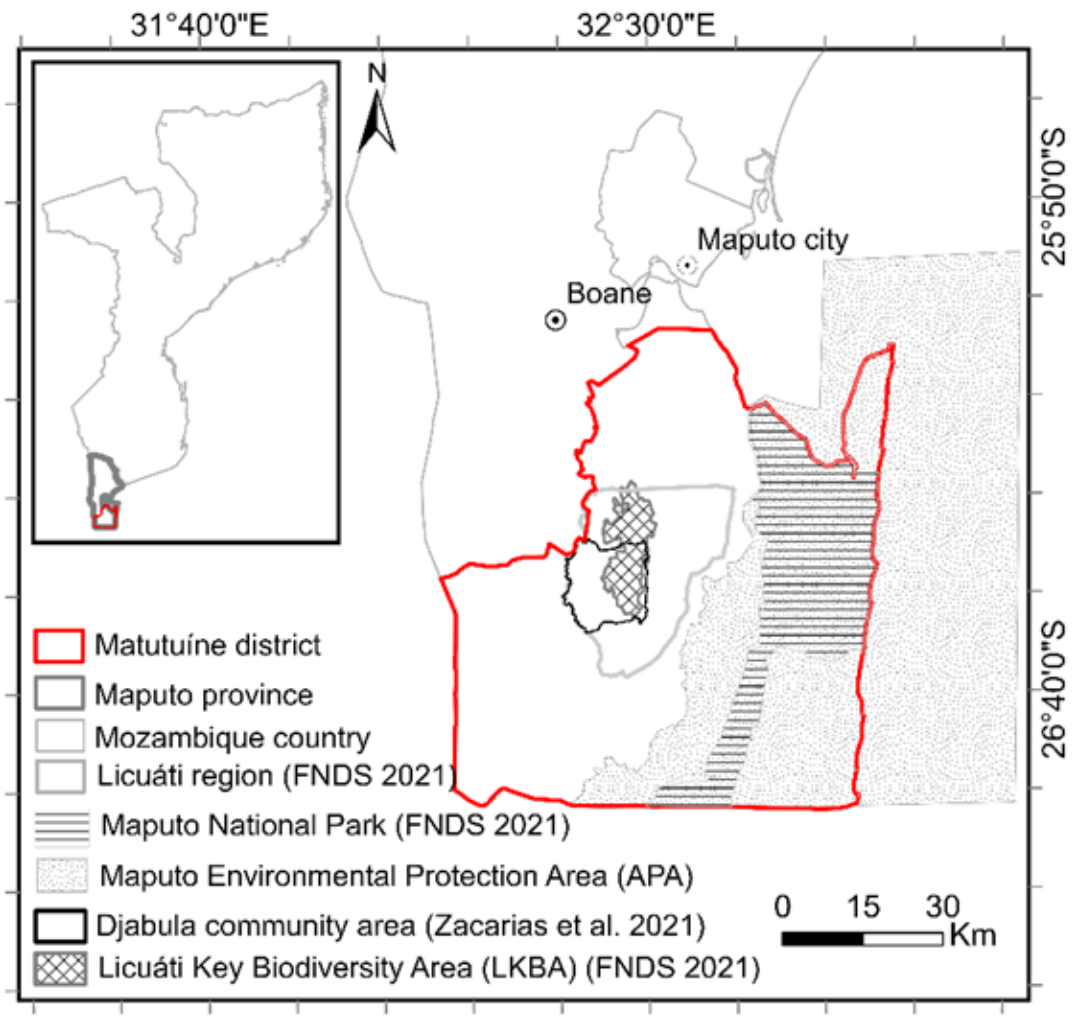
-> production units [kilns] are as big as a person can handle

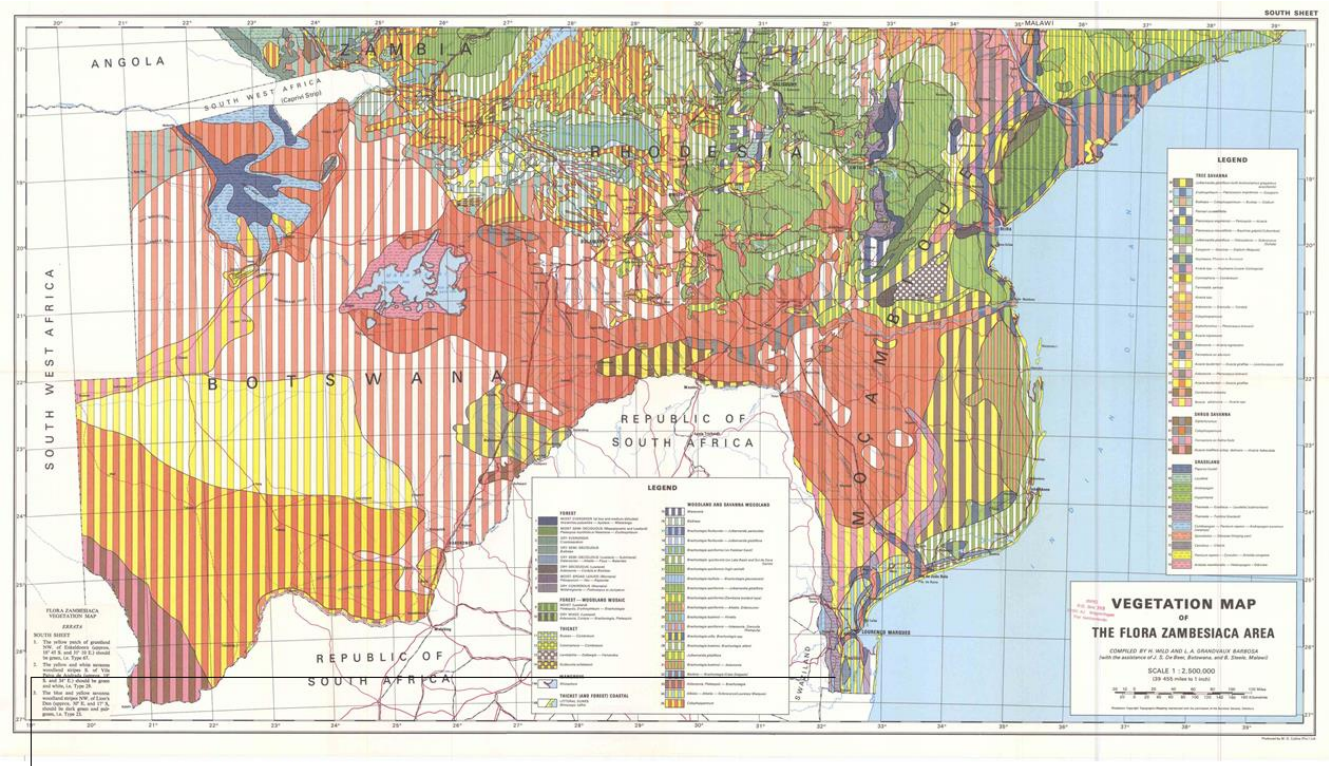
. Selective -> itinerant

«(…) '**invisible trees**'—the trees around fields, next to houses, along roads, and so on that do not show up in most satellite remote sensing surveys or national forest statistics.»

(World energy assessment UNDP, 2000)

STUDY AREA





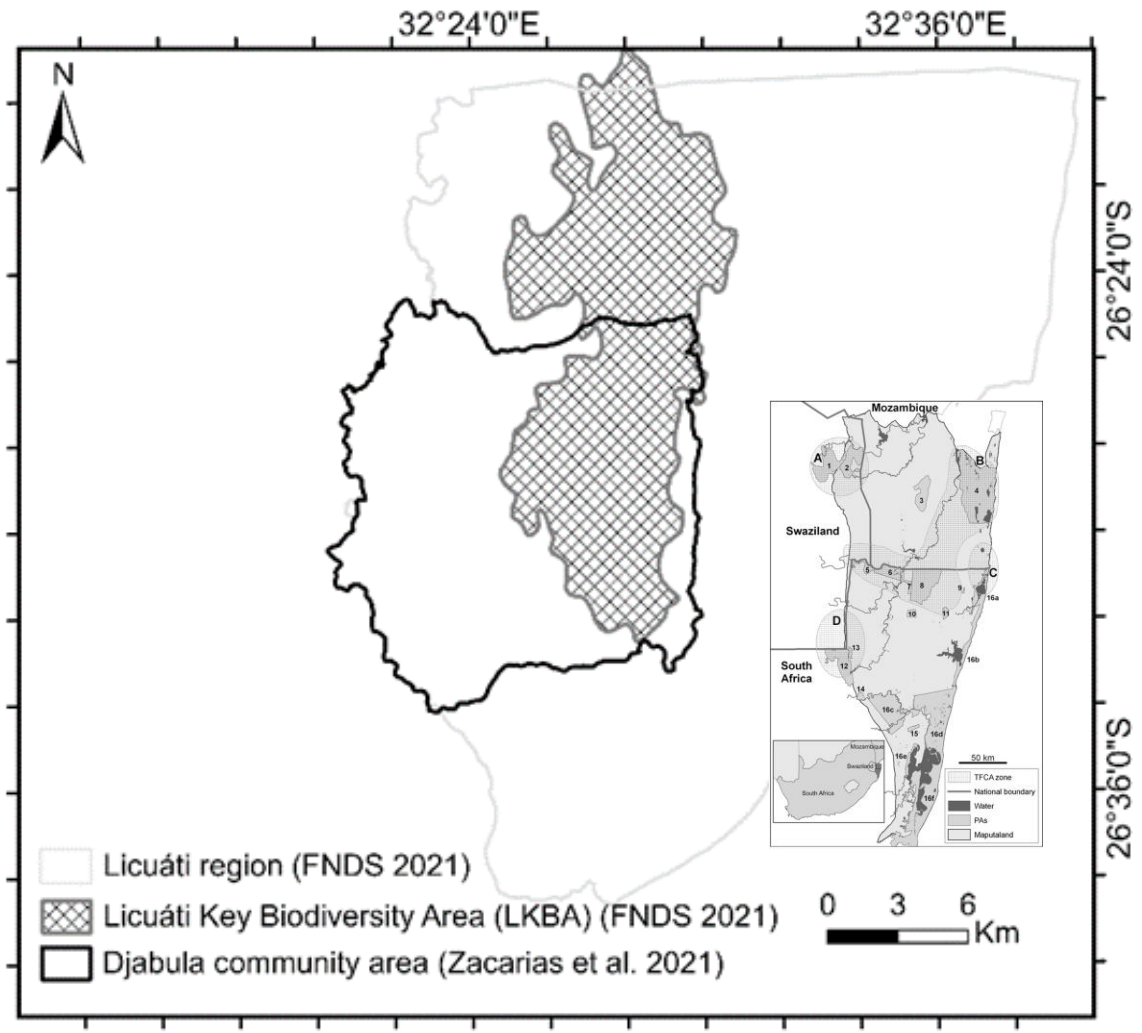
AEOLIAN SANDS remnants of early Quaternary sand dunes

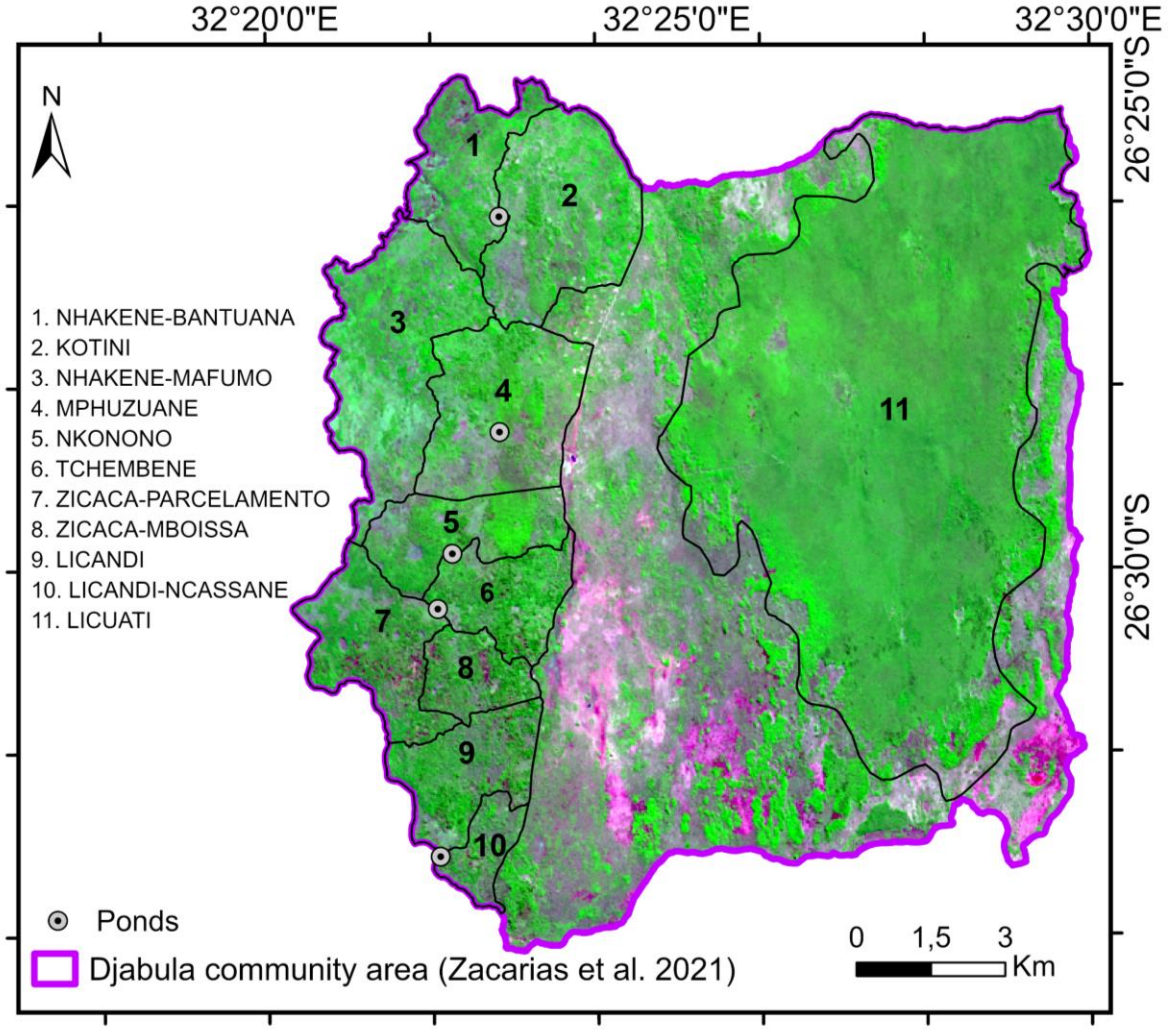
CLIMATE Tropical Savanna dry-winter - Aw transition to Cwa/Cfa & Bsh

↓

SAND FORESTS

LICUATI KEY BIODIVERSITY AREA

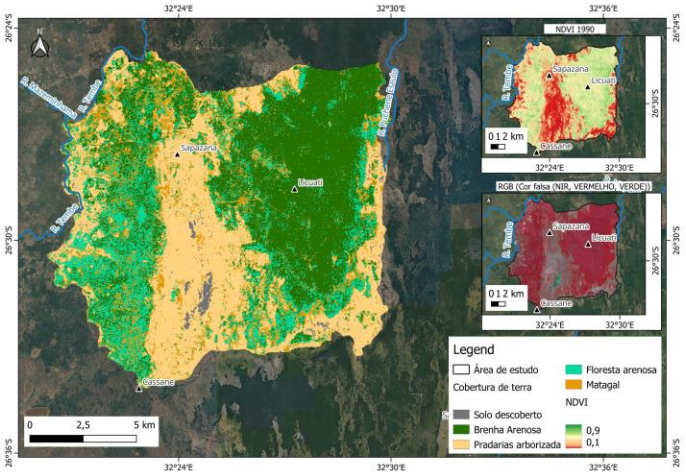


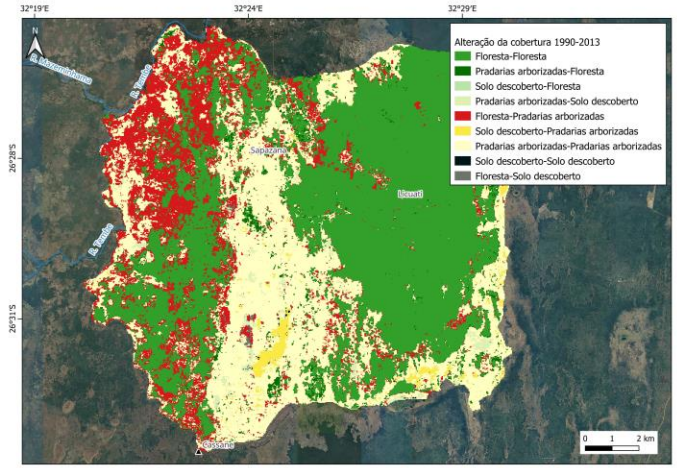


NEWTONIA HILDEBRANDTII

MPHUZUANE 26.48780S 32.37874E

NEWTONIA HILDEBRANDTII





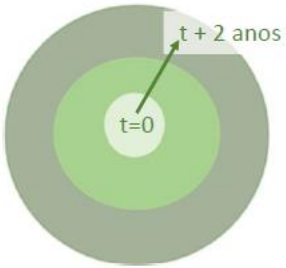
DETERMINANTS OF NON-SELECTIVE HARVEST

1- THE FELLING OF THE SELECTED TREES

2- THE NEED TO MAKE ROOM FOR THE NECESSARY OPERATIONS TO TAKE PLACE

- Harvest
- Kiln pyre assembly

2- CLEARED AREAS COALESCENCE WHEN NO MORE AREAS ARE ACCESSIBLE TO BROWSE FOR THE TARGETED SPECIES



2.1 – POVERTY IS A PREDICTOR

2.2 – SECONDARY SPECIES BECOME TARGETED

2.3 – DEFORESTATION

IMPACT OF CLEARED AREAS COALESCENCE ON ESTIMATING CLEARED AREAS PER KILN

When the area found surrounding a kiln had been generated over several production cycles, how to assess a single cycle impact ?

STANDARDIZATION OF THE AREAS CLEARED

N=268 kilns on the data set

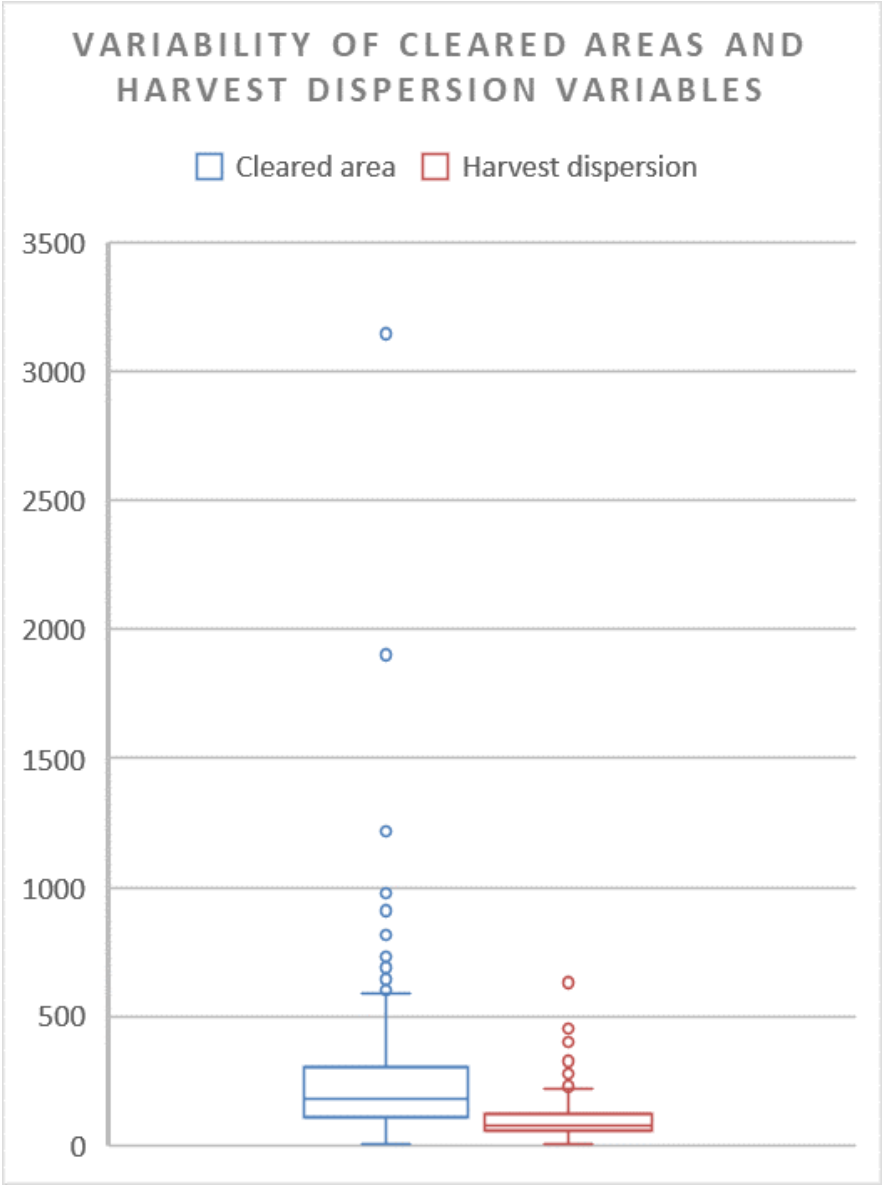
MAXIMUM AREA 3145,80 M^2

MINIMUM 7,03 M^2

$$Harvest\ dispersion = \frac{Area\ cleared\ (m^2)}{\Sigma sectioned\ diameters\ (m)}$$

MAXIMUM HARVEST DISPERSION 659,30 M^2/M

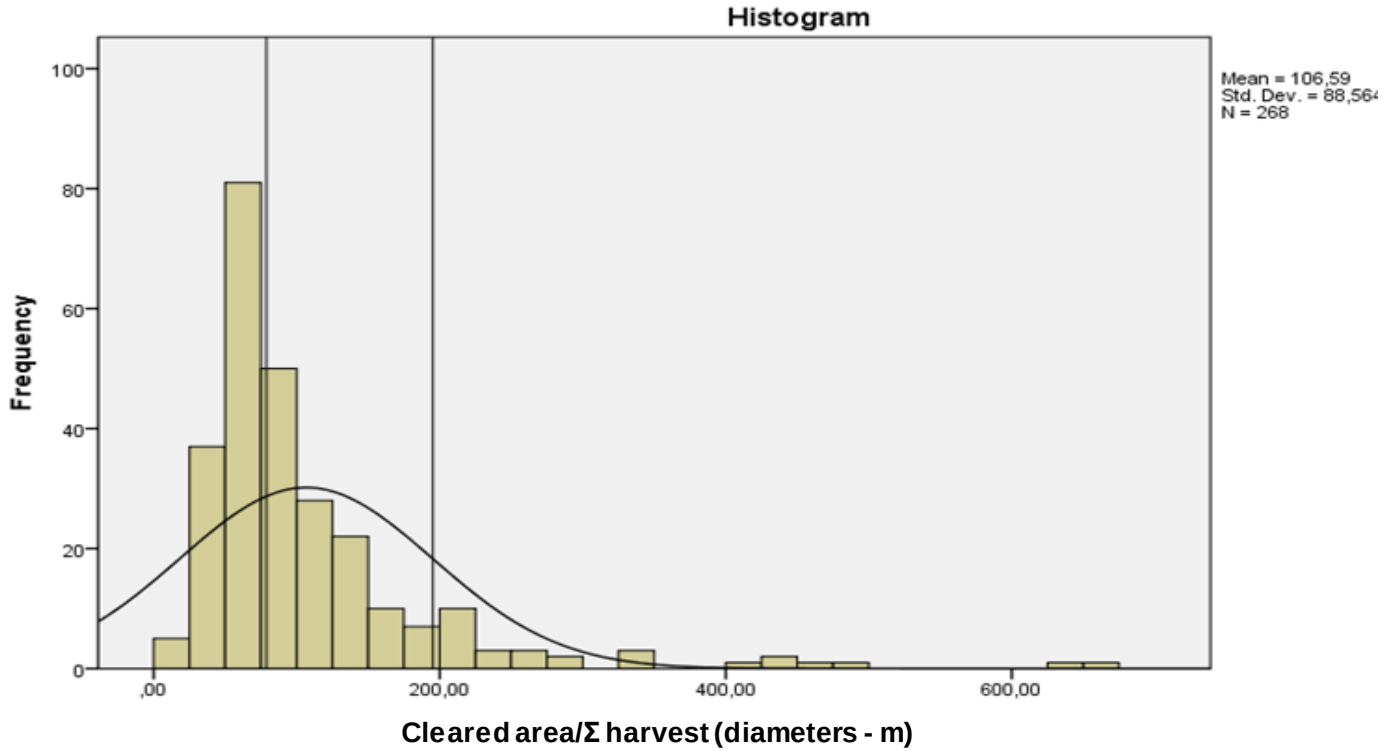
MINIMUM HARVEST DISPERSION 9,09 M^2/M



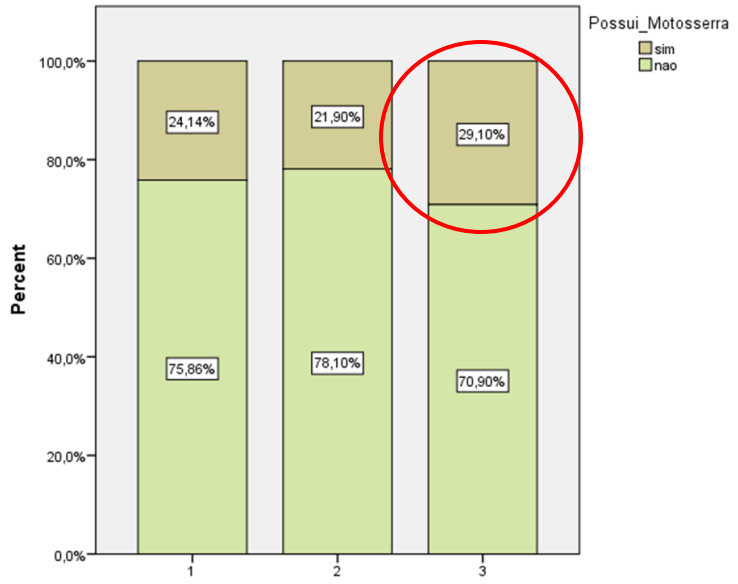
Harvest dispersion $> 195{,}15822$
$Cleared\ area = 21{,}728 + 71{,}041 \times \Sigma$ sectioned diameters
N=29 | $R^2 = 0{,}763$ | p-value =0,000

$78{,}4850 <$ Harvest dispersion $\leq 195{,}15822$
$Cleared\ area = 33{,}205 + 102{,}684 \times \Sigma$ sectioned diameters
N=105 | $R^2 = 0{,}743$ | p-value =0,000

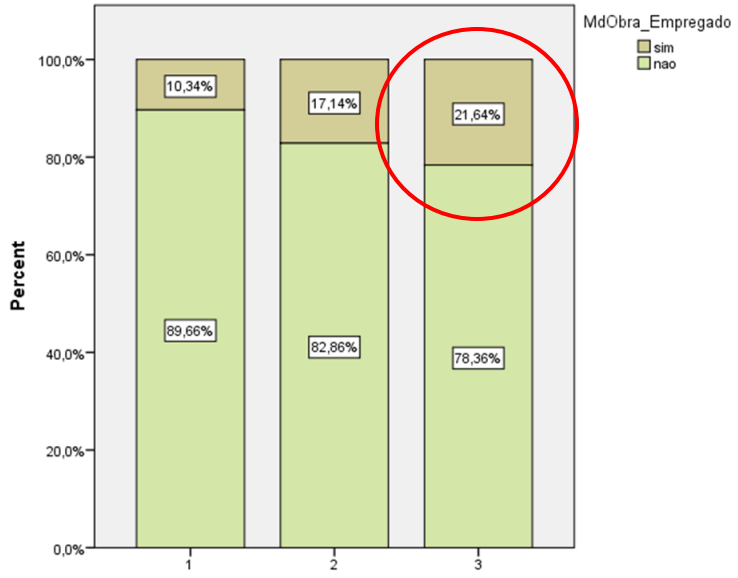
Harvest dispersion $\leq 78{,}4850$
$Cleared\ area = -5{,}379 + 56{,}821 \times \Sigma$ sectioned diameters
N=134 | $R^2 = 0{,}761$ | p-value =0,000



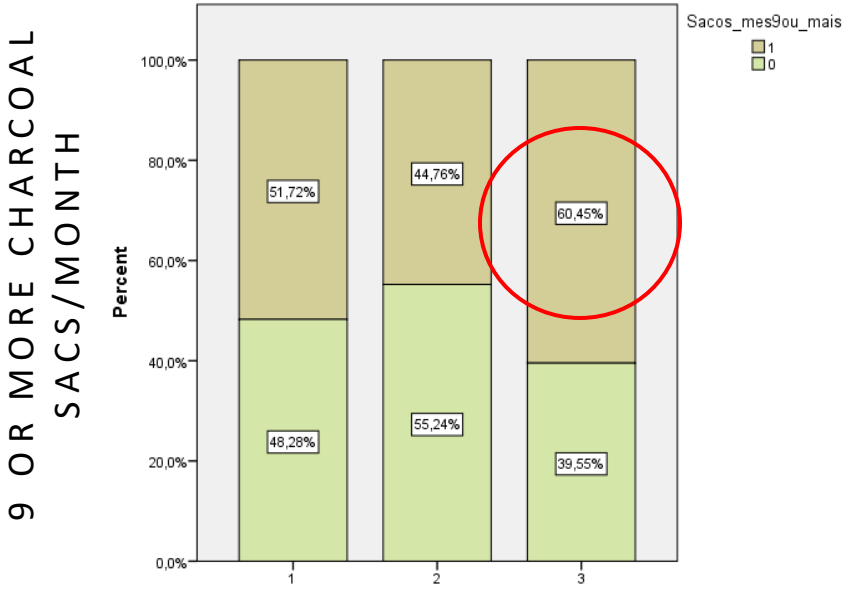
CHAINSAW OWNERSHIP



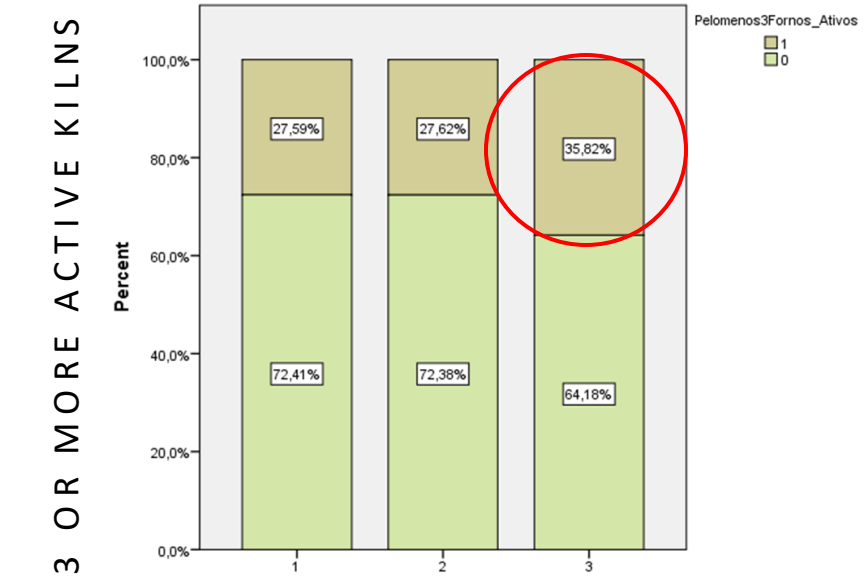
PAID LABOR



9 OR MORE CHARCOAL SACS/MONTH



3 OR MORE ACTIVE KILNS



TIME-SERIES OF 6 KILNS

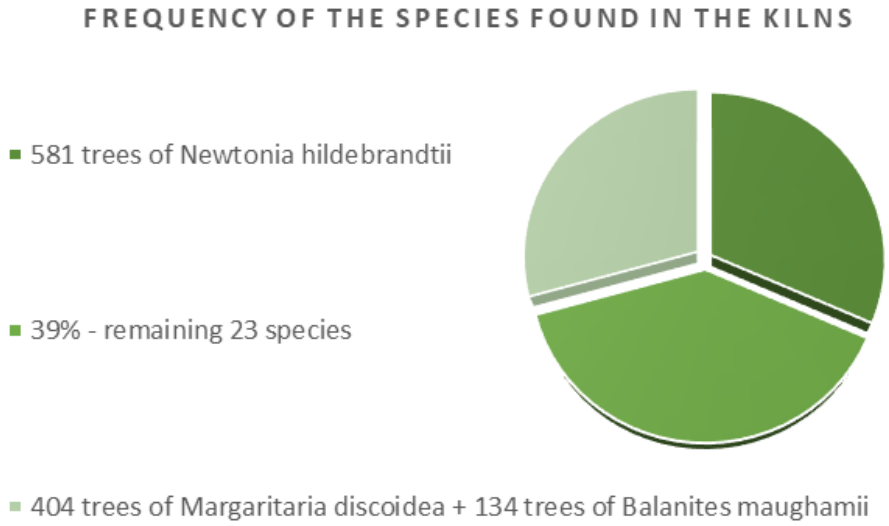
6 Kilns were followed from beginning to end

All were made in new areas except producer AF048.1

	Σ Area cleared$_{parcial}$ (m^2)	Area cleared$_{final}$ (m^2)	Σ Sectioned diameters (m)	% Non-selective cuttings	Harvest dispersion (m^2/m)
AF012.1	140.6	75.0	3.36	11	22.3
AF014.1	250.7	128.5	2.88	12	44.6
AF036.1	142.5	118.9	2.47	26	48.1
AF048.1	115.1	115.1	1.27	0	90.6
AF050.1	87.3	135.2	2.42	40	55.9
AF075.1	221.5	160.0	2.69	13	59.5

DISTRIBUTION OF THE SPECIES FOUND

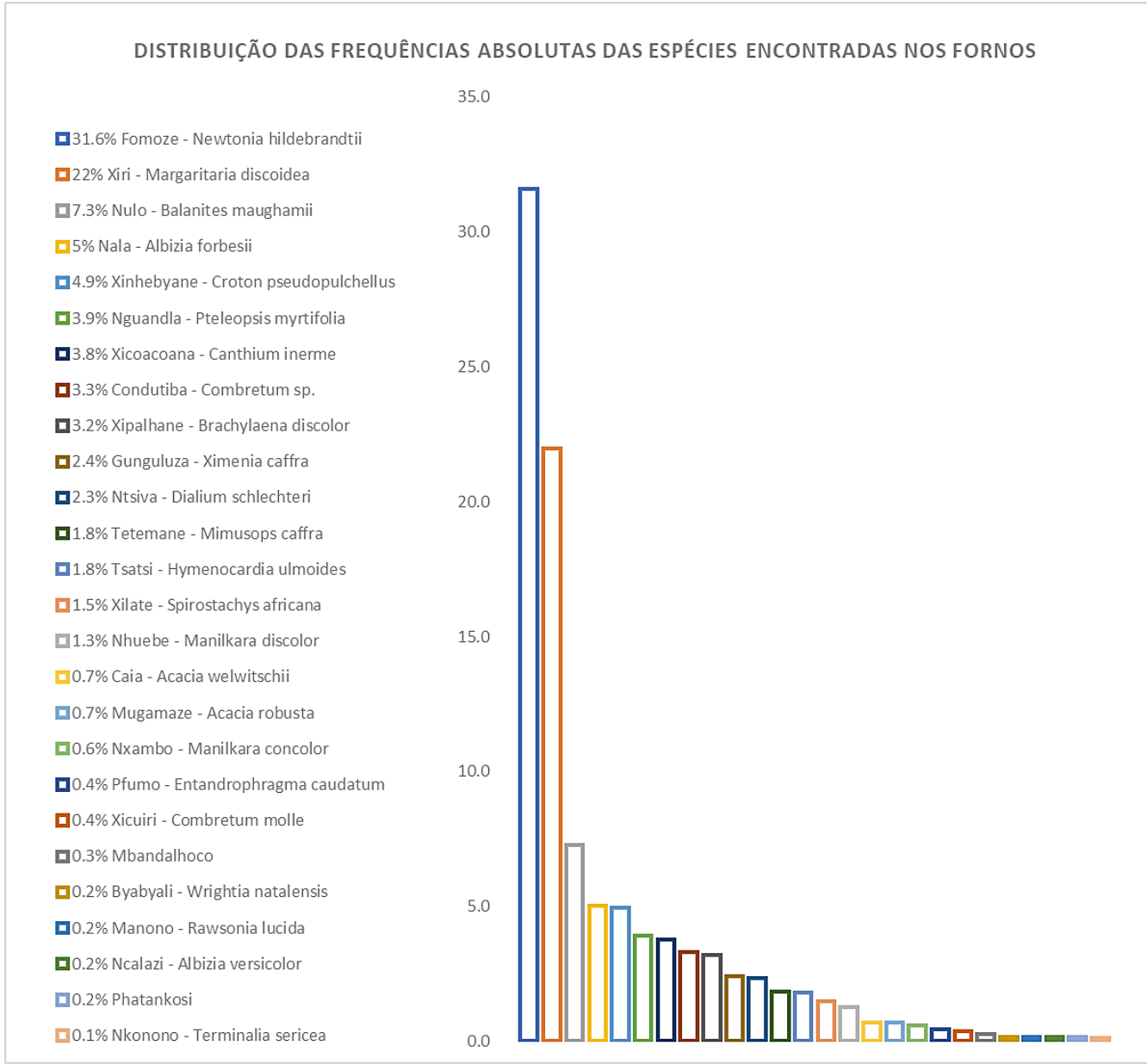
1839 TREES – 286 KILNS



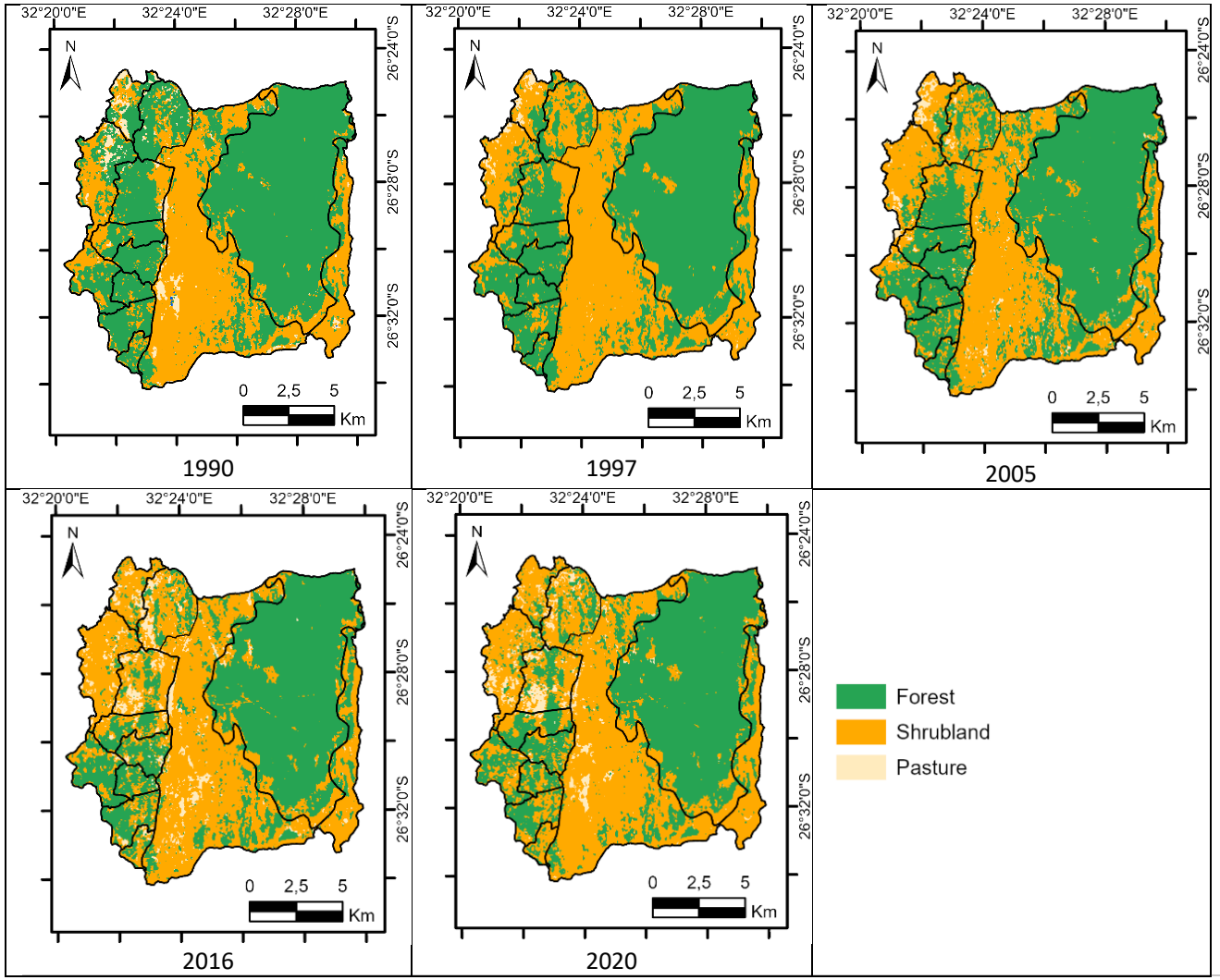
ONLY TWO SPECIES WHERE FOUND IN MONO-SPECIES KILNS

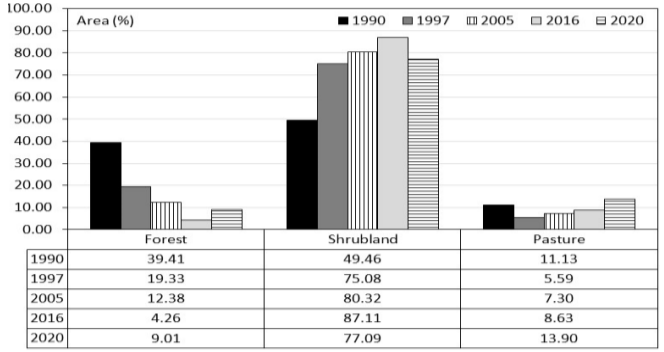
20% Newtonia hildebrandtii

6% Margaritaria discoidea



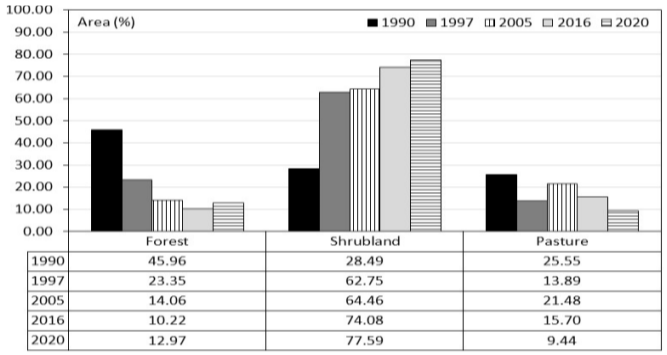
CHARCOAL FOREST DEGRADATION AND DEFORESTATION PATTERNS 1990-2020





	Forest	Shrubland	Pasture
1990	39.41	49.46	11.13
1997	19.33	75.08	5.59
2005	12.38	80.32	7.30
2016	4.26	87.11	8.63
2020	9.01	77.09	13.90

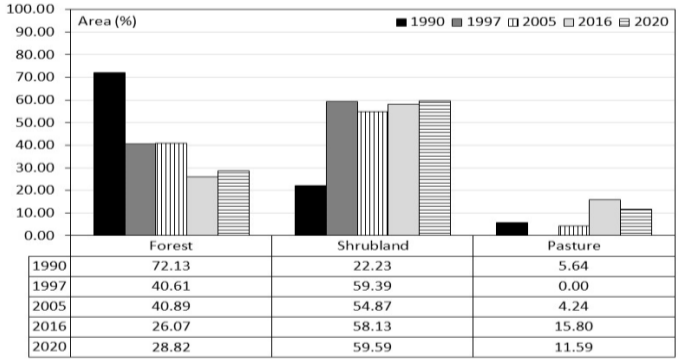
(Nhakene Mafumu)



	Forest	Shrubland	Pasture
1990	45.96	28.49	25.55
1997	23.35	62.75	13.89
2005	14.06	64.46	21.48
2016	10.22	74.08	15.70
2020	12.97	77.59	9.44

(Nhakene Bantuana)

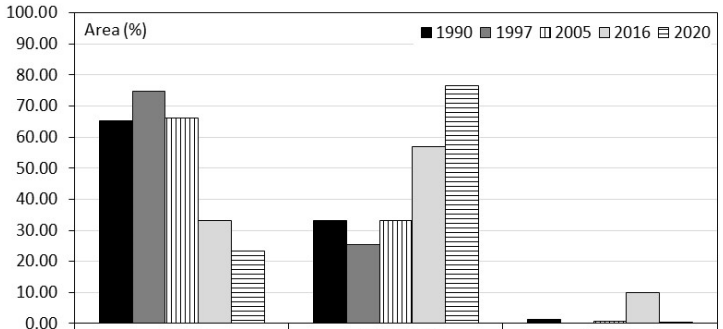
1- NORTH-SOUTH ORIENTATION



	Forest	Shrubland	Pasture
1990	72.13	22.23	5.64
1997	40.61	59.39	0.00
2005	40.89	54.87	4.24
2016	26.07	58.13	15.80
2020	28.82	59.59	11.59

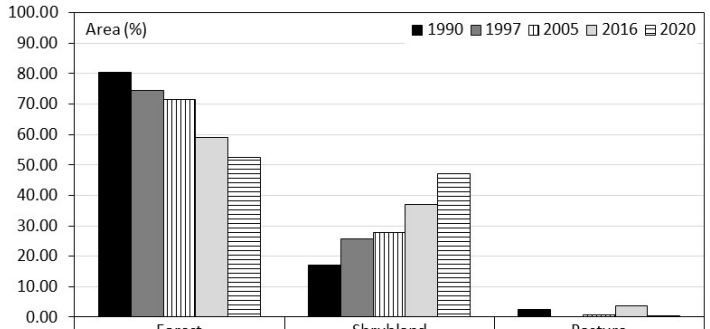
(Kotini)

2- US vs. THEM



	Forest	Shrubland	Pasture
1990	65.32	33.28	1.40
1997	74.67	25.33	0.00
2005	66.02	33.15	0.82
2016	33.24	56.96	9.80
2020	23.31	76.65	0.04

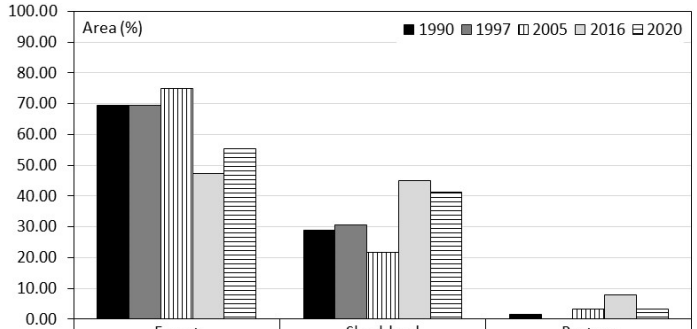
(Licandi-Ncassane)



	Forest	Shrubland	Pasture
1990	80.42	17.03	2.55
1997	74.42	25.58	0.00
2005	71.48	27.68	0.83
2016	59.14	37.10	3.76
2020	52.45	47.26	0.29

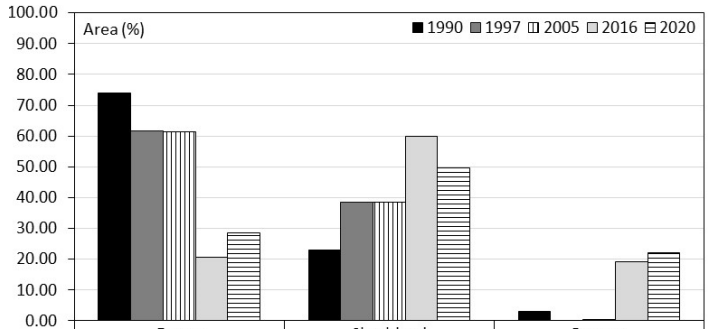
(Licandi)

3- REGENERATION



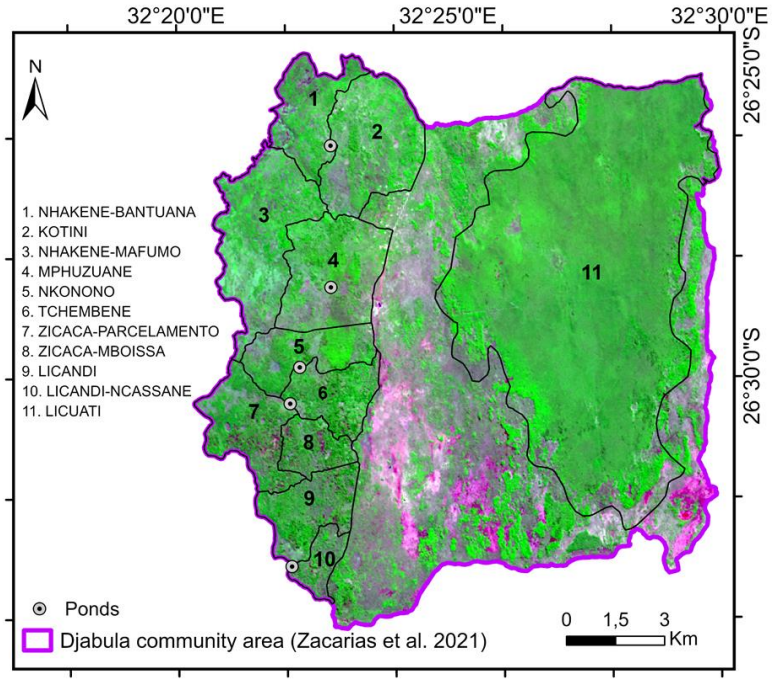
	Forest	Shrubland	Pasture
1990	69.40	28.91	1.69
1997	69.45	30.55	0.00
2005	74.92	21.68	3.40
2016	47.24	44.93	7.83
2020	55.33	41.22	3.45

(Nkonono)

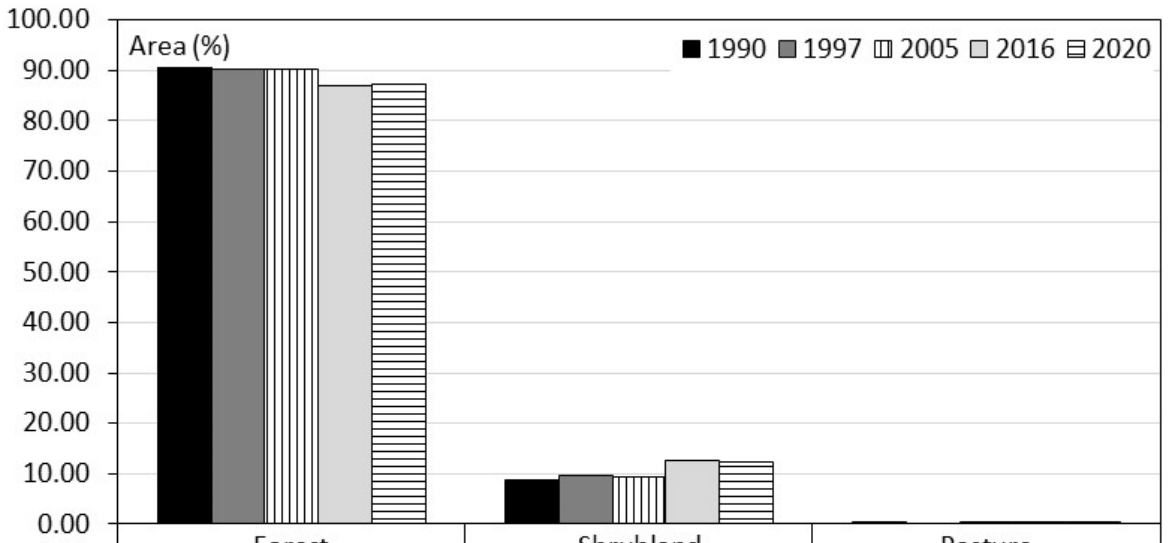


	Forest	Shrubland	Pasture
1990	74.06	22.96	2.97
1997	61.58	38.42	0.00
2005	61.23	38.38	0.38
2016	20.72	60.02	19.26
2020	28.48	49.51	22.01

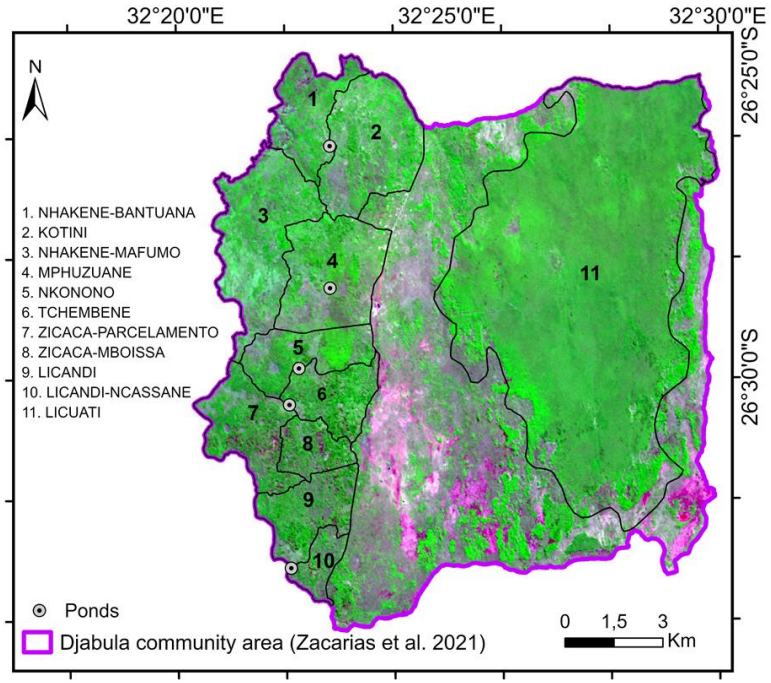
(Mphuzuane)

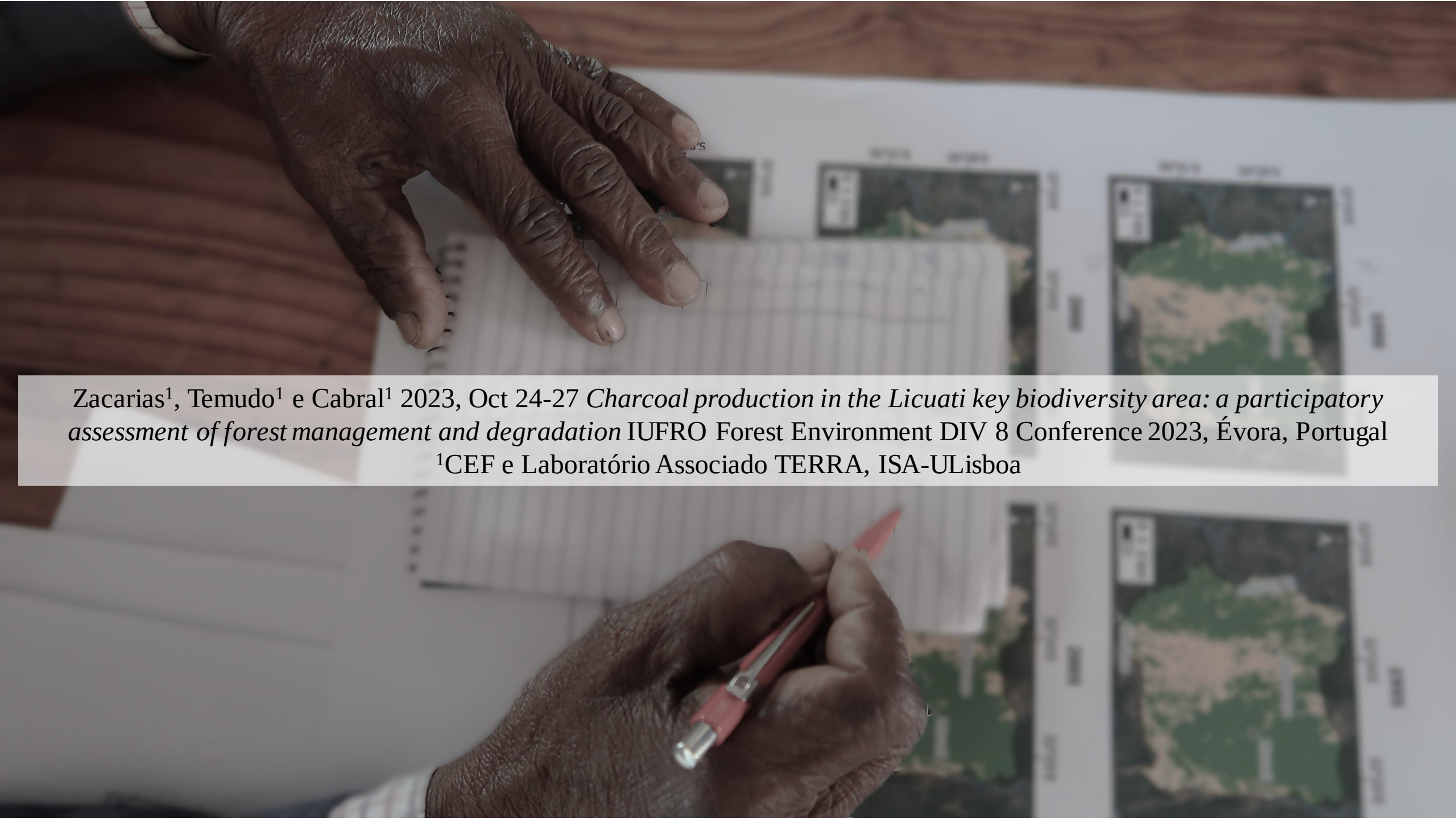


4- UNDISTURBED LICUATI



	Forest	Shrubland	Pasture
1990	91.15	8.59	0.26
1997	90.32	9.68	0.00
2005	90.13	9.42	0.44
2016	86.97	12.53	0.50
2020	87.43	12.34	0.23





Zacarias[1], Temudo[1] e Cabral[1] 2023, Oct 24-27 *Charcoal production in the Licuati key biodiversity area: a participatory assessment of forest management and degradation* IUFRO Forest Environment DIV 8 Conference 2023, Évora, Portugal
[1]CEF e Laboratório Associado TERRA, ISA-ULisboa