Spatiotemporal dynamics of informal sharecropping and ecosystem degradation in the periphery of Ankarafantsika National Park, Madagascar

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-70.2 %
of forest lost in nine years

2.5 ×
more forest loss in contact with the park

+9.9 %
more savanna at the edge: forest degrades first

77.1 %
of sharecroppers under a verbal agreement

1 Background

- Madagascar: 44 % of forest cover lost between 1953 and 2014.
- Ankarafantsika park: over 130,000 ha of dry forest under agricultural pressure.
- Missing link: distance to the park and tenure insecurity never analysed together.

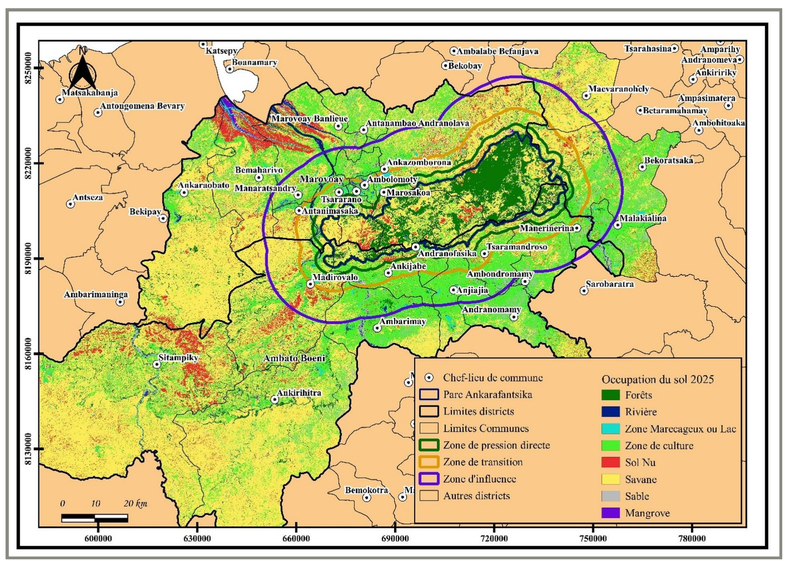
HYPOTHESIS

Contractual insecurity does not restrain clearing. It blocks conservation investment.

2 Materials and methods

- Sentinel-2, 2016 and 2025. Random Forest classification, eight classes.
- 329 fokontany-by-ring units, 457,818 ha. Identical area at both dates.
- Three concentric rings around the park.
- Annual rate r = ln(S2025/S2016)/9 (Puyravaud, 2003).
- Paired Wilcoxon and Kruskal-Wallis tests, 5 % level.
- 215 farm operators surveyed: 110 landowners, 105 sharecroppers, 24 fokontany.

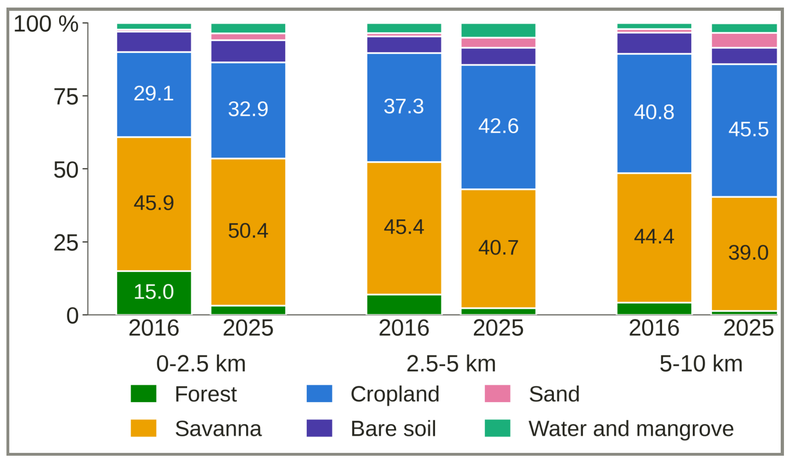
- 0 to 2.5 km direct pressure
- 2.5 to 5 km agro-forest transition
- 5 to 10 km wider influence



Land cover in 2025 and buffer zones: direct pressure in green, transition in orange, wider influence in purple.

3 Forest collapse along the edge

- Forest: 29,160 ha in 2016, 8,692 ha in 2025.
- Loss of 70.2 % in nine years, that is 13.45 % per year ($p < 0.001$).
- Median loss: -78.3 % at 0-2.5 km against -55.3 % and -59.1 % beyond ($p = 0.024$).
- Forest share at the edge: from 15.0 % to 3.2 %.



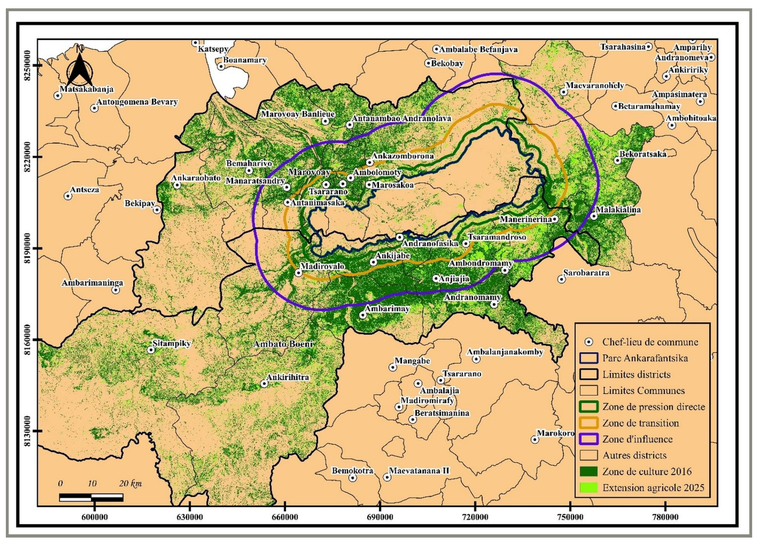
Land cover by ring, as a percentage of each ring's area, 2016 and 2025.

4 Cropland does not follow the gradient

- Cropland: +21,749 ha, that is +12.4 % ($p < 0.001$).
- No difference between the three rings ($p = 0.821$).
- Evenly distributed regional expansion, no marked front at the edge.

5 Savanna, a two-step pivot

- Savanna: +9.9 % at 0-2.5 km, -10.4 % and -12.1 % beyond ($p = 0.002$).
- At the edge, forest degrades into savanna: fire, wood cutting, grazing.
- Farther out, savanna is converted into cropland.
- Sand: from 5,153 to 19,852 ha, a sign of erosion ($p < 0.001$).



Cropland extent in 2016 and expansion between 2016 and 2025.

6 Informality blocks sustainable management

- Verbal agreements: 73.6 % of landowners, 77.1 % of sharecroppers.
- 54.3 % of sharecroppers hold no document for the plot.
- 62.7 % leave no fallow, for fear of losing rights according to 56.5 % of landlords.
- 52.7 % practise burning, 61.0 % apply no sustainable land management.
- These are the practices that turn forest into savanna.

Indicator	0-2.5 km	2.5-5 km	5-10 km	p
Sharecropping tenants (105 surveyed)				
Sharecropping to expand area	46.7	30.8	66.7	0.027
Constraint: tenure insecurity	0.0	17.9	0.0	0.002
Reported land conflicts	0.0	7.7	28.6	0.001
Landowners letting land out (110 surveyed)				
Constraint: tenure insecurity	23.1	12.5	0.0	0.016
No document for the land	28.2	10.0	32.3	0.051
Migrant status	38.5	25.0	12.9	0.053

Table 1. Values in per cent, by distance ring. Chi-square test of independence.

7 Conclusions and recommendations

1. Monitor woody-cover degradation at the edge, not only the advance of plots.
2. Formalise sharecropping contracts in writing: minimum duration, compensation for improvements.
3. Cover both steps: forest degradation at 0-2.5 km, savanna conversion beyond.

KEY MESSAGE

In nine years the edge forest lost 70 % of its area while the cropland front did not advance faster at the park boundary. Degradation runs through savanna, and informal tenure locks in the practices that sustain it.

References

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Acknowledgements

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Limitations: confusion matrix to be built; sand class to be validated; survey-to-landscape link not yet significant (15 fokontany).