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Spatiotemporal dynamics of informal sharecropping and ecosystem degradation in the Ankarafantsika national park peripheries, Madagascar

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Abstract

Ankarafantsika National Park, located in the Boeny Region of northwestern Madagascar, is a major biodiversity hotspot. It is increasingly threatened by anthropogenic pressures, particularly agricultural expansion in its surrounding areas. In these agricultural frontier zones, informal land arrangements, especially insecure sharecropping, shape land-use trajectories and may accelerate deforestation. The land-tenure insecurity inherent to such arrangements often encourages short-term exploitation strategies, discouraging sustainable investments and promoting the opening of new agricultural plots. This study examines how land-tenure insecurity (risks of eviction, verbal agreements) drives short-term land-use decisions, combining low adoption of sustainable practices with speculative parcel expansion, thereby intensifying ecosystem degradation. The socio-ecological framework adopted here models the causal chain linking economic vulnerability, informal sharecropping, land-tenure insecurity, and deforestation.

The methodology combines remote sensing, spatial analysis, and socioeconomic data. Land-cover changes were assessed using Sentinel-2 satellite imagery from 2016 and 2025. A supervised classification based on the Random Forest algorithm was applied to map land-cover types and detect deforestation dynamics. Spatial analysis was organised along a distance gradient from the park, using buffer zones of 0–2.5 km (direct pressure zone), 2.5–5 km (agro-forest transition zone), and 5–10 km (broader influence zone). Changes were examined through diachronic comparison and transition matrices. Spatial datasets were integrated with structured, GPS-assisted land-tenure surveys conducted with 215 agricultural operators (110 landowners and 105 sharecroppers), complemented by qualitative interviews with 12 local authorities. The analysis aims to identify spatial relationships between the distribution of informal sharecropping and areas experiencing deforestation.

Results indicate that the direct pressure zone exhibits a forest-to-agriculture conversion rate 2.3 times higher than areas with secure land rights ($r = 0.65$; $p < 0.001$). This heightened conversion is driven both by the search for fertile forest soils and by economic behaviours aimed at minimising investment on insecure land. Together, these dynamics confirm that land-tenure insecurity strongly shapes land-use strategies and accelerates environmental degradation around protected areas. These findings highlight the need to integrate land-tenure considerations and sustainable land-management approaches into

conservation policies to reduce anthropogenic pressures and enhance the long-term resilience of surrounding socio-ecological landscapes.

Keywords: Ankarafantsika, land tenure insecurity, Madagascar, random forest, remote sensing, sharecropping