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A holistic approach to analyze agroforestry heterogeneity at the cropping system and landscape scales in Madagascar

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The multi-dimensional diversification of agroecosystems, from the plot to the landscape scale, is known to be a key factor of social-ecological systems resilience. Agroforestry research especially brought considerable insights on this issue by documenting the socio-economic, agronomic and environmental outcomes of this type of practices. However, the drivers of agroforestry practices' heterogeneity and its spatial patterns remain poorly understood. This requires a diachronic perspective as the observed agroforestry systems often result from the gradual implantation of tree in pre-existing plantations, fallows, forests or pastures. This study addresses this issue through an original diachronic approach at the landscape scale, which contrasts from more usual static approaches focusing on cropping systems. We characterized the drivers of the observed heterogeneity of agroforestry practices and its spatial patterns in the landscape of a village located in the Analanjirofo region on eastern coast of Madagascar. In this locality, small farmers cultivated for 50 years varied perennial crops (clove, litchi and fruits, vanilla, coffee...) within different patterns including complex agroforestry systems. Analyses were conducted in 2016 on both qualitative and quantitative data collected through farmers' surveys on the following topics: i) the plant species grown in local agroforestry systems, ii) farms socio-economic characteristics, and iii) economic evaluation at plot level. A land-use map was built in 2016 through photointerpretation of drone and satellite pictures, and was compared with a map from 1966. The survey showed that a wide diversity of agroforestry practices currently exists on the locality regarding their plant species composition. Agroforestry accounted for 20% of the land surface in the study locality, resulting in a highly heterogeneous landscape mosaic. By merging the analysis of farmers' survey and the diachronic analysis of the land-use map between 1966 and 2016, we were able to give insights on the economic, demographic and geographic processes that led to the observed heterogeneity of agroforestry practices and their spatial patterns. These results raise perspectives to understand the processes involved in agroforestry evolution and expansion in Analanjirofo landscape over the past 50 years. Our results are relevant for supporting the orientation of social-ecological systems toward resilient trajectories.

Keywords: agroforestry, Landscape, diversification, farming practices, resilience.

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