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# Does certification improve biodiversity conservation in Brazilian coffee farms?

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ABSTRACT

Socio-environmental certification uses evaluation criteria to promote the conservation of the natural environment and landscape connectivity, with the aim of constructing agricultural landscapes more suitable for biodiversity conservation. To test this, we examine whether socio-environmental certification of Brazilian coffee farms contributes to local conservation, particularly in terms of deforestation control, habitat protection and regeneration, and connectivity. The analysis compared changes in landscape structure and connectivity in certified farms before (1995–2002) and after nine years from the beginning of the certification process (2002–2011), using as a reference the surrounding landscape and a control group of non-certified farms. To quantify changes in landscape connectivity we used probabilistic indices of functional connectivity based on graph theory, and two species of terrestrial mammals with contrasting dispersal capacities and habitat requirements: *Priodontes maximus* (giant armadillo) and *Marmosops incanus* (gray slender mouse opossum). Our results show that changes in the last decade have been subtle, but that certified farms differ from surrounding areas for the greater deforestation control and habitat availability for both land cover types, and for the greater connectivity for *P. maximus*. The difference between certified and non-certified farms is not clear-cut, however, we have evidence that the certified farms contributed more than the surrounding areas to the conservation of the studied species when the balance of gains and losses of connectivity is considered. The subtle differences in temporal changes and groups might be partially explained by the fact that certified farms already had a different conservation profile at the beginning of the certification process. Despite the limitations in the sampling size (small number) and time scale (only nine years after certification) which may hinders the detection of certification effects, our findings indicate that certification was important in controlling deforestation and the conversion of new natural areas to agricultural lands.



## 1. Introduction

Socio-environmental certification is a voluntary market-based instrument aimed at promoting changes in production systems toward sustainability (Viana et al., 1996; Cashore et al., 2004). Contribution to biodiversity conservation is one of the explicit goals of many certification schemes and this contribution has been usually studied for forest certification (Gardner, 2010; Zagt et al., 2010). Assessments of biodiversity conservation in agricultural certification are less common, and are usually limited to the inventory of species and community diversity and abundance at a local scale (Mas and Dietsch, 2004; Perfecto et al., 2005), even though certification has been considered as a tool to protect biodiversity at larger spatial scales (Harvey et al., 2008; Scherr and McNeely, 2008).

The Sustainable Agriculture Network (SAN) – Rainforest Alliance certification system was founded in the 1980s and is considered one of the mainstream certification systems for tropical agriculture (Potts et al., 2014). Its standard has been implemented in more than 700,000 farms in 35 tropical countries, accounting for 2.6 million ha in 2013. In Brazil, it encompasses 242,567 ha in 299 farms and it has mostly been implemented in coffee farms in the Cerrado and Atlantic Forest regions (Pinto, 2014). The farm or full rural property

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is the unit for audit in the SAN certification standard. To be certified, a farm has to comply with 16 critical criteria and reach at least an 80% score of compliance with other 83 criteria (SAN, 2013). There are different incentives for farmers to get certified, such as premium prices, access to markets, better management and higher efficiency or reputation, although the SAN system does not formally guarantee any of them (Pinto, 2014).

Among the mainstream agriculture certification systems, SAN standards have a strong focus on biodiversity conservation (Potts et al., 2014), with explicit criteria on: (i) protection of current natural ecosystems and wildlife; (ii) restoration of natural ecosystems; (iii) protection of threatened wildlife species; (iv) deforestation control since 2005; and (v) improvement of structural connectivity of natural ecosystems within farms and the surrounding landscape (SAN, 2011). Despite the level of implementation and the goal to protect biodiversity, there are few studies assessing whether or not this and other certification systems applied to agriculture contribute to the conservation of biodiversity and to the improvement of landscape structural conditions for species of concern.

One reason for this is the difficulty to measure biodiversity, due to its complexity and scales of analysis. An alternative to deal with this issue is to use biological or structural biodiversity indicators (Banks-Leite et al., 2011). Given the strong relationship between landscape structure and biodiversity maintenance in human-altered landscapes (Dauber et al., 2003), these indicators have been increasingly used (Banks-Leite et al., 2013; Hardt et al., 2014). Among these indicators, the connectivity or capacity of the landscape to facilitate biological flow among its elements may be considered an efficient indirect measure of biodiversity conservation (Taylor et al., 1993; Saura, 2013). The increase in connectivity raises the probability of exchange of individuals among isolated populations, favoring the maintenance of biodiversity by reducing extinction rates, increasing recolonization rates (Crooks and Sanjayan, 2006), and promoting the adaptation of species to the negative effects of fragmentation and of climate change, amongst other factors (Opdam and Wascher, 2004).

Connectivity measures should include, in addition to landscape structure, the specific characteristics of movement and dispersion of species in the landscape (With et al., 1997), making the analysis more complex, but at the same time more biologically realistic (Moilanen and Nieminen, 2002; Saura, 2013). There are many metrics for this approach (Saura and Pascual-Hortal, 2007), but the probability of connectivity index is especially consistent with the analysis of landscape change and conservation planning, as it can evaluate simultaneously intra-patch habitat quality and the functionality of the landscape to movement – inter-patch habitat (Saura and Rubio, 2010). Habitat cover is also considered as one of the main structural landscape features associated with biodiversity, and as the most relevant parameter for some authors (Fahrig, 2003, 2013; Hanski, 2011). Thus, measures of habitat loss or stimulus to regeneration are very useful for biodiversity conservation, as lower rates are associated with maintenance or increase of native habitat cover. By comparing temporal changes in landscape connectivity, habitat availability, native vegetation loss and regeneration between certified and non-certified farms, before and after certification, this study aims to assess whether the implementation of SAN standard certification has contributed to biodiversity conservation in coffee farms in Brazil.

## 2. Material and methods

### *2.1. Study area*

This study was carried out in an area with vegetation predominantly characterized as savanna – the Brazilian Cerrado – with patches of Atlantic Forest, mainly around water bodies (Fig. 1). Cerrado as well as Atlantic Forest are considered important world biodiversity hotspots (Myers et al., 2000). The main economic activities in the region are agriculture, mainly coffee, soy, and corn production, as well as livestock grazing, and mining. These activities have promoted loss and fragmentation of natural habitats (MMA, 2008).

### *2.2. Sample design*

The main sample design consisted of spatial and temporal change analysis of certified and non-certified coffee farms, comparing a period of 10 years before certification (1995–2005) with a period of 9 years after the start of the certification process (2002–2011). We followed the impact assessment approach (COSA, 2014) and the control group design suggested by Palmieri (2008). The analysis compared a treatment group (certified farms) and two control groups: non-certified farms and landscapes adjacent to certified farms. Thereby, the analysis was conducted at two different spatial scales: a local (area delimited by farms), and a broader scale called landscape level or surrounding landscape, defined as the micro-basin in which the farm is located, excluding the farm area. The selection of the micro-basin as a landscape unit was particularly important to guarantee similar environmental conditions inside and outside the farms. The landscapes surrounding the farms are similar in terms of suitability for agriculture, as they have the same soil types (dystrophic red latosol or oxisol), and have a similar topography and climate, equally suitable for typical coffee planting in the Cerrado.

The analysis assessed the temporal dynamics of land cover, habitat availability and landscape connectivity changes after the certification, by comparing 2002–2010/2011. We emphasize here that the starting year (2002) represents the beginning of the certification process and not the year when the farms received their first certification seal (2005–2006). It typically takes between 2 and 4 years for a farm to gradually adjust land use and conservation management practices to achieve a conservation profile suitable for certification. Additionally, we included remote-sensing data for the year of certification (2005) and for 10 years earlier (1995) to understand land cover evolution before certification (1995–2005). The different resolution for this dataset did not allow for the analysis of landscape connectivity – no satellite imagery was available for 1995–2005 with the same resolution of 2002–2011.

Most of the 98 coffee farms certified by SAN in Brazil have only recently started the certification process (i.e., post 2010), which means that changes in landscape structure may be difficult to identify given the short time period and the gradual adjustments in conservation practices. To overcome this limitation and observe the impact of certification on conservation practices and landscape connectivity, we decided to focus on a small number of farms where certification standards have been met for a longer period. Therefore, we considered all certifications implemented between 2005 and 2006, for a total of five certified farms (Table 1 and Fig. 1). The control group was defined *a posteriori* based on the profile of certified farms by comparing the following variables among the two groups: length of time growing coffee (at least since 2005/2006), location within the same mesoregion, farming area (between 180 and 1460 ha), total farm area (between 500 and 5400 ha) (Table 1). Although the groups (treatment and control) were similar in all variables ($t$-test > 0.05), the farm area for the control group was lower due to the regional profile of small non-certified producers.

Property boundaries were obtained from maps provided by farm owners. The boundaries of the micro-basins examined at the landscape level were defined manually with ArcGis® 10.1