SOCIOECONOMIC FACTORS AND NATIVE VEGETATION COVER IN RURAL LANDS IN SÃO PAULO STATE, BRAZIL[1]

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Introduction

Conserving native vegetation in private lands is an important complementary strategy to conservation in state protected areas. In Brazil, native vegetation on private lands accounts for more than half of all remnant vegetation (SOARES-FILHO et al., 2014) and for about 30% of all above-ground carbon stock (FREITAS et al., 2017). Thus, the effectiveness of environmental conservation policies is significantly affected by landowners' decisions in land-use changes (CLAASSEN et al., 1999). Such decisions are influenced by environmental factors which drive land suitability for agriculture, e.g. soil type, vegetation cover, relief, and climate (MORAN; BRONDÍZIO; MCCRACKEN, 2002). Unsuitable areas would be avoided and maintained with native vegetation or abandoned after the first agricultural attempts (BARRETTO et al., 2013b; CALABONI et al., 2018). However, socioeconomic and political factors also have a major influence on landowners' decisions in land-use change.

In this study, we focus on three socioeconomic aspects in which there is no theoretical consensus about their influence on land-use decisions: the size, the type of economic activity and the social group to which the rural land belongs. Studies showed that large Brazilian properties had higher percentages of native vegetation cover and lower deforestation rates (D'ANTONA; VANWEY; HAYASHI, 2006; MICHALSKI;

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METZGER; PERES, 2010), being more suitable to ecological restoration (FARINACI et al., 2014). However, large farms are directly related to global commodity markets, which promote deforestation in the tropics (DEFRIES et al., 2010). On the other hand, small properties would be more prone to deforestation due to the limited area available for agricultural activities (D´ANTONA; VANWEY; HAYASHI, 2006) and the low productivity of their technologies (ANGELSEN; KAIMOWITZ; BULTE, 2001).

Market expansion, without instruments to identify and track the negative social and environmental impacts of products and processes, constitutes a perverse channel for allocation of these impacts to sites that offer less socio-environmental restrictions on economic activities (IGARI; TAMBOSI, 2016). Social and environmental certification mechanisms were developed to mitigate information asymmetry in value chains among producers, distributors, financiers and consumers. Silviculture, for example, has advanced in the implementation of socio-environmental certification instruments, pushed by social pressure on the value chains in which it participates, which are historically problematic (MONTEBELLO; BACHA, 2009). Brazil figures among the top countries of certified planted forests in the world, and has great potential for expanding its certification instruments, which can reduce deforestation and promote restoration and compliance with environmental legislation (PINTO, 2014). Therefore, the assumption is that silviculture lands are more likely to comply with legal requirements on land-use.

Land management decisions also reflect the diversity of values, attitudes, and motivations of landowners (FARINACI et al., 2014). Variations in cultural, historical and economic aspects characterize the diversity of rural social groups, which materialize different forms of territory appropriation (BRONDÍZIO et al., 2009). In Brazil, the historical duality between family farming and large-scale agriculture gives rise to a reality marked by regional heterogeneities, differences in management strategies, production scale, as well as diversification of production and income sources (SCHNEIDER, 2010). As example, there are local communities with their ancestral practices and shared management of natural resources (FUTEMMA; MUNARI; ADAMS, 2015), as well as diversified local productive arrangements based on innovation, cooperation, solidarity and exchange of experiences in horizontal learning and interaction networks (MURDOCH, 2000). Land reform settlements characterize another rural social group with its own forms of relationship with the land, especially for its historical foundation based on class struggle (RODRIGUES et al., 2007). Understanding how different social groups are promoting or reducing environmental conservation in their territories is fundamental to create more specific and effective public policies for rural development and environmental conservation.

In this context, it is necessary to take into account policies of both rural development and for the restriction of land-use towards environmental conservation. The structure of Brazilian agrarian incentives is contradictory and asymmetric, prioritizing large-scale commodity production, while allocating scarce resources to the production of food for domestic supply, which usually occurs in small and medium properties (ABRAMOVAY, 1997; DELGADO, 2012). This unbalanced public incentive structure, mainly via subsidized rural credit, deepens the economic disadvantages of smallholder farmers

in relation to large-scale exporting agriculture, what may leverage foreign pressures on land use conversion.

The main government policy tool for conserving native vegetation in private areas in Brazil is the federal law 12.651/2012, known as the New Forest Act (BRASIL, 2012). This law rules over the legal guidelines on Permanent Preservation Areas (APP) and Legal Reserves (RL), limiting land conversion in order to maintain remnants of native vegetation within private properties. Even though the recent reformulation of the Forest Code has been considered a setback in environmental legislation by reducing the mandatory areas of native vegetation preservation (SPAROVEK et al., 2012), other mechanisms in the law are promising for conservation purposes (SOARES-FILHO et al., 2014). The main of these mechanisms is the Rural Environmental Registry (CAR), a tool for monitoring and promoting social control of environmental conservation in rural properties. CAR is intended to make viable the environmental regularization of the farms by registering spatially explicit land use data of the properties. The CAR database provides a powerful empirical source for understanding the processes and determinants of land-use change and, consequently, the conversion of native vegetation in rural lands.

In this study, we use a dataset from the Rural Environmental Registry (CAR) to understand how socioeconomic characteristics of properties relate to environmental conservation in rural lands in the state of São Paulo. We compared the native vegetation cover declared by land owners between properties with different sizes, economic activities and belonging to different social groups. Thus, we evaluated whether the proportion of native vegetation: (1) increases with the size of the properties; (2) differs between social groups, assuming that the less commercial (more subsistence-oriented and local traded) and more relational (grounded in historically constructed social relations) is the land-use, the greater the percentage of native vegetation would be kept on the property; and (3) is higher in properties with silviculture activity compared to other economic activities, given the historical and international pressures for socio-environmental certification of this sector. Understanding that the contributions of the scientific community are critical to guide environmental policies, this study aims to contribute for design and improvement of public policies and programs to encourage the development and environmental conservation of rural landscapes, as they explicitly incorporate parameters of property size, social groups and type of economic activity.

Methods

Study area

São Paulo is the most populated state of Brazil and also the major contributor to Brazil's Gross Domestic Product (INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA, 2016). São Paulo is in the transition region between the Cerrado and Atlantic Forest biomes, and only 16% of the original vegetation cover of both biomes remains (SOS MATA ATLÂNTICA; INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS, 2017; MINISTÉRIO DO MEIO AMBIENTE, 2015). Currently, the agri-

cultural production structure is concentrated in pastures, sugar cane, eucalyptus, oranges and coffee - products primarily aimed at foreign markets. However, São Paulo has also a relevant agricultural production for local supply, mainly delivered by small and medium farms (FREDO; OTANI, 2015). We used the Brazilian Institute of Geography and Statistics (IBGE) classification for the administrative mesoregions (hereafter called regions) of São Paulo, which reflects the grouping of municipalities with similar historical and socioeconomic characteristics.

Data collection

We used the data of properties registered in the São Paulo Rural Environmental Registry System (SICAR-SP), delivered by request to São Paulo Environmental Agency (SMA-SP) in April, 2017 (records until March 31). CAR data registration is self-reporting, online and mandatory for all Brazilian rural properties, resulting in the electronic public repository of the property's environmental information. The following spatial information was used for each property: total area (in hectares), native vegetation area (in hectares), main economic activity and the owner's social group. Native vegetation here is any vegetation remnant of Atlantic Forest or Cerrado in early, intermediate or advanced successional stage, whether or not belonging to the categories of Permanent Preservation Area (APP) or Legal Reserve (RL).

The properties were classified according to CAR's self-declaratory data for social groups: land reform settlements, properties of traditional communities and family farms. Properties whose owners did not claim to belong to any of these categories were classified as conventional agriculture. It is important to mention that there are two distinct types of land reform settlements according to the National Land Reform Plan (INCRA, 2004), which cannot be segregated in the database provided by SICAR-SP. In land acquisition approach, properties are purchased by private agents through state-financed loans (LIMA, 2017), resulting in small individual settlements. The other approach is the expropriation of large lands by government and subsequent subdivision. In CAR, land reform settlements via expropriation and properties of traditional communities are registered entirely, regardless how many families live there. Because of that, the apparent large properties of these groups cannot be directly comparable to the large properties of conventional agriculture belonging to only one owner. However, Forest Code rules for native vegetation apply on these properties similarly, allowing us to analyze the data properly.

By using self-reporting data from SICAR-SP, we understand that the data may incorporate possible sources of error and bias of interest, which could decrease the quality of the information. This issue is clearly exemplified by the amount of area overlaps between properties (approximately 5%), which can be a result of registration errors or evidence of land conflicts. Due to the large amount of data used, we believe that these local errors and biases do not represent a problem in our analysis of broader regional patterns. On the other hand, self-reporting data are able to incorporate rural informalities, for example traditional communities or land reform settlements that are not yet officially recognized in

other data sources. Analysis with property-level data is a gain when compared to studies that use aggregate data at municipal or regional level.

We excluded all properties overlapped to state protected areas. Properties with register errors were also excluded, as well as properties with less than 0.1 hectare (ha). We believe that properties below this threshold are likely to be registration errors or rural households without productive activity.

Data analysis

We conducted exploratory analyses to compare the amount of declared native vegetation per property in relation to size, economic activity and social group. We also compared the proportion of properties without native vegetation according the same three parameters. We present the summary results for the entire state of São Paulo and disaggregated by region. Data manipulation and analysis were performed using QGIS (version 2.18) and R (version 3.4) programs.

We categorized rural properties into four size classes, following Helfand et al. (2014): very small properties - up to 5 ha; small properties - between 5 and 100 ha; medium-sized properties - between 100 and 500 ha; and large properties - over 500 ha. In order to allow comparisons with other studies and to facilitate the articulation of the results with the main Brazilian land-use public policies, we also classified property size into fiscal modules (MF). MF is a land reference, given in hectares, established for each municipality by the federal law 6.746/79 (BRAZIL, 1979). The value of MF takes into account the predominant land-use, access to large consumer markets and the ecological characteristics of the areas. It reflects the amount of land capable of producing a given economic gain. The larger is the land productivity and the closer to consumer markets, the smaller is the MF. In São Paulo, the size of the MF per municipality varies between 5 and 40 hectares, i.e. a property with 4 MF in the state may have between 20 and 160 hectares, depending on the municipality. Size classes in MF are: very small (*minifúndio*) - up to 1 MF; small property - between 1 and 4 MF; medium-size properties - above 4 until 15 MF; and big properties (*latifúndio*) - above 15 MF.

For economic activity, we adopted three original SICAR aggregated categories: agriculture, livestock and silviculture. Other SICAR categories of rural economic activity, as leisure, tourism and mining, were excluded from the analyses because they encompassed too few registered properties. CAR data do not allow detailing the types of agricultural crops in each properties, thus all crops are grouped in the agriculture category. Because more than 80% of the state's livestock activities rely on grazing animals (SÃO PAULO et al., 2008), we assumed that all livestock properties have pasturelands as main land-use. This generalization inserts errors in the analysis, however, given the predominance of extensive cattle ranching in São Paulo properties, and the expressive difference of farm area between pasture and confined livestock, we believe that these errors are not sufficient to skew substantially the results of our study.

Given the reduced number of properties of land reform settlements and traditional communities, and considering the concentration of these properties in some regions

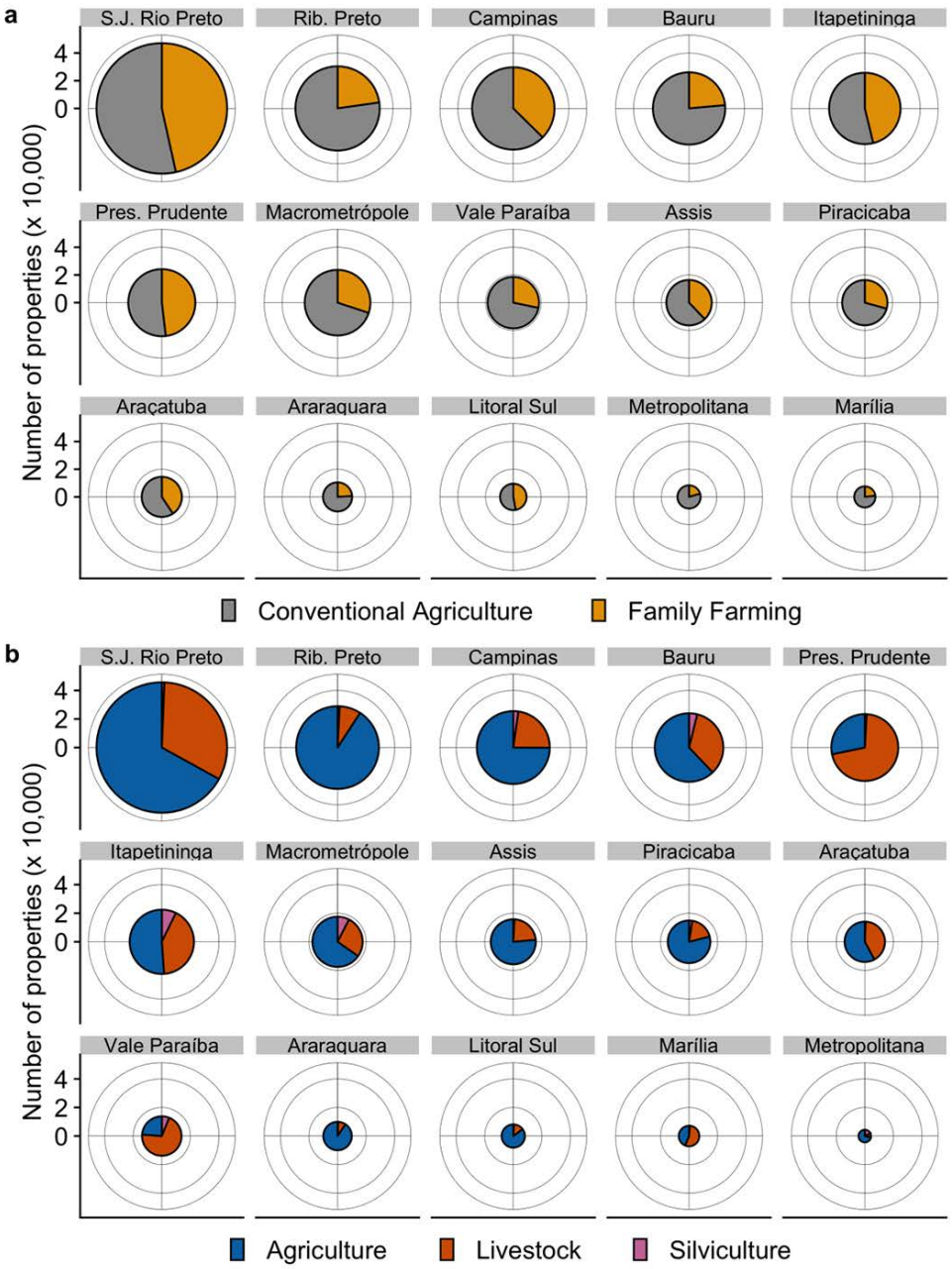
(see results section), results for these groups can just reflect the predominant regional vegetation cover pattern, and not necessarily the characteristics of the social group land management. In order to control for that, we did additional comparisons between social groups only for regions with higher occurrence of land reform settlements or traditional communities. Following the same rationale, we have also compared silviculture with other economic activities in the regions with the largest representation of silviculture in the state.

Results

We analyzed 309,675 properties registered in the Rural Environmental Registry (CAR) of the State of São Paulo (Figure 1), which correspond to 99.5% of properties registered until March 31st, 2017. Properties with up to 5 ha summed 66,044 records; properties between 5 to 100 ha were the most abundant with 208,776 records; properties between 100 to 500 ha totaled 29,332 records, and properties with 500 ha or more summed 5,523 records. There were 168,122 properties with up to 1 fiscal module (MF), 96,431 properties between 1 to 4 MF, 33,497 properties between 4 to 15 MF and 11,625 properties larger than 15 MF. Total native vegetation area declared in all properties was 24,024 km^2, which corresponds to 13% of the total area of the properties and about 10% of the state of São Paulo. The overlap among native vegetation inside properties was 1,244 km^2, representing a possible double counting that corresponds to 5% of the total calculated native vegetation and 0.5% of the state area.

The most abundant social groups were conventional agriculture (N = 199,293) and family farming (N = 109,458). Together they compose 99.7% of the properties (Figure 1a). Land reform settlements (N = 626) represent 0.2% of the properties and have an aggregated distribution in Presidente Prudente and Bauru regions (N = 272). In these regions, total native vegetation cover is very low (Table 1). Traditional communities (N = 298) correspond to 0.1% of the total properties and are concentrated in the Litoral Sul and Vale do Paraíba regions (N = 140), where there are the largest remnants of the Atlantic Forest. Agriculture was the most recurrent type of economic activity (Figure 1b) (N = 177,884), followed by livestock (N = 90,263) and silviculture (N = 7,686). The most representative regions for silviculture were Itapetininga and Macrometrópole.

Figure 1 – Number of properties for each region of São Paulo state, Brazil by (a) social group (N = 309,675) e (b) economic activity (N = 275,833). In (a) we omitted traditional communities and land reform settlements due to the small number of properties. See Figure 2 for regions location.



Source: The authors.

Table 1 – Median and mean of the native vegetation cover per property and proportion of properties without native vegetation per region of São Paulo state, Brazil. For all regions, minimum values of native vegetation cover were 0% and maximum values were 100%. See Figure 2 for regions location.

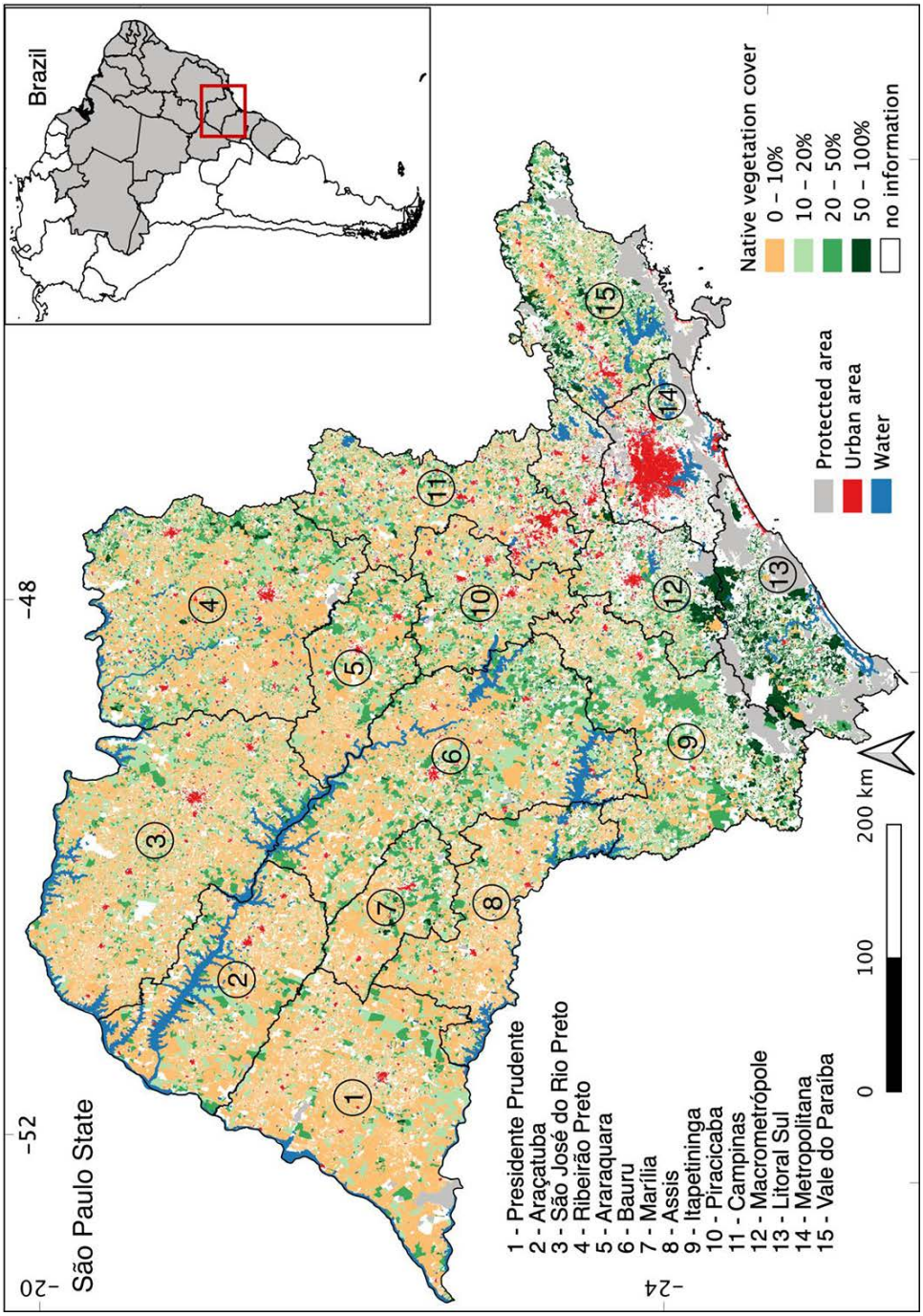
Region	Properties without native vegetation cover		% native vegetation cover	
	N	%	Median	Mean
Araçatuba	7,504	51.5	0.0	4.6
Araraquara	5,308	50.4	0.0	7.3
Assis	7,036	42.8	1.4	6.0
Bauru	10,878	41.5	2.5	8.5
Campinas	12,668	42.6	3.1	9.2
Itapetininga	8,077	31.2	7.9	13.8
Litoral Sul	1,658	17.2	35.3	38.7
Macrometrópole	7,635	32.2	10.1	18.2
Marília	4,008	52.3	0.0	6.4
Metropolitana	2,982	35.6	12.8	23.0
Piracicaba	6,012	36.8	4.1	9.2
Presidente Prudente	13,329	54.6	0.0	3.8
Ribeirão Preto	10,650	35.0	3.8	9.1
São José do Rio Preto	20,805	44.1	1.4	5.5
Vale do Paraíba	5,645	30.4	9.1	16.9
TOTAL	**124,195**	**40.0**	**3.0**	**10.5**

Source: The authors.

Native vegetation cover per property

Considering all properties of the state of São Paulo registered in SICAR-SP (Figure 2), the median and mean percentage of declared native vegetation cover were 3% and 10.5%, respectively (Table 1). The regions with the lowest and highest mean percentages of native vegetation were Presidente Prudente (3.8%, median 0%) and Litoral Sul (35.3%, median 38.7%), respectively (Table 1). The percentage of native vegetation tended to grow with property size (Figure 3a and 3b, Figure 4a and 4b), from 0% (median) on properties up to 5 ha, 3% on properties between 5 and 100 ha, 7% on properties between 100 and 500 ha and 9% on properties above 500 ha. Traditional communities maintained the highest percentages of native vegetation declared by property (median 6.5%), followed by land reform settlements (3.9%), conventional agriculture (3.5%) and family farming (2.2%). For economic activity, silviculture properties presented the highest percentages of native vegetation (median 10%), while agriculture and livestock maintained lower and similar values (median: 2.8 and 2.7%, respectively). Within any group, native vegetation cover values ranged from 0 to 100%.

Figure 2 – Native vegetation cover in rural lands of São Paulo state, Brazil. Numbers refers to IBGE administrative regions.



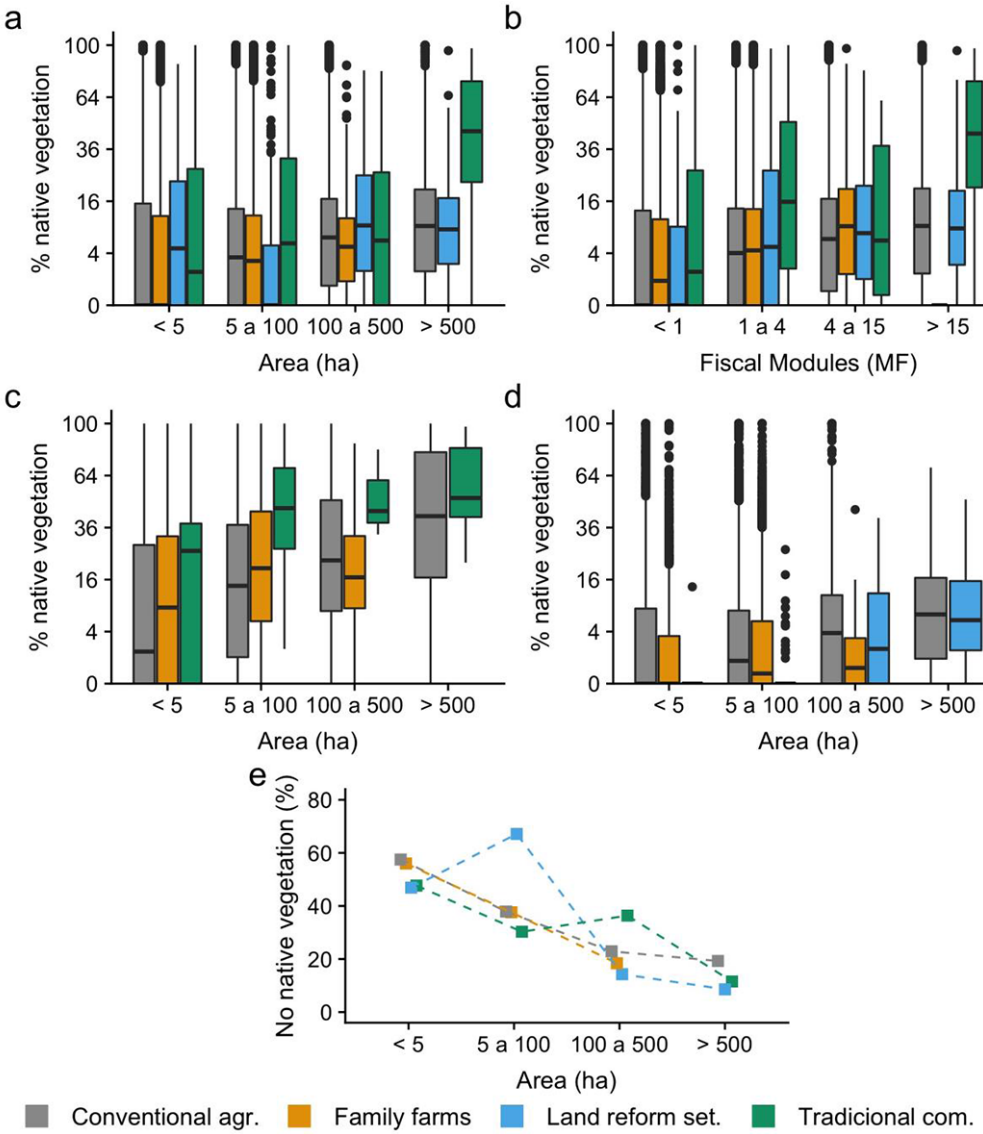
Source: The authors.

Native vegetation cover by property size and social group

The increase in native vegetation cover along with property size occurs mainly in traditional community properties (Figures 3a and 3b). When the same analysis is replicated only in the Litoral Sul and Vale do Paraíba regions, where this social group is more representative, the results show an even greater coverage of native vegetation in the mid-sized properties of traditional communities, compared to conventional agriculture and family farming (Figure 3c). The percentage of native vegetation cover is generally higher in these regions (differences between the median lines of figures 3a and 3c). It is important to mention that the results in fiscal modules for São Paulo (Figure 3b) identified 128 family farms that declared to be larger than 4 fiscal modules, what is not coherent with legal definition of family farming in Brazil, but available data for public consultation in CAR do not allow us to identify the reason for the inconsistency.

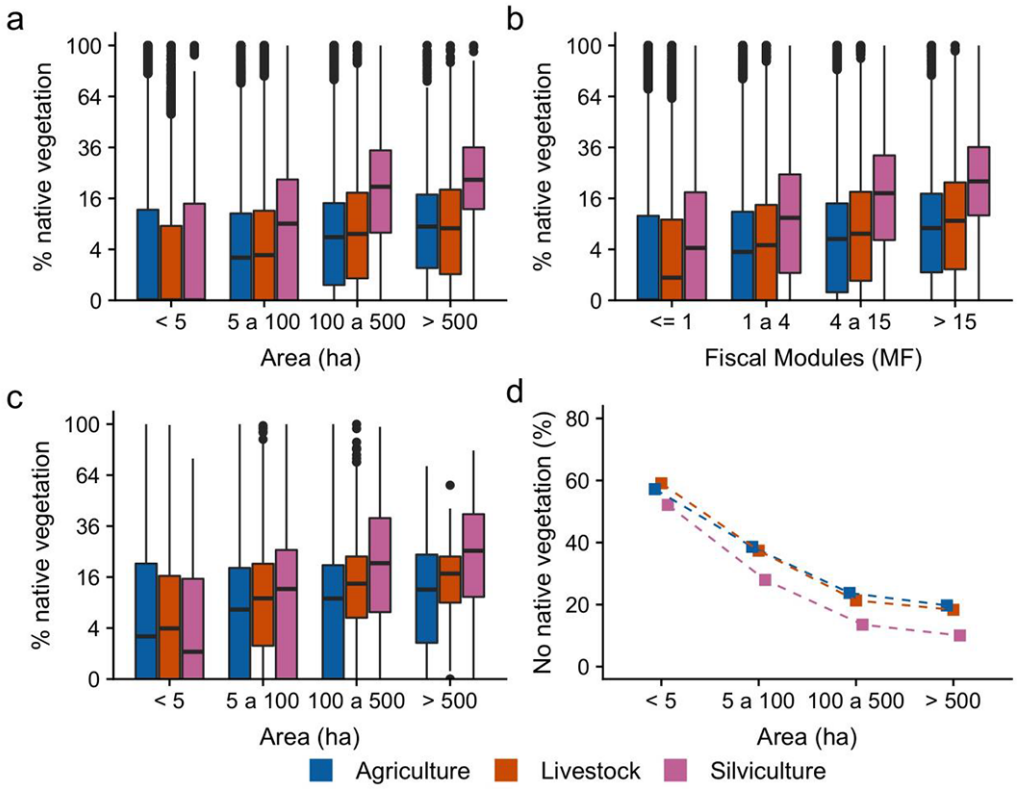
For land reform settlements, the increase in native vegetation cover along with increase of property size was not relevant, resembling the trends identified for conventional and family farming (Figures 3a and 3b). In the regions with the highest occurrence of land settlements (Presidente Prudente and Bauru - figure 3d), the pattern was similar between social groups, but in these regions the median percentages of native vegetation cover in the properties were lower compared to the data for the entire state of São Paulo (Figure 3a).

Figure 3 - Percentage of native vegetation cover (a, b, c, d) and percentage of properties without native vegetation (e) by property size and social group for the state of São Paulo. In (a) size of the property measured in hectares and (b) fiscal modules (MF). In (c) subset analysis for regions with more traditional communities (Litoral Sul and Vale do Paraíba) and (d) for regions with greater representation of land reform settlements (Presidente Prudente and Bauru). The boxes indicate median (centerline), first and third quartile (ends), and extreme values in black circles. In (a, b, c, d) the y-axis scale is in square root for better observation of low values. At (e) the dashed lines connecting the dots indicate the trend in relation to the property size.



Source: The authors.

Figure 4 - Percentage of native vegetation cover (a, b, c) and percentage of properties without native vegetation (d) by property size and main economic activity. In (a) size of the property measured in hectares and (b) fiscal modules (MF) for the entire state of São Paulo. In (c) subset analysis for the regions with the largest representation of silviculture (Itapetininga and Macrometrópole). The boxes indicate median (centerline), first and third quartile (ends), and extreme values in black circles. In (a, b, c) the y-axis scale is in square root for better observation of low values. In (d) the dashed lines connecting the dots indicate the trend toward property size.



Source: The authors.

Native vegetation cover by property size and economic activity

Silviculture showed the largest percentage increase in native vegetation cover with increasing property size (Figures 4a and 4b), reaching about 20% (median) on properties above 100 ha (Figure 4a). In the Itapetininga and Macrometrópole regions, silviculture maintained the state trend, and showed above 25% native vegetation cover on half of the properties over 100 ha (Figure 4c).

Properties without native vegetation

Properties without native vegetation represent approximately 40% of rural properties throughout the state. Four regions (Araçatuba, Araraquara, Marília and Presidente Prudente) present more than half the properties registered with no native vegetation (Table 1). Litoral Sul has the lowest percentage of properties without native vegetation (17.2%).

The proportion of properties with no native vegetation decreases with increasing property size (Figures 3e and 4d), from about 57% on properties under 5 ha to 19% on properties over 500 ha. Traditional communities maintained the lowest proportions of properties without native vegetation (34%), followed by properties in land reform settlements (37%) and conventional agriculture (39%). Family farms presented the highest proportions of properties with no native vegetation (42%), however they maintained values close to those of conventional agriculture for each property size class (Figure 3e). Agriculture and livestock activities had about 40% of the properties without native vegetation, while for silviculture the percentage was 29%, reducing to less than 10% in properties above 500 ha (Figure 4d).

Discussion

This study presents an analytical refinement on some socioeconomic elements that may underlie public policies on conservation and use of rural lands in Brazil. The results contribute to understand the current state of land use in rural properties in the state of São Paulo as well as the potential effects of size, economic activity and social group on the conservation of native vegetation in the properties. We found that native vegetation cover in rural lands of São Paulo is generally very low, corroborating results in other spatial research scales (CALABONI et al., 2018; FARINACI et al., 2014; IGARI; TAMBOSI; PIVELLO, 2009).

Even though native vegetation cover tends to increase with property size, large farms are still falling short of what is required by the Forest Code. The results indicate that only large properties belonging to traditional communities and large properties with silviculture present most farms (more than 50%) with percentage of native vegetation above the 20% required by law. The number of properties without native vegetation tends to decrease with increasing property size. There is also an important regional heterogeneity in native vegetation cover on farms that needs to be taken into account in planning environmental conservation actions, what demand flexibility and adaptability to different contexts.

Native vegetation cover and property size

Property size plays an important role in the strategies for allocation of time, effort and resources for a given land use. Property size classes are controversially addressed in literature and among Brazilian government agencies and programs (BRONDÍZIO et al., 2009). They are often used to define the criteria for credit allocation and rural assistance

and were also adopted in the Forest Code as a criterion for mandatory recover of Permanent Preservation Areas (APP) and Legal Reserve (RL), the so-called "step ladder rule", which determines differentiated guidelines for recovering APP according to the size of the property.

In São Paulo, more than half of very small properties (up to 5 ha) do not have native vegetation, a proportion that drops to a quarter on very large properties (over 500 ha). The results indicate that the proportion of native vegetation increases with the size of the property, corroborating studies in several regions of Brazil (BRONDÍZIO et al., 2009; D'ANTONA; VANWEY; HAYASHI, 2006; GUIDOTTI et al., 2017; MICHALSKI; METZGER; PERES, 2010). On the other hand, these same studies indicate that small properties, although numerous, contribute little in absolute terms for total deforested area or the amount of RL and APP deficit. In São Paulo, Guidotti et al. (2017) show that properties with up to 4 fiscal modules account for 80% of the number of properties and only 20% of the APP and RL native vegetation deficit area. In other words, small farms find it more difficult to comply with the Forest Code, but the environmental consequences are lower than non-compliance with legislation on large farms.

One of the hypotheses to explain the relationship between native vegetation cover and property size is that smallholder farmers would be more sensitive to non-economic land-use. The limited scale of production of small farms may even harm the livelihoods of larger groups that depend on the farm income. In addition, smallholder farmers would rely on low-tech and low-yielding agricultural systems, then, increasing, or at least keeping profitability would foster expansion of produtive area over native vegetation. However, the hypothesis of low productivity is not generalizable (ABRAMOVAY, 1997), since the diversity of methods applied by smallholders reflects a wide variation of productivity (HELFAND; PEREIRA; SOARES, 2014; NAVARRO; CAMPOS, 2013). It is not only access to technologies that defines smallholder productivity and profitability, but also subsidized credit, technical assistance and access to transportation systems, as well as price negotiation skills in local and regional markets (BRONDÍZIO et al ., 2009).

Many obstacles that smallholder farmers face, however, can be mitigated through collective action, learning, and the development of appropriate institutional arrangements. Organization of small producers into associations and cooperatives can result in better local and productive structures, which contribute to reduce operating costs of accessing technologies, to improve bargaining power with suppliers and buyers, to increase profitability and foster the development of regional markets (HELFAND; PEREIRA; SOARES, 2014; MURDOCH, 2000; SCHNEIDER, 2010). These associations and cooperatives then allow economic improvement from organizational, technological and commercial gains of scale that would not be accessible to smallholders in isolation. It remains to be clarified whether such an economic gain would result in abandonment of less productive land, allowing native vegetation to regenerate, or whether increasing production scale and market access would increase the opportunity cost of conservation areas (ANGELSEN; KAIMOWITZ; BULTE, 2001), what would impose further pressure on deforestation in the properties.

To reduce the environmental issue only to the property size aspect underestimate

the importance of the diversity of social groups and the different territorial dynamics acting in the rural environment (BRONDÍZIO et al., 2009; FREDO; OTANI, 2015; SCHNEIDER, 2010). Given the differences in practices, experiences, motivations, as well as the biased stereotype regarding small-scale production systems (ABRAMOVAY, 1997) and the ambiguity in the definition of smallholders play an important role in interpreting their contribution to deforestation (BRONDÍZIO et al., 2009), making its demystification indispensable.

Native vegetation cover and social group

This study contributes to understand the separated effects of social groups and property size on native vegetation of properties through independent comparison among social groups in each size class. Traditional communities, land reform settlements and family farms are generally grouped into the generic classification of small farmers, mainly due to economic and income factors (BRONDÍZIO et al., 2009; NAVARRO; CAMPOS, 2013). In fact, traditional communities and land reform settlements are included as beneficiaries of the National Program for Strengthening Family Farming (PRONAF, federal law 11.326 / 2006; BRAZIL, 2006) not because of farm size or scale of production, but due to reliance of the rural economic activity on family labor. Maintaining the generic aggregation of smallholder farmers, we see that these social groups have no smaller proportion of native vegetation inside their properties compared to what we call conventional agriculture. Large land reform settlements whose land registry covers the entire settlement area (over 500 ha) and properties of traditional communities of any size obtained similar percentages of native vegetation or larger than conventional agriculture properties of the same size.

Properties of traditional communities must be highlighted for presenting highest percentage values of native vegetation, mainly in large properties, demonstrating the importance of these communities for environmental conservation. Such communities, which in São Paulo are mainly indigenous, quilombolas (communities historically established by resistance of fugitive slaves) and caiçaras (ancient fisher communities), are characterized by properties for collective or communal use. In some of these communities, the multifunctional use of the territory and the consolidation of networks of articulation between local and regional actors in the co-management of natural resources promote opportunities for income generation through multi-active initiatives combined with conservation practices (FUTEMMA; MUNARI; ADAMS, 2015; PENNA-FIRME; BRONDÍZIO, 2017).

Native vegetation cover and economic activity

As Brazilian silviculture is an activity focused mainly on the foreign market (MOURA, 2016), we would expect that there would be an increase in production area over environmental conservation areas (DEFRIES et al., 2010). However, in São Paulo, silviculture maintains higher proportions of native vegetation compared to other activities

(BASSO et al., 2011; FARINACI; FERREIRA; BATISTELLA, 2013) and even promotes the recovery of the Atlantic Forest (CALABONI et al., 2018; SILVA; BATISTELLA; MORAN, 2016). Two non-excluding factors may explain this phenomenon. The first is that silviculture on large properties in São Paulo is highly mechanized (MONTEBELLO; BACHA, 2009), which makes production difficult in steep slopes, rocky terrains or poorly drained soils. These unexplored areas allow properties to maintain RL and APP.

The second factor would be the strength of international pressures for socio-environmental certification in the silviculture production chains (FARINACI; FERREIRA; BATISTELLA, 2013). In Brazil, it is estimated that 63% of planted forests are certified (INSTITUTO BRASILEIRO DE ÁRVORES, 2016), and São Paulo represents the state with the second largest area of planted and certified forests (ASSOCIAÇÃO BRASILEIRA DE PRODUTORES DE FLORESTAS PLANTADAS, 2013). However, the certification process is still considered costly, especially for the adhesion of small and medium properties. Moura (2016) identifies that the highest costs in the socio-environmental certification process for silviculture are precisely associated with the compliance of the property with environmental legislation, such as recover of APP and RL areas. This explains why small silviculture properties also fail to meet the minimum percentages of native vegetation cover required by law.

Implications for public policies

Large properties have more access to the public benefits of subsidized credits that finance the technification of their activities. In return, we would expect these properties to provide public benefits in form of environmental conservation and associated ecosystem services (soil maintenance, nutrient cycling, water supply, natural pest control, pollination). However, this same technification somewhat decreases the dependence of large properties on ecosystem services (RAUDSEPP-HEARNE et al., 2010), discouraging environmental conservation. In large properties - responsible for about 80% of the total RL and APP deficit area in São Paulo (GUIDOTTI et al., 2017) -– public economic incentives should always be conditional on compliance with legal requirements for environmental conservation (IGARI; TAMBOSI, 2016). In this regard, the recent reform of the Forest Code has included a clause that imposes as condition for subsidized rural loans and financing the enrollment in the Rural Environmental Registry, making it a promising tool for enforcing environmental land use laws in Brazil.

There is also a distortion of incentives for conservation between small and large properties. Small properties, regardless of social group, have a deficit with environmental legislation, and face greater difficulty in accessing credit and technology. As a result, they are more dependent on declining ecosystem services, but more economically limited in allocating areas for environmental conservation. In the social aspect, small producers are more labor intensive, generating more jobs and consequently a greater social benefit from their agricultural practices (ABRAMOVAY, 1997; HELFAND; PEREIRA; SOARES, 2014). On small farms the reconciliation between social welfare and environmental conservation is dependent on increasing land productivity (BARRETTO et al., 2013a).

It is the role of public policies to address these imbalances between public incentives and social and environmental returns between small and large properties (SCHNEIDER, 2010). It would be necessary to assist smallholders in fulfilling their environmental obligations, while at the same time increasing their level of well-being by stimulating land profitability increase.

Targeting access to subsidized credit to small producers and driving part of this credit to financing environmental regularization can be a prolific path to be implemented via Environmental Regularization Programs (BARRETTO et al., 2013a; SOARES-FILHO et al., 2014). This path would foster policies for active environmental recovery, associated with initiatives that promote greater gains for small farmers, such as agroecology, integration of agricultural systems, and encouragement of associations and cooperativism.

Conclusions

São Paulo is one of the Brazilian states with the lowest percentages of native vegetation cover on farms and with the highest number of non-compliers with the Forest Code. It is also the state with the most advanced technological development and institutional structure, showing elevated potential to promote environmental conservation in its territory. This study found that rural properties characterized as large properties, traditional communities or silviculture farms have on average greater coverage of native vegetation compared to the other analyzed groups. Thus, conceiving specific public policies, not only on the basis of property size, but also social group and economic activity would confer greater effectiveness and fairness in the allocation of public efforts and resources for environmental conservation. Distinction and differentiated support for social groups, along with pressures via social and environmental certification for different economic activities can be important tools for the development of public policies that promote both social welfare and environmental conservation in rural areas.

References

ABRAMOVAY, R. Agricultura familiar e uso do solo. **Revista São Paulo em Perspectiva**, n.2, p.73-78, 1997.

ANGELSEN, A.; KAIMOWITZ, D.; BULTE, E. Technological change and deforestation: a theoretical review. In: ANGELSEN, A.; KAIMOWITZ, D. (Eds.). **Agricultural Technologies and Tropical Deforestation**. New York, NY, USA: CABI Pub. in association with Center for International Forestry Research, 2001.

ASSOCIAÇÃO BRASILEIRA DE PRODUTORES DE FLORESTAS PLANTADAS (ABRAF). **Anuário Estatístico**. Brasília, DF, 2012.

BARRETTO, A. G. O. P.; LIMA, R. C. A.; MAULE, R. F.; MARTINS, S. P. Efeito da aplicação do novo Código Florestal sobre o pequeno produtor e a viabilidade ambiental da agricultura familiar. In: CAMPOS, S. K.; NAVARRO, Z. (Eds.). **A pequena produção rural e as tendências do desenvolvimento agrário brasileiro:** Ganhar tempo é possível?

Brasília, DF: Centro de Gestão e Estudos Estratégicos (CGEE), 2013a.

BARRETTO, A. G. O. P.; BERNDES, G.; SPAROVEK, G.; WIRSENIUS, S. Agricultural intensification in Brazil and its effects on land-use patterns: an analysis of the 1975-2006 period. **Global Change Biology**, v.19, n.6, p.1804-1815, 2013b.

BASSO, V. M.; JACOVINE, L. A G.; ALVES, R. R.; VIEIRA, S. L. P.; SILVA, F. L. Certificação em grupo no Brasil. **Floresta e Ambiente**, v.18, n.2, p.160-170, 2011.

BRASIL. **Lei nº 6.746**, de 10 de dezembro de 1979. Altera o disposto nos arts. 49 e 50 da Lei nº 4.504, de 30 de novembro de 1964 (Estatuto da Terra), e dá outras providências. Disponível em: <http://www.planalto.gov.br/ccivil_03/LEIS/1970-1979/L6746.htm>. Acesso em: 17 jul. 2017.

_____ **Lei nº 11.326**, de 24 de julho de 2006. Estabelece as diretrizes para a formulação da Política Nacional da Agricultura Familiar e Empreendimentos Familiares Rurais. Disponível em: <http://www.planalto.gov.br/ccivil_03/_Ato2004-2006/2006/Lei/L11326.htm>. Acesso em: 17 jul. 2017.

_____. **Lei nº 12.651**, de 25 de maio de 2012. Dispõe sobre a proteção da vegetação nativa; altera as Leis nos 6.938, de 31 de agosto de 1981, 9.393, de 19 de dezembro de 1996, e 11.428, de 22 de dezembro de 2006; revoga as Leis nos4.771, de 15 de setembro de 1965, e 7.754, de 14 de abril de 1989, e a Medida Provisória no2.166-67, de 24 de agosto de 2001; e dá outras providências. Disponível em: <http://www.planalto.gov.br/ccivil_03/_Ato2011-2014/2012/Lei/L12651.htm>. Acesso em: 17 jul. 2017.

BRONDÍZIO, E. S. et al. Small farmers and deforestation in Amazonia. In: KELLER, M.; BUSTAMENTE, M.; GASH, J.; DIAS, P. S. (Eds.). **Geophysical Monograph Series**. Washington, D. C.: American Geophysical Union, 2009. v.1, 186p., pp.117-143.

CALABONI, A.; TAMBOSI, L. R.; IGARI, A. T.; FARINACI, J. S.; METZGER, J. P.; URIARTE, M.. The forest transition in São Paulo, Brazil: historical patterns and potential drivers. **Ecology and Society**, v.23, n.4, 2018.

CLAASSEN, R.; TEGENE, A. Agricultural land use choice: A discrete choice approach. **Agricultural and Resource Economics Review**, v.28, p.26-36, 1999.

D'ANTONA, A. O.; VANWEY, L. K.; HAYASHI, C. M. Property Size and Land Cover Change in the Brazilian Amazon. **Population and Environment**, v.27, n.5-6, p.373-396, 2006.

DEFRIES, R. S.; RUDEL, T.; URIARTE, M.; HANSEN, M. Deforestation driven by urban population growth and agricultural trade in the twenty-first century. **Nature Geoscience**, v.3, n.3, p.178-181, 2010.

DELGADO, G. C. **Do capital financeiro na agricultura à economia do agronegócio:** mudanças cíclicas em meio século (1965-2012). UFRGS Editora, 2012.

FARINACI, J. S.; RUSEVA, T. B.; TUCKER, C. M.; EVANS, T. P.; BATISTELLA, M. Humans as agents of change in forest landscapes. In: AZEVEDO, J. C.; PERERA, A. H.; PINTO, M. A. (Eds.). **Forest Landscapes and Global Change: Challenges for Research**

and Management. New York: Springer, 2014. pp. 75-105.

FARINACI, J. S.; FERREIRA, L. C.; BATISTELLA, M. Forest transition and ecological modernization: eucaliptus forestry beyond good and bad. **Ambiente & Sociedade**, v.16, n.2, p.25-44, 2013.

FREDO, C. E.; OTANI, M. N. Caracterização preliminar da agricultura familiar no Estado de São Paulo. **Informações Econômicas**, v.45, n.6, p.9-29, 2015.

FREITAS, F. L. M.; ENGLUND, O.; SPAROVEK, G.; BERNDES, G. GUIDOTTI, V.; PINTO, L. F. G.; MÖRTBERG, U. Who owns the Brazilian carbon? **Global Change Biology**, v.24, n.5, p.2129-2142, 2017.

FUTEMMA, C.; MUNARI, L. C.; ADAMS, C. The Afro-Brazilian Collective Land: Analyzing Institutional Changes in the Past Two Hundred Years. **Latin American Research Review**, v.50, n.4, p.26–48, 2015.

GUIDOTTI, V.; FREITAS, F. L. M.; SPAROVEK, G.; PINTO, L. F. G.; HAMAMURA, C.; CARVALHO, T.; CERIGNONI, F. **Números detalhados do novo código florestal e suas implicações para os PRAs**: Sustentabilidade em Debate 5: IMAFLORA, 2017. Disponível em: <https://goo.gl/gWza3X>. Acesso em: 15 jun. 2017.

HELFAND, S. M.; PEREIRA, V. F.; SOARES, W. L. Pequenos e médios produtores na agricultura brasileira. Situação atual e perspectivas. In: BUAINAIN, A. M.; ALVES, E.; SILVEIRA, J. M.; NAVARRO, Z. (Eds.). **O mundo rural no Brasil do século 21**. Brasília, DF: Embrapa, 2014. pp. 533-559.

IGARI, A. T; TAMBOSI, L. R. Agribusiness and Socioeconomic Drivers of Land Cover Change in Brazil. In: GHELER-COSTA, C.; LYRA-JORGE, M. C.; VERDADE, L. M. (Eds.). **Biodiversity in Agricultural Landscapes of Southeastern Brazil**. Warsaw/Berlin: De Gruyter Open, 2016.

IGARI, A. T.; PIVELLO, V. R. Crédito Rural e Código Florestal: irmãos como Caim e Abel? **Ambiente & Sociedade,** Campinas, v.14, n.1, p.133-150, 2011.

IGARI, A. T.; TAMBOSI, L. R.; PIVELLO, V. R. Agribusiness Opportunity Costs and Environmental Legal Protection: Investigating Trade-Off on Hotspot Preservation in the State of São Paulo, Brazil. **Environmental Management**, v.44, n.2, p.346-355, 2009.

INDÚSTRIA BRASILEIRA DE ÁRVORES (IBA)**. Relatório Anual**. Brasília, DF, 2016. Disponível em: <https://goo.gl/K5TdQw>. Acesso em: 8 set. 2018.

INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA (IBGE). **Estados: São Paulo**. 2016. Disponível em: <http://www.ibge.gov.br/estadosat/perfil.php?sigla=sp>. Acesso em: 18 dez. 2016.

INSTITUTO NACIONAL DE COLONIZAÇÃO E REFORMA AGRÁRIA (INCRA). **II Plano Nacional de Reforma Agrária:** Paz, Produção e Qualidade de Vida no meio rural. Brasília: MDA, 2004.

LIMA, E. A. C. R. A questão agrária no Brasil: contribuições para a compreensão das políticas de reforma agrária redistributiva e de reforma agrária de mercados. **RURIS--Revista do Centro de Estudos Rurais-UNICAMP**, v.11, n.1, p.189-214, 2017.

MICHALSKI, F.; METZGER, J. P.; PERES, C. A. Rural property size drives patterns of upland and riparian forest retention in a tropical deforestation frontier. **Global Environmental Change**, v.20, n.4, p.705–712, 2010.

MINISTÉRIO DO MEIO AMBIENTE (MMA). **Mapeamento do Uso e Cobertura da Terra do Cerrado:** Projeto TerraClass Cerrado 2013. Brasília: MMA, 2015.

MONTEBELLO, A. E. S.; BACHA, C. J. C. Avaliação das pesquisas e inovações tecnológicas ocorridas na silvicultura e na produção industrial de celulose no Brasil. **Revista de Economia e Sociologia Rural**, v.47, n.2, p.485–517, 2009.

MORAN, E. F.; BRONDÍZIO, E.; MCCRACKEN, S. Trajectories of land use: soil, succession and corp choice. In: WOOD, C. H.; PORRO, R. (Eds.). **Deforestation and Land Use in the Amazon**. Gainesville FL: University Press of Florida, 2002.

MOURA, A. M. M. Contribuição da certificação de florestas para o cumprimento da legislação florestal no Brasil. In: SILVA, Ana Paula Moreira Da et al. (Eds.). **Mudanças no código florestal brasileiro:** desafios para a implementação da nova lei. Rio de Janeiro: IPEA, 2016.

MURDOCH, J. Networks - a new paradigm of rural development? **Journal of Rural Studies**, v.16, n.4, p.407–419, 2000.

NAVARRO, Z.; CAMPOS, S. K. A "pequena produção rural" no Brasil. In: **A pequena produção rural e as tendências do desenvolvimento agrário brasileiro:** Ganhar tempo é possível? Brasília, DF: CGEE, 2013.

PENNA-FIRME, R.; BRONDÍZIO, E. S. Quilombolas as "green collectives": contesting and incorporating environmentalism in the Atlantic Forest, Brazil. **Ambiente & Sociedade**, v.20, n.2, p.139-158, 2017.

PINTO, L. F. G. **INCENTIVOS PARA A CONSERVAÇÃO DE FLORESTAS:** a experiência da certificação no Brasil: Sustentabilidade em Debate 1: IMAFLORA 2014. Disponível em: <https://www.imaflora.org/downloads/biblioteca/53dc06bcbf461_Sustentabilidade_em_debate_vol1_01_08_14.pdf>. Acesso em: 10 nov. 2017.

RAUDSEPP-HEARNE, C. et al. Untangling the Environmentalist's Paradox: Why Is Human Well-being Increasing as Ecosystem Services Degrade? **BioScience**, v.60, n.8, p.576–589, 2010.

RODRIGUES, E. R.; CULLEN, L.; BELTRAME, T. P.; MOSCOGLIATO, A. V.; SILVA, I. C. Avaliação econômica de sistemas agroflorestais implantados para recuperação de reserva legal no Pontal do Paranapanema, São Paulo. **Revista Árvore**, v.31, n.5, 2007.

SÃO PAULO, Governo do Estado. Secretaria de Abastecimento e Agricultura. **Levantamento censitário de unidades de produção agrícola do Estado de São Paulo:** LUPA

2007/2008. 2008. Disponível em: <http://www.cati.sp.gov.br/projetolupa>. Acesso em: 10 jul. 2017.

SCHNEIDER, S. Reflexões sobre diversidade e diversificação agricultura, formas familiares e desenvolvimento rural. **RURIS-Revista do Centro de Estudos Rurais-UNICAMP**, v.4, n.1, 2010.

SILVA, R. F. B.; BATISTELLA, M.; MORAN, E. F. Drivers of land change: Human--environment interactions and the Atlantic forest transition in the Paraíba Valley, Brazil. **Land Use Policy**, v.58, p.133–144, 2016.

SOARES-FILHO, B.; RAJÃO, R.; MACEDO, M.; CARNEIRO, A.; COSTA, W.; COE, M.; RODRUGIES, H.; ALENCAR, A. Cracking Brazil's Forest Code. **Science**, v.344, n.6182, p.363-364, 2014.

SOS MATA ATLÂNTICA; INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS. **Atlas dos Remanescentes Florestais da Mata Atlântica:** Período: 2015-2016. Fundação SOS Mata Atlântica, Instituto Nacional de Pesquisas Espaciais, 2017. Disponível em: <https://www.sosma.org.br/wp-content/uploads/2014/05/atlas_2012-2013_relatorio_tecnico_20141.pdf>. Acesso em: 27 jul. 2017.

SPAROVEK, G.; BERNDES, G.; BARRETTO, A. G. O. P.; KLUG, I. L. F. The revision of the Brazilian Forest Act: increased deforestation or a historic step towards balancing agricultural development and nature conservation? **Environmental Science & Policy**, v.16, p.65-72, 2012.

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Original Article

SOCIOECONOMIC FACTORS AND NATIVE VEGETATION COVER IN RURAL LANDS IN SÃO PAULO STATE, BRAZIL

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SOCIOECONOMIC FACTORS AND NATIVE VEGETATION COVER IN RURAL LANDS IN SÃO PAULO STATE, BRAZIL

***Abstract*:** This study investigated how farm size, economic activity and social group are related to declared native vegetation cover in rural lands in the state of São Paulo, Brazil, evaluating implications to environmental public policies. We analyzed data from Rural Environmental Registry System of São Paulo (SICAR-SP). More than one third of the farms does not have declared native vegetation and half of them have up to 3% of native vegetation cover. Percentage of declared native vegetation cover tends to increase with farm size. However, only community lands and silviculture farms larger than 500 hectares showed most properties (more than 50%) with at least 20% of its area covered with native vegetation, as determined by the Brazilian Forest Act (federal law 12,651/2012). Our results suggest that, beyond property size, property social group and economic activity are also important aspects to be considered into public policy design aiming at environmental conservation in rural landscapes.

***Keywords*:** Brazilian Forest Act; Rural Environmental Registry; public policy; rural development; environmental conservation.

FATORES SOCIOECONÔMICOS E A VEGETAÇÃO NATIVA EM IMÓVEIS RURAIS NO ESTADO DE SÃO PAULO

***Resumo*:** Investigou-se como tamanho de propriedade, atividade econômica e grupo social relacionam-se com a cobertura de vegetação nativa em imóveis rurais do estado de São Paulo, avaliando implicações para políticas públicas para conservação ambiental. Foram analisados dados do Cadastro Ambiental Rural de São Paulo. Mais de um terço das propriedades não possui vegetação nativa declarada e cerca de metade delas possui até 3% de cobertura de vegetação nativa. A porcentagem de cobertura de vegetação nativa declarada

tendeu a aumentar com o tamanho da propriedade. Entretanto, somente os grandes imóveis pertencentes às comunidades tradicionais e os grandes imóveis com atividade de silvicultura têm, em sua maioria (mais de 50%), percentual de vegetação nativa declarada acima dos 20% exigidos pelo Código Florestal (lei federal 12651/2012). Os resultados sugerem que, além do tamanho da propriedade, também grupos sociais e atividades econômicas são importantes na formulação das políticas públicas para conservação ambiental no meio rural.

***Palavras-chave*:** Código Florestal; Cadastro Ambiental Rural; políticas públicas; desenvolvimento rural; conservação ambiental.

LOS FACTORES SOCIOECONÓMICOS Y LA VEGETACIÓN NATIVA EN LAS PROPIEDADES RURALES EN EL ESTADO DE SAO PAULO

***Resumen*:** Se investigó como tamaño de propiedad, actividad económica y grupo social se relacionan con cobertura de vegetación nativa declarada en inmuebles rurales del estado de São Paulo, Brasil, evaluando posibles implicaciones para políticas públicas de conservación ambiental. Se analizaron datos del Registro Ambiental Rural de São Paulo (SICAR-SP). Más de un tercio de las propiedades no tienen vegetación nativa declarada y cerca de mitad tiene hasta 3% de cobertura de vegetación nativa. El porcentaje de vegetación nativa tiende a aumentar con el tamaño de la propiedad. Todavía, sólo tierras en comunidades tradicionales y haciendas de silvicultura con más de 500 hectáreas tuvieron más de mitad de los inmuebles con vegetación nativa por encima del 20% exigido por el Código Florestal (ley federal 12651/12). Los resultados sugieren que, además del tamaño de la propiedad, también grupos sociales y actividades económicas son importantes para formulación de políticas públicas de conservación ambiental rural.

***Palabras Clave*:** Código Forestal Brasileño; Registro Ambiental Rural; políticas públicas; desarrollo rural; conservación ambiental.

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