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"There was a virgin forest here; it was all woods": local perceptions of landscape changes in Northeastern Brazil

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ABSTRACT

This paper presents a case study to understand how people from a rural population that has been undergoing intense anthropogenic transformations in recent decades perceive these local landscape changes. We conducted a participatory workshop, during which we used the scoring exercise method to stimulate the participants to rank the plant species that they consider most important for utilitarian and commercial purposes, and we employed the historical chart method to they represent the perceived changes in the availability of agricultural, wood, and medicinal plant resources over the last five decades. In order to further explore the historical chart results, we employed the thematic oral history method with those residents considered by the local people as having a high degree of knowledge about the local forest. Our findings show that people attribute great importance to the species of edible plants in the region, although they perceive them as having a low commercial potential. Regarding the perceived changes in the landscape, people indicated that there were declining areas of forest in the region, and that in the past, agriculture was practiced more intensely. Additionally, people perceive a decline in the availability of plants for wood purposes, and an increase in the availability of plants for medicinal purposes. These results indicate that even small rural populations can undertake significant changes in their surrounding ecosystems over time.

Keywords: Local Landscape Representations; Landscape Ethnoecology; Seasonally Dry Tropical Forests

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INTRODUCTION

Globally, rural populations living in the vicinity of forest areas have made substantial changes in these environments, mainly through slash-and-burn agriculture and extensive livestock farming (Cabral and Costa 2017; Schulz et al. 2016; Tomson et

al. 2015; Zhang et al. 2017). In addition, there is increasing evidence that the collection of timber and non-timber forest products (including fruits, leaves, tree bark and flowers for use as medicine or food), even on a small scale, can change plant communities in a long term (DeVries et al. 2015; Endress et al. 2004; Moegenbur and Levey 2005; Ruger et al. 2008; Specht et al. 2015). As a consequence, there have been efforts, mainly among landscape ecologists, to “isolate” and recognize the drivers of these changes, including demographic and socioeconomic factors (Babulo et al. 2009; Cavendish 2000; Medeiros et al. 2012) to try to predict the future of forest ecosystems (An et al. 2001; Pepper et al. 2017; Wang and Zhang 2001).

However, we still have a very limited understanding of how people from small rural populations deal and perceive these changes in their environments when they are themselves the agents of these changes. These qualitative aspects are also relevant because demographic and socioeconomic drivers alone may not be able to predict changes in ecosystems because these variables are not capable of assessing human behavior and their beliefs and ideologies. Assessing these factors is relevant because there is evidence that when people perceive changes in the local landscape, they may alter their behavior with regard to the use of forest resources and agricultural and livestock management (Boillat and Berkes 2013; Shikuku et al. 2017; Wood et al. 2014; Wyman and Stein 2010).

Therefore, our aim was to understand, with a case study, how people in a rural community that has undergone extensive anthropogenic transformations during recent decades perceive landscape changes. This study has an approach clearly practical and directed toward conservation applications, and the goal was to stimulate people to reflect about changes in ecosystems and become part of this discussion. However, we also have a theoretical approach with the goal of assessing the factors underlying representations of landscape changes, i.e., to understand the opinions, attitudes and ideologies that influences people’s interpretations of environmental changes.

We are not specifically interested in describing the actual transformations of landscape characteristics but rather in understanding how people define, perceive, and interpret these changes. Therefore, we have the following specific objectives: 1. to record which native plant species are perceived by the local people as being of greater utilitarian and commercial importance and discuss the potential of these species to contribute to subsistence and income generation; 2. to understand how people perceive the changes in plant resource availability over the last five decades according to three use categories that we consider potentially related to changes in the local landscape (agricultural plants, plants that provide useful wood and medicinal plants); and 3. to access the opinions and thoughts of local specialists of the region (individuals perceived as most knowledgeable about the ecosystems in the region) about the most important changes that they have witnessed during their lives as well as the factors that may have caused these changes.

MATERIAL AND METHODS

Study area

This study was conducted in the Sucruiu community, Barreiras Municipality (in Western Bahia State, Northeastern Brazil) in

2014 (see Figure 1). According to the most recent Brazilian demographic census (performed in 2010), Barreiras had a population of approximately 137,427 inhabitants, but its current population (in 2018) is estimated to be 153,831 inhabitants (IBGE 2018). Nearly 11% of this population lives in the rural area, and livestock rearing is responsible for approximately 16% of the gross domestic product of the municipality. Barreiras has a tropical climate (Aw/Köppen-Geiger) and two well-defined seasons: a dry season from May to September and a rainy season from October to April. Minimum and maximum temperatures vary from 20°C to 26°C respectively, and the annual rainfall varies from 800 to 1,600 mm (Embrapa 2010).

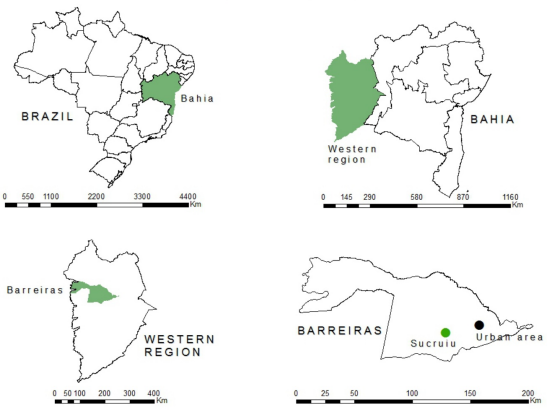

Figure 1. Study area

The ecosystems in the study region belong to the Cerrado domain, which is characterized by the presence of different vegetation types, including *campo limpo* (a kind of grassland), *campo sujo* (a shrub savanna), *campo cerrado* (a woodland savanna), *cerrado strictu sensu* (a woodland) and *cerradão* (a tall woodland) (Batalha et al. 2001). The Cerrado has high species diversity, of which a large portion is endemic, moreover this domain is considered the most diverse tropical savanna in the world (Klink and Machado 2005). The Cerrado is currently estimated to have only about 50% of its “natural” vegetation cover, although deforestation rates have decreased in the 2000s (Beuchle et al. 2015). In Western Bahia, most of the changes in plant cover between the 1980s and 2000s are due to the expansion of modern farming (mainly for soy and coffee production) and irrigation. Traditional farming was also responsible for changes in plant cover (albeit on a much lower scale), mainly for the reduction of grassland areas (Batistella and Valladares 2009).

The Sucruiu community (12°12’29.06” S and 45°15’24.03” W) is located approximately 25 km from the urban center of Barreiras. The local population consists of 28 households and is mainly composed of older men who were born in the community and women who migrated from the urban region to Sucruiu after marriage. Most inhabitants are small farmers who usually supplement their income with the extractivism of fruits that are sold in the urban center of the municipality. There are also some private farms in the community where some individuals work to supplement their income. Most of the younger individuals have emigrated to the urban centers in search of better jobs and different life styles. Because there is no health center in the community, residents have to go to the urban region if they need health care, but usually health agents go to Sucruiu to assist the families. Regarding education, the community only has an elementary school, and students must go to the urban center to complete their secondary education. At the beginning of our fieldwork, we explained the aim of the study to the residents and asked them to sign an informed consent form, as required by the Research Ethics Committee of the Brazilian National Health Council (Resolution 196/96). This research followed

the guidelines of the Declaration of Helsinki and Tokyo for humans, was submitted to the above-mentioned committee and was approved under number CAAE 07488513.4.0000.5026.

Data collection and analysis

Since we are interested in to access people percepcions about landscape changes, it is worthy to explain what we are designating as landscape. There are many different definitions of landscape, and we believe that for the purposes of our study, the definition from Crumley & Marquardt (1990) adjust very well. To these authors, the landscape is a spatial manifestation of the relationship between human beings and the environment. The landscapes are composed of two kinds of structures: socio-historical structures and physical structures. The socio-historical structures include class, inheritance, descent, political liaisons and interest groups, defense, trade and laws. While physical structures include processes that are relatively independent of anthropic influence, such as climate, topography, and geology (Crumley & Marquardt 1990). Although it may seem that we are interested in changes perceived only in physical elements of the landscape, there are socio-historical processes that are associated with these changes, and that will be accessed as well.

We employed two different approaches to assess people's representation of changes in the local landscape: participatory methods and a thematic oral history. For the former, all residents, including adolescents and children, were invited to a participatory workshop, in which 19 individuals participated including four aged older than 60 years, six aged between 20 and 30 years and nine adolescents and children. We did not separate the participants into focus groups but instead stimulated all individuals to engage in two techniques, which are explained in the next section. This workshop was conducted by five researchers, which stimulated all the individuals to have an effective participation.

During the participatory workshop, individuals were encouraged to make representations about changes in the landscape related to times that most of them did not experience. This may seem completely misleading, however, there are three aspects that we need to clarify. First, we are not interested in the factual changes that occurred in the landscape. Rather than that we are attempting to access what people think about these possible changes. Second, we are considering a concept of collective psychology called collective memories. Collective memories are the memories shared by individuals mainly through narratives and conversations (Coman et al. 2009). Relying on this concept, we argue that individuals who have experienced certain past events may have transmitted their memories about these events to younger individuals. We do not mean that this phenomenon standardizes individuals' memories about past events, rather than that we argue that the age of individuals does not preclude them from having opinions and worldviews about events they have not experienced (see Schuman and Rieger 1992; Schuman and Scott 1989). Finally, we emphasize that the participatory workshop provided an opportunity for individuals to reflect and discuss collectively about landscape changes.

For the thematic oral history (Medeiros et al. 2014), we employed the snowball technique (Albuquerque et al. 2014) to select individuals who are recognized by the local

population as having a high degree of knowledge about the ecosystems of this region. Although only five people were selected using this technique, we decided to not use an additional informant selection technique because we were interested in understanding the opinions of the individuals who were most knowledgeable about the forest ecosystems of the region.

Participatory methods

Exercise 1: Plant species of greater utilitarian and commercial importance

We used the scoring exercise method (Sieber et al. 2014) to stimulate the participants to indicate the relative importance of the local plant species they consider the most important in two previously defined use categories: utilitarian importance (subsistence use) and commercial importance. We clarified to the participants that "utilitarian importance" refers to the domestic uses that they make of the plants, such as firewood, construction, medicine or food. While "commercial importance" refers to perceived commercial potential. The objective of this categorization was to identify which species may contribute to the subsistence of the local population and which species may contribute to income generation and, thus, to discuss the potential of these species to contribute to the sustainable use of plant resources in the region.

We first asked the participants to list the 10 tree species they consider to be the most important as well as their uses and then which of the species have commercial importance. Afterwards, we asked the participants to assign scores (0 to 10) to each of the 10 selected species in both categories (utilitarian and commercial). In this method, the scores attributed to each species proportionally represent the importance of the species to the participants, i.e., its relative importance. To test whether there is a correlation between the relative importance of these species in the utilitarian and commercial categories, we calculated the Pearson correlation between the scores in both categories using the software BioEstat 5.0 (Ayres et al. 2005). Most of the species mentioned by the participants were collected, identified and deposited in the Herbarium of the Federal University of Bahia.

Exercise 2: Historical changes in plant resource availability

The second method employed in the participatory workshop consisted of the construction of a historical chart (Sieber et al. 2014), for which we asked the participants to represent the changes in the availability of plant resources in three previously defined categories: agricultural plants, plants that supply useful wood and medicinal plants; these categories were chosen to make the participants indirectly express the factors that may have contributed to changes in the local landscape. Ecological and ethnobiological studies have shown that subsistence agriculture, wood harvest for firewood or for building houses and fences and, tree bark extraction for medicinal use are the activities performed by small landowners with the greatest potential for altering the local landscape (Feitosa et al. 2014; Ferreira Júnior et al. 2012; Mamede and Araújo 2008; Medeiros et al. 2011; Ramos et al. 2008a,b; Sobrinho et al. 2016). As part of this method, we directed the participants to represent the availability of these elements using graphical representations of trees, with

10 trees indicating maximum availability, and we further asked them to represent the availability of these elements 50 years ago, 30 years ago, 10 years ago and presently. During this exercise, some participants expressed their opinions on the factors related to the changes in plant resource availability; we recorded their discourses and presented them in the results section.

Thematic oral history

In this method, we directed the participants to describe changes in the forest ecosystems of the region by asking the following question: "Which changes in the landscape do you remember have witnessed during your lifetime?" The thematic oral history is a data collection method which is qualitative, subjective, and fully open (Medeiros et al. 2014). We have used it aiming to understand the perceptions, opinions and thoughts of individuals known for their outstanding knowledge of local ecosystems in terms of the most important landscape changes and their driving factors. Therefore, we highlight that the results of this analysis represent the perceptions of only five informants and are intended to complement and deepen the information obtained with the historical chart.

The discourses of these informants were recorded and transcribed and then analyzed using the collective subject discourse analysis (Lefevre & Lefevre 2005). This method consists of a qualitative analysis of the narratives of the informants with the intention of constructing one or more synthetic discourses that represent a given thought about or social representation of a phenomenon, and it involves seeking central ideas and their corresponding key expressions in the discourse of each individual and then using the key expressions of similar central ideas to construct one or more discourses. The key expressions are excerpts or literal transcriptions of the discourses that reveal the essence of the narrative or, more precisely, of the discursive content of the segments into which the narrative is divided. In turn, the central ideas are names or linguistic expressions that reveal and describe, in the most synthetic and precise mode possible, the meaning of each of the analyzed discourses and of each homogeneous set of key expressions (Lefevre & Lefevre 2005). It was not possible to construct a collective subject discourse for just one central idea that was recorded from a single informant; in this case, we simply transcribed the key expressions of their discourse.

RESULTS

Representations of the usefulness of the local flora: utilitarian and commercial importance

In the scoring exercise (Table 1), we observed that people seem to assign great importance to the species of edible plants in the region, although some species for medicinal and wood purposes have also been listed among the most important. However, they perceive a low commercial potential for most of these species. We did not find a significant correlation between the utilitarian and commercial scores ($r=0.12$, $p=0.74$), indicating that the people may have different motivations for attributing utilitarian and commercial importance to a plant species. Two species (*Mauritia flexuosa* L.f. and *Myracrodruon urundeuva* Allemão) attained the maximum score (10) for both categories, utilitarian and commercial. Whereas the former species is noted for the

Table 1. Plant species perceived as outstanding in terms of utilitarian and commercial importance in the community of Sucruiu, municipality of Barreiras, Northeastern Brazil. Grades for each species were between 0 and 10 and were given by local dwellers using participatory techniques.

Species (common name/scientific name)	Voucher #	Local uses	Utilitarian importance	Commercial importance
Buriti (*Mauritia flexuosa* L.f.)	Identified in field	Food	10	10
Umburana (*Amburana cearensis* (Allemão) A.C.Sm.)	BRBA 5.484	Wood	10	0
Pequi (*Caryocar brasiliense* Cambess)	Identified in field	Food	8	6
Mangabeira (*Hancornia speciosa* Gomes)	BRBA 5.541	Food	10	0
Jatobá (*Hymenaea stigonocarpa* Mart. Ex Hayne)	BRBA 5.482	Food/Wood	5	9
Cajuí (*Anacardium humile* A.St.-Hil.)	Identified in field	Food	10	5
Barbatimão (*Stryphnodendron polyphyllum* (Mart.) Coville)	BRBA 5.609	Medicinal	6	0
Bruto (*Annona crassiflora* Mart.)	BRBA 5.595	Food	8	6
Alcanfozinho (*Croton bidentatus* Muell Arg.)	BRBA 5.504	Medicinal	0	6
Aroeira (*Myracrodruon urundeuva* Allemão)	BRBA 5.501	Wood/Medicinal	10	10

dietary importance of its fruits, *M. urundeuva* is noted for its wood and medicinal uses; according to the participants, the greater importance attributed to *M. urundeuva* is due to the quality of its wood.

In the historical chart (Table 2), the participants indirectly represented that the local population possibly conducted intense agricultural activities 50 years ago and that there was an abrupt decline in this activity between 50 and 30 years ago; afterward, agriculture declined more gradually. The availability of wood resources showed a similar pattern as the participants indicated that there was high regional availability of these resources approximately 50 years ago followed by an abrupt decline between 50 and 30 years ago and a more gradual decrease in recent years. The availability of medicinal plant resources exhibited a different pattern, with low availability until approximately 30 years ago, an abrupt increase between 30 and 10 years ago and a stabilization in recent years.

Table 2. 50-year change on natural resource availability (crop, timber, and medicinal resources) as perceived by local dwellers in the community of Sucruiu, municipality of Barreiras, Northeastern Brazil. Grades were between 0 and 10 and were given by local dwellers using participatory techniques.

Time (years past)	Crop	Timber	Medicinal
Over 50	10	10	4
30	5	4	4
10	3	3	10
Today	2	2	10

Some participants expressed opinions about these changes as follows:

Here, there was so much (wood); there were carts full of wood; there was so much. Informant J.

The IBAMA (Brazilian Institute of Environment and Renewable Natural Resources) regulates so much that people don't plant anything more and so that no one removes the forest to avoid floods. Informant R.

Currently, no one plants anything anymore. Informant J.

Discourse of experts regarding changes in the local landscape

By using the central ideas extracted from the narratives of the five selected key informants, we detected some patterns in their discourses about changes in the local landscape (Table 3). When asked which landscape changes they remember to have witnessed during their lifetimes, all informants reported that the forests in the region were denser in the past and that deforestation has been ongoing. However, the informants showed little propensity to clearly speak about the factors to which they attribute these changes in the local landscape. Only one informant clearly stated that the forests were converted into agricultural areas.

In addition, the informants did not speak just about changes in the ecosystems; four of the informants reported changes in the regional infrastructure (including road construction, electricity installation, public transportation, and automobiles) that resulted in quality-of-life improvements for the community. This is important because it shows that as perceived by these informants, the landscape is not only composed of the local ecosystems but of anthropogenic elements as well. Moreover, regarding the anthropogenic landscape elements, three of the informants reported that agriculture was a very important activity in the past but showed no clear recognition that this activity contributed to changes in the local landscape. Instead, the informants stated that there was a decrease in agricultural production and attributed this decrease to climate factors.

DISCUSSION

We observed that the studied population perceives great importance in the edible plants of the region. These findings are in line with others ethnobotanical studies that were carried out in the Cerrado region (see Lima et al. 2012; Sousa 2014). Particularly the latter study observed that many species of edible plants are among those of greater cultural importance for the people, although the central species in the culture of the populations studied by Sousa (2014) are those that are the target of extractivism, and that, consequently, contribute significantly to the family's income.

Interestingly, in this respect, the human populations that inhabit areas of the Cerrado domain differ from those inhabiting areas of the Caatinga, which is another type of seasonally dry tropical forest that occupies extensive areas of the Northeast of Brazil. In areas of Caatinga, there are few species of native edible plants that are usually consumed; in these regions the abandonment of the consumption of these species seems to be associated to a social stigma, since these were consumed mainly in times of great droughts, and, consequently, times of food scarcity (Cruz et

Table 3. Central ideas and key expressions identified in the discourse of the collective subject concerning landscape changes among five local specialists in the community of Sucruiu municipality of Barreiras, Northeastern Brazil. The numbers in parenthesis refer to the number of local specialists who expressed each of the central ideas.

Central ideas	Discourses of the collective subject
There was a dense forest here, but now it has been reduced. (5)	*There was a virgin forest here, with a lot of wood. It was only forest here…. Only a dense forest. It was a weird forest. No gap could be seen. Then things began to get scarce. And it got scarcer and scarcer. And now it is like that. Now the amount of wood decreased…the number of trees decreased. The old trees get died and the young trees are not like the former.*
There were improvements in our life conditions. (4)	*It is worse now than before because there used to have more trees. But things are better for us. They got much better. Nowadays this region is much more organized. There are roads, cars, there is transport…we no longer need to walk on foot. We did not have electric energy before. We used lamps and gas.*
It was possible to assure our subsistence through agriculture before, but not now (3)	*It was very good to work and to grow plants here before…we use to plant, and we could harvest out crops. We worked in our own fields, we use to plant cassava...we use to plant many things. But now everything changed a lot...we cannot even compare today to the past times. Nowadays if someone plants something he cannot harvest.*
Landscape changed because it is no longer raining as it used to in the past (2)	*I think that these (landscape) changes may have occurred because of the lack of rain. Rain is scarcer now, isn't it? Everyone can see that it is not raining as it did before**
Landscape changed because of the agriculture (1)	*It was only forest here...but people have begun to plant here, and it (the forest) became like this*

* This central idea indicates that individuals were more prone to talk about changes in agricultural fields, instead of talk about the forest.

al. 2014; Nascimento et al. 2012). This kind of behavior concerning native edible plants is probably less common in Cerrado areas because drought events may have been less intense or less frequent in these regions. In addition, the consumption of several food plants of the Caatinga requires a very elaborate preparation, which is not required for species of the Cerrado.

From a conservationist perspective, it is quite interesting that most of the species perceived as being the most important are trees from which non-timber forest products are obtained and whose harvest may be less harmful to the plant populations than those exploited for wood (Ticktin 2004). Many of these species, including *M. flexuosa* L.f, *Caryocar brasiliense* Cambess and *Hancornia speciosa* Gomes, are reported in the literature as having great potential for making many culinary and cosmetic products as well as handicrafts (Araújo 1995; Cavalcanti et al. 2015; Martins et al. 2012; Nascimento et al. 2015; Pinto et al. 2016). However, this potential is not relevant by itself if it is not perceived by the people or if they are unable to collectively organize themselves to manufacture and process these products. Based on a case study of extractive communities, there is evidence that in situations which people are unable to organize themselves socially and politically to process plant products, the individual may adopt individualistic and competitive behavior, with each one collecting as many resources as possible. This social behavior may lead to overexploitation of plant populations, resulting in depletion of the resources used by the entire extractive population (Silva et al. 2015). In the case of the studied community, the processing of *C. brasiliense* and *M. flexuosa* is incipient and includes only oil extraction. The absence of cooperatives and other means of social organization related to the harvest and commerce of these species may also direct the local context toward unsustainable use.

Therefore, the low commercial potential perceived for most species is not due to the intrinsic characteristics of the species, since there is literature that shows that this potential has been explored in other communities, as mentioned above. Actually, this observation can be due to the lack of an adequate economic and logistic structure for the production and commercialization of these products. The economic viability of extractivism of non-timber forest products depends on a series of economic and political factors that need to be evaluated on a case-by-case basis (see Harbi et al. 2018). Therefore, it is possible that the local population perceives these difficulties and recognizes a low potential of these products in contributing to the increase of their incomes.

Regarding changes to the local landscape, the two methods used in this study (historical chart and thematic oral history) permitted these changes to be synthesized. The local population perceives that there was a dense and extensive forest in the region that, according to all indications (the results of the historical chart), was reduced due to agricultural conversion and the harvest of wood products. However, agricultural activity seems to have decreased over for a series of reasons including regulation by environmental agencies, changes in the rainfall regime and migration of the younger individuals. In addition, there were improvements in the local infrastructure (installation of electricity and road construction) and an increase in the perceived availability of medicinal plants.

This synthesis is inferred based on our results, but the community members showed little inclination to discuss clearly about the

factors that reduced the forested areas. In general, we only noted the discourse of a dense forest that kept decreasing or was cut down, and this narrative is essentially similar to that observed by Silva et al. (2014) in populations of small farmers using a riparian forest area in northeastern Brazil. A first explanation for this type of discourse is that the people were still not comfortable discussing this subject even though our research group has worked in the community for approximately three years. In addition, in studies conducted by biologists, the informants may fear that the researchers work for environmental regulatory agencies (Silva et al. 2014).

However, another possible explanation that has been little explored in studies of environmental representation is that this discourse may be a consequence of moral disengagement. Social psychology theoreticians argue that our moral behavior has an internal self-control system based on the moral norms of a society, but there are situations in which people, via different psychological mechanisms, may disengage from moral conducts, thus allowing themselves to perform immoral acts (Bandura et al. 1996). The most common moral disengagement behaviors include moral justification (when people reinterpret an immoral behavior to consider it socially acceptable), advantageous comparison (when people justify and accept immoral conduct through comparison to other, more grievous conduct), displacement of responsibility (when people view their actions as springing from the social pressures or blame the others rather than acknowledge that they are personally responsible), and euphemistic labeling (when individuals use language to justify an immoral act, such as "giving a lesson to someone" in the sense of assaulting an individual, or "telling a story" in the sense of lying) (Bandura et al. 1996; Doyle and Bussey 2017).

The type of moral disengagement behavior that appears to lead to the discourse observed in this study is the responsibility diffusion, in which the agentive relationship between the actions and consequences of any sort of conduct are obscured or distorted. Responsibility diffusion can lead individuals to perceive that no one is guilty because all are responsible for a harmful behavior, that is, the responsibility diffuse so much in the population that no one fells himself as responsible (Bandura et al. 1996; Beyer et al. 2017; Corrion et al. 2009; Robson and Witenberg 2013). Thus, as all the individuals in the population are agents of the changes in the ecosystems of the region, no one necessarily feel responsible for this conduct.

Although moral disengagement processes (including responsibility diffusion) were firstly studied to understand aggressive behaviors, recent studies have also employed these phenomena to explain other types of attitudes, including the decision to tell a lie (Doyle and Bussey 2017), violate a the rules of a sport (Corrion et al. 2009) or the willingness to answer doubts from stranger individuals by e-mail or on social network sites (Barron and Yechiam 2002; Martin and North, 2015). More recently, Campos et al. (2018) noted that an indigenous population in Northeastern Brazil perceived a great decline in the abundance of a palm species of great importance to them, but they apparently did not see themselves as causal agents of such decrease. They attributed this decline mainly to the tenants who live in their lands, even themselves being the leasers. Therefore, although the authors did not choose this line of argumentation, this is clearly a case of

moral disengagement, more specifically a case of displacement of responsibility (see Bandura et al. 1996). However, situations in which individuals from rural populations alter regional ecosystems for their own subsistence may be a more complex scenario, as the people may recognize that some conduct may be inappropriate but employ it anyway due to their dependence on these resources for survival.

It is possible that the main processes that led to the reduction of the forested areas in the study region are small-scale agriculture and wood collection. The agricultural fields in the study region are managed by slash-and-burn, which applies to different types of agricultural systems in which gaps are opened in primary or secondary forest by cutting down and burning the vegetation. When the productivity of the agricultural field declines after a given period, there is a fallow period, and the farmer searches for new areas for production (Fujisaka et al.1996).

Many landscape ecology studies have attempted to understand the consequences of these agricultural practices in different parts of the world with quite diverse findings, so there are opposing opinions regarding these practices within scientific academia. On the one hand, some researchers see slash-and-burn agriculture as a predatory practice that is responsible for the deterioration of tropical forests, so these authors propose alternative agricultural systems (Pedroso-Junior et al. 2008). On the other hand, other researchers attempt to demonstrate the sustainable nature of slash-and-burn agriculture and defend the maintenance of this traditional practice (Pedroso-Junior et al. 2008).

It is possible that these opposing views are the result of the wide variety of management techniques classified as slash-and-burn agriculture. Certainly, the harmful effects of this practice (as indicated by our local scenario) may result from inappropriate management strategies, including a short fallow period and a lack of management of these fallow areas. Short fallow periods can preclude plant populations from reestablishing, resulting in areas with a lower density of plants, and with a smaller basal area (Sobrinho et al. 2016). In a way, this corroborates the discourse of some informants on the changes to the local landscape as exemplified by statements such as *“The new branches are never like the first ones”* or *“Now the branches are smaller; the trees are smaller; the trees are not like before”*.

Another process that appears to be responsible for the reduction in the forested areas in the region is wood collection. The local population uses wood from the surrounding vegetation for fuel (firewood and coal), constructing houses and fences and for making objects such as tables, chairs, and windows. Although it may seem difficult to recognize that subsistence wood collection by a small rural population may result in substantial changes to local ecosystems, there is evidence in the literature that this process may occur, and the explanation is based on the behavior related to the use of wood resources. Among the different types of wood resource use, fuel use is the most harmful to plant populations as people need to collect these resources more frequently and in larger amounts than for other uses (Medeiros et al. 2011).

This high frequency of natural resource use combined with the fact that the ecological consequences of this activity may occur just in the medium to long term has led ecologists to consider the use of wood by small rural populations as a chronic

anthropogenic disturbance. From this perspective, even the extraction of small amounts of natural resources may have irreversible consequences for the harvested plant populations if this extraction is frequent (Kittredge Junior et al. 2003; Lung and Espira 2015; Martorell and Peters 2005; Sagar et al. 2003; Singh 1998). In addition, another factor that reinforces the harmful character of native wood collection is that people employ certain criteria to select the species that they use, including local preference, so some species are more affected than others (Dahdouh-Guebas et al. 2000; Mutchnick and McCarthy 1997; Nascimento et al. 2009; Ramos et al. 2008b; Tabuti et al. 2003). Therefore, it is worrisome that three of the 10 species ranked as the most important to the local population are used for their wood, including for commercial purposes.

Contrary to what was observed in terms of the availability of agricultural and wood resources, the local population perceives an increased availability of plants with medicinal use. However, this increase may be either due to an increase in the availability of medicinal plants in anthropogenic areas or due to the ingress of exotic plants, from markets or transported by individuals from nearby urban areas. Therefore, we believe that this increase in perceived availability may corroborate the hypothesis of diversification in local medical systems, by which the local populations in rural areas select common exotic plant species to diversify the possible treatments in their local medical systems (Albuquerque 2006; Alencar et al. 2010; Hart et al. 2017; Medeiros et al. 2017).

CONCLUSIONS

Based on local perceptions, this study provides evidence that even small rural populations may be responsible for intense landscape transformations over a relatively large time span (decades). In addition, we observed that people are able to identify processes responsible for changes in local ecosystems, however individuals show little inclination to recognize themselves as contributing agents of these changes. In this context, this behavior may be harmful from a conservationist perspective because individuals who do not consider themselves responsible for changes in the local landscape may continue to present this behavior of unsustainable resource use. However, we highlight that these findings must be cautiously considered to avoid inciting preservationist discourses, as the observed behavior may be a consequence of the complexity of the situations in which people largely depend on forest resources for survival.

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