



Sustainability of tropical dry forests: Two case studies in southeastern and central Brazil

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ABSTRACT

In this study, we review the current available information on the social–ecological context of Brazilian tropical dry forests (TDFs), a vegetation type that covers approximately 3% of the country territory. For this purpose, we conducted a comparative analysis of two case studies, one study in the north of Minas Gerais state and the other in Paranã River Basin, situated in southeastern and central Brazil, respectively. We compiled published bibliographical and census-based data for the two regions, concerning the historical human occupation and land use and the environmental and development policies affecting TDF management and sustainable use. Brazilian TDFs usually occur in semi-arid climates, and have been intensely converted mainly to extensive pasturelands in large farms, thus leading to high income concentration in those areas. Our case studies involve less-developed regions that support populations with very low human development indices, which is the norm for Brazilian TDFs. Many of these are traditional populations, such as indigenous and slave descendents, with peculiar cultural practices only recently considered in government policies proposed for the forest management. Though the two regions have similar land use histories, current social–ecological scenarios are very different. In the north of Minas Gerais, TDF conversion policies were debated intensely for the last 15 years, recently resulting in a state law specifically generated to regulate TDF use. Also, this region has 20 conservation units (CUs), some of them delimited inside the territories of the several traditional populations that inhabit TDF areas. This process caused enduring conflicts that can affect both CUs' effectiveness and the sustenance of these populations. In the Paranã River Basin, there is no specific policy towards TDFs, whose use is regulated by the 43-year-old Brazilian Federal Forest Code. There are only four CUs in this region, and most traditional populations were expelled from their original territories and consequently lost their cultural identity. Government sustainability strategies are limited to the establishment of CUs, a response that may disregard social demands and cultural practices, depending on the local context. Given the uniqueness and threat level to TDFs, specific and more diversified policies towards land use should be established for these ecosystems in order to stimulate low-impact activities that maintain ecosystem services and improve the livelihoods of TDF inhabitants.

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1. Introduction

Tropical dry forests (TDFs) are among the most threatened ecosystems in the Americas, where they were historically

preferred for human settlements and agricultural activities (Maass, 1995; Ewel, 1999). In Brazil, TDFs extend over 27,367,815 ha, representing 3.21% of its territory (Sevilha et al., 2004), predominantly distributed in the semi-arid northeastern region (Fig. 1). As in other parts of the world, Brazilian TDFs are neglected in terms of research and conservation efforts compared to tropical rain forests (Sánchez-Azofeifa et al., 2005; Espírito-Santo et al., 2006). For this reason, human occupation and land

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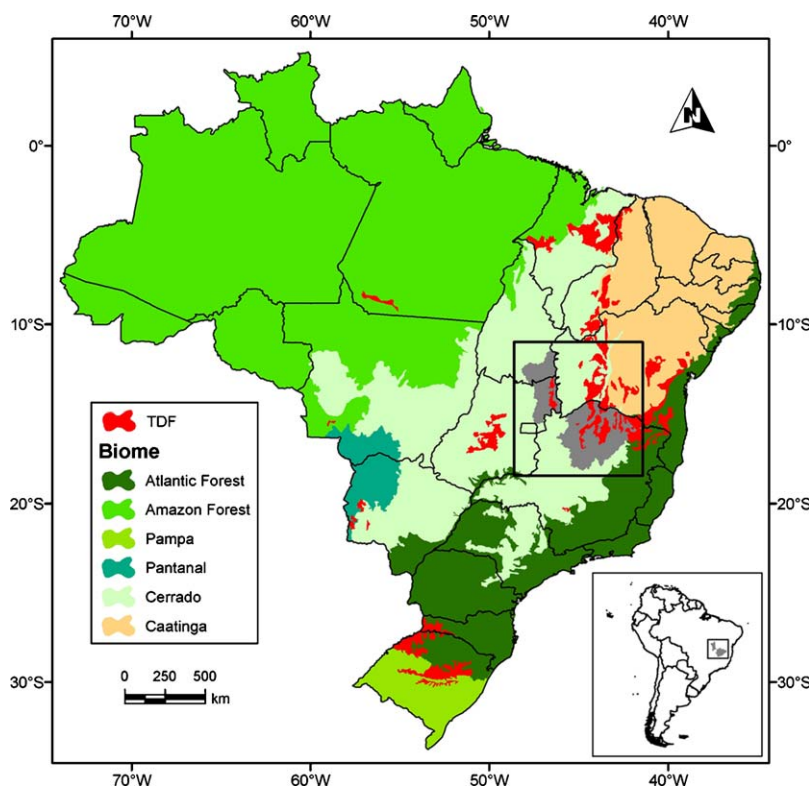


Fig. 1. Map of major Brazilian biomes, based on the classification made by IBGE (1992). TDF distribution was defined in the vegetation map also produced by the IBGE in 1988. Notice that TDFs are scattered throughout several different biomes. Gray areas represent the north of Minas Gerais (southeastern Brazil) and the Parana River Basin (central Brazil).

use, deforestation rates and the real status of conservation of the remaining TDF fragments are largely unknown.

As a result of the high proportion of valuable timber species and fertile soils where these forests occur, Brazilian TDFs are in high demand for logging and farming, the main drivers of land cover change in this ecosystem (Scariot and Sevilha, 2005; Anaya et al., 2006). Another important threat is the mining of limestone outcrops, which are commonly encountered where TDFs occur. Due to high deforestation rates and their restricted distribution, TDFs can be considered the most threatened ecosystem in Brazil. Large intact areas are now rare, found almost solely in a few conservation units (CUs), due to the local government's limited conservation strategy towards this ecosystem. In the farmland landscape, only small fragments of TDFs remain, most of them disturbed by selective logging and cattle ranching (Sevilha et al., 2004; Scariot and Sevilha, 2000, 2005).

TDF distribution in Brazil includes some of the poorest regions of the country, thus any conservation strategy for these ecosystems must address human welfare and social justice. The predominant model for nature preservation adopted in Brazil is derived from the American concept of protected areas, which is essentially the conservation of "pieces" of the natural world in their original state (Arruda, 2000). The primary expression of this concept is the creation of CUs of Restricted Use (equivalent to IUCN categories Ia, II and III), where the only allowed human activities are the tourism, education and scientific research. Frequently these areas of limited access are established in territories historically occupied by vulnerable human populations, precluding their access to natural resources that are essential to their survival. The paradigm of "sustainable development" emerged in the late 1980s (World Commission on Environment and Development, 1987) and posed an alternative conservation strategy to CUs and the conflicts generated by their creation. In spite of its vagueness (Mebratu, 1998; Robinson, 2004), the concept of sustainable development

implies a consensus among economic, social and environmental interests (World Commission on Environment and Development, 1987; Robinson, 2004; Teixeira, 2005). However, the Commission's findings are often interpreted as a set of compensatory actions and technical adaptations to legitimate large market-oriented projects, such as agriculture, mining, energy production and the raising of livestock (Zhou et al., 2005; Leff, 2006). In this sense, sustainable development strategies usually place a high priority on economic growth and devalue social diversity, ignoring traditional management practices of local populations as sustainable forms of land use and poverty alleviation.

In order to address sustainability issues for a given region, it is necessary to analyze the social conflicts involving the access to natural resources, which are inevitably inequitable and determined by longstanding practice. This paper aims to understand the social–ecological context of Brazilian TDFs, through the examination of two case studies in the north of Minas Gerais state and the Parana River basin, situated in southeastern and central Brazil, respectively. These two regions had different human activities over the past several centuries and were subjected to contrasting developmental and environmental policies in the last few decades. Also, they represent some of the most active current frontiers of deforestation and forest degradation in the country. Thus, we compiled published bibliographical and census-based data to revise the available information on the historical occupation and land use in these regions. We also conducted a comparative policy analysis in order to explain the situation of TDFs and of the inhabitants whose livelihoods highly depend upon TDF management.

2. The case studies: general context

The north of Minas Gerais encompasses approximately 120,000 km² (20.7% of the state area; Fig. 1), characterized by a

large transitional area between three biomes: the Cerrado at the south and west, the Caatinga at the north, and the Atlantic Rain Forest at the east (Fig. 1). The predominant climate is tropical semi-arid, with dry winters (May–September) and rainy summers (November–March; Aw in Köppen's classification), with average precipitation ranging from 700 to 1200 mm and average temperature between 21 and 25 °C (Antunes, 1994). Fifty percent of the original vegetation in the north of Minas Gerais remains intact, comprised mainly of Cerrado and dry deciduous and semi-deciduous forests in different successional stages (Scolforo and Carvalho, 2006). This region is inhabited by 1.5 million people (65% reside in urban areas), and is one of the poorest regions of the state, with a low human development index (HDI = 0.697; the whole state = 0.773; Brazil = 0.757) (IBGE, 2000). The most important economic activity is extensive cattle ranching (59% of the rural areas), supporting an estimated 3,700,000 head of cattle in 2006 (Rodrigues, 2000; IBGE, 2006). Other important activities include agriculture (21.6% of the rural areas), primarily cultivating corn, beans, manioc, banana and sugarcane; and silviculture (11.7%) (Rodrigues, 2000). Most of this production is commercial and conducted in large farms: only 17% of the rural properties are larger than 100 ha, but occupy 84% of the farm area in the region.

The Paranã River Basin has 59,403 km² and is part of the Tocantins River Basin, in central Brazil (Fig. 1), situated inside the Cerrado biome, in a transition zone between the Amazonian Rain Forest and the semi-arid Caatinga biomes. This region is covered by a mosaic of savanna and forest formations, and possesses some of the last remnants of flat-land TDFs in Brazil (Scariot and Sevilha, 2005). These forest remnants represent less than 5% of the original TDF area (Andahur, 2002). TDFs occur from 400 to 600 m asl in areas with the same climate type as that which occurs in the north of Minas Gerais. Average temperature ranges between 16 and 21 °C, and average annual precipitation is approximately 1200 mm, concentrated (89%) between October and March (Scariot and Sevilha, 2000, 2005; Sevilha et al., 2004). The Paranã River Basin is inhabited by 300,000 people, 69% of whom reside in urban areas. There is a large variation in developmental indices among its 33 counties, with HDI ranging from 0.603 to 0.750. The average HDI for the Paranã River Basin region is 0.665, much lower than the level observed for the states of Goiás (0.770) and Tocantins (0.721), the immediately surrounding area (IBGE, 2000). Only 45% of the rural properties at the Paranã River Basin include acreage between 10 and 100 ha (IBGE, 2000), located mainly in the most rugged terrains. On the other hand, flat areas with high-fertility soils tend to have larger farms (over 500 ha) (Scariot and Sevilha, 2005). The regional economy is dominated by cattle ranching farms (69.4% of the rural areas), supporting 1,300,000 head of cattle (IBGE, 2000; Scariot and Sevilha, 2005), followed by farms with both agriculture and cattle ranching (15.5%), and farms used exclusively for

agriculture (11.6%). Other rural economic activities consist of forestry, logging, charcoal production, fishery, and aquaculture (IBGE, 2000; Scariot and Sevilha, 2005).

3. The north of Minas Gerais

3.1. Historical human occupation and land use

The first record of human occurrence in the TDFs in Brazil dates from 12,000 years ago, populated by natives from various nomadic hunters/collector tribes (Schimiz, 1993; Barbosa and Schimiz, 1988; Ribeiro, 2005). During this period, humans occupied all of northeastern, central-eastern and southeastern Brazil. In the north of Minas Gerais, the European colonizers arrived in the 16th and 17th centuries aiming to capture the natives to work as slaves in the coastal plantations, to discover and explore natural resources and to populate the interior regions of the country (Ribeiro, 2005; Costa, *in press*). These colonists adopted cattle ranching as their main economic activity, since the animals adapted easily to semi-arid conditions (Rodrigues, 2000; Ribeiro, 2005). With the labor of native and African slaves, pastures were established throughout large farmland areas, which concentrated economic and political power in the region until the 1950s (Costa, *in press*; Fig. 2).

After the Second World War, the Brazilian government created an agency for the development of the northeastern region (called SUDENE – Superintendência para o Desenvolvimento do Nordeste), including the north of Minas Gerais. The SUDENE launched a program of modernization policies for the region, with a large federal development plan that included financial incentives intended to diversify the economy (Rodrigues, 2000; Costa, *in press*). This program was structured over three main axes: (i) large irrigation-based agricultural projects; (ii) industrialization, and (iii) reforestation with the exotics *Eucalyptus* and *Pinus* to produce charcoal and to support the metallurgy sector in central Minas Gerais State (Rodrigues, 2000; Anaya et al., 2006). The modernization process defined a new social–economic scenario for the north of Minas Gerais. In spite of a significant improvement of the productive infrastructure, the development program was not able to generate enough job positions in rural areas, causing massive migration to urban areas (Rodrigues, 2000). In addition, it necessitated the maintenance of large commercial farmlands, leading to income concentration and reinforcing the great social inequality in the region. Finally, the lack of strict environmental regulations increased deforestation rates, water pollution and, consequently, zoonotic and water-borne diseases.

The modernization process had a deep impact on the several traditional populations that inhabited the north of Minas Gerais, such as African slave descendents (“Quilombolas”), an indigenous people (the Xakriabá tribe), and groups specialized in using natural

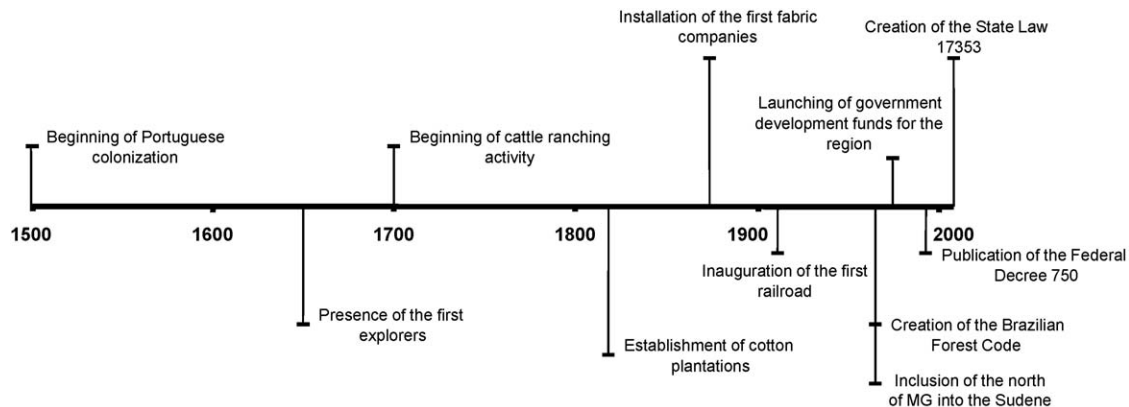


Fig. 2. Timeline of major events regarding the human occupation and environmental policies in the north of Minas Gerais.

resources from the Cerrado (“Geraizeiros”), from the TDFs (“Caatingueiros”), and from the margins of the São Francisco river (“Ribeirinhos” and “Vazanteiros”) (Dayrell, 1998; Costa, *in press*). So far, 153 communities of Quilombolas (CEDEFES, 2008) and 12 communities of Vazanteiros (C. Dayrell, personal communication) were recognized in the region. Since these populations did not have land possession titles, the establishment of large commercial farmlands systematically expelled them from their ancestral territories. Many of them migrated to the surrounding cities, to poor-quality lands, or to labor at the large commercial farmlands that usurped them.

Recognizing the fragility of these populations, the Brazilian government launched the National Policy for the Sustainable Development of Traditional Populations and Communities (Federal Decree 6040, February 2007). This policy defined traditional populations as “self-recognized, culturally distinct groups, with a particular social organization, which occupy and use the natural resources as a condition for their cultural, social, religious and economic perpetuation, using knowledge, innovations and practices generated and transmitted by tradition”. It guarantees the possession and sustainable use of resources in their territories. In addition, this policy aims to promote the social inclusion of traditional communities by providing and encouraging the use of sustainable technology that preserves local natural resources and by inclusion of their products in local markets.

The main characteristics of a traditional population are (i) a certain degree of geographic isolation, (ii) adaptation to a specific ecological habitat, and (iii) social cooperation (Diegues and Arruda, 2001). Each traditional population has a different form of perceiving, representing and using its territory. For this reason, their adaptation to the ecological environment is highly complex. According to Santos (2002), the territory is formed by an inseparable conjunction of the physical substrate (natural or artificial) and its use. In this sense, the concept of territory is both technical and political, aggregating the natural systems and the anthropogenic historical context. Cultural and management practices of traditional populations are integrally linked to their territory and were developed over generations, leading to currently observed sustainable land management and resource use. For example, the Xakriabá tribe consists of 7000 individuals occupying an area of 53,000 ha of Cerrado and TDFs in the north of Minas Gerais. Their cultural organization and practices were devastated during the colonization process in the 17th century, and replaced by the dominant economic activities in the region, especially cattle ranching (Diniz et al., 2006). Recently, NGOs such as the Center for Alternative Agriculture are trying to revive traditional management techniques used by these populations and help them promote a sustainable use of their reserves. This strategy includes the establishment of agroforestry systems, with plantation of corn, beans and manioc in the understorey of TDFs, preventing deforestation and maintaining ecosystem services. Also, forest recovery will also be promoted with the propagation of native trees and exotic fruit-bearing plant species.

3.2. Influence of environmental policies

Policies affecting TDFs in the State of Minas Gerais have recently become controversial. In 1965, the new Forest Code (Federal Law 4771) stated that 20% of a given rural property in Brazil (with the exception of the Amazonian region, where this area increases up to 80%) should be left intact as a legal reserve. Given the historically high levels of deforestation in the Atlantic Rain Forest, which reduced this biome to less than 7% of its original area in the 1990s (Morellato and Haddad, 2000), the Brazilian government decided to expand its specific policies regarding occupation. Consequently, the Federal Decree 750, published in 1993, prohibited the

exploitation and suppression of the primary and secondary vegetation in intermediate or late stages of regeneration in the Atlantic Rain Forest. The main controversy generated by Federal Decree 750 emerges from the fact that TDFs are considered to be a formation or associated ecosystem of the Atlantic Rain Forest, thus conferring upon them the status of a “specially protected ecosystem.” Furthermore, the aforementioned decree stated that the boundary of each forest formation is defined by the vegetation map of the Brazilian Institute of Geography and Statistics (IBGE, 1992), produced in 1988 in a 1:5,000,000 scale.

The Federal Decree 750 has created three main practical problems for TDF management: (i) TDFs are formations encountered in four different biomes: Atlantic Rain Forest, Cerrado, Caatinga, and Amazonia (see Fig. 1). In transition zones, such as the north and northeastern Minas Gerais, it is difficult to associate a TDF with a particular biome, and different authors claim the region belongs to Caatinga or Atlantic Rain Forest (Rizzini, 1963; Andrade-Lima, 1981; Prado, 2003); (ii) due to its imprecision and age (20 years), the IBGE map is not useful for the definition of vegetation cover in the field, and updated maps at finer scales do not exist. For example, some regions of TDFs in Minas Gerais can be interpreted from the map as either Cerrado, Caatinga or Atlantic Forest, designations that might change their protection status; and (iii) the decree has no legal parameters with which to differentiate forest successional stages, and the final decisions have been made after a subjective evaluation of analysts by the Brazilian Institute for the Environment and Renewable Natural Resources (IBAMA), and by the State of Minas Gerais’s Forestry Institute (IEF). The last problem was resolved in June 2007, when the Ministry for the Environment published the Resolution 392, with more precise definitions of successional stages, based on forest structure and composition. The other two practical problems still generate discussion between policy-making agencies and conservation organizations.

Since the publication of Federal Decree 750 in 1993, environmental agencies entrusted with conservation enforcement have suffered severe political pressures from Brazilian rural associations (called “ruralists”) at the under-developed north and northeastern parts of Minas Gerais, which are predominantly covered by TDFs. As a result, several state resolutions were produced to regulate the use of these ecosystems. In 2002, State Forestry Law 14309 considered TDFs, commonly called “Matas Secas”, as a “specially protected ecosystem” at the state level, and appointed the Environmental Policies Council (COPAM) to be responsible for regulating their use. In 2004, the Council published a new legal norm entitled DN 72 that established that up to 20% of a given private property covered with mature TDFs can be deforested, but only for sustainable agriculture and ranching projects. In properties with TDFs at secondary stages of regeneration, up to 60% of the area could be converted to such projects. After intense protests of ruralists, who presented a technical study demonstrating that this restriction would be responsible for the loss of 90,000 job positions in the region (EMATER, 2005), this norm was blocked by the Minas Gerais State Chamber of Representatives in 2005. With this procedure, Federal Decree 750 prevailed again, with TDFs again a “specially protected ecosystem,” and no deforestation was allowed thereafter.

After almost 14 years of debate, a new “Atlantic Rain Forest law” (Federal Law 11428) was published in December 2006. This new federal law did not provide any changes to the current status quo regarding land use change in TDFs, but the formal definition of the Atlantic Rain Forest as a biome (a term not used in Federal Decree 750) brought some drastic consequences, at least in the State of Minas Gerais. In 2007, the Commission of Constitution and Justice of the State Chamber of Representatives addressed Federal Law 11428 and decided that the distribution of the Atlantic Rain

Forest in Minas Gerais must be established by the IBGE biome map (IBGE, 1992; Fig. 1), not the vegetation map. Thus, the TDFs in the north of Minas Gerais were no longer included in the Atlantic Rain Forest biome, but in the Caatinga and Cerrado biomes (Fig. 1). The same commission decided that the Chamber of Representatives had the legal opportunity to regulate land use in the TDFs in the Minas Gerais. After 7 months of discussion, State Law 17353 was approved in January 2008, and allows up to 60% of land conversion to sustainable projects if the property has more than 80% of its area covered with primary TDFs. In the remaining properties (the vast majority), the deforestation limit increases to 70%. This is valid for TDFs inside the Caatinga and Cerrado biomes, but the TDFs at the northeastern part of Minas Gerais (see Fig. 1), which are the same formation but inside the limits of the Atlantic Rain Forest biome, are fully protected.

The other 30% (and rarely 40%) of each property containing TDFs must remain intact as a legal reserve, which is a slight concession compared to the Cerrado and Caatinga biomes, where the preservation of only 20% of each area is required. This is a striking example of how imprecise technical terminology (formation, associated ecosystem, biome) can strongly affect land use policies, with potentially deep impacts in environmental conservation. A rapid and large increase in deforestation is expected in the TDFs at the north of Minas Gerais, similar to what is occurring with the Cerrado and Caatinga, which already lost 50–60% (Alho and Martins, 1995) and 30–50% (Castelletti et al., 2004) of their areas, respectively.

Currently, the only governmental conservation initiative for TDF protection is the establishment of CUs, mainly those of Restricted Use. In the north of Minas Gerais, a large irrigation project using the waters from the São Francisco River has been

operating since the 1970s (the “Jaíba Project”), with total investments of US\$ 470 millions in an area of 100,000 ha (Rodrigues, 2000; Anaya et al., 2006). To compensate for the environmental impact of such an enterprise, the State Environmental Policies Council (COPAM) imposed the creation of five CUs of Restricted Use (State Parks) and two CUs of Sustainable Use in the region during the 1990s (Table 1) (Anaya et al., 2006). All of the Sustainable Use CUs are Areas of Environmental Protection (AEPs; equivalent to IUCN category V), which are sets of public and private properties usually serving mainly as buffer zones for the State Parks. In this case, federal and state laws determine the rules for land use in private lands, whereas public land use is regulated by the same government agencies (the IEF and IBAMA) responsible for the CU administration (Ministério do Meio Ambiente, 2002a). Currently, there is a collection of federal and state protected areas in the north of Minas Gerais with 14 CUs of Restricted Use and 6 CUs of Sustainable Use (Ricardo, 2004; Drummond et al., 2005). These lands are located predominantly along the margins of the São Francisco River between the cities of Januária and Manga (Table 1).

This compensation policy has caused intense conflict between traditional populations and CU administrators in the north of Minas Gerais, because the access of these populations to State and National Parks and Areas of Environmental Protection is usually prohibited. In fact, the boundaries of some of these CUs lie within the territory of traditional populations, affecting their means of sustenance. For example, the State Parks Lagoa do Cajueiro and Verde Grande, covered with TDFs, collectively encompasses an area claimed as traditional territory by one community of Quilombolas. The leaders of this community, with the support of NGOs and the National Institute for Colonization and Agrarian

Table 1
Conservation units (CUs) situated in the north of Minas Gerais and Paranã River Basin.

CU name	County	CU type	CU category	Area (km ²)
<i>North of Minas Gerais</i>				
Lagedão ^a	Matias Cardoso	Area of Environmental Protection	Sustainable Use	120
Serra do Sabonetal ^a	Itacarambi/Jaíba/Pedras de Maria da Cruz	Area of Environmental Protection	Sustainable Use	825
Pandeiros	Januária/Bonito de Minas	Area of Environmental Protection	Sustainable Use	2100
Cochá e Gibão	Januária/Bonito de Minas	Area of Environmental Protection	Sustainable Use	2845
Cavernas do Peruaçu	Itacarambi/Januária	Area of Environmental Protection	Sustainable Use	1439
Veredas do Acari	Chapada Gaúcha/Uruçuia	Extractive Reserve	Sustainable Use	610
			<i>Total</i>	<i>7939</i>
Jaíba ^a	Matias Cardoso	Biological Reserve	Restricted Use	64
Serra Azul ^a	Jaíba	Biological Reserve	Restricted Use	73
Lapa Grande	Montes Claros	State Park	Restricted Use	70
Grão Mogol	Grão Mogol	State Park	Restricted Use	333
Caminho dos Gerais	Mamonas/Monte Azul/Gameleiras/Espinosa	State Park	Restricted Use	562
Lagoa do Cajueiro ^a	Matias Cardoso	State Park	Restricted Use	205
Mata Seca ^a	Manga	State Park	Restricted Use	102
Montezuma	Montezuma	State Park	Restricted Use	17
Serra das Araras	Chapada Gaúcha	State Park	Restricted Use	111
Serra do Cabral	Buenópolis/Joaquim Felício	State Park	Restricted Use	225
Serra Nova	Rio Pardo de Minas	State Park	Restricted Use	127
Verde Grande ^a	Matias Cardoso	State Park	Restricted Use	226
Veredas do Peruaçu	Januária	State Park	Restricted Use	307
Cavernas do Peruaçu	Itacarambi	National Park	Restricted Use	568
			<i>Total</i>	<i>2990</i>
<i>Paraná River Basin</i>				
Serra Geral de Goiás	São Domingos/Guarani de Goiás	Area of Environmental Protection	Sustainable Use	443
Nascentes do Rio Vermelho	Damianópolis/Buritinópolis/Mambáí/Posse	Area of Environmental Protection	Sustainable Use	1762
Pouso Alto	Alto Paraíso de Goiás/Cavalcante/Nova Roma/Teresina de Goiás	Area of Environmental Protection	Sustainable Use	1508 ^b
Mata Grande	São Domingos	National Forest	Sustainable Use	20
			<i>Total</i>	<i>3733</i>
Terra Ronca	São Domingos/Guarani de Goiás	National Park	Restricted Use	560
			<i>Total</i>	<i>560</i>

^a CUs created as a compensation for the Jaíba project. See text for further details.

^b Area of the CU inside the Paranã River Basin.

Reform (INCRA), have initiated legal procedures to guarantee their historical possession of the park area. This process can last several years and, in the meantime, the Quilombolas suffer restricted access to and use of their territory. To avoid such problems, the Brazilian government created the National System of Conservation Units, in 2000 (SNUC, Federal Law 9985) (Ministério do Meio Ambiente, 2002a), which aims also to protect the natural resources for the sustenance of traditional populations and valuation of their cultural management practices.

The SNUC established regulations stating that the government must inform the local people and seek advice from the public in order to define the location, size and delimitations of most conservation unit categories (Ministério do Meio Ambiente, 2002a). Furthermore, the SNUC recommended the creation of CUs of Sustainable Use in areas inhabited by traditional populations (Silva, 2005). The creation of Extractive Reserves, areas set aside for traditional populations to use in their customary ways, such as those observed in the Amazon, has been under considerable debate (Redford and Sanderson, 2000; Schwartzman et al., 2000a,b; Terborgh, 2000; Peres and Zimmerman, 2001), but there is evidence that this is a viable strategy that serves the interests of both conservationists and traditional populations (Schwartzman et al., 2000b; Schwartzman and Zimmerman, 2005).

4. The Paranã River Basin

4.1. Historical human occupation and land use

The first official records and detailed descriptions about human occupation in the Paranã River Basin were made by naturalists and explorers, such as Spix and Martius (1818) and Gardner (1839–1840), who visited the region in the 19th century (Gardner, 1975; Spix and Martius, 1976). By that time, the colonization process had already caused deep impacts on the indigenous populations of central Brazil (Barbosa and Schimiz, 1988). The Xerentes and Coroás tribes, cited by these authors, were not originally from the Paranã River Basin, and had invaded this region (Gardner, 1975; Spix and Martius, 1976). Except for the presence of the Canoeiros tribe (nowadays named Ava-Canoeiros), there is no historical record that proves that other modern tribes had an enduring occupation of this territory. Similarities in language and customs with coastal tribes suggest that these tribes moved to the Paranã Basin with the intensification of colonization at the coast, attempting to escape enslavement by the Portuguese settlers (Barbosa and Schimiz, 1988).

During the first half of the 18th century, gold and diamond miners occupied the western and north boundaries of the Paranã River Basin (Barbosa, 2008) (Fig. 3). Their demand for food attracted farmers to the region, who took advantage of the natural pasturelands for cattle ranching. With the decline of mining activity in the late 18th century, cattle ranchers and fugitive slaves remained in the area, spreading along the basin and forming small villages, farms and communities of fugitive slaves and their descendants (the “Quilombos”). During the first half of the 19th century, cattle ranching was already the most important economic activity in the Paranã River Basin (Gardner, 1975; Spix and Martius, 1976; Barbosa, 2008).

Until 1970, moderate cattle meat and leather production kept the TDFs in the Paranã Basin relatively well-preserved. Unlike the north of Minas Gerais, no government development plan was officially defined for the region. However, a large wave of human occupation occurred after 1970, when farmers from southern and southeastern parts of Brazil arrived to expand the timber and cattle ranching industries (Luíz, 1998), mainly in TDF areas. The intensive timber extraction ended in the 1990's, but cattle ranching remains the primary economic activity in the Paranã Basin today. Sporadic timber extraction for wood and charcoal production still occurs as TDFs are cleared for grazing. In the last decade, limestone mining has increased in the region, threatening the last intact remnants of TDF growing on limestone outcrops.

The intensification of the cattle ranching after 1970 also affected the traditional populations that inhabited the Paranã River Basin. As in the north of Minas Gerais, the new colonists expelled these populations from their territories, taking advantage of their lack of land possession title. With the consequent limitation of their means of sustenance and loss of their cultural identity, indigenous people are practically extinct in the Paranã Basin, with only 18 individuals from the Ava-Canoeiro tribe living in Cavalcante county (Barbosa and Schimiz, 1988). The Quilombola populations are more numerous, but most of these small, isolated groups are unaware of their legal rights over their ancestral territories. To date, only the Kalunga community, with approximately 4500 people situated in the hills surrounding the Paranã River Basin, was recognized in the region as a traditional population by the Goiás state government, with a delimited territory of 253,000 ha (Tiburcio and Valente, 2007; Fioravanti et al., 2008). Their traditional land uses include rudimentary, subsistence agriculture, manioc flour production to supply the surrounding cities (Tiburcio and Valente, 2007) and small-scale cattle ranching (Fioravanti et al., 2008). These activities have a low cumulative environmental impact. Recent studies have evaluated

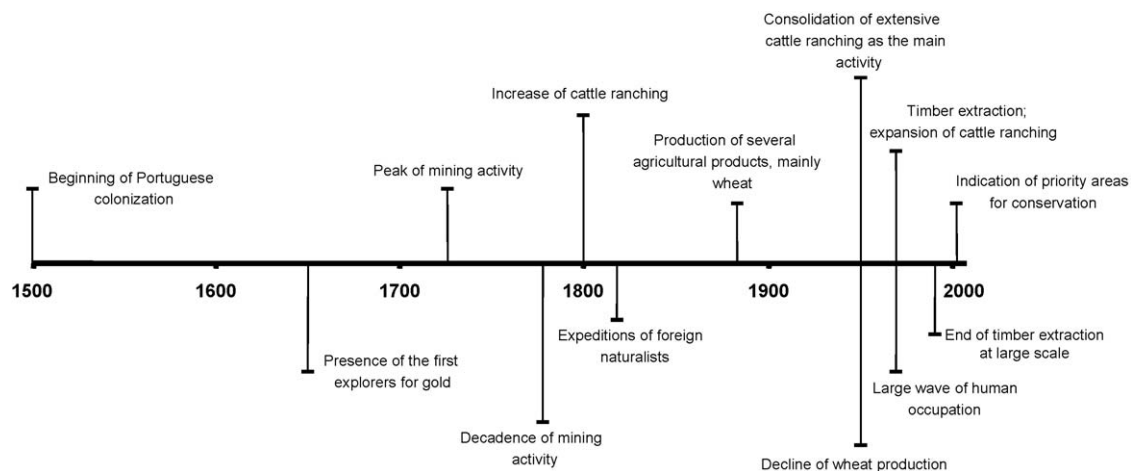


Fig. 3. Timeline of major events regarding the human occupation and environmental policies in the Paranã River Basin.

the introduction of Kalunga agricultural products in local markets and the impact of ecotourism activity (which fosters the consumption of hand-crafted Kalunga products) as a method for improving the standard of living for this traditional society in a sustainable fashion (Cruz and Valente, 2004, 2005).

4.2. Influence of environmental policies

Unlike the north of Minas, in the Paranã Basin there is no legal controversy regarding the land use in TDF areas, since they are treated as a vegetation type belonging to the Cerrado biome in the States of Goiás and Tocantins. Thus, there is no specific policy towards TDFs and their use is regulated by the Brazilian Forest Code (Law 4771, 1965), meaning that up to 80% of each rural property can be deforested. This permissive policy reduced the TDFs on flat soils to less than 5% of their original area (Andahur, 2002), and the high ongoing deforestation rates urge the need for specific policies to regulate TDF use in this region.

One of the few government environmental policies towards the Paranã River Basin was the definition of four priority areas for biodiversity conservation for the Cerrado Biome in this region: (i) Valley and Hills of Paranã, (ii) Great Sertão Goiás-Bahia and São Domingos Caves, (iii) Semideciduous Forests of Southeast Tocantins, and (iv) Southern Tocantins – Conceição/Manuel Alves region (Ministério do Meio Ambiente, 2002b). In 2006, these areas were re-evaluated, increasing the biodiversity priority areas from 56% to 83% of the total area of the Paranã Basin (approximately 60,000 km²) (Ministério do Meio Ambiente, 2007). Nevertheless, there are only five protected areas in this region (Table 1): one National Forest (CU of Sustainable Use, equivalent to the IUCN category VI) with 2000 ha already implemented, i.e. the area was delimited and the original land-owners were paid for their properties; one CU of Restricted Use, the Terra Ronca State Park, which is delimited but land-owners are still to be paid. Until fully implemented, this park receives limited surveillance and is highly vulnerable to invasion by domestic animals, cultivation, hunting, deforestation and frequent fires. However, most of the CUs are large AEPs (Table 1), composed by public and private properties encompassing urban areas. There is considerable debate about the effectiveness of the AEPs to biodiversity conservation (Oliveira, 2003; Moraes, 2004; Artaza-Barrios and Schiavetti, 2007), and this type of CU is considered by some as a mechanism to land use management, not an actual protected area (Rylands and Brandon, 2005). Due to the scarcity of both CUs and traditional populations, conflicts such as those observed in the north of Minas Gerais have not yet been noted in the Paranã River Basin.

5. Discussion

The two case studies considered here showed some convergences and contrasts. The human colonization until the 20th century was similar, starting with indigenous populations and Portuguese colonization, followed by the predominance of cattle ranching after the 19th century. The difference is that cattle ranching was the first economic activity in the north of Minas Gerais, whereas in the Paranã River Basin, mining for gold prevailed in the 17th and 18th centuries. In both cases, the current predominance of extensive cattle ranching in large farms has deep historical roots and poses a challenge to the sustainability of both regions. The most common extensive pasture management techniques are highly disturbing, with the complete substitution of the original vegetation, including the riparian forests, for exotic grasses. These pasturelands usually support a high animal density, resulting in overgrazing and grass depletion (Hernandez et al., 1995). Typically pastures are renewed through burning, which increases the emission of greenhouse-effect gases and leads to soil

degradation (Keller et al., 1993; Bouman and Nieuwenhuys, 1999), culminating in land abandonment and deforestation of new areas (Fearnside, 1990; Muchagata and Brown, 2003).

In the north of Minas Gerais, Law 17353 stated that deforestation is allowed in private properties only for sustainable farming projects, but no technical regulation for such projects is provided. Several propositions for sustainable cattle ranching occur in the literature, including technical recommendations from the Brazilian Agricultural Research Corporation (EMBRAPA) (Primavesi et al., 2007). Sustainable management practices include pasture division and paddock rotation, partial maintenance of trees, use of grass-legume mixtures, elimination of fire as a management tool and reduced use of fertilizers and pesticides (Bouman and Nieuwenhuys, 1999; Melado, 2000; Beetz and Rinehart, 2006). Thus, the conversion of TDF areas to new pasturelands as well as the use of current pastures must be regulated by the State government and enforced by environmental agencies.

In the Paranã River Basin, current policies towards the Cerrado biome are very permissive, and specific regulations to TDF use are nonexistent. To avoid further deforestation, two strategies may be adopted: (i) change land use policies, increasing restrictions to the TDF conversion. For this purpose, the State or Federal governments can both increase the legal reserve proportion of private properties or indicate the status of “specially protected ecosystem” to TDFs in the region; (ii) increase the TDF area protected inside CUs. Given that only 5% of TDFs in flat soils remain in the Paranã Basin (Andahur, 2002), the establishment of CUs of Restricted Use is indeed necessary. In this case, the selection of protected areas must respect the occurrence of traditional populations. In areas inhabited by these populations, CUs of Sustainable Use, such as Extractive Reserves, are recommended. However, traditional populations and other local communities must be consulted and informed during the entire process, and these CUs should incorporate their cultural management practices into conservation strategies.

Preferably, the development of new policies to land use in Brazilian TDFs should be preceded and supported by multi-disciplinary investigations, which was not the case with respect to the Law 17353 in Minas Gerais. For example, baseline indicators from the IBGE indicated that cattle population in the north of Minas Gerais increased 72% from 1996 to 2006, whereas the pasture area decreased 18.7% during the same period (IBGE, 1996, 2006). Thus, the ruralist’s assertion that further TDF clearing is necessary the increase cattle ranching activity and create job positions in the region is not supported. The usefulness of Law 17353 for conservation purposes is questionable, and its social, economic and environmental impacts should be investigated towards an objective, scientifically derived revision in the near future. This should include anthropological studies concerning cultural integrity and population wealth, econometric assessment of deforestation drivers, remote sensing approaches to temporal land cover changes and evaluation of ecological mechanisms involved in the maintenance of ecosystem functions.

To date, the only government strategy for sustainable occupation of TDF areas in the case studies considered here was the creation of CUs. However, the intensity and motivation for this intervention differ between regions. In the Paranã River Basin, 7.2% of the area is under protection, in contrast to 9.1% in the north of Minas Gerais. This difference is higher if we consider CUs of Restricted Use only (0.94% versus 2.49%; Table 1). In the north of Minas Gerais, most of the CUs were implemented as a pre-requisite to the expansion of the Jaíba irrigation project, a type of environmental compensation not observed in the Paranã Basin (Table 1). This is an example of a distorted application of the notion of sustainable development, since the Jaíba project benefited large agro-industrial companies, strengthening the capitalist production

model emphasizing advanced technology and high productivity (Cardoso and Chaloult, 2005). Smallholders were resettled by the government and grouped without regard to their regional origin or cultural identity (Araújo et al., 2007). As a consequence, most of them failed to create social and commercial organizations, and increased costs of individual production led to unsuccessful crops and land abandonment (Araújo et al., 2007). Furthermore, the compensation policy for the Jaíba project completely ignored the widespread occurrence of traditional populations in the north of Minas Gerais and cannot be considered sustainable from a social justice perspective.

A sustainability strategy for TDFs in the north of Minas Gerais and the Paranã River Basin might also include building on alternative environmental policies, such as government incentives for the restoration of abandoned pastures and riparian forests, which is a type of payment for ecosystem services. Finally, local development policies should be based on previous ecological–economic zonation and stimulate low-impact activities. Thus, family-based agriculture, sustainable extractivism, ecotourism and strategic projects such as biodiesel production using large abandoned areas are some of the possible alternatives to extensive farming activities that dominate TDF areas in the case studies considered here.

6. Conclusions

Many sustainable strategies have been proposed for Brazilian biomes that contain TDF areas, such as the Cerrado and Caatinga. However, this is the first attempt to analyze the social–ecological context of TDFs in Brazil, by including traditional populations in the analysis and treating TDFs as a separate biome. The description of historical human occupation and environmental policies is extremely important to understand current land use patterns and cultural practices that affect TDF management in both the north of Minas Gerais and the Paranã River Basin. Given that cattle ranching is profoundly rooted as the predominant economic activity in both regions, one of the main challenges to the sustainability of their TDFs (and the co-occurring Cerrado and riparian forests) is to devise alternatives to the use of the high-impact management techniques observed in large-scale ranching. For this purpose, the state and federal governments must regulate and enforce current land use policies and diversify their conservation strategies.

In order to create effective public policies for the sustainable development of TDF regions, however, it is extremely important to go beyond the current dichotomy “ecosystem preservation versus farming projects.” It is necessary to account for the social segments that historically inhabited and preserved the cultural and environmental resources existent in the TDFs. For this purpose, the prevalent vision of conservation through the creation of people-free parks should be carefully evaluated in a case-to-case basis. Where traditional populations are widespread, the delimitation of CUs of Sustainable Use may be the preferred method for reconciling human welfare and biodiversity protection.

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References

- Alho, C.J.R., Martins, E.S., 1995. Bit by Bit the Cerrado Loses Space. Technical Report for WWF, Brasília.
- Anaya, F., Barbosa, R., Sampaio, C., 2006. Sociedade e biodiversidade na mata seca mineira. *Unimontes Científica* 8, 35–41.
- Andahur, J.P., 2002. *Florestas e Questões de Gestão Ambiental na Bacia do Rio Paranã*. Dissertation, Universidade de Brasília, Brasília.
- Andrade-Lima, D., 1981. The Caatingas dominium. *Revista Brasileira de Botânica* 4, 149–153.
- Antunes, F.Z., 1994. Caracterização climática do Estado de Minas Gerais: climatologia agrícola. *Informe Agropecuário* 17, 9–13.
- Araújo, T.C.A., Godrim, M.D., Souza, V.S., 2007. A Organização Social da Agricultura Familiar do Projeto Jaíba-MG como Desafio para o Desenvolvimento Local Sustentável. In: SOBER (Eds.), *Annals of the XLV Congresso da Sociedade Brasileira de Economia, Administração e Sociologia Rural*, SOBER, Londrina, pp. 1–21.
- Arruda, R.S.V., 2000. “Populações Tradicionais” e a Proteção dos Recursos em Unidades de Conservação. In: Diegues, A.C. (Org.), *Etnoconservação: Novos Rumos para a Proteção da Natureza nos Trópicos*. Hucitec, São Paulo, pp. 273–290.
- Artaza-Barrios, O.H., Schiavetti, A., 2007. Análise da Efetividade do Manejo de duas Áreas de Proteção Ambiental do Litoral Sul da Bahia. *Revista da Gestão Costeira Integrada* 7, 117–128.
- Barbosa, A.S., Schimiz, P.I., 1988. Ocupação Indígena do Cerrado: Esboço de uma História. In: Sano, S.M., Almeida, S.P. (Eds.), *Cerrado: Ambiente e Flora*. Embrapa – CPAC, Brasília, pp. 3–42.
- Barbosa, A.G., 2008. As estratégias de conservação da biodiversidade na Chapada dos Veadeiros: conflitos e oportunidades. Master Dissertation, Universidade de Brasília, Brasília.
- Beetz, A., Rinehart, L., 2006. Pastures: Sustainable Management. National Sustainable Agriculture Information System, <http://www.attra.ncat.org/attra-pub/PDF/sustpast.pdf>.
- Bouman, B.A.M., Nieuwenhuys, A., 1999. Exploring options for sustainable beef cattle ranching in the humid tropics: a case study for the Atlantic Zone of Costa Rica. *Agricultural Systems* 59, 145–161.
- Cardoso, A.D., Chaloult, Y., 2005. A Alca e empresários do Cone Sul. *Política e Sociedade* 6, 83–100.
- Castelletti, C.H.M., Silva, J.M.C., Tabarelli, M., Santos, A.M.M., 2004. Quanto Ainda Resta da Caatinga? Uma Estimativa Preliminar. In: Silva, J.M.C., Tabarelli, M., Fonseca, M.T., Lins, L.V. (Orgs.), *Biodiversidade da Caatinga: Áreas e Ações Prioritárias para a Conservação*. Ministério do Meio Ambiente, Brasília, pp. 91–100.
- CEDEFES-Centro de Documentação Eloy Ferreira da Silva, 2008. *Comunidades Quilombolas de Minas Gerais no Século XXI: História e Resistência, Autêntica, Belo Horizonte*.
- Costa, J.B.A., in press. A linha do tempo da historicidade norte mineira. *Revista Verde Grande* 4.
- Cruz, K.C.M.S., Valente, A.L.E.F., 2004. Produção Familiar, Agronegócio e Desenvolvimento Local Sustentável em Área Remanescente de Quilombo – um Estudo de Caso na Comunidade Kalunga. <http://www.sober.org.br/palestra/12/12O503.pdf>.
- Cruz, K.C.M.S., Valente, A.L.E.F., 2005. A cachoeira do Poço Encantado: empreendimento familiar e presença Kalunga na cadeia do ecoturismo em Teresina de Goiás. *Revista de Economia e Sociologia Rural* 43, 779–804.
- Dayrell, C.A., 1998. Geraizeiros y Biodiversidad en el Norte de Minas Gerais: La Contribución de la Agroecología y de la Etnoecología en los Estudios de los Agroecosistemas. Dissertation, Universidad Internacional de Andalucía, Huelva.
- Diegues, A.C., Arruda, R.S.V., 2001. Saberes Tradicionais e Biodiversidade no Brasil. Ministério do Meio Ambiente/Universidade de São Paulo, Brasília.
- Diniz, S.C., Magalhães, F.N.C., Monte-Mór, R.L.M., 2006. Economia e Etnodesenvolvimento no Território Indígena Xakriabá, MG. In: *Proceedings of the 12th Seminar on the Economy of Minas Gerais*. In: http://www.cedeplar.ufmg.br/seminarios/seminario_diamantina/2006/D06A082.pdf.
- Drummond, G.M., Martins, C.S., Machado, A.B.M., Saibo, F.A., Antonini, I., 2005. Biodiversidade em Minas Gerais: um Atlas para sua Conservação. Fundação Biodiversitas, Belo Horizonte.
- EMATER, 2005. Estimativa dos Efeitos da Deliberação Normativa número 72 – Technical Report. Empresa de Assistência Técnica e Extensão Rural de Minas Gerais, Montes Claros.
- Espírito-Santo, M.M., Fagundes, M., Nunes, Y.R.F., Fernandes, G.W., Sanchez-Azoifeifa, G.A., Quesada, M., 2006. Bases para a conservação e uso sustentável das florestas estacionais decíduas brasileiras: a necessidade de estudos multidisciplinares. *Unimontes Científica* 8, 13–22.
- Ewel, J.J., 1999. Natural systems as models for the design of sustainable systems of land use. *Agroforestry Systems* 45, 1–21.
- Fearnside, P.M., 1990. Predominant land uses in the Brazilian Amazon. In: Anderson, A.B. (Ed.), *Alternatives to Deforestation: Towards Sustainable Use of the Amazon Rain Forest*. Columbia University Press, New York, pp. 235–251.
- Fioravanti, M.C.S., Sereno, J.R.B., Neiva, A.C.G.R., Abud, L.J., Lobo, J.R., Francescantônio, D., Cardoso, W.S., Silva, F.X., Machado, J.R.L., 2008. Reintrodução do gado curraleiro na comunidade quilombola Kalunga de Cavalcante, Goiás, Brasil: resultados preliminares. In: *Annals of the II International Symposium on Tropical Savannas*, Brasília.
- Gardner, G., 1975. Viagem ao interior do Brasil, principalmente nas províncias do Norte e nos distritos do ouro e do diamante durante os anos de 1836–1841. Itatiaia/Edusp, Belo Horizonte/São Paulo.

- Hernandez, M., Argel, P.J., Ibrahim, M.A., 't Manneetje, L., 1995. Pasture production, diet selection and liveweight gains of cattle grazing *Brachiaria brizantha* with or without *Arachis pintoi* at two stocking rates in the Atlantic Zone of Costa Rica. *Tropical Grasslands* 29, 134–141.
- IBGE, 1992. Manual Técnico da Vegetação Brasileira. Fundação Instituto Brasileiro de Geografia e Estatística, Departamento de Recursos Naturais e Estudos Ambientais, Rio de Janeiro.
- IBGE, 1996. Censo Agropecuário. Fundação Instituto Brasileiro de Geografia e Estatística, Rio de Janeiro.
- IBGE, 2000. Censo Demográfico 2000 – Resultados do Universo: Malha Municipal 1997. Instituto Brasileiro de Geografia e Estatística, Rio de Janeiro.
- IBGE, 2006. Censo Agropecuário-Resultados Preliminares. Fundação Instituto Brasileiro de Geografia e Estatística, Rio de Janeiro.
- Keller, M., Veldkamp, E., Weitz, A.M., Reiners, W.A., 1993. Effect of pasture age on soil trace-gas emissions from a deforested area of Costa Rica. *Nature* 365, 244–246.
- Leff, E., 2006. Racionalidade Ambiental: a Reapropriação Social da Natureza. Civilização Brasileira, Rio de Janeiro.
- Luiz, G.C., 1998. Estudo do Impacto Ambiental a Partir da Análise Espaço-Temporal – Caso da Região Vão do Paraná – GO. Dissertation, Universidade Federal de Goiás, Goiânia.
- Maass, J.M., 1995. Conversion of tropical dry forest to pasture and agriculture. In: Bullock, S.H., Mooney, H.A., Medina, E. (Eds.), *Seasonally Dry Tropical Forests*. Cambridge University Press, New York, pp. 399–422.
- Mebratu, D., 1998. Sustainability and sustainable development: historical and conceptual review. *Environmental Impact Assessment Review* 18, 493–520.
- Melado, J., 2000. Manejo de Pastagem Ecológica: um Conceito para o Terceiro Milênio. Centro de Publicações Técnicas, Viçosa.
- Ministério do Meio Ambiente, 2002a. Sistema Nacional de Unidades de Conservação da Natureza – SNUC. Ministério do Meio Ambiente, Brasília.
- Ministério do Meio Ambiente, 2002b. Biodiversidade Brasileira – Avaliação e Identificação de Áreas Prioritárias para Conservação, Utilização Sustentável e Repartição de Benefícios da Biodiversidade Brasileira. Ministério do Meio Ambiente, Brasília.
- Ministério do Meio Ambiente, 2007. Áreas Prioritárias para Conservação, Uso Sustentável e Repartição de Benefícios da Biodiversidade Brasileira: Atualização. Ministério do Meio Ambiente, Brasília.
- Moraes, M.B.R., 2004. Área de Proteção Ambiental como Agência de Desenvolvimento Sustentável: APA Cananéia-Iguape-Peruíbe, SP. AnnaBlume/Fapesp, São Paulo.
- Morellato, L.P.C., Haddad, C.F.B., 2000. Introduction: the Brazilian Atlantic Forest. *Biotropica* 32, 786–792.
- Muchagata, M., Brown, K., 2003. Cows, colonists and trees: rethinking cattle and environmental degradation in Brazilian Amazonia. *Agricultural Systems* 76, 797–816.
- Oliveira, G.M., 2003. A Legislação Ambiental das APAs (Áreas de Proteção Ambiental) como Instrumento de Gestão Ambiental: Estudo de Caso das APAs Municipais de Ilha Grande no Paraná. Dissertation, Universidade Federal de Santa Catarina, Florianópolis.
- Peres, C.A., Zimmerman, B., 2001. Perils in parks or parks in peril? Reconciling conservation in Amazonian reserves with and without use. *Conservation Biology* 15, 793–797.
- Prado, D.E., 2003. As Caatingas da América do Sul. In: Leal, I.R., Tabarelli, M., Silva, J.M.C. (Eds.), *Ecologia e Conservação da Caatinga*. Editora Universitária da Universidade Federal de Pernambuco, Recife, pp. 3–73.
- Primavesi, O., Arzabe, C., Pedreira, M.S., 2007. Mudanças climáticas: visão integrada das causas, dos impactos e de possíveis soluções para ambientes rurais ou urbanos-Docmentos 70. Embrapa Pecuária Sudeste, São Carlos.
- Redford, K.H., Sanderson, S.E., 2000. Extracting humans from nature. *Conservation Biology* 14, 1362–1364.
- Ribeiro, R.F., 2005. Florestas Anãs do Sertão: o Cerrado na História de Minas Gerais, vol. 1. Editora Autêntica, Belo Horizonte.
- Ricardo, F. (Org.), 2004. Terras Indígenas e Unidades de Conservação da Natureza: o Desafio das Sobreposições. Instituto Socioambiental, São Paulo.
- Rizzini, C.T., 1963. Nota prévia sobre a divisão fitogeográfica (florístico-sociológica) do Brasil. *Revista Brasileira de Geografia* 25, 3–64.
- Robinson, J., 2004. Squaring the circle? Some thoughts on the idea of sustainable development. *Ecological Economics* 48, 369–384.
- Rodrigues, L., 2000. Formação Econômica do Norte de Minas e o Período Recente. In: Oliveira, M.F.M., Rodrigues, L., Machado, J.M.A., Botelho, T.R. (Eds.), *Formação Social e Econômica do Norte de Minas Gerais*. Editora Unimontes, Montes Claros, pp. 105–170.
- Rylands, A.B., Brandon, K., 2005. Brazilian protected areas. *Conservation Biology* 19, 612–618.
- Sánchez-Azofeifa, G.A., Kalácska, M., Quesada, M., Calvo-Alvarado, J.C., Nassar, J.M., Rodrigues, J.P., 2005. Need for integrated research for a sustainable future in tropical dry forests. *Conservation Biology* 19, 285–286.
- Santos, M., 2002. O País Distorcido: o Brasil, a Globalização e a Cidadania. Publifolha, São Paulo.
- Scariot, A., Sevilha, A.C., 2000. Diversidade, Estrutura e Manejo de Florestas Deciduais e as Estratégias para a Conservação. In: Cavalcanti, T.B., Walter, B.M.T. (Eds.), *Tópicos Atuais em Botânica. Embrapa Recursos Genéticos e Biotecnologia, Brasília*, pp. 183–188.
- Scariot, A., Sevilha, A.C., 2005. Biodiversidade, Estrutura e Conservação de Florestas Estacionais Deciduais no Cerrado. In: Scariot, A., Felfili, J.M., Sousa-Silva, J.C. (Eds.), *Cerrado: Ecologia, Biodiversidade e Conservação*. Ministério do Meio Ambiente, Brasília, pp. 123–139.
- Schimiz, P.I., 1993. Caçadores e Coletores Antigos. In: Pinto, M.N. (Ed.), *Cerrado: Caracterização, Ocupação e Perspectivas*. Editora Universidade de Brasília, Brasília, pp. 104–154.
- Schwartzman, S., Moreira, A., Nepstad, D., 2000a. Rethinking tropical forest conservation: perils in parks. *Conservation Biology* 14, 1351–1357.
- Schwartzman, S., Nepstad, D., Moreira, A., 2000b. Arguing tropical forest conservation: people versus parks. *Conservation Biology* 14, 1370–1374.
- Schwartzman, S., Zimmerman, B., 2005. Conservation alliances with indigenous people of the Amazon. *Conservation Biology* 19, 721–727.
- Scolforo, J.R., Carvalho, L.M.T., 2006. Mapeamento e Inventário da Flora Nativa e dos Reflorestamentos de Minas Gerais. Editora da Universidade Federal de Lavras, Lavras, Lavras.
- Sevilha, A.C., Scariot, A., Noronha, S.E., 2004. Estado Atual da Representatividade de Unidades de Conservação em Florestas Estacionais Deciduais no Brasil. In: Sociedade Brasileira de Botânica (Eds.), *Biomass Florestais-Annals of the 55th Congresso Nacional de Botânica, Sociedade Brasileira de Botânica, São Paulo*, pp. 1–63.
- Silva, M., 2005. The Brazilian protected areas program. *Conservation Biology* 19, 608–611.
- Spix, J.B., Martius, C.F.P., 1976. Viagem pelo Brasil: 1817–1820, third edition. Melhoramentos, São Paulo.
- Teixeira, C.O., 2005. Desenvolvimento sustentável em unidade de conservação: a “naturalização” do social. *Revista Brasileira de Ciências Sociais* 20, 51–66.
- Terborgh, J., 2000. The fate of tropical forests: a matter of stewardship. *Conservation Biology* 14, 1358–1361.
- Tiburcio, B.A., Valente, A.L.E.F., 2007. O comércio justo e solidário é alternativa para segmentos populacionais empobrecidos? Estudo de caso em Território Kalunga (GO). *Revista de Economia e Sociologia Rural* 45, 497–519.
- World Commission on Environment Development, 1987. *Our Common Future*. Oxford University Press, London.
- Zhou, A., Laschefski, K., Pereira, D. (Eds.), 2005. *A Insustentável Leveza da Política Ambiental: desenvolvimento e conflitos sócio-ambientais*. Autêntica, Belo Horizonte.