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The negative influences of the new brazilian forest code on the conservation of riparian forests

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ABSTRACT

More than one million hectares of riparian forests were degraded or altered in Mato Grosso State (Brazil) up to 2009. The aim of the research is to set a comparative scenario to show differences in the quantification of environmental liabilities in riparian forest areas resulting from the change in native vegetation protection rules due to the transition between Laws 4771/65 and 12651/2012. Data collection took place in a marginal stretch of Vermelho River in Rondonópolis County, Mato Grosso State. The following data set was taken into consideration: aerial images derived from unmanned aerial vehicle, Rapid Eye satellite images and orbital images hosted at Google Earth. The spatial resolution of those images was compared. The aerial photos composed a mosaic that was photo-interpreted to generate land use and occupation classes. The riparian forest areas of a rural property were used as parameter, and their environmental situation was compared in 05 meter and 100 meter strips. Thus, by taking into consideration the current rules, 23,501 m² of area ceased to be an environmental liability within the riparian forest and became a consolidated rural area. According to the previous Forest Code, in a different scenario, that is, in a set of rural properties, the public authority would receive USD 68,600.00 in fines. The new Brazilian Forestry Code of 2012, which replaces the previous one made in 1965, exempts those responsible for rural property from regenerating previously deforested native vegetation — an obligation established by older Forest Code. We have shown that the new Forest Code has diminished the legal responsibility of the rural owners in relation to the maintenance of forest fragments in their properties.

KEYWORDS

Ecological restoration; environmental regularization; remotely piloted aerial systems; deforestation; Brazilian forest code (2012); riparian forests; Cerrado biome

Drive south from Rondonópolis, and for mile after mile the flat tableland stretches away to the far horizon, a limitless green prairie carpeted with swelling crops. The monotony of the landscape is broken only by the artefacts of modern agri-business: a crop-dusting plane swoops low over the prairie to release its chemical cloud, while the occasional farmhouses have giant harvesting machines lined up in the yard outside. It could be the mid-western United States. In fact, it is the very heart of tropical South America, its central watershed, in the Brazilian state of Mato Grosso.

(Growth in the prairies. The Economist, 1999)

INTRODUCTION

The writing of the new Brazilian Forest Code (Law 12651/2012) motivated intense debates among environmentalists, scientists and politicians linked to the powerful Brazilian agribusiness. During those debates, the predominant argument among Brazilian scientists was that the change in legislation would make the Brazilian forests more vulnerable to degradation, especially the fragments of forest located on farms and other rural properties (Sociedade Brasileira para o Progresso da Ciência 2011; Garcia 2012). It is important to emphasize that the new Brazilian Forest Code (Brasil Law 12651/2012) covers the entire territory of Brazil, and its six biomes, including two biodiversity hotspots: the Atlantic Forest and the Cerrado, where our case study was carried out.

More than half (≅ 55%) of the Cerrado's 2 million km² has been transformed into pasture, cash-crop agriculture, and other uses in the last decades. The area under conserva-

tion is roughly 33,000 km². The Cerrado biome – a biodiversity hotspot (Silva & Bates 2002) – has a rich biological diversity. The number of vascular plants exceeds 7000 species, and 30% of them occur in riparian forests. Forty-four percent of the flora is endemic, and this percentage reaches 80% for herbaceous species. In this sense, the Cerrado is the richest tropical savannah in the world (Silva & Bates 2002; Klink & Machado 2005; Araújo et al. 2010).

Approximately 1200 fish species have been identified in the Cerrado. The mammal fauna consists of 199 species, of which 19 species are endemic and 21 species are endangered. 82% of mammal species are mainly associated with or restricted to patches of forest or riparian forests (Marinho-Filho & Gastal 2000). The number of bird species in the Cerrado is also high: there are 837 species, or 50% of the Brazilian bird species. Of these 837 species, 29 species are endemic and 23 are endangered. 83% of the bird species of the Cerrado are partially or totally dependent on forest environments, such as riparian forests (Aguiar et al. 2004; Araújo et al. 2010). Despite this rich biodiversity, only 2.2% of the Cerrado is legally protected. At least 137 Cerrado animal species are threatened with extinction because of large-scale agricultural expansion (Silva & Bates 2002; Klink & Machado 2005; Borges et al. 2014). There are 11 different phytophysiognomies in the Cerrado biome. The riparian forests, one of the phytophysiognomies, are those that accompany its medium and large rivers. They are characterized by trees from 20 to 25 meters. Most of the tree species of the Cerrado riparian forests are deciduous and lose their leaves during the dry season (Ribeiro & Walter 2008).

The riparian forests are important for two main reasons. From the point of view of biotic resources, the riparian forests create favourable conditions for the survival and maintenance of gene flow between populations of animal species that inhabit the riparian environments or even larger forest fragments that can be connected by them. From the point of view of the abiotic resources, the forests located near the bodies of water play important hydrological functions, including protection of the riparian zone, filtration of sediments and nutrients, control of the nutrient and chemical inputs to the courses of water, control erosion of channel banks and control of changes in the temperature of the aquatic ecosystem (Duringan & Silveira 1999; Naiman et al. 2010; Silva et al. 2017).

The aim of the current research was to set a comparative scenario to express differences in the quantification of environmental liabilities in the riparian forest, resulting from changes in the protection rules due to the transition from the old to the new Brazilian Forest Codes (Brasil, Laws 4771/65 and 12651/2012). In addition, we emphasize the need for interlocution between lawmakers and scientists dealing with environmental sciences.

Table 1. Width of the permanent preservation area according to the water body bank type (Valle Junior 2010; CONAMA 2012)

Drainage channel width	PPA width
Up to 10 m	30 m in each bank
from 10 to 50 m	50 m in each bank
from 50 to 200 m	100 m in each bank
from 200 to 600 m	200 m in each bank
Wider than 600 m	500 m in each bank

1. MATERIALS AND METHODS

1.1. Study site characterization

Rondonópolis County, whose territory comprises 4,159.12 km², is located in the south-eastern region of Mato Grosso State and shows estimated population 220,000 inhabitants (IBGE 2010).

1.2. Permanent preservation areas (fragments of riparian forest) delimitation in the study site

The study site occupies a stretch along Isabela Carrasqueira Smozinski state highway (MT 471), also known as 'Rodovia do Peixe' (Fish Highway), near Vermelho River. It is located between the geographic coordinates 16°30'21.48" S / 54°48'37.70" O and 16°30'29.38" S / 54°48'54.03" W, in Rondonópolis County - MT (Figure 1). The herein analysed environment comprises the marginal area to Vermelho River, whose riparian vegetation represents an important corridor connecting the remnant native Cerrado and Pantanal Plain vegetation.

The criteria set by Law 4771/1965 and its updates, as well as by Law 12651/2012 and Decree 7830/2012, were adopted to set the permanent preservation strips (Brasil 2012). Rapid Eye satellite images (R4G3B2 colour composition, from September 2013, 5-meter spatial resolution) (MMA 2015), Google Earth images (constellation of satellite images from May 2015, spatial resolution up to 50 centimetres) (Google Earth 2014), and suborbital UAV images obtained in October 2014 with 6-cm spatial resolution were used to compare the environmental liabilities in the riparian forest strips.

A rural property (total area 13.18 hectares) located in Rondonópolis County – MT was taken into consideration in order to set a comparative scenario between the two Forest Codes (1965 and 2012). The property has less than one fiscal module (0.22), since one fiscal module is equivalent to 60 hectares in Rondonópolis County (BRASIL, 1980). The rural fiscal module is a measurement unit expressed in hectares. It was set by the National Institute of Colonization and Agrarian Reform (INCRA - Instituto Nacional de Colonização e Reforma Agrária), and its size changes according to the Brazilian county (from 5 to 110 hectares) due to some aspects such as predominant exploitation type and the income resulting from such activity (Embrapa 2014).

The first simulation took into consideration the rules set by Law 4771/1965 and Law 7803 from 18 July 1989. The width of Vermelho River channel in the range covering a rural property and its surroundings was measured through the orbital images hosted at Google Earth.

The second simulation was based on the PPA determination rules set by Law 12651/2012 (Table 2). It took into

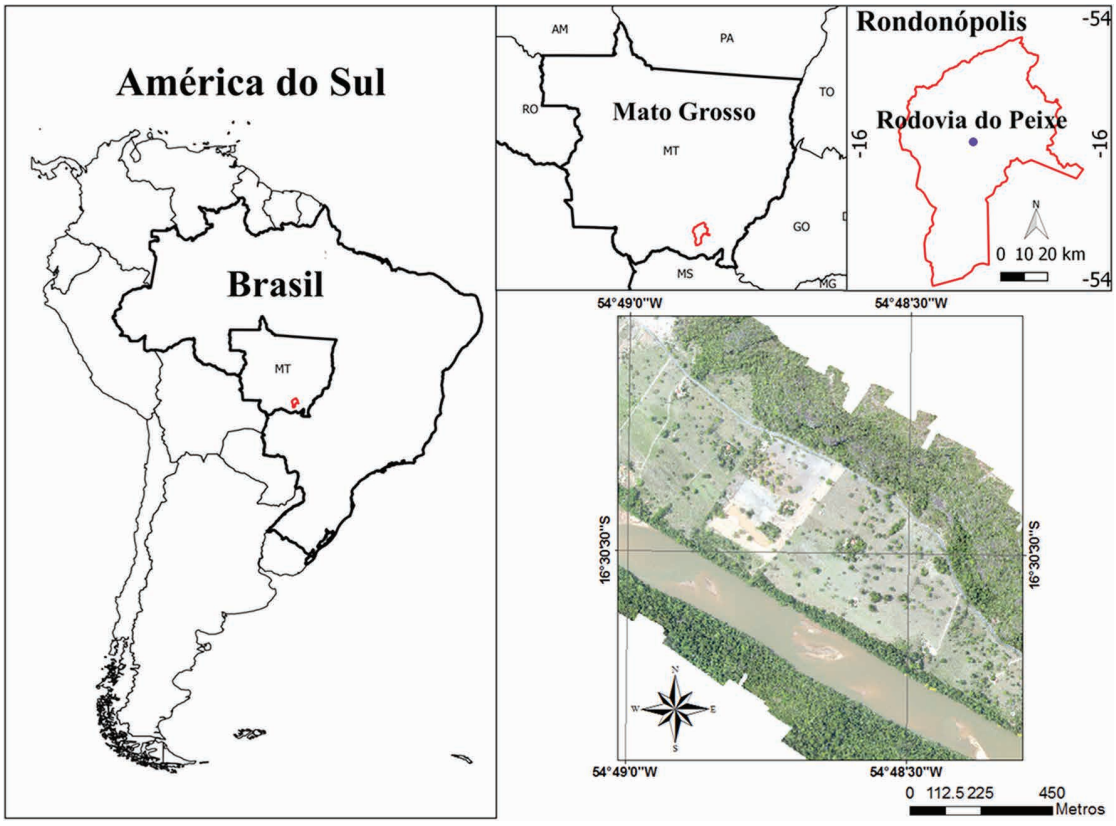

Figure 1. Location of the study site emphasizing a stretch of Vermelho riverbank in Rondonópolis County -MT; data obtained through UAV images

Table 2. Rules used to set the PPA strips, according to Law 12651/2012

Property size / PPA Modality	01 Fiscal Module		From 01 to 02 Fiscal Modules		From 02 to 04 Fiscal Modules		> 04 Fiscal Modules
Natural Watercourses	All widths	5m	All widths	8m	All widths	15m	20m 50% river. Provided that: Min. 20m and Max. 100m
Water springs	20m		20m		20m		20m
Natural Lakes and Ponds	5m		8m		15m		30m
Veredas	30m		30m		30m		50m
Maintenance of residence and infrastructure	Consolidates		Consolidates		Consolidates		Consolidates
Recomposition requirement	10%		10%		20%		Unlimited

consideration the watercourse width (regular bed), the vegetation suppression period, the size of the rural property in terms of fiscal modules, the type of land cover in the studied site, and the PPA rate in the rural property. The historical collection of Google Earth images was used to measure the vegetation suppression.

The orthomosaic from suborbital UAV images was imported to the TerraView software version 4.2.2. (INPE 2013). The database generated in this software also included RapidEye and Google Earth images, and it was systematized in UTM projection, Zone 21, Sirgas 2000 datum.

The river width in the stretch of the study site was estimated at 150 meters. A 100-meter-wide buffer was generated in the TerraView software version 4.2.2 based on the vectorized line concerning the Vermelho River banks. The parameters set by Law 7803/89 were taken into consideration (Brasil 1989).

A 5-meter-wide strip starting from the riverbank was set in the same area, according to the parameters set by Laws 12651/2012 and 12727/2012 (Brasil 2012). In this case, the land use and cover classes were identified in order to set the consolidated rural area in the surroundings of the watercourse bank. These data allowed comparing the environmental liabilities in the scenario where the PPA strip ranged from 5 to 100 meters.

São Lourenço Hydrographic Basin Specialized Public Prosecutor's Office (which belongs to Mato Grosso State Public Prosecutor's Office), along with the Special Environmental Mobile Court (*JUVAM - Juizado Especial Volante Ambiental*) and with the Federal University of Mato Grosso carried out a joint action to map the fragments of riparian forests located at the Vermelho River banks, near the urban perimeter of Rondonópolis County – MT.

2. RESULTS AND DISCUSSIONS

We identified 85 hectares of arboreal-size riparian vegetation and 43.92 hectares of areas altered or degraded by agroforestry activities in a 100-meter-wide 16-kilometer-long strip along Vermelho River, through the interpretation of orthomosaic UAV images. According to the rules set by Law 4771/65 and it updates, 43.92 hectares of area should be recovered. However, according to Law 12651/2012 and its updates, this environmental liability does not exceed 0.8 hectares.

The environmental regularization of this liability should be a strategic action to enable the technical and legal enforcement of an ecological corridor able to connect native vegetation remnants to the Cerrado and Pantanal biome-associated biodiversity. For example, by adopting the criteria set by Federal Decree 6514/2008, and by considering that 43.92 hectares were suppressed in the PPA (riparian forest) strip (Brasil, Law 4771/1965 and updates), the public authority (payment of fines) would collect USD 68,600.00, according to a conservative estimate (USD 1,561.00 per hectare, according to Article 44 of the aforementioned decree).

In addition, if the same area remained an environmental liability, those responsible for it would also be required to indemnify society for the ecosystem services that the lack of vegetation cover is failing to comply with, since it would be sufficient to point out the simple occurrence of environmental damage in this case (Brasil 1981). The herein mentioned financial resource (USD 68,600.00) could be used in different ways to favour environmental protection measures such as the implementation of native seedling and seed banks for donation purposes, as well as of free ecological restoration courses. However, according to the rules in force in the current Forest Code, the environmental liability in question virtually disappears.

Still, according to the previous Forest Code, the land owner should start from the 33-meter strip (Figure 2 A) and, through a degraded area recovery project, advance the riparian vegetation recovery process (Figure 2 B) until reaching 100 meters of native vegetation recovery (Figure 2 C). In summary, the previous environmental liability with mandatory recovery became a consolidated rural area with no obligation to regenerate the native vegetation.

This is a disturbing scenario, since the environmental liability in riverbank riparian forests exceeded one million hectares about a decade ago in the entire Mato Grosso State (Mato Grosso 2009). The lack of recovery through revegetation with native species in this environment implies carbon capture deficit and does not help in controlling the anthropogenic climate changes (Jacobi et al. 2011).

Brazil had more than five million rural properties in 2012 (INCRA 2016); however, the change in the Forest Code rules has substantially changed the number of environmental liability areas in the country. People who suppressed the native vegetation in riparian forests and other forest fragments until 22 July 2008 were granted amnesty; 58% decrease in the amount of degraded and altered areas in Brazilian rural properties were recorded at that time due to political and non-scientific reasons.

The unauthorized vegetal-suppression area, which was an environmental liability according to the previous legislation – and therefore, should be restored – reduced from 50 to 21 million hectares in the Brazilian territory (Soares-Filho et al. 2014).

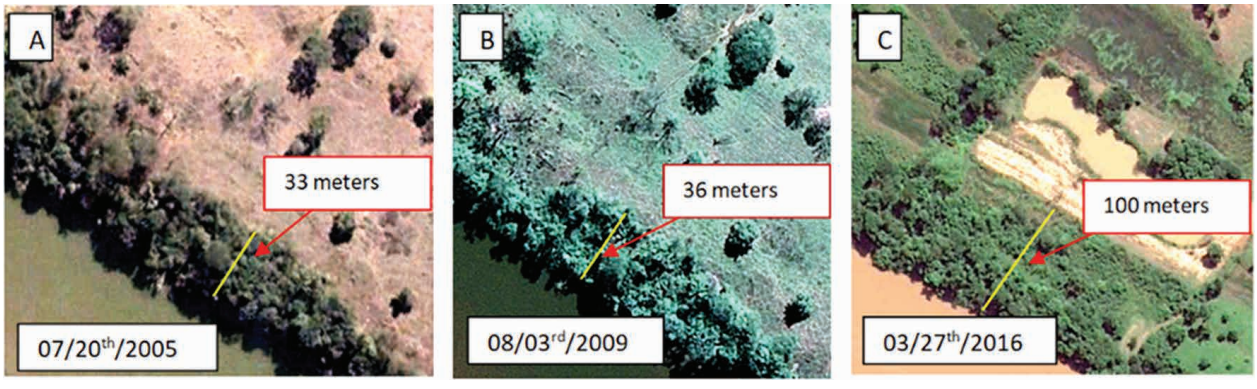

Figure 2. Orbital and suborbital images showing variation in the APP strip over time (Google Earth 2016)

Effectively, in a recent study on the effects of Law 12.651/2012 on the protection of Cerrado forest fragments in 75 farms in the rural area of the municipality of Rondonópolis (State of Mato Grosso, Brazil) having areas totalling to 187,000 hectares, Vacchiano (2017) demonstrated that the new legislation allowed the advancement of deforestation in those forest fragments. The Brazilian Forest Code of 2012 legitimizes the deforestation of previously protected forests, through the granting of amnesties to the owners of farms, for instance (Vacchiano 2017).

Important segments of the Brazilian scientific society, led by the Brazilian Society for the Advancement of Science (SBPC) and the Brazilian Academy of Sciences (ABC), before the enactment of Law 12.651 in 2012, had already been publicly announced because of the low participation of scientists in the discussions on replacing the forest code. When there was participation, this occurred at the request of the scientific community itself. In this context, Brazilian researchers from several areas of scientific knowledge produced the book 'The Forest Code and Science: Contributions to the Dialogue', launched on 25 March in Brasilia (Sociedade Brasileira para o Progresso da Ciência 2011). The scientific community understands that Law 12.651/2012 did not consider scientific studies that portray the peculiarities of ecosystems, such as flood fields (Sociedade Brasileira para o Progresso da Ciência 2011). There was also no consideration of the importance of native vegetation cover in different relief positions, in terms of maintenance of rainwater runoff (Tambosi et al. 2015).

The scenario identified in the county of Rondonópolis - MT regarding the environmental responsibility in the Permanent Preservation Areas should be understood as an opportunity for the public and private sectors to prioritize the environmental quality of riparian ecosystems, which constitute an important transition region between the Cerrado and Pantanal biomes. In addition, it is important to emphasize that the Cerrado biome is a biodiversity hotspot. Estimates indicate that the rate of expansion of agricultural activity over the native areas of Cerrado is 3% per year, and that by 2030, this biome will be restricted to legally protected areas (Aquino & Miranda 2008).

Thus, it is essential to focus on strategies concerning the investment in lines of credit for landowners who must recover their degraded areas, as well as on increasing the financing of scientific and technological innovation researches that will provide measurable results to allow assessing the degree of effectiveness of ecological restoration practices through refined data.

3. CONCLUSIONS

We have shown that, with the case study in the riparian forest adjacent to the 'Rodovia do Peixe' (Fish Highwat) in Rondonópolis, the new Forest Code has diminished the legal responsibility of the rural owners in relation to the maintenance of forest fragments in their properties. In other words, the degradation of forests exists, and rural landowners cannot be held liable for these environmental damages. As anticipated by several scientists, before the implementation of the new Brazilian Forest Code in 2012 (for instance Casatti 2010; Marques et al. 2010; Toledo et al. 2010), and as evidenced by several subsequent studies (Pinheiro et al. 2015; Azevedo et al. 2017; Roriz et al. 2017; and this paper), the new Forest Code increased deforestation and weakened the biodiversity conservation of the Brazilian forests. Case studies like this one carried out by our team are very important, as they inform the society about the urgency of improving the current Brazilian Forest Code, materialized under Federal Law 12651/2012. One way to improve the Brazilian Forest Code would be to make it more similar to the European Union's environmental legislation for the protection of biological diversity, known as the Natura 2000 Network. This legislation provides for two types of conservation units: the *Special Protection Areas for Birds* and the *Special Conservation Areas*. These protected spaces are articulated as a transnational ecological network of special areas of conservation, composed of more than 26,000 areas, in the 27 States of the European Union. Although Natura 2000 is not free from criticism and controversy (see for instance Young et al. 2005; Beunen et al. 2013), it has succeeded in protecting about 18% of European territory (European Commission 2008).

Riparian forests, despite their enormous ecological importance on a wide geographic scale, are suffering a severe reduction worldwide (Garófano-Gómez et al. 2013; Nunes et al. 2014; Shafroth et al. 2016; Silva et al. 2017). Although the Brazilian Federal Law 12651/2012 provides rules aimed at protecting the native vegetation, as presented in its preliminary section, it reduced the environmental liability of several areas that used to be protected.

According to an optimistic and edifying environmental protection scenario in Brazil, it is necessary to strengthen partnerships among judicial entities, universities, research centres, environmental secretariats and non-governmental organizations, including rural associations, so that the environmental regularization of rural properties can be an actual process rather than a mere rhetoric that does not bring robust benefits to the society.

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