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Importance of legislation for maintaining forests on private properties in the Brazilian Cerrado

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Abstract

This paper evaluates compliance with environmental laws in the municipality of Sorriso and the impact of changing legislation on vegetation. To verify the size of the properties, the areas designated as legal reserves (LRs), permanent protection areas (APPs), and springs were studied. Details of compliance with the New Forest Code (NFC) were drawn from the Rural Environmental Register (CAR) database. The database provided by PRODES/CERRADO was used to gather data to monitor deforested areas. SojaMaps data were used to verify the areas used for soybean cultivation followed by the Perpendicular Crop Enhancement Index. The data were plotted and superimposed on the deforestation data provided by PRODES/CERRADO. The areas were calculated using QGiS software version 2.18.22. The results showed that only 20.04% of the original Cerrado vegetation cover remains in the municipality. The results also revealed environmental LR, APP, and spring deficits of 92,772.32, 1,656.28, and 322.86 ha, respectively. Measures such as the CAR in the New Forest Code are ineffective for inhibiting illegal deforestation, and new legislation authorized the loss of 75.22% of the APP areas due for recovery. The proposed changes to eliminate LRs will allow the suppression of 91,000 ha of vegetation in Sorriso. Expanding the Amazon Soy Moratorium to the Cerrado could bring immediate benefits to the maintenance of the last continuous forested areas in this biome.

Keywords Agricultural frontier · Legal reserve · CAR · APP · Environmental deficit

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1 Introduction

Brazil is home to the most expansive biodiversity on the planet and represents one of the great agricultural frontiers in tropical areas worldwide. Its agricultural expansion areas are concentrated in the Amazon and Cerrado (Brazilian savanna) biomes, which have lost or suffered great degradation in their natural vegetation in recent decades (Gollnow & Lakes, 2014). Between 1985 and 2017, Brazil lost 71 million hectares (Mha) of natural vegetation that was replaced by pastures or agricultural areas, primarily in these two biomes (Souza Junior et al., 2020). In addition, these biomes have concentrated the largest number of fire foci in the last two decades, compromising the climate agreements signed by Brazil (Silva Junior et al., 2020).

The Amazon covers 419 Mha (49.29% of the Brazilian territory), and 23% of its forests are protected in the form of conservation units (UCs); 70 Mha of public lands remain undesignated (Azevedo-Ramos & Moutinho, 2018), and legislation allows the legal deforestation of only 20% of any property. The biome suffers from sanctions from the Soy Moratorium (Gibbs et al., 2015) and the Meat Moratorium (Gibbs et al., 2016), which imposed restrictive economic measures on producers of soy and meat produced in deforested areas after 2008 and 2009. The Cerrado occupies 23.92% of national territory (203 Mha), and legislation allows deforestation of 65–80% of vegetation, which is also exempt from moratoria. Currently, 19% of the total area remains unchanged, and 7.5% of the territory is protected (Strassburg et al., 2017); this rate falls well below the 17% indicated as conservation goals for protected areas (Butchart et al., 2015).

The Cerrado requires special attention from the Brazilian government, as it contains 40 Mha of native areas that can be legally converted to agricultural land (Soares-Filho et al., 2014). Additionally, the Cerrado is considered a new agricultural frontier of soya in the region known as MATOPIBA (an acronym drawing on the initials of the names of the states of Maranhão, Tocantins, Piauí, and Bahia), which concentrates its last continuous and preserved areas of vegetation (Noojipady et al., 2017; Spera, 2017). Soy was responsible for 22% of Cerrado land conversion from 2003 to 2014, with most farms violating environmental legislation (Rausch, et al., 2019). Nonetheless, Brazil has already shown through a series of initiatives and political actions that inhibiting deforestation is possible (West & Fearnside, 2021). However, the same political will can be used for destruction encouraged by the law (Alves et al., 2020), and Brazil has seen an alarming increase in deforestation since 2016, with the rapid creation of forest fragments and a decrease in large patches of forest, especially in the Cerrado (Montibeller et al., 2020). Most of the native vegetation (53%) is found on private rural properties (Brancalion et al., 2016; Soares-Filho et al., 2014); one mechanism to ensure the permanence of the remnants of these forest areas is the application of the Forest Code (FC). The FC requires the conservation of areas designated as Legal Reserves (LRs), the protection of riparian forests—called Areas of Permanent Preservation (APPs), and protection of areas around springs.

Currently, Brazilian congressmen have proposed the elimination of LRs (Alves et al., 2020), which could suppress 167 Mha of native forests across the country (Chiaretti, 2019). Considering this proposal, this work intended to assess compliance with environmental legislation in a soy-producing municipality in the Cerrado and the effect of this proposal on the suppression of LRs in the municipality. The selected municipality of Sorriso, Mato Grosso, represents consolidated agriculture and is the largest soybean and corn producer in Brazil. The results of this study should contribute to the formulation of public policies aimed at the Cerrado and in supply chain initiatives (soy and meat) for biome conservation.

Additionally, the study will help turn the Cerrado into a global model for agricultural frontier areas regarding the successes and mistakes of environmental protection.

2 Materials and method

2.1 Study area

The municipality of Sorriso is located in the northern region of the state of Mato Grosso, at latitude 12º 32′43″ S and longitude 55º 42′41″ W, along the BR-163 highway. It was colonized in the 1970s and gained independence in 1986. In the beginning of its occupation, it was entirely covered by native vegetation and spread across an area of 9346 km^2 (Fig. 1). As explained by Alvares et al. (2013), the predominant climate is classified as "Aw" according to *Köppen-Geiger*, with a rainfall range falling between 1900 and 2200 mm. Sorriso is located in the Cerrado-Amazon transition region and 78.16% of its territory is inserted within the Cerrado. Today, it is the largest soybean and corn producing

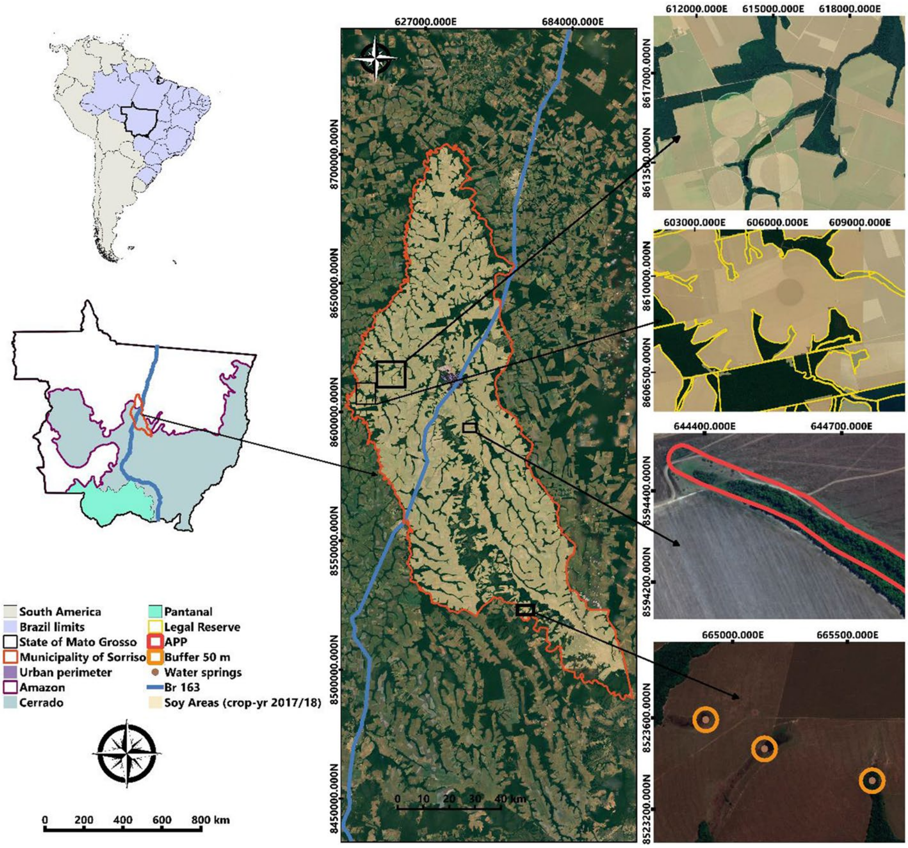

Fig. 1 Map of the location of the municipality of Sorriso, which is inserted in the Amazon and Cerrado biomes, with the categories of land use and occupation

municipality in Brazil. The last population census reported that Sorriso had 87,815 inhabitants (IBGE, 2018).

3 Database

3.1 Deforestation calculation

Deforestation in the Cerrado areas of the municipality was mapped between 2000 and 2017. For the purpose of mapping, land use and occupation were classified as pasture, agriculture, urban areas, and other uses. The database provided by Terrabrasilis, a product of the National Institute of Space Research (INPE), was used to present information on land use by classifying it as either anthropic (agricultural and extractive areas, intensive pasture, mining, burning in anthropic and urban areas) or natural (watercourse, wetlands, and forest formations) (INPE, 2018). The rates of deforestation were made available by PRODES/CERRADO (INPE, 2018). The deforested areas from 2013 onward, that is, in the period after the NFC was also evaluated and would be used for soybean cultivation in the 2017/2018 harvest. For this purpose, the SojaMaps (SojaMaps, 2021) database was used, followed by the Perpendicular Crop Enhancement Index (PCEI) (Eq. 1) (Silva Junior et al., 2017). These data were plotted and superimposed on the deforestation data provided by PRODES/CERRADO. The areas were calculated using QGiS software version 2.18.22.

$$PCEI = g.\frac{\left(Max\frac{\rho_{IVP}-a\rho_V-b}{\sqrt{1+a^2}}+S\right)-\left(Min\frac{\rho_{IVP}-a\rho_V-b}{\sqrt{1+a^2}}+S\right)}{\left(Max\frac{\rho_{IVP}-a\rho_V-b}{\sqrt{1+a^2}}+S\right)+\left(Min\frac{\rho_{IVP}-a\rho_V-b}{\sqrt{1+a^2}}+S\right)} \quad (1)$$

where MaxPVI is the maximum value of PVI observed in the period of maximum development of the soybean crop; MinPVI is the minimum value observed in the pre-planting and/or emergency period; S is the coefficient of improvement (10^2); and g is the gain factor (10^2).

4 The Forest Code

The FC dates back to 1965 and was reformulated after several stages of work following many rounds of discussion and pressure from a rural group representing the interests of the agribusiness sector in the National Congress. After a lot of criticism on the ground that there was a lack of scientific basis and debate between the scientific community and the National Congress (Azevedo et al., 2017; Brancalion et al., 2016; Karam-Gemael et al., 2018), the law was approved in October 2012 and was called the "Law of Protection of Native Vegetation," popularly known as the New Forest Code (NFC) (Brasil, 2012).

The NFC makes a differentiation for the maintenance of the vegetation cover in private properties based on the biome in which they are inserted, along with the size of the property evaluated in the fiscal modules (FM), which also varies according to the biome and region in which they are inserted (INCRA, 2018). LR areas are 80% in the Amazon, to between 20 and 35% in the Cerrado, and to 20% in the other biomes. The APPs, which had a minimum width of 30 m in the old FC, passed with the NFC needing to recompose illegally deforested riparian forest to a minimum width of 5 m to a maximum of 100 m, and still allowing the use of these areas for agroforestry, ecotourism, and rural tourism activities (Ramos & Anjos, 2014).

The NFC also promoted amnesty for producers who illegally deforested land until 2008 besides reducing the areas to be reforested along the banks of water bodies. The NFC brought about two more novel developments, namely the Rural Environmental Registry (CAR) and the Environmental Reserve Quota (CRA). The CAR is an electronic registry that is mandatory for all rural properties and forms a strategic database for the control, monitoring, and combat of deforestation of both forests and other forms of native vegetation in Brazil (Brancalion et al., 2016; MMA, 2019). The CRA is a means to preserve and avoid the continuation of deforestation and can be used to compensate real estate with LR deficits in the same biome (Brasil, 2012). This measure allows the property with an environmental liability to compensate by acquiring forested areas outside of its municipality or state but within the same biome.

5 Calculation of forest remnants

The shapefile data on the private properties of the CAR public database (CAR, 2018) were used for the evaluation of the LR, APPs, nascent areas, and consolidated real estate areas. The APPs and springs were initially calculated based on the maintenance of a strip of forest on the banks of water bodies to the extent of 30 m, which was the minimum range required prior to NFC approval. Subsequently, the CAR data were applied to evaluate the areas to be recovered based on NFC and FMs, where a FM in Sorriso was equivalent to 90 ha. According to Decree no. 7,830 (Brasil, 2012), in the areas of up to one FM, the re-composition of the APP increased to 5 m. In the areas between one and two modules, it increased to 8 m. In the areas between two and four modules, it increased to 15 m. All these values are independent of the width of the rivers. Between 4 and 10 FM, in rivers with width up to 10 m, the re-composition range was 20 m. In all other cases, an extension corresponding to half the width of the watercourse, observing a minimum of 30 m and a maximum of 100 m, was counted from the gutter of the regular riverbed.

The LR areas were elaborated with the need to retain 35% of the native forest cover in Cerrado areas within the Legal Amazon. The Legal Amazon is a political-administrative territorial unit established by the Brazilian government that covers the entire Amazon and parts of the Cerrado. The NFC requires the retention of only 20% of the area as LR in the Cerrado areas outside this territory. For the evaluation of the areas with forest surplus that could be used to trade the CRAs, the CAR data were used to calculate the forest areas above 35% in each property, regardless of its FM.

6 Results

The municipality of Sorriso has already lost 583,679.00 ha of its Cerrado portion, which is equivalent to 79.96% of its original vegetation cover. Between 1988 and 1999, 37,333.00 ha were deforested. The highest rates of deforestation occurred between 2000 and 2012, with approximately 538,000 ha deforested, of which 481,924.80 ha were occupied by soybeans in the 2017/2018 harvest. Between 2013 and 2017, 7,664.34 ha were deforested, with 4,253.10 of them with soy in the 2017/2018 harvest (Fig. 2).

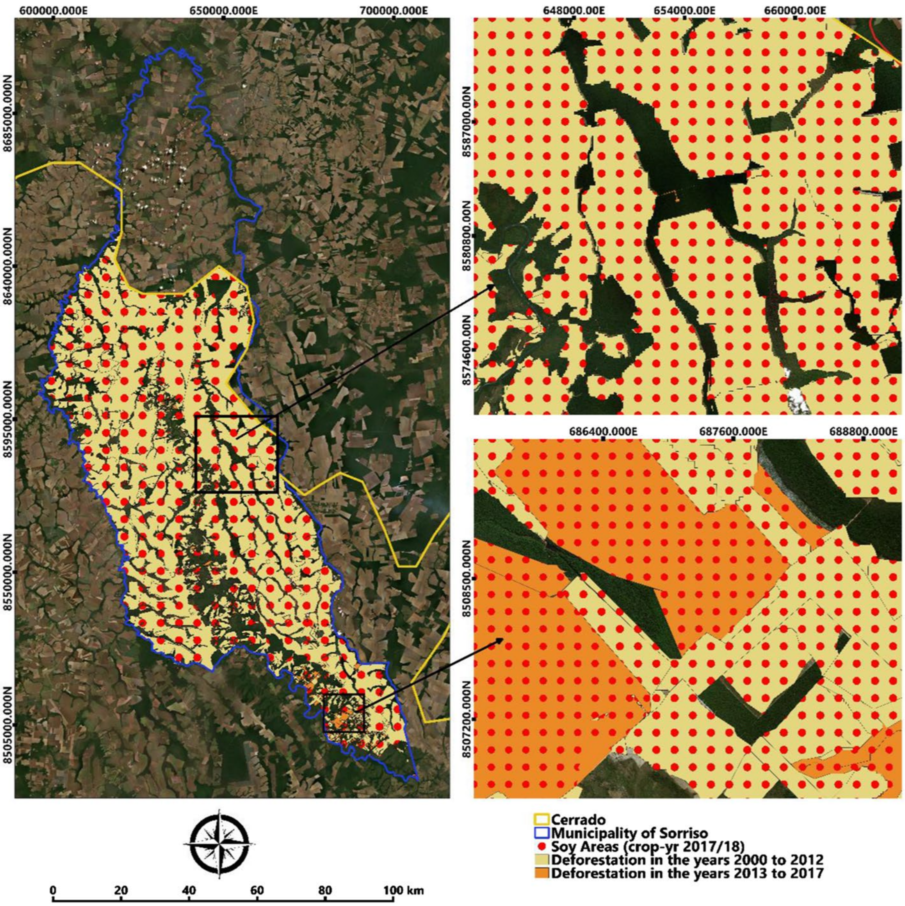

Fig. 2 Deforestation occurred in the municipality of Sorriso that was inserted in the Cerrado Biome between the years 2000 and 2017 and soybean area planted in the 2017/18 harvest

This area of the municipality covers 1,173 rural properties, of which 331 measure up to 1 FM; 151 between 1 and 2 FM; 203 between 2 and 4 FM; 286 between 4 and 10 FM; and 202 over 10 FM (Table 1).

Of these 1,173 properties evaluated, only 233 (19.86%) comply with the legislation concerning the maintenance of LR. The other 940, which total 527,073.32 ha, present a deficit in LR areas of 92,772.32 ha. Areas of up to 1 FM have a deficit of 81.45% (2,859.17 ha). Those that are between 1 and 2 FM have a deficit of 60.50% (3,127.76 ha). Those between 2 and 4 FM have a deficit of 60.25% (8,905.31 ha). Those that are between 4 and 10 FM have a deficit of 54.18% (26.007.59 ha). Finally, those that are above 10 FM have a deficit of 45.89% (51,872.49 ha).

Of the 1,173 rural properties analyzed, 1,027 properties have APP areas. A total of 3,054 APPs have been identified, which are distributed in 129 properties that are smaller than 1 FM, 111 properties ranging between 1 and 2 FM, 170 properties ranging between 2 and 4 FM, 305 properties ranging between 4 and 10 FM and, finally, 312 in properties that are sized larger than 10 FM (Table 2).

Table 1 Number of properties according to the fiscal module (FM) (1 FM = 90 ha) that are with the LR in accordance with the NFC, buildings that do not comply with the NFC and the forest deficit of the LR according to the FM of the rural properties of the municipality of Sorriso that are inserted in the Cerrado biome

Properties FM	N properties in accordance with LR (35%)	N properties not complying with LR (35%)	Total area (ha) of non-conforming properties	Forest remnants (ha) of non-conforming properties	Area of reference to 35% of forest (ha)	Forest deficit (ha)
≤ 1 FM	60	271	10,028.95	650.95	3,510.13	2,859.18
1 to 2 FM	32	119	14,768.58	2,041.24	5,169.00	3,127.76
2 to 4 FM	46	157	42,227.80	5,874.42	14,779.73	8,905.31
4 to 10 FM	48	238	137,138.29	21,990.81	47,998.40	26,007.59
≥ 10 FM	47	155	322,909.70	61,145.90	113,018.39	51,872.49
TOTAL	233	940	527,073.32	91,703.32	184,475.65	92,772.32

Table 2 Total APPs according to FM, total APP area in hectares, total forest remnants in APPs, forest deficit of APPs, and total degraded APPs and their forest deficit in rural properties in Sorriso inserted in the Cerrado

Property FM	Total Property	APP Total in Property	Water course	Total of irregular APPs (units)	Total of regular APPs	Total APP area (ha)	Total area of APPs (ha)	Forest deficit (ha)	Restore according to new Forest Code (ha)	Re-composition area	Forest deficit (ha)
≤1 FM	331	129	up to 10 m	79	65	253.64	207.12	46.52	5.526	5 m	40.995
1 to 2 FM	151	111	up to 10 m	188	73	673.01	452.52	220.48	48.91	8 m	171.577
2 to 4 FM	203	170	up to 10 m	379	155	1,656.12	1,381.47	274.65	110.78	15 m	163.872
4 to 10 FM	289	271	up to 10 m	771	327	4,694.00	3,970.76	723.24	420.29	20 m	302.952
		34	50 to 200 m	43	20	668.95	311.38	357.56	167.90	50 m	189.671
≥10 FM	199	199	up to 10 m	1.457	539	11,659.20	9,540.87	2,118.33	0	30 m	2,118.33
		7	10 to 50 m	31	9	59.17	10.239	48.93	26.94	30 m	21.992
		106	50 to 200 m	106	103	3,019.93	128.035	2,891.90	875.95	50 m	2,015,95
Total	1,173	1,027		3,054	1,291	22,684.05	16,002.42	6,681.63	1,656.28		5,025.34

Of the 3,054 APPs identified, 1,291 (42.27%) have forest remnants and comply with the legislation. The other 1,763 do not comply with the current environmental legislation, representing a forest deficit of 1,656.28 ha. In properties that are up to 1 FM in size with a watercourse up to 10 m, there is a forest deficit in the APPs of 40.99 ha (0.82%). In properties ranging between 1 and 2 FM with a watercourse of up to 10 m, the forest deficit was 171.57 ha (3.41%). In properties ranging between 2 and 4 FM with a watercourse of up to 10 m, the forest deficit was 163.87 ha (3.26%). In properties ranging between 4 and 10 FM with a watercourse of up to 10 m, the forest deficit was 302.95 ha (6.03%). In properties ranging between 4 and 10 FM with a watercourse of size between 50 and 200 m, there was a forest deficit of 189.67 ha (3.77%). In properties sized above 10 FM with a watercourse of up to 10 m, the forest deficit was 2,118.33 ha (42.15%). In properties with a watercourse between 10 and 50 m, the forest deficit was only 21.99 ha (0.44%) and in those with a watercourse of size between 50 and 200 m, the forest deficit was 2,015.95 ha (40.12%).

In the 1,173 properties evaluated, 472 had springs. A total of 1,279 springs were found on these properties. Of these, 480 (37.52%) were forested according to the requirements of the NFC and 799 (62.47%) were deforested, thus presenting a forest deficit of 322.86 ha (Table 3).

Of the 799 springs with deficits, 11 were in properties of up to 1 FM and their deficit was 9.19 ha (2.85%). In properties ranging between 1 and 2 FM, there were 23 springs with a deficit of 18.57 ha (5.75%). In properties ranging between 2 and 4 FM, there were 87 springs with a deficit of 51.49 ha (15.95%). In properties ranging between 4 and 10 FM, there were 203 springs and the deficit was 86.01 ha (26.64%). In properties that were above 10 FM, the deficit was 157.60 ha (48.81%).

As of 2013, after the NFC, the extent of land subject to deforestation amounted to 7,664.34 ha. Properties larger than 10 FM were responsible for 91.84% of these deforestations (7,039.03 ha). Of these, 4,042.24 (57.42%) were deforested properties with LR above 35%, and 2,996.78 (42.58%) were deforested properties with LR below 35%.

Of the 1,173 properties surveyed, only 233 (19.86%) comply with the NFC and had a surplus of 30,415.07 LR that could be used for environmental compensation through the CRA. There were 60 properties of size of up to 1 FM that had 364.95 ha (1.20%) of surplus areas. In 32 properties between 1 and 2 FM, the surplus was 1,030.06 ha (3.39%). In 46 properties between 2 and 4 FM, the surplus was 1,652.84 ha (5.43%). In 48 properties between 4 and 10 FM, the surplus was 5.114,61 ha (16.82%). Finally, 47 properties larger than 10 FM had the largest areas, totaling a surplus of 22,252.61 (73.16%) that could be traded as a quota.

7 Discussion

7.1 Cerrado deficit in Sorriso

Tropical forests in agricultural frontier areas are extremely vulnerable to loss of biodiversity and major contributor to global warming. The Cerrado, one such agricultural frontier, lost 7,340 km^2 of natural vegetation from August 2019 to July 2020 (INPE, 2021). Greenhouse gas (GHG) emissions due to fires accounted for 32% of emissions from all Brazilian biomes (Silva Junior et al, 2020); in 2017, the greenhouse gas emissions in the Cerrado were higher than those in industrial areas due to the conversion of land use to agriculture (SEEG, 2018). Today, the Cerrado in the MATOPIBA represents the new agricultural

Table 3 Total springs according to FM, number of springs with forest remnants, number of springs that are deforested, and forest deficit in the source areas of the rural properties of Sorriso inserted in the Cerrado

Property Size	Number of properties	Properties with springs	Number of springs	Springs with forest	Springs without forest	Buffer of 50 m in the areas of springs (ha)	Spring with forest (ha) in the buffer of 50 m	Forest deficit (ha)	Restore 15 m (ha)	Forest deficit (ha)
≤ 1 FM	331	22	24	13	11	18.55	7.68	10.87	1.68	9.19
1–2 FM	151	56	56	33	23	43.29	23.09	20.2	1.63	18.57
2 to 4 FM	203	80	153	66	87	118.27	62.07	56.2	4.7	51.49
4 to 10 FM	289	146	325	122	203	251.22	157.74	93.48	7.47	86.01
≥ 10 FM	199	168	721	246	475	557.33	386.22	171.12	13.52	157.6
Total	1.173	472	1.279	480	799	988,66	636,8	351,87	29	322,86

soybean frontier (Noojipady et al., 2017; Spera, 2017), and tens of millions of hectares of original vegetation cover can be legally converted into agricultural areas (Soares-Filho et al., 2014). Consequently, the scientific community is greatly concerned for the conservation of the last continuous areas of vegetation in the Cerrado.

The Cerrado biome covers 36.6% of the area of Mato Grosso, and the area of agricultural land increased by 111% from 2000 to 2016 (Bonanomi et al., 2019). Mato Grosso is the largest Brazilian soybean producer with 10.7 Mha distributed in its Cerrado and Amazonia areas and Sorriso, although it was colonized only four decades ago, which is also a national record holder in the planted area of this oilseed, with 643,542 ha in the 2019/2020 harvest (SojaMaps, 2021). Currently, 20.04% of the original Cerrado coverage remains in Sorriso, far below the 35% conservation rate required by legislation in the Legal Amazon. The deficit of LR areas is 92,772.32 ha; the deficit of the largest properties (51,872.49 ha) corresponds to 45.89% of the absolute total. However, in relative terms, the smallest properties have the highest deficit of LR areas (81.45%). This pattern of higher relative deforestation on small farms has been observed in other municipalities of Mato Grosso and Pará (Asunción et al., 2017).

The municipality also presents negative data for APP and springs, which were expected to comply with the NFC. This is because the municipality is primarily engaged in agriculture, and the soil soaked in the banks of the water bodies and springs has prevented mechanization of the area. However, the APP and spring deficits reach 1,656.28 and 322.86 ha, respectively, with the highest relative values observed on larger properties. According to previous legislation (1965), Sorriso presented an APP deficit of 6,681.63 ha to be reforested. According to the NFC, APP areas in need of re-composition reached 1,656.28 ha; thus, 24.78% of the area is currently required to be restored according to the 1965 legislation. Therefore, the total decrease of area marked for recovery reaches 5,025.34 ha.

7.2 Implications for biodiversity conservation

This deficit compromises biodiversity and is the result of disorderly occupation that did not respect existing legislation at the time of the colonization and of an NFC developed without an adequate debate with the scientific community (e.g., Azevedo et al., 2017; Brancalion et al., 2016; Karam-Gemael et al., 2018; Vieira et al., 2018). Changing the width of riparian corridors, for example, is the most important factor that could benefit biodiversity (Metzger, 2010; Ramos & Anjos, 2014); 50 m of riparian vegetation are required for the maintenance and conservation of biodiversity (Ramos & Anjos, 2014). The current protection range is reduced to 5 m; however, it is unclear if exotic species can recover in such a small strip and maintain gene flow between the native plant and vertebrates species (Siqueira et al., 2015). Zimbres et al. (2018) noted that the involvement of riparian forests also compromises landscape connectivity and does not protect fundamental hydrological functions in aquatic ecosystems.

7.3 Limitations for curbing deforestation in the Cerrado

Azevedo et al. (2017) observed that developments such the Rural Environmental Register (CAR) are insufficient for inhibiting illegal deforestation and further reducing LR areas. After passage of the NFC, the CAR verified that 2,996.78 ha of land had been subject to deforestation in properties with an LR below 35%. Most deforestation was conducted after 2013 on the larger properties, and most of the areas were converted to soybean cultivation. The landowners practicing illegal deforestation suffer no sanctions in the commercialization of soybeans produced in these areas, as would have occurred in the Amazon biome with an implemented Soy Moratorium (Gibbs et al., 2015)—an agreement by which major exporting companies pledged not to acquire soybeans produced in deforested areas in the Amazon after July 2008; the expansion of the moratorium to the Cerrado has been presented as a means to contain the high rates of deforestation (Lima et al., 2019; Strassburg et al., 2017). Other conservation efforts conducted in the Cerrado by the soybean production chain included the “Soja Plus” Program, promoted by the Brazilian Vegetable Oils Industry Association (ABIOVE). “Soja Plus” was developed to meet the market demand for sustainable products and addresses the improvement of the environmental, social, and economic aspects of production to enable better management of rural properties (ABIOVE, 2019). Lima et al. (2019) noted that the program, which was a beautiful initiative in the search for sustainability in soybean production, only reached a small number of properties within the community of Brazilian soybean producers and was unable to make a large contribution to halt deforestation in the Cerrado and the Amazon. Even Zero Deforestation Commitments, voluntary initiatives in which companies or countries have pledged to eliminate deforestation from their supply chains, have been effective in the Cerrado (Ermgassen, 2020).

The largest forest areas in Mato Grosso and Sorriso belong to larger properties (Richards & VanWey, 2016). Sorriso contains 233 properties that respect LR legislation, accounting for a surplus of 30,415.07 ha that could be used for commercialization as CRA. If the proposal in the Brazilian parliament to eliminate LR is approved, the area would have a surplus of 61,288.25 ha that could be suppressed (Table 1). Brazilian natural vegetation has already suffered a severe setback with amnesty to illegal deforestation before 2008; additionally, areas slated for reforestation along the banks of water bodies have been reduced. Soares-Filho et al. (2014) noted that this last measure reduced the total area to be restored from 50 to 21 million hectares (Mha) nationwide. In addition to the environmental liability of the 29 Mha, Metzger (2010) noted that the reduction of the width of the riparian corridors removed an essential safeguard for biodiversity. Legalizing the suppression of LRs will add 167 Mha to the total area of vegetation lost nationwide due to political interference in environmental laws, further compromising biodiversity and GHG emissions in the Cerrado biome.

7.4 Future perspectives

Agricultural production in the Cerrado could currently be doubled without deforestation (Brandão Jr et al., 2020; Rausch et al., 2019), and zero deforestation proposals are already coming from consumer markets for Brazilian soy. In 2020, ABIOVE received a representative document from 159 European companies demanding immediate adoption of policies to purchase Cerrado soy with zero deforestation (ABIOVE, 2020). These facts and evidence show that producing food and conserving forests is possible. Past environmental mistakes can be avoided; and the case of Sorriso should serve as a model for decision makers and formulators of environmental legislation.

8 Conclusion

Tropical forests in agricultural frontier areas are subject to the political interests of their leaders, who can change the laws to allow the expansion of agribusiness. The municipality of Sorriso is a classic example of disorderly past occupation, the inability to comply with current laws, and the effect of changing legislation on forests. Sorriso presented deficits in LR, APP, and nascent areas that compromise biodiversity. Changes in legislation may allow the suppression of the 91.703 ha of LRs remaining in the municipality, which already has an LR deficit of 92.772 ha. Legislation and CAR have proved inefficient for inhibiting further deforestation and encouraging the restoration of degraded areas. The quickest and most effective response to minimize the loss of natural vegetation in the Cerrado would be to expand the Soy Moratorium into this biome per the demand of international soy consumers. A moratorium that would suspend the expansion of soy production in native vegetation in the Cerrado would be the most valuable contribution to safeguarding the last continuous and preserved areas of vegetation and will help in meeting the Brazilian environmental targets for gas emissions.

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