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Deforestation control in the Brazilian Amazon: A conservation struggle being lost as agreements and regulations are subverted and bypassed

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Deforestation control in the Brazilian Amazon: A conservation struggle being lost as agreements and regulations are subverted and bypassed

Abstract

Despite efforts to reduce deforestation in the Brazilian Amazon, there has been an up-turn in clearing rates since 2012. These increases are in part due to failures in deforestation control. Soybean planters, cattle ranchers, and timber merchants find ways to circumvent agreements and legislation. Here we explain some of the key problems with the implementation of the principal agreements and Brazilian laws that should be keeping clearing rates under control. To combat increased clearing in the Amazon, we suggest an urgent need to strengthen Brazilian environmental agencies, improve technologies used to monitor the effectiveness of clearing-reduction programs, better integrate agrarian and environmental policies and integrate environmental enforcement across federal, state and municipal governments, as well as improve transparency along global supply chains and raise awareness among consumers to put market pressure on producers to avoid new deforestation.

Keywords: Amazonian savannahs; Cerrado; timber; Soy Moratorium; ecosystem services; beef agreement

Brazil has been considered to be a global example in terms of policies to reduce CO_2 emissions (Nepstad et al., 2014), being recognized for its programs, agreements and public policies to solidly and consistently reduce deforestation, particularly in the tropical forests of the Amazon region (Gibbs et al., 2015; Gibbs et al., 2016; Rausch and Gibbs, 2016; Barreto et al., 2017). Indeed, in order to avoid increased degradation of the Amazon, non-governmental organizations (NGOs), civil society, private initiatives and the Brazilian government have come together to create agreements that seek to reduce 'clearing', that is, deforestation and the removal of other types of native vegetation. These agreements include the "Terms of Adjustment of Conduct" for meatpacking companies (*Termo de Ajustamento de Conduta da carne*, or *TAC da carne*, in Portuguese) (see Gibbs et al., 2016; Barreto et al., 2017), the Soy Moratorium (*Moratório da Soja* in Portuguese) (Gibbs et al., 2015; Rausch and Gibbs, 2016), and federal legislation that has also been put in place to prohibit the commercialization of timber from newly cleared areas (Brasil, 2008).

However, while Brazil's Amazon deforestation rates declined dramatically from 2004 to 2012, the agreements mentioned above were not the only factors acting to reduce deforestation at the time (Fearnside, 2017a). Indeed, 70% of the "deforestation slowdown" occurred between 2004 and 2007, during which time the exchange rate of the US dollar against the Brazilian Real fell by more than half, in turn making soy and beef exports less profitable (data in: Assunção, 2015). As such, the deforestation rate declined in direct parallel with the price of these commodities, and lagged prices of soy and beef explain over 75% of the deforestation in this period (Arima et al., 2014). From 2008 to 2012, deforestation continued to decline under various improved governance measures, including a 2008 policy change that denied access to the highly subsidized financing from government banks for agriculture and ranching in properties with pending environmental fines, improved satellite monitoring systems, and a "blacklist" system to penalize municipalities (counties) with high illegal deforestation. Among the measures in effect during this period were the 2006 Soy Moratorium and the 2009 beef

agreement (*TAC da Carne* in Portuguese) discussed in this paper. Arguably, since 2008 these two measures have been important barriers against deforestation for soy and livestock (Gollnow and Lakes, 2014; Fearnside, 2017a), which are the main land uses in cleared Amazon forest areas (Fearnside, 2005; Barona et al., 2010; Fearnside and Figueiredo, 2016).

However, despite a 16% decrease in the rate of forest loss in the Brazilian Amazon between 2016 and 2017, the general trend since 2012 has been one of increasing clearing rates (Fearnside, 2017a; INPE, 2018a). Indeed, between 2015 and 2016 there was an alarming 29% increase in the annual clearing rate in Brazil's Amazon forest and even higher increases in the neighbouring Cerrado biome (Figure 1). In the Cerrado, the clearing rate in 2015 was 11,795 km^2, a rate 47% higher than that recorded in Brazil's Amazon forest in the same year (INPE 2018a, 2018b). In 2015, Brazil entered an economic crisis that led to GDP contraction and a tripling in unemployment rates (Dobrovolski et al., 2018).

[Figure 1 here]

Increased clearing rates in the Amazon have triggered a clause in Norway's agreement with Brazil, such that in June 2017 the Norwegian government halved its annual contribution to the Amazon Fund, which is used to fund actions to prevent, monitor and combat deforestation in the Amazon (Crouzeilles et al., 2017). Norway has further warned that funding may be completely withdrawn if the upward deforestation trend continues (Crouzeilles et al., 2017). The estimated rates for 2018 show a deepening of the trend for increasing clearing rates (INPE, 2018a), and there are now a number of reasons to expect this trend to continue and further deepen in the coming four years. On 1 January 2019, Brazil's new presidential administration came into power, and since then a number of key changes have been made that will have major implications for conservation in the Amazon (Fearnside, 2018a). These include the transfer of the administration of indigenous lands from the Ministry of Justice to the Ministry of Agriculture, and the elimination of the climate sections of both the Ministry of the Environment and the Ministry of Foreign Affairs (Artaxo, 2019). Beyond this, the Bolsonaro administration has suggested that Brazil may leave the United Nations Paris Agreement, in which the national commitment is to reduce greenhouse gas emissions by 43% by 2030, via both an end to illegal deforestation and commitments to reforestation of large areas (Artaxo, 2019). The new president currently says that Brazil will remain in the accord "for now" and only if several (unlikely) changes are made in the agreement (Fearnside, 2019).

It is in this context of increasing clearing rates that we seek to understand the limitations of three key environmental initiatives for deforestation control in Brazil: the Soy Moratorium, *TAC da Carne* and logging legislation, and why they have not been more effective in slowing clearing rates. Specifically, we will: 1) discuss the ways in which soy planters, cattle ranchers and timber merchants subvert and bypass agreements and legislation, circumventing surveillance and enforcement efforts; 2) discuss the failures of the mechanisms currently employed to reduce the impact of soy, beef and timber in the Brazilian Amazon; and, 3) suggest how local, national and international forces could be employed to combat these failures and help to once more slow clearing rates in the region.

[Figure 2 here]

The Soy Moratorium

Created in 2006, the Soy Moratorium was the first voluntary agreement between civil society, industry and government with the aim of stopping the main soy traders from purchasing soybeans produced in areas of the Amazon cleared after July 2006. The base date was changed to July 2008 in the 2014 renewal to meet the criteria of the new Brazilian forest code that was enacted in 2012. Under the new forest code, it was no longer possible to penalise those who had, before July 2008, deforested legal reserves and the “areas of permanent protection” that each property is required to maintain along watercourses and on steep hillsides (Gibbs et al., 2015; Rausch and Gibbs, 2016). The Soy Moratorium had been renewed for limited periods since its creation, but in 2016 the agreement was renewed indefinitely (Patiño, 2016). Following the original 2006 agreement and until 2014, the area planted with soybeans decreased in the Amazon biome (Macedo et al., 2012; Gibbs et al., 2015; Rausch and Gibbs, 2016; Kastens et al. 2017; Gollnow et al., 2018).

While the Soy Moratorium has a role in preventing deforestation, it is also subject to both “laundering” and “leakage” (Rausch and Gibbs, 2016; Macedo et al., 2012; Gollnow et al., 2018). Laundering occurs in this agreement when soy produced in embargoed areas is commercialized as if it were produced in “regularized” areas or in the names of "*laranjas*" (people whose names and identity documents serve as ‘fronts’ for illegal activities) (Gibbs et al., 2015; Rausch and Gibbs, 2016). When this occurs, the final purchaser may not know the true source of the soy purchased. Indeed, since many producers own several farms, soybeans produced in an embargoed area can easily be traded as being from another farm with regularized status (Rausch and Gibbs, 2016). Alternatively, the soy production from an embargoed area may be marketed together with the production from a regularized area within the same property (Rausch and Gibbs, 2016).

Leakage from the Soy Moratorium occurs at two scales. Producers may plant soy in regularized portions of their properties (usually pasture areas that were cleared before 2008), but then deforest other areas in the same property to create replacement pastures for the displaced grazing activity (Rausch and Gibbs, 2016; Gollnow et al., 2018). However, this type of migration of deforestation to other areas also occurs across broader spatial scales (Barona et al., 2010) and the extent of this impact would be hard to exaggerate. In Mato Grosso, a state twice the size of the US state of California, vast expanses where deforested areas were formerly used for cattle pasture are now fields of soybeans (Arima et al., 2011). Cattle ranchers and soy planters are distinct social groups and have different specialized skills. When land in an area becomes significantly more valuable for soy than for pasture, there is a strong incentive for ranchers to sell their land to soy planters and use the money to buy larger areas of cheap land elsewhere, which they then clear for cattle pasture (Fearnside, 2017a).

A substantial impact of converting pasture to soy in both the Amazon and Cerrado portions of the state of Mato Grosso has been the displacement of ranching to other areas of forest in the Amazon, especially in the state of Pará, and this relationship has been demonstrated statistically (Arima et al., 2011; Richards et al., 2014). Furthermore, deforestation displacement for soy planting may be contributing to rapid clearing in the Cerrado biome (see Noojipady et al., 2017; Gollnow et al., 2018), as soy planters can avoid the deforestation restrictions of the Soy Moratorium by establishing their plantations in the Cerrado instead of the Amazon biome. While rates of clearing in the Amazon forests were declining, without a corresponding moratorium the rates of clearing in the Cerrado remained high in the years since the Soy Moratorium was signed, especially in the region known as “MAPITOBA”, an acronym representing the

states of Maranhão, Tocantins, Piauí and Bahia (Figure 3a). Approximately 40% of total soy expansion in MAPITOBA between 2007 and 2013 occurred in areas of native vegetation (Gibbs et al., 2015), which were legally and/or illegally cleared (IBAMA, 2018; Araújo et al., 2019). Across the whole of the Amazon and Cerrado biomes, data are available at the municipal level on deforestation rates, numbers of cattle produced and km^2 of soybeans planted (INPE, 2018a; INPE, 2018b; IBGE, 2019; Figure 3). These data show a general pattern of increases in area of soybean plantations in areas where the number of cattle have remained constant or decreased (e.g. in municipalities of the MAPITOBA region, particularly Formosa do Rio Preto and São Desidério in Bahia, and Baixa Grande do Ribeiro in Piauí), and only small increases in the area planted with soybeans in areas where the number of cattle have increased greatly (e.g. São Felix do Xingu in the state of Pará, and Porto Velho in the state of Rondônia) (Figures 3b and 3c), which are usually the areas with the highest clearing rates (Figure 3a). However, data are not available at a finer spatial scale across the whole region to make a direct analysis of land conversion.

[Figure 3 here]

Clearing is also now accelerating in non-forest ecosystems in the Amazon biome, particularly across the Amazonian savannahs, with dramatic increases in two large savannah complexes in the extreme north of the Amazon - the Cerrado of Amapá and the Lavrados of Roraima (Figure 1) (Carvalho and Mustin, 2017; Hilário et al., 2017; Mustin et al., 2017).

"Terms of Adjustment of Conduct" for meatpacking companies

The *TAC da Carne* (hereafter referred to as "TAC"), was signed in 2009 by cattle producers, meatpackers and the federal government, aiming to block the commercialization of cattle produced on land that was embargoed either due to illegal clearing or because other legal requirements had not been met (Figure 2) (Gibbs et al., 2016; Barreto et al., 2017). Under the agreement, animals from properties in the Amazon biome cleared after July 2008 (the base date of the new forest code) cannot be sold for slaughter, thus generating losses. However, ranchers found ways to circumvent the agreement either by selling cattle to meatpackers that were not yet signatories to the TAC, by registering only the 'deforestation free' parts of their properties in the Rural Environmental Register (*Cadastro Ambiental Rural* - CAR in Portuguese, see footnote to Figure 2), or by "laundering" cattle raised and fattened on non-compliant properties through compliant properties that serve as middle-men before sale to slaughterhouses (Gibbs et al., 2016; Barreto et al., 2017; Klingler et al., 2018). Eight years after its creation, sixty-three meatpackers (48%) active in the Amazon biome had joined the TAC, and they together slaughter approximately 70% of the cattle produced in the biome (Barreto et al., 2017). Meatpackers that are not signatories to the agreement avoid costs of enforcement and monitoring, making net profits higher (Barreto et al., 2017). Crucially, there is no real market pressure for non-signatory companies to join the TAC, as many international markets for the meat produced in Brazil, including the increasingly important Chinese market, do not require any kind of monitoring and enforcement of rules regarding the origin of cattle (Barreto et al., 2017). At the beginning of 2018, the Federal Public Prosecutor (MPF – *Ministério Público Federal* in Portuguese) released the results of the first audits of the TAC, however, there was no punishment for the slaughterhouses that received cattle produced in illegal areas (Mengardo, 2018). In other words, the efforts of the slaughterhouses that did not buy

livestock from illegal areas were not recognized, which makes the TAC an even more fragile agreement for achieving zero deforestation.

Prohibition of timber sales from newly cleared areas

Sale of timber and other forest products in Brazil is controlled by a series of authorizations and documents under the responsibility of either federal or state environmental agencies (Brasil, 2011a). This process takes place through computerized systems in which a 'Forest Origin Document' (*Documento de Origem Florestal*, or DOF in Portuguese (MMA, 2006; Brasil, 2011b) is issued electronically to the timber merchant and to companies that harvest timber after approval of a 'Sustainable Forest Management Plan' (*Plano de Manejo Florestal Sustentável*, or PMFS in Portuguese) or via an 'authorized deforestation' permit. The DOF is a compulsory license to control the transport of native forest products and by-products, including charcoal (IBAMA, 2017). However, there are at least three ways by which illegal timber merchants circumvent this system. Firstly, dealers may purchase invoices and DOFs from places where the government has authorized extraction, where permit holders often overestimate the amount of timber extracted from the authorized management project in order to give the appearance of legality to timber extracted from unauthorized areas (Greenpeace Brasil, 2015; Schmitt, 2015). Secondly, small fake timber merchants are created in the names of "*laranjas*" (see description in section on the Soy Moratorium), simulating the movement of timber products that, in reality, are transferred to large real timber merchants in areas with a high potential for exploitation (Polícia Federal, 2017). Thirdly, volumes of timber species with high commercial value are overestimated in logging licenses. This is shown by large systematic discrepancies between the volumes of these species approved for extraction and the volumes that the RadamBrasil surveys (Projeto RadamBrasil, 1973-1983) indicate as present in the original forest at the locations of the forest management projects (Brancalion et al., 2018).

Needed improvements in control of deforestation and logging

Deforestation

To combat the subversion of deforestation-control agreements and legislation there is an urgent need to support: (i) strengthening of federal, state and municipal environmental agencies via employment of public servants and investment of resources to improve implementation and enforcement of legislation and agreements; (ii) use of technologies to monitor the efficiency of clearing-reduction programs such as electronic cattle identification (e.g. tags and microchips), timber tracking along the production chain and high-resolution real-time satellite imagery to monitor deforestation; (iii) effective and correct implementation and control of the CAR to assist in the process of environmental regularization of rural properties and land claims in order to permit monitoring new deforestation and to avoid irregular occupation and land grabbing (*grilagem*); (iv) integration of implementation, control and enforcement systems across federal, state and municipal governments such that, for example, a producer with land embargoed by the state or municipal-level agency in one state would not be able to sell timber in another state, v) implementation of stricter laws to prevent illegal clearing of new areas in the Amazon and Cerrado, (vi) promotion of the integration of public policies with private agreements, and (vii) increased transparency in global supply chains, coupled with better labelling and consumer information.

In many cases, suitable technologies and systems already exist to better control adherence to the terms of deforestation agreements and legislation, and what is lacking is political will to make full use of these tools. For example, the Soy Moratorium must

now be properly implemented and monitored in non-forest ecosystems in the Amazon. A zero-net deforestation agreement must also be put in place for the Cerrado, with the expansion of soy production limited to agronomically suitable areas currently under pasture (Strassburg et al., 2017). In October 2017, as a promising first step, 23 major international companies signed a letter of support for the "Cerrado Manifesto" – a document that calls for companies that purchase soy and meat from the Cerrado to adopt effective policies and commitments to eliminate conversion of native vegetation, dissociate their production chains from recently cleared areas, and develop incentives and financial instruments to compensate producers who preserve areas of native vegetation (Sustainable Brands, 2017). Market pressure must be kept up to ensure that these promises are kept, and, crucially, effort is required to pre-empt potential leakage and laundering in the design of any new agreement. Beyond this, it is crucial that consumers be provided with clear, timely information regarding the origin of soy and meat across the Cerrado and Amazon biomes. Initiatives such as the "Transparent Supply Chains for Sustainable Economies" project (hereafter referred to as Trase.Earth) must be supported, promoted and expanded to allow consumers to understand the trade flows of commodities such as soy and beef, leading to whole supply chain transparency and providing consumers with the power to make informed decisions about their consumption and associated environmental impacts (Trase.Earth, 2019). Furthermore, this type of initiative will also allow individual companies to assess the sustainability of their production and allow governments and civil society as a whole to monitor and evaluate progress towards sustainability commitments (Trase.Earth, 2019).

"Laundering" of cattle could be reduced by better monitoring and enforcement of the CAR and by integrating it with the Animal Transit Permit (*Guia de Trânsito Animal*, or GTA in Portuguese), which is a legally required hygiene check. GTAs can only be emitted to properties registered in the state-level sanitary control system (Barreto et al., 2017). The GTA is obligatory for any means of transport, allowing for the monitoring of the flow of animals to and from markets (Brasil, 2006). If connected to the CAR, the GTA could also be used, much like the DOF for timber, to monitor compliance with environmental legislation and agreements. Specifically, the number of head of cattle that leave one place and arrive at another throughout the entire cycle (breeding, raising and fattening) would be registered by the GTA, making it difficult to launder cattle from illegal ranches through those with authorizations in place. Of course, measures are needed to prevent the GTA from being falsified, as occurs today with the DOF. Effective implementation of the CAR is also needed for this mechanism to work, and completing the CAR has been postponed four times since it was created by the new forestry code in 2012. These postponements have been due to pressure from agribusiness politicians ("*ruralistas*") who demanded more time to carry out the environmental regularization of rural properties. The most recent deadline, which was not met, was 31 December 2018 (Valor Econômico, 2018).

Finally, from the point of view of national and global societies, the Amazon forest provides valuable ecosystem services in terms of maintaining biodiversity, recycling water needed to maintain rainfall in the Amazon and in south-eastern and central Brazil (as well as in neighbouring countries), and in avoiding global warming through its storage of carbon (Fearnside, 1997, 2008b). In this context, the Amazon has a value for society that is much greater than the profits that a landholder can reap by destroying the forest. However, and crucially, progress has been slow in converting this value into payments for ecosystem services (hereafter referred to as PES) that would use this value as an incentive to keep the forests standing. Complexities associated with implementing PES include the tremendous impact that the various ways that ecosystem

services can be calculated have on the resulting values (e.g., Fearnside, 2012a, 2018c), and the ways that payments are made need careful regulation to both achieve the environmental objectives and avoid negative social side effects (e.g., Fearnside et al., 2018). PES in Amazonia is of a variety of types, all of which involve controversies (Fearnside, 2012b). PES projects and plans range from voluntary market projects in indigenous lands (e.g., Vitel et al., 2013) and conservation units (e.g., Yanai et al., 2012) to state and national-level programs (e.g., MMA, 2016; Neves et al., 2013). Like command-and-control, PES requires inspection and enforcement mechanisms to function in practice. Ecosystem services have high potential for maintaining traditional Amazonian populations and the forests they inhabit, but currently these services have much less potential to compete with highly profitable destructive activities such as conversion of forest to soybeans. However, this can and should change in the future if the provision of ecosystem services becomes more highly valued in Brazil.

Logging

Logging, whether legal or illegal, is a major factor in Amazon forest degradation and loss. Areas logged each year are much larger than those that are currently deforested, and, in contrast to deforestation, annual logging rates have remained relatively stable over time. Biomass loss and carbon emissions from logging are substantial, with annual carbon emissions estimated to total between 61×10^6 (Fearnside, 2000) and 80×10^6 tons (Asner et al., 2005). For comparison, the estimated gross carbon emission from the "alteration of vegetation" (i.e., deforestation) in Brazil in 2017 was 117×10^6 tons (see SEEG, 2019). Logging also causes massive additional emissions by increasing the risk and severity of forest fires, which are an increasingly pervasive threat to the forest (Nepstad et al., 1999), and favours deforestation by expanding "endogenous" roads and providing money to pay for forest clearing (Fearnside, 2008a).

Legal logging for forest management is currently unsustainable for various reasons. One is that the Sustainable Forest Management Plans are undermined by a series of regulatory loopholes that allow harvesting timber in an entire management area in the first few years instead of following the sequence of annual harvests in one plot for each year, such that the system will be sustained financially throughout the 30-year cycle (Fearnside, 2018b). Expecting the landowner to wait without income for up to 29 years until the next cycle is a formula for deforestation of the management area, either by the holder of the management license or by a future property owner. A more fundamental underlying problem is the inherent contradiction between financial logic and the biology of tree growth: destroying the forest and switching to alternative investments can provide better returns than waiting for logged forest stands to recover in a sustainable management system (Fearnside, 1989, 2003). This contradiction needs be addressed based on the ecosystem services of managed forests.

Illegal logging is still rampant despite a substantial decrease in the last decade. In Pará, for example, as a result of the migration of illegal logging activity to legally authorized logging, the proportion of logging which was illegal fell from 97% between 2011 and 2012, to 44% between 2015-2016 (Cardoso and Souza Jr., 2017). However, Sustainable Forest Management Plans for legal logging can also facilitate illegal logging by providing a means of "laundering" illegal timber. To better combat illegal timber extraction, there are techniques capable of identifying forests that have undergone selective logging (Souza and Barreto, 2000; Asner et al., 2005). These techniques are less precise than those that detect deforestation, but they can be used to identify locations where such illegal activities have occurred, and thus allow on-the-

ground enforcement efforts to be directed to these places. This could be further supported by the implementation of integrated authorization systems, such as the National System for the Control of the Origin of Forest Products (*Sistema Nacional de Controle da Origem dos Produtos Florestais*, or Sinaflor in Portuguese), which is in the process of being implemented by the Brazilian Institute for the Environment and Renewable Natural Resources (IBAMA) (IBAMA, 2017). These systems would allow for overlaying of spatial data on timber extraction with data on transport and property locations, facilitating the identification of illegal activities.

Legal and public policy challenges

Brazil's enforcement and legal systems provide multiple opportunities for infractions of environmental laws to go undetected or unpunished. Authorities only catch a small fraction of illegal actions , and if caught, the probability of the perpetrator actually paying the resulting fine is also very low. For example, based on data from assessments and fines applied by IBAMA between 2008 and 2013, Schmitt (2015) found that 45% of deforestation in the Amazon is not detected in a timely fashion such that action could be taken, and that in only 24% of the detected cases a fine is actually levied. In addition, due to delays in fines, lack of technicians to handle fines and numerous administrative problems, only between 0.2 and 5% of fines are paid (Schmitt, 2015; Odilla, 2019). This leads the government to lose billions of Brazilian reals (Odilla, 2019) that could be applied to environmental conservation and restoration. It also means that, from the point of view of illegal actors, the expected monetary value of choosing the illegal course is very high. Brazil's legal system is both notoriously slow and allows for a virtually endless succession of appeals, with the result that for environmental infractions a violator with money for legal defence can avoid punishment almost indefinitely. Calculations of the economics of illegal activities in the Amazon show that these activities are highly profitable, despite Brazil's Environmental Crimes Law (Brito and Barreto, 2005; Cunha et al., 2014; Schmitt, 2015).

The relative ease with which landowners can obtain permission for "legal" deforestation also impedes efforts to reduce net deforestation to zero. In 2012, the new Forest Code came into effect and both significantly reduced the proportion of private properties required to be preserved as "permanent preservation areas" (e.g., Roriz et al., 2017), and changed the proportional area requirements for "legal reserves". In the Amazon in particular, requirements for legal reserves are implemented in an unequal manner. The Forest Code requires properties within the Legal Amazon must maintain 80% of the area of the property as legal reserves (Overbeck et al., 2015), unless the property falls within areas of Amazonian savannah, which the MMA erroneously categorises as belonging to the Cerrado biome. Properties in areas of Amazonian savanna are then only required to maintain 35% of the property within legal reserves (Overbeck et al., 2015), following the requirements for properties in the Cerrado biome. However, the agribusiness politicians (*ruralistas*) have been able to further reduce the area requirements in the Amazonian forests to 50% when the state already conserves more than 65% of its area through Protected Areas. This fact alone could lead Brazil to lose 6.5-15.4 million hectares of private land to legal deforestation in the coming decades (Freitas et al., 2018). However, the situation may be worse still as these same politicians, with the help and endorsement of the current government, are now trying to get approval for a law that would completely revoke the obligation of private landowners to preserve proportions of their properties in legal reserves (see Almeida et al., 2019).

Even the CAR, which has the potential to be an excellent tool for environmental conservation, is being used to facilitate deforestation, as the CAR is accepted by licensing authorities as proof that the owner of the property has the right to clear more of the property if the registered areas of permanent protection and legal reserve do not pass the proportional limits required. As such, the CAR is making it easier to obtain clearing permits as it is based on unverified self-declared information, thus facilitating false claims. Permits are likely to become even more easily obtained under the new presidential administration, since the new head of the federal environmental agency (IBAMA) wants agriculture and ranching to be authorized automatically by merely filling out an online form (Borges, 2018). Obtaining permission for legal logging in forest management plans has also become progressively easier. Environmental impacts of deforestation and logging, such as biodiversity loss and greenhouse gas emissions, do not depend on whether or not these activities are legal.

The problems mentioned above are the tip of the iceberg in comparison with those still to come in relation to the conservation of one of the most biodiverse regions in the world. Brazil's new presidential administration, which took office on 1 January 2019, has a markedly anti-environmental stance both in rhetoric and practice. With Jair Bolsonaro well ahead in polls for the October 2018 election, the Amazonian deforestation rate increased by 48.8% in the last three months of the campaign as compared to the same months in the previous year (Masionnave, 2018). In its first months after taking office, the current Brazilian presidential administration has taken measures that go against the world trend towards increased sustainability and conservation of ecosystems. Among the measures already taken by the current administration is transferring the secretariats responsible for demarcation of indigenous lands (from the National Indian Foundation - FUNAI), quilombos and for rural settlements (from the National Institute of Colonization and Agrarian Reform - INCRA) to parts of the government led by agribusiness politicians (Ministry of Agriculture Livestock and Food Supply – MAPA and part of the Ministry of Women, Family and Human Rights) (Abessa et al., 2019; Artaxo, 2019; Begotti and Peres, 2019; Giacomo, 2019). With this, the current government will be more easily able to control demarcation of these traditional lands, which has long since been high on the wish list of the *ruralistas*. Added to this, there is much pressure from the agribusiness lobby to allow large-scale agriculture (mainly soybean plantations) and mining to be carried out within Indigenous Lands (Gonzales, 2019), with negative implications for traditional ways of life, indigenous rights and conservation. Beyond this, the administration of the Ministry of the Environment has made threats to ICMBio and IBAMA officials, as well as replacing technicians specialized in the environmental area with people with no appropriate training or experience (Bourscheit, 2019). This has led to conflicts within the Brazilian environmental agencies, as well as key decisions being made without technical justification (Bourscheit, 2019). The current government has even acted against the law when trying to impede inspection actions of IBAMA agents working to monitor deforestation within Conservation Units in the Amazon (Maisonnave, 2019). Furthermore, the administration has passed a decree that transfers the responsibility for environmental licensing from IBAMA (the federal agency) to states and municipalities (Bragança, 2019), a move that, in practice, will weaken the licensing process and act as a gateway to a law currently being processed by the congress that intends to change Brazilian environmental licensing requirements (Abessa et al., 2019). The new government has already stated more than once that it intends to open the Amazon to mining (Fonseca and Spring, 2019; Sauer, 2019; Woodward, 2019), large-scale agriculture (Kilvert, 2019; Sauer, 2019) and infrastructure (Woodward, 2019), measures

that are unprecedented in the history of world conservation and that present a real threat to one of the world's most megadiverse regions. Global reactions to Brazil's new direction on environmental issues has already begun. Recently a letter was signed by 609 European researchers and conservationists and 2 Brazilian Indigenous organisations that together represent 300 Brazilian indigenous groups (Kehoe et al., 2019). In the letter, the signatories request the European Union to ensure that Brazil protects indigenous and local communities, human rights and the environment, creating environmental criteria for traded commodities (see Kehoe et al., 2019).

Deforestation control agreements and legislation are essential tools for conservation of Brazil's sociobiodiversity, although they are not the only factors in preventing forest loss and degradation. In order to combat the subversion of these agreements, the legal structures, public policies and verification systems that underpin them must be constantly upgraded to keep pace with the new ways that soy planters, cattle ranchers and timber merchants will find to circumvent commodity agreements and government regulations. Without this, clearing of all habitat types will continue across Brazil's biomes, turning the country into an ever more fragmented patchwork of soy plantations, cattle pastures and illegal deforestation.

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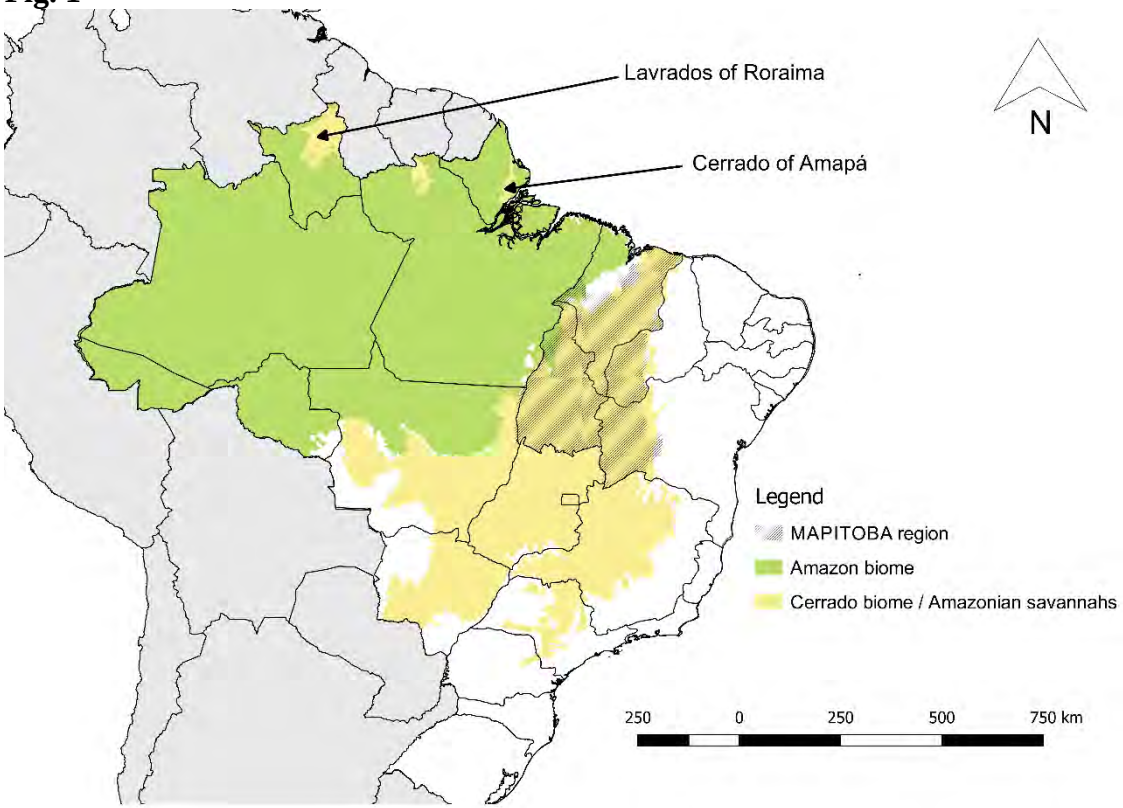
Fig. 1. Map of Brazil showing the Amazon and Cerrado biomes, the major Amazonian savannahs, and the Brazilian states in which they occur. The biome limits are based on the Brazilian Institute of Geography and Statistics (IBGE) vegetation cover map (IBGE 2004).

Fig. 2. The three key agreements for deforestation-control in the Brazilian Amazon discussed in this paper ("Agreements" box), the ways in which these agreements are subverted and therefore undermined ("Subversions" box) and possible measures that could be implemented to improve the functioning of these agreements to curb deforestation rates ("Solutions" box). Coloured arrows trace from the agreements (Red = Soy Moratorium, Blue = *TAC da Carne*, and brown = prohibition of commercialization of illegal timber), to the subversions to the possible solutions. *CAR (*Cadastro Ambiental Rural, or* Rural Environmental Register) identifies all rural properties and owners, including geographic coordinates and the identification of preservation areas within the properties (Brasil, 2012).

Fig 3. Maps of (a) average annual clearing rates between 2006 and 2017 for Amazon (INPE, 2018a) and Cerrado biome (INPE, 2018b), (b) average annual rate of change in area planted with soybeans between 2006 (when the soy moratorium came into force) and 2017 (IBGE, 2019), and (c) average annual change in number of head of cattle being grazed between 2009 (when the TAC came into force) and 2017 (IBGE, 2019), per municipality in the Amazon and Cerrado biomes.

Fig. 1


Lavrados of Roraima
Cerrado of Amapá
N
Legend
MAPITOBA region
Amazon biome
Cerrado biome / Amazonian savannahs
250
0
250
500
750 km

819 **Fig. 2**
820

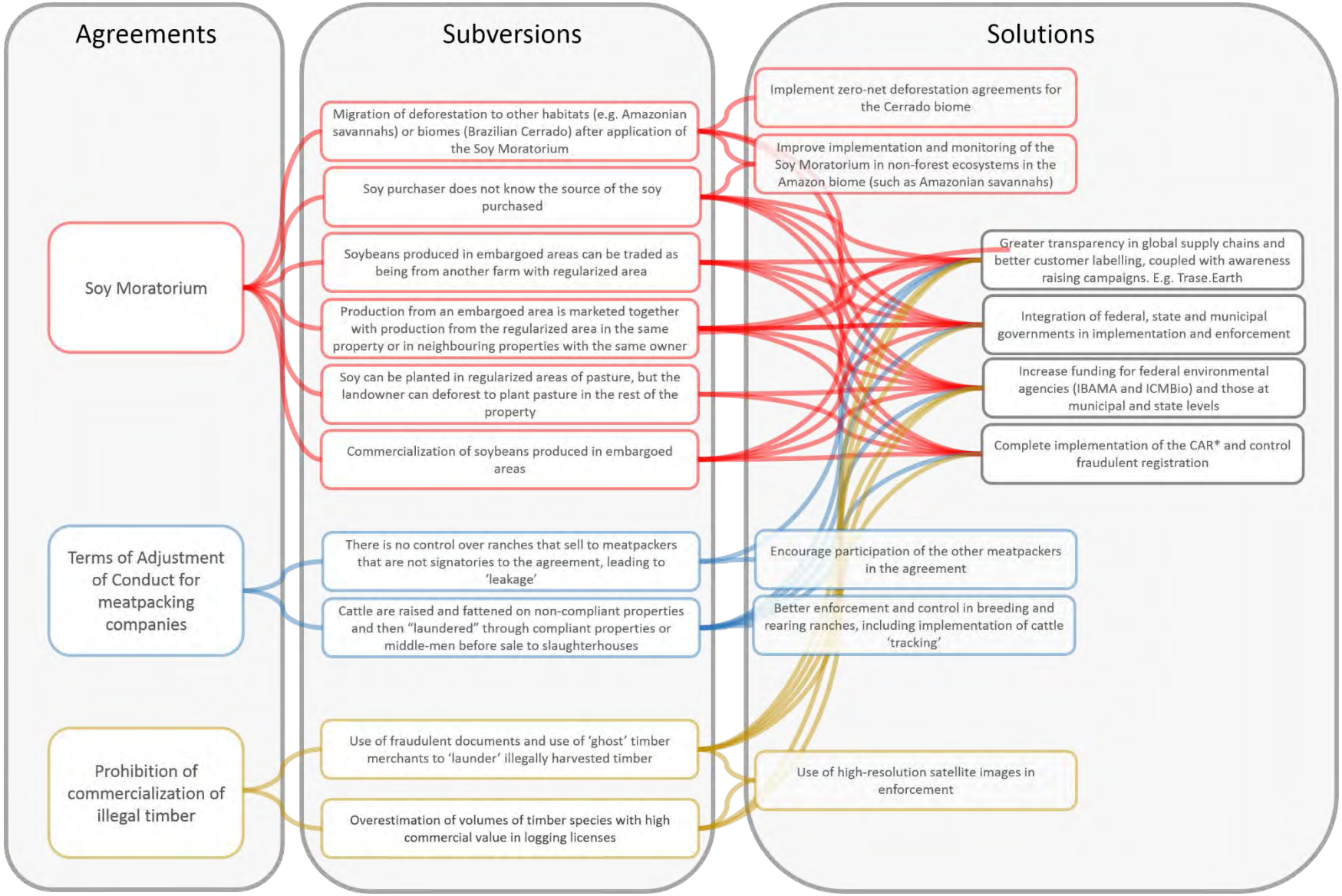
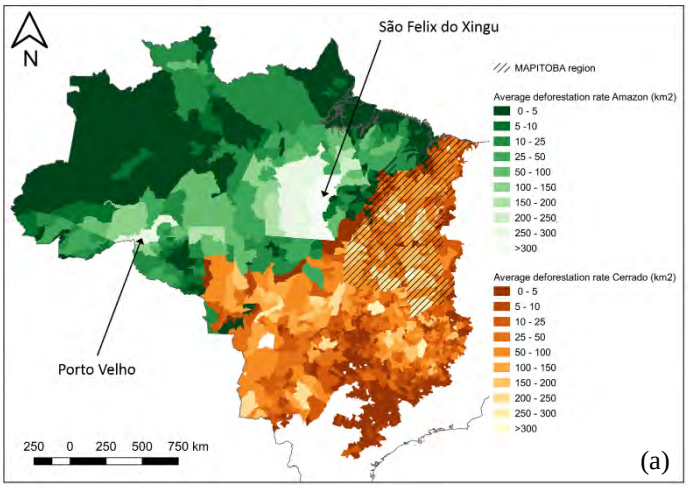
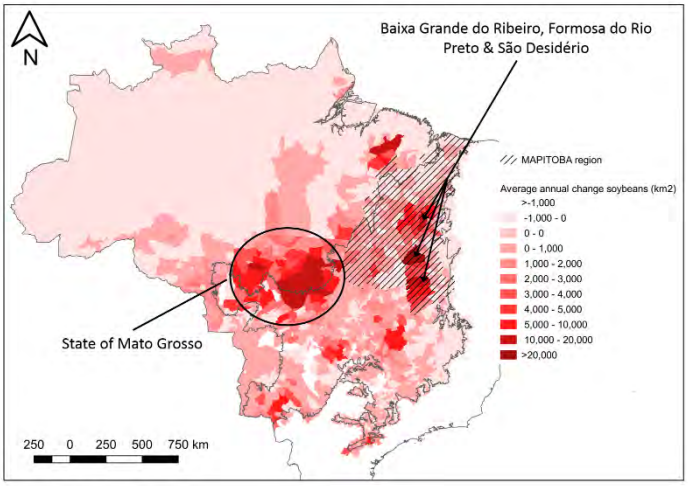
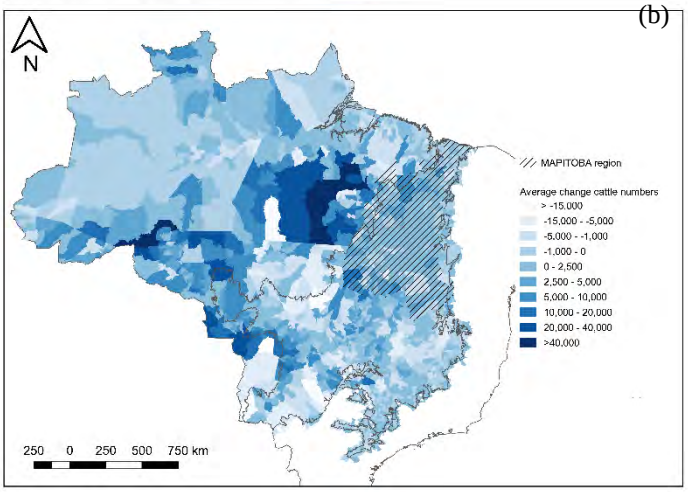

Agreements
Subversions
Solutions
Soy Moratorium
Terms of Adjustment of Conduct for meatpacking companies
Prohibition of commercialization of illegal timber
Migration of deforestation to other habitats (e.g. Amazonian savannahs) or biomes (Brazilian Cerrado) after application of the Soy Moratorium
Soy purchaser does not know the source of the soy purchased
Soybeans produced in embargoed areas can be traded as being from another farm with regularized area
Production from an embargoed area is marketed together with production from the regularized area in the same property or in neighbouring properties with the same owner
Soy can be planted in regularized areas of pasture, but the landowner can deforest to plant pasture in the rest of the property
Commercialization of soybeans produced in embargoed areas
There is no control over ranches that sell to meatpackers that are not signatories to the agreement, leading to 'leakage'
Cattle are raised and fattened on non-compliant properties and then "laundered" through compliant properties or middle-men before sale to slaughterhouses
Use of fraudulent documents and use of 'ghost' timber merchants to 'launder' illegally harvested timber
Overestimation of volumes of timber species with high commercial value in logging licenses
Implement zero-net deforestation agreements for the Cerrado biome
Improve implementation and monitoring of the Soy Moratorium in non-forest ecosystems in the Amazon biome (such as Amazonian savannahs)
Greater transparency in global supply chains and better customer labelling, coupled with awareness raising campaigns. E.g. Trase.Earth
Integration of federal, state and municipal governments in implementation and enforcement
Increase funding for federal environmental agencies (IBAMA and ICMBio) and those at municipal and state levels
Complete implementation of the CAR* and control fraudulent registration
Encourage participation of the other meatpackers in the agreement
Better enforcement and control in breeding and rearing ranches, including implementation of cattle 'tracking'
Use of high-resolution satellite images in enforcement

Fig. 3


São Felix do Xingu
Porto Velho
N
MAPITOBA region
Average deforestation rate Amazon (km2)
0 - 5
5 -10
10 - 25
25 - 50
50 - 100
100 - 150
150 - 200
200 - 250
250 - 300
>300
Average deforestation rate Cerrado (km2)
0 - 5
5 - 10
10 - 25
25 - 50
50 - 100
100 - 150
150 - 200
200 - 250
250 - 300
>300
250 0 250 500 750 km
(a)


Baixa Grande do Ribeiro, Formosa do Rio Preto & São Desidério
State of Mato Grosso
N
MAPITOBA region
Average annual change soybeans (km2)
>-1,000
-1,000 - 0
0 - 0
0 - 1,000
1,000 - 2,000
2,000 - 3,000
3,000 - 4,000
4,000 - 5,000
5,000 - 10,000
10,000 - 20,000
>20,000
250 0 250 500 750 km
(b)


N
MAPITOBA region
Average change cattle numbers
> -15,000
-15,000 - -5,000
-5,000 - -1,000
-1,000 - 0
0 - 2,500
2,500 - 5,000
5,000 - 10,000
10,000 - 20,000
20,000 - 40,000
>40,000
250 0 250 500 750 km
(c)