THE LEGAL RESERVE AREAS COMPENSATION MECHANISM AND ITS ECONOMIC AND ENVIRONMENTAL IMPLICATIONS

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Introduction

The conservation of biodiversity has been on the political agenda of many countries, since the Convention on Biological Diversity in 1992 (JOLY *et al.*, 2010). Considering that the loss of habitat is the main threat to biodiversity, the most effective protection strategies seek to limit changes in land use in areas which are important for conservation, imposing limits on human actions (CHOMITZ, 2004). The imposition of these limits, however, can lead to intense conflicts, in particular when they interfere with the productivity of private lands or the freedom of property owners to make decisions regarding the use of their lands (DOREMUS, 2003; PALONIEMI; TIKKA, 2008). As a result of these conflicts, it has not been easy to find a means of using private land whilst preserving natural heritage (KNIGHT,1999; DOREMUS, 2003).

Despite these difficulties, the conservationist community has been increasingly interested in developing strategies to ensure that cattle-raising and agricultural activities can continue whilst safeguarding the conservation of biodiversity and the generation of environmental services (MICHALSKI *et al.*, 2010; MARQUES; RANIERI, 2012). The importance of private areas for conservation purposes is justified by the fact that they make up the largest part of the territory of many countries. They encompass a large portion of our planet and the resources on which the biota depends (DOREMUS, 2003; SWIFT *et al.*, 2004; TIKKA; KAUPPI, 2003).

In Brazil, of a total of 850Mha, 605Mha (71%) are registered in the National System of Rural Registration, INCRA [National Institute for Colonization and Agrarian Reform) as rural properties (SNCR, 2012). Furthermore, of all the native vegetation still in existence in the country (537Mha), most (367Mha) is found in private areas used for agricultural production (SPAROVEK *et al.*, 2012). Thus, privately owned areas are an

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essential component of biodiversity conservation in Brazil (MICHALSKI *et al.,* 2010). In order that economic exploitation of land can take place whilst ensuring the maintenance of a minimum amount of environmental services, rural landowners in Brazil are obliged to preserve natural areas on their properties: Permanent Preservation Areas (APPs) and the so-called legal reserves (BRASIL, 2012).

APPs and legal reserves are types of protected natural areas of a mandatory nature. They are currently enforced by Federal Legislation n. 12.651/2012 (amended by Law 12.727/2012). This legislation substituted the Forestry Code (Federal Law n. 4.771/1965) and establishes the new bases for the territorial protection of the main Brazilian ecosystems and for regulating the exploitation of forest resources. The legal revision was marked by heated discussions in the National Congress revealing the difficulties in negotiating a reform which establishes a consensus between the different interest groups (NASSAR; ANTONIAZZI, 2012). Although the new legislation provides flexibility of some of the provisions in the Forestry Code, APPs and legal reserves continue to be the main mechanisms for protecting environmental assets in the country (MARQUES; RANIERI, 2012).

Permanent Protection Areas (APPs) are defined as areas, whether covered by vegetation or not, situated along water courses, around water sources, steep slopes and in areas over one thousand eight hundred metres high (BRASIL, 2012). On the other hand, legal reserves encompass a percentage of the area of a rural property (its value will depend on the region and the biome where the rural property is located) where native vegetation has to be maintained. Its economic exploitation is only permitted on the condition that sustainable management is adopted (BRASIL, 2012).

Despite the importance of APPs and legal reserves for protecting and recovering essential ecological processes, most Brazilian rural properties are environmentally indebted in relation to native forest cover, as environmental laws are widely disrespected (RANIERI, 2004; BACHA, 2005; METZGER *et al.*, 2010; SPAROVECK *et al.*, 2011). Sparovek et al. (2012) estimated the deficit in relation to APPs and legal reserves in Brazil in accordance to the requirements of the Forestry Code. Only 86Mha of APPs in Brazil are covered by natural vegetation out of a total of 103Mha. In the case of legal reserves, the total area needed to meet legal obligations was estimated at 254Mha. However, even if all natural vegetation existing outside conservation units and APPs could be legally established as a legal reserve, 43Mha of land would still need to be restored and the existing agricultural activities would have to be curtailed (SPAROVECK *et al.*, 2012).

On the one hand, the conversion into forests of lands which currently have a productive use could have an enormous socio-economic impact (SPAROVEK, 2012). On the other hand, the compliance with the regulations regarding APPs and legal reserves is essential to conserve and recover Brazilian ecosystems (MARQUES; RANIERI, 2012). In this context, particularly with regard to legal reserves, since the end of the 1990s alternatives for regulating the debt accumulated throughout years of deforestation have been advanced. These alternatives are based on the spatial flexibilization of areas, amongst which is the legal reserve compensation mechanism (CHOMITZ, 2004; BONNET *et al.*, 2006).

Through compensation, an owner of a rural property in deficit with regard to legal reserves can acquire surplus areas covered in vegetation from another property, so as to meet the legally required percentage of both properties (BRASIL, 2012). Legal reserve compensation can reduce the costs associated to conservation actions (CHOMITZ, 2004; FERREIRA *et al.*, 2007; SPAROVEK*et al.*, 2011). Thus, compensation is seen as a mechanism which can stimulate environmental preservation of remnant forests in Brazilian private land, attenuating potential conflicts of interest (NUSDEO, 2007). However, questions arise as to whether compensation is advantageous from an environmental point of view (FEARSINDE, 2000; RANIERI, 2004; SILVA *et al.*, 2011), despite its potential as a market mechanism (CHOMITZ, 2004).

When analyzing mechanisms whose purpose is to conciliate seemingly conflicting interests such as cattle-raising and agricultural production and environmental conservation, it is common to discuss the effectiveness and the future effects of these instruments when they are employed as conservation strategies (DOREMUS, 2003). Whilst analyzing the real repercussions of these different provisions, Sparovek et al. (2011) suggest that different factors should be equally considered, including social, economic and ecological aspects, so as to prevent certain interests prevailing over others. It has been emphasized that studies should be developed so as to provide data, enabling the interaction between the biological and the socio-economic perspectives of the different conservation strategies which can assist in the process of improving the planning and implementation of State actions.

In face of this, the aim of this study is to analyze under which conditions legal reserve compensations can bring real benefits to nature (environmental implications), whilst reducing the impact of these measures on agricultural production (economic implications). This study brings together the different perspectives presented in the literature on the compensation mechanism, based on the legal criteria currently in force.

Before addressing the core issues at stake, it is important to describe in detail the main functional aspects of legal reserves, given that the current study discusses compensation as a mechanism which aims to put in practice an environmental policy instrument (legal reserve) of recognized importance for the conservation of biodiversity (CAMPOS *et al.*, 2002; BACHA, 2005; METZGER, 2010).

Functional aspects of legal reserves and the compensation mechanism

Legal reserves, as currently established by law, are areas located inside a rural property, whose function is to "guarantee the economic use of the rural property's natural resources in a sustainable way, assisting in the conservation and recovery of ecological processes and promoting the conservation of biodiversity, whilst providing shelter and protecting the native fauna and flora" (BRASIL, 2012). Thus, legal reserves have two well-defined purposes: to provide economic goods (timber and other forest sub-products) by employing sustainable practices and to contribute to the conservation of biodiversity as elements of the landscape (CAMPOS *et al.*, 2002; METZGER*et al.*, 2010).

Although reserved areas in rural properties were initially planned as "forest exploitation" sites, they are currently considered as areas whose main function is to keep a stock of natural vegetation in the landscape, benefiting various natural aspects. For example, biodiversity, the mitigation of negative climate effects, the survival of species threatened with extinction, controlling erosion, water reloading, as well as scenic and landscaping aspects (CAMPOS *et al.*, 2002; METZGER *et al.*, 2010; SPAROVEK, 2012).

Unlike APPs, maintaining legal reserve functions is not associated to a specific geographical location (SPAROVEK, 2012). Essentially, the purpose of APPs is to protect water resources, preserve the soil and provide geological stability, as well as contribute to the conservation of biodiversity. They act as ecological corridors in the landscape (BRASIL, 2012). Thus, they are always defined in relation to their proximity to water courses, high declivity areas, hilltops or areas of extreme altitude. The choice of areas for allocating legal reserves is more flexible, enabling the application of the compensation mechanism (SPAROVEK, 2012).

A rural property owner can carry out compensation by: (i) acquiring an Environmental Reserve Quota (CRA); (ii) leasing an area under the environmental services or legal reserve regime; (iii) donating to the State an area within a public Conservation Unit pending the regularization of land tenure; or (iv) registering an equivalent area exceeding the size of the legal reserve in a property belonging to the same owner or in an acquired property belonging to a third party, with established native vegetation, vegetation in a state of regeneration or re-composition, as long as it is located within the same biome (BRASIL, 2012).

Compensation can take place according to criteria established by law and in accordance with the state environmental body responsible for managing/monitoring these areas (BERNARDO, 2010). Before the Forestry Code was repealed, legal reserve compensations had to be carried out mainly in areas of similar size and equivalent ecological relevance, located within the same ecosystem and the same micro river basin. If these conditions could not be met, exchanges between areas located within the same river basin, and at most within the same state, were permitted.

However, the new legal instrument (Federal Legislation n. 12.651/2012) increased the possibilities of compensation. Exchanges can take place between areas belonging to different river basins and even different states, as long as the area allocated as a legal reserve is equivalent in size and situated within the same biome as the indebted property. In the case of exchanges between areas in different states, the legal reserve must be set up in areas identified as a priority by the federal or state governments. For example, priority areas should promote the recovery of river basins which have been excessively deforested, the creation of ecological corridors, the conservation of large protected areas and the conservation or recovery of threatened ecosystems or species (BRASIL, 2012).

The success of this compensation mechanism in guaranteeing the conservation of biodiversity requires a discussion of the criteria used to guide these exchanges (RANIERI, 2004; SILVA *et al.*, 2011), given that they are the only legal instrument ensuring that the choice of reserves is not the exclusive prerogative of rural landowners (BONNET *et al.*, 2006). That is, it is expected that these criteria can assist in regulating the market of

legal reserves established by compensations so that there are no distortions with regard to the objectives of the instrument in question.

Legal reserve compensation markets and economic benefits

Considering that Brazilian environmental policy determines that private benefits cannot result in a loss of public well-being, rural landowners in Brazil are obliged to preserve natural areas inside their properties (IGARI *et al.*, 2009). The general lack of compliance in relation to legal reserves occurs for a number of reasons, including the constant changes in legal requirements and the imprecise definition of some mechanisms, as well as a lack of government monitoring (SPAROVEK *et al.*, 2011). However, the high opportunity cost of conservation, associated to having to give up opportunities for converting land to profitable uses, as well as the financial costs involved in recovering natural areas affecting rural landowners, are the main factors disclosed in the literature to explain the resistance to maintaining legal reserves, particularly in federal units with intensive land use (GONÇALVES; CASTANHO FILHO, 2006; IRIGARAY, 2007; SPAROVEK *et al.*, 2011).

On the other hand, a study by Marques e Ranieri (2012) contradicts recurrent claims that economic factors are determinants in the decisions of rural landowners regarding the maintenance of legal reserves. The authors observed that in the municipalities of the state of São Paulo, variables such as the sales value of land and the value of production had a low correlation with the rates of compliance of legal reserves. Therefore, they did not significantly affect compliance with regulations relating to this obligation. Their conclusion was reinforced by the revelation that the municipalities located in areas of high intensive land use presented compliance rates in relation to legal reserves far above the average for the state, as for example in Ribeirão Preto, Franca and São Carlos.

Nevertheless, even if economic factors do not entirely justify the non-compliance with regulations regarding legal reserves (MARQUES; RANIERI, 2012), compensation is an economically interesting alternative for non-compliant landowners interested in regularizing their situation. In theory, the costs of leaving a productive area uncultivated and the costs its recovery through the planting of native species are greater than the costs of compensation (FERREIRA *et al.*, 2007; SPAROVEK, 2012). Irigaray (2007) suggests that acquiring an area in another property to be maintained as a legal reserve is the preferred alternative of rural landowners as opposed to recovering the reserve within their own property. Generally speaking, no property owner who converted an area of legal reserve for economic exploitation is keen to recover it by planting native species if the law allows compensation through the acquisition of another area (IRIGARAY, 2007).

A study by Campos (2010) showed that compensation is a regularization option. This is particularly the case for the large rural producers in the states of Minas Gerais and Paraná whose motivation does not stem from legal requirements but market demands, given that there are restrictions to agro businesses when properties are not regularized. On the other hand, there are still many uncertainties regarding the use of this mechanism,

due to the inconsistencies of legal regulations and the lack of information provided by the public environmental bodies (CAMPOS, 2010).

The compensation mechanism can also benefit those who conserve natural vegetation over and above legal requirements, given their potential for income generation. Compensation can add value to land covered in original vegetation when compared to other economic means of exploitation (CHOMITZ, 2004; FERREIRA *et al.*, 2007). This can be an incentive to preservation (NUSDEO, 2007).

According to Martins and Chaves (2006) the existence of forest cover is generally associated to regions of low economic performance. In fact, most natural vegetation which could be registered as a legal reserve via compensation is located in regions of lower agricultural value, that is, with lower profitability per area (BONNET *et al.*, 2006; SPAROVEK *et al.*, 2011). Thus, the compensation mechanism may enable the transfer of income between regions, contributing to the reduction of regional inequalities and generating alternatives for local economic development (MARTINS; CHAVES, 2006; IGLIORI *et al.*, 2007).

Sparovek (2012) claims that legal reserve compensation puts in practice the global objective of "payment for the standing forest". Compensation becomes an economic instrument of the market (NUSDEO, 2007) in that it involves the remuneration of one rural property owner to another (by means of either purchasing or leasing an area). Conservation becomes a business, attenuating the effects of command and control mechanisms (SPAROVEK, 2012).

The recently established online platform, the Green Stock Market of Rio de Janeiro (BVRio), operates a market of environmental assets where it is possible to buy and sell environmental reserve quotas (CRAs). The Bolsa Verde [Green Stock Market] works in a similar way to traditional stock markets where there are offers, negotiations and a futures market for prices and products (RIBEIRO, 2012; BOLSA VERDE DO RIO DE JANEIRO, 2013). Rural landowners across Brazil indebted with regard to their properties' legal reserves can comply with environmental legislation by means of contracts offered in the Green Stock Market, whilst those with surplus vegetation can launch contracts for the sale of CRAs. Contracts may be temporary (5, 10 or 20 years) or permanent. The price of natural areas vary from R$ 100.00 to R$1000.00 per hectare (ha), per year, according to the length of the contract and the type of existing vegetation. An area of Atlantic Rainforest in the South-East region of Brazil can cost on average R$1000.00 ha/year. Currently this platform has over 400 registered producers and a supply of 250,000 ha in rural properties across all types of biomes (BOLSA VERDE, 2013).

However, the consolidation of the market for legal reserve compensations - in which the average price per lease/purchase of areas is based on supply and demand - depends on the effectiveness of government regulations requiring that rural landowners set up a reserve or comply with compensation (NUSDEO, 2007). Furthermore, it is essential that there are clear legal requirements to guarantee sales contracts (IGLIORI *et al.*, 2007). Government regulations relating to legal reserve compensations are not only essential from the point of view of their viability as a market mechanism, but also to prevent economic interests from prevailing over expected environmental benefits (SPAROVEK, 2012).

Environmental implications and controversies

One of the most important aspects to consider when assessing the market potential of legal reservation compensation is the territorial unit where it will be applied (CHOMITZ, 2004; FERREIRA *et al.*, 2007). The spatial make up of this type of market is fundamental to attain expected results (IGLIORI *et al.*, 2007). In theory, the larger the range of application, the greater the gains in terms of economic efficiency, increasing the supply of legal reserves, reducing costs and promoting more transactions (CHOMITZ, 2004; FERREIRA *et al.*, 2007). However, the use of broader criteria such as wider geographical limits for compensation, for example, "large river basins" or "states" result in greater environmental costs (RANIERI, 2004; IGLIORI *et al.*, 2007; SILVA*et al.*, 2011), as will be discussed below.

The main advantage of compensation from an environmental point of view, considering that property boundaries are no longer limiting factors (RANIERI, 2004), is the potential for planning the occupation of rural areas so that legal reserves are set up in places which are more suitable for the conservation of different environmental attributes. By analyzing rural landscapes, the location of a legal reserve compensation area can be projected so as to create vegetation corridors and other elements to maintain forest connectivity, including existing forests or areas being restored (DITT *et al.*, 2008).

A legal reserve outside a particular property can act as an important mechanism for promoting the integration of forest fragments, giving priority to vegetation cover in areas where there is a high degree of species endemism and ecological communities (FERREIRA *et al.*, 2007; SILVA *et al.*, 2011). Thus the protection of primary forests or forests in the more advanced stages of regeneration can be prioritized. This would have considerable impact on the conservation of the flora and the fauna, particularly tropical forests (BARLOW *et al.*, 2007; GIBSON *et al.*, 2011).

Furthermore, compensation mechanisms can be important tools for the integrated management of forest-water. In these cases, the geographical definition of legal reserves can contribute by filling in possible gaps and helping to improve both the way APPs work and their use (POMPERMAYER, 2006). Thus, the layout of legal reserves enables us to define the best areas for the conservation of biodiversity. It can also greatly contribute to the protection of water resources (RANIERI, 2004).

However, there are doubts as to the benefits of compensation to the conservation of biodiversity if it occurs in areas which are very far from one another (FEARSINDE, 2000; METZGER, 2002). The less restricted the geographical limits of the market of legal reserves, the smaller the chances of preserving local biodiversity. In these cases, the large environmental costs mentioned above are a result of the possibility of making transactions between properties located in heterogeneous ecosystems (FERREIRA *et al.*, 2007; IGLIORI *et al.*, 2007).

Currently the biome is used as the criterion for defining where compensations can take place (BRASIL, 2012). It encompasses a geographical area which presents a particular environmental uniformity, imbuing it with particular functions and structure. That is, it has its own ecology (COUTINHO, 2006). However, uniformity should not be confused

with homogeneity. Brazilian biomes occupy extensive geographical areas and encompass a wide range of environmental conditions such as different types of soils, climate conditions and ranges in altitude (DURIGAN *et al.*,2003; COUTINHO, 2006). This means that within each large biome there is considerable diversity of vegetation physiognomy, marked by differences in species composition and ecosystem structures (METZGER *et al.*, 2010). Thus, compensations defined exclusively in terms of the biome can result in exchanges between areas which do not have ecological equivalence in terms of species composition and ecosystem structure or function (SILVA *et al.*, 2012).

For example, if a landowner, forced to conserve a legal reserve where the original vegetation is semi-deciduous seasonal forest, purchases an area of dense rainforest for regularization purposes, compensation will not have ensured the protection of ecologically equivalent forests (SILVA *et al.*, 2011). Given the longitudinal variation, these forests are situated in very distinct environmental and climate conditions, with very different vegetation and ecosystems (RIBEIRO *et al.*, 2009). Each of these forests has its own characteristic species, better adapted to each condition (RANIERI, 2004). Differences mean that these forests are not interchangeable, despite belonging to the same biome (METZGER *et al.*, 2010).

Heterogeneity may be observed even in remnant areas with the same vegetation physiognomy. In the case of the Atlantic Rainforest, the variability of the flora within semi-deciduous seasonal forest and dense rainforest areas may be comparable to the variability observed between each forest area (GANDOLFI *et al.*1999; RBMA, 1999). The same occurs in the Cerrado biome, given that strictly speaking, in the Cerrado species are spatially distributed in mosaics, with a combination of less than one hundred species per area studied, so that even communities located close to each other can differ in terms of flora (FELFILI *et al.*, 1993).

On the other hand, communities with similar flora can be considerably different structurally. Structural parameters of vegetation such as density, basal area/ha, trunk to height ratio and the maximum height of trees can be associated to successional process characteristics or more strongly linked to factors such as the fragmentation condition or the availability of water or nutrients in the soil (DURIGAN *et al.*, 2008).

From a functional point of view, the ecosystem services provided by the natural vegetation of legal reserves are often limited to the agricultural property or its immediate surroundings, for example, natural pest and disease control and the attenuation of drought effects (DELALIBERA *et al.*, 2008; SILVA *et al.*, 2012). These and other ecological (biotic, water, edaphic, climatic and aesthetic) services provided by legal reserves do not return to their original area, except by particular forms of compensation (METZGER *et al.*, 2010).

In order to meet ecological equivalence criteria, particularly in relation to the composition of species and function, compensation at the level of the biome requires limitation in terms of geographical distance. For this reason, Silva et al. (2011) argue that compensation outside rural properties should be restricted to geographical areas located within the same bio-geographical region or in areas with equivalent phyto-physiognomic make-ups. This is because, non-adjacent compensation areas or areas outside the same micro river basin, which disregard the heterogeneity of the different Brazilian vegetation

make-ups and the limited geographical distribution of most species within each biome, are not suitable for conserving species belonging to the 'lost' region (METZGER *et al., 2010 SILVA* et al., 2011). Areas of compensation which are more restricted would ensure that exchanges are made within the same ecosystem of the degraded area so that legal reserves can contribute to protect regional ecosystem services.

According to Sparovek et al. (2011), the main problem with using the biome as a limiting factor in the market of legal reserve compensations is that it does not provide geographical guidance as to the areas which should be protected. Therefore, in addition to allowing exchanges between areas which have no ecological equivalence, legal reserve markets based on the biome can prioritize the conservation of certain Brazilian ecosystems in detriment of others (BONNET *et al.*, 2006), as well as the conservation of certain micro river basins in detriment of others (SILVA *et al.*, 2011).

Bonnet et al. (2006) cite the example of the Brazilian Cerrado (savannah). The vegetation formations which usually occur in areas with little potential for agricultural mechanization such as the *Campos e Cerrados Rupestres* (rocky areas) suffer less agricultural pressure and could be better remunerated by the compensation market. On the other hand, the forested and wooded savannah physiognomies which are frequently found in flat areas and are intensively farmed would not be protected because it is in these areas that agricultural expansion is taking place.

Similarly, if the natural vegetation available to the legal reserve market is concentrated in regions with lower agricultural potential and compensations are not geographically restricted, they will produce, in biological terms, large contrasting areas of landscape: on the one hand, lower levels of vegetation in certain micro river basins (precisely where there is high water demand) and on the other, micro river basins with a high concentration of legal reserves (SILVA *et al.*, 2011). Pompermayer (2006) points to the fact that compensation can be an effective tool for forest-water management, so long as the micro river basin is taken as a planning unit. In the majority of states where land use is more intensive, the distribution of natural vegetation between basins is no longer homogeneous. The largest fragments of remnant vegetation are concentrated in particular regions, whereas in other regions discontinuous distribution of inexpressive levels is observed (BONNET *et al.*, 2006).

Large areas of natural habitat, which are characteristic of public systems of protected areas, have a fundamental role. This is because, unlike the countless number of small fragments, they are able to support viable populations (RICKLEFS, 2003). However, the conservation potential of small fragments should not be ignored. Remnant native forests, even when small, contribute significantly, not only by directly protecting areas of biological importance, but also because they act as ecological springboards, displacing and dispersing species across the landscape, reducing the isolation between the large protected areas (RIBEIRO *et al.*, 2009; SILVA *et al.*, 2011).

The protection of biological diversity depends on the preservation of large habitat areas, and also on the inclusion of representatives of all types of habitats, forming a system of protected territorial spaces. Thus, taking into account more restricted geographical limits, legal reserve compensation areas could help bridge the gaps in the preservation

of diversity in changed and fragmented landscapes (RANIERI, 2004). Particularly in ecosystems under pressure of changing land use (BONNET *et al.*, 2006). In this way, we avoid the risk of exclusively protecting the natural vegetation of remote areas or of regions which have no agricultural potential because they are cheaper (SPAROVEK *et al.*, 2011).

The delimitation currently used by the state of Paraná to establish the areas where compensation between properties is possible is well-regarded by the professionals involved with legal reserve compensation (BERNARDO *et al.*, 2009). In order to define the Paraná state criteria, the biome was divided into 16 river basins (taking into account the different forest physiognomies), which together with the political-administrative divisions of the Environment Department formed the basis for the set of restrictions employed. Exchanges can only occur between properties belonging to the same biome, the same river basin and the same municipality grouping (19 all together), in accordance to the state law which also stipulates priority areas for conservation (BERNADO, 2010).

Bernardo (2010) shows that, contrary to expectations, this spatial design did not affect the legal reserve compensations market in the state of Paraná. Compared to the states of Minas Gerais and Mato Grosso do Sul, where compensation areas are more extensive, the state of Paraná has a greater number of registered legal reserves which include the compensation mechanism (Chart I).

Chart I. Indicators of the success of legal reserve management systems, focusing on the compensation mechanisms in the states of Paraná (PR), Minas Gerais (MG) and Mato Grosso do Sul (MS). Adapted by Bernardo (2010).

Estimates (2009)	States		
	PR	MG	MS
Area (km^2)	17 568 089	35 669 795	26 449 105
Total n. of agricultural and cattle-raising establishments	373 238	550 529	65 619
Total n. of registered legal reserves	13 593	4 521	598
Total n. of compensated legal reserves	1 191	234	43
Percentage of properties holding legal reserves	4	3	1
Percentage of compensated reserves/ total n. of legal reserves	9	5	7

The greater success the state of Paraná has had in registering legal reserves and in applying the compensation mechanism is not due to the greater number of rural properties in this state compared to others, nor to the fact that this state is larger (BERNARDO, 2010). The author argues that institutional aspects relating to the environmental body managing legal reserves may have had a decisive role in this case, particularly organizational aspects such as the existence of completed and integrated information systems, the definition of regulations and standard procedures, as well as issues relating to internal and external communication.

Results emphasize the idea that the effectiveness of the compensation mechanism as a conservation strategy is less dependent on the exaggerated size of compensation areas, such as when the entire biome is considered (SPAROVEK *et al.*, 2011), but relate more to the definitions of legal criteria and clear procedures based on scientific knowledge of national ecosystems and the existence of geographical information systems to assist the environmental body's technicians and managers in defining suitable areas for compensation (RANIERI, 2004; METZGER, 2010).

Finally, it is worth emphasizing that compensation, as it is established by Legislation n. 12.651/2012, is not only criticized by academics, but also from a legal point of view. The Prosecutor General Office (PGO) considers the re-composition of vegetation in areas of the same biome when there is no ecological identity between areas to be insufficient as a compensation mechanism. This is one of the key points of direct actions of unconstitutionality put forward by the Prosecutor's Office to the Supreme Federal Court (SFC), against the provisions established by the current legislation (BRASIL, 2013; PGO, 2013). The PGO argues that by determining compensation, this legislation goes against the fundamental duty of preserving and restoring essential ecological processes. It also results in the adulteration of legal reserves (BRASIL, 2013). Forms of compensation involving the leasing or the donation of an area within a governmental conservation unit are also considered to be unconstitutional. The former because it does not fully comply with the idea of "compensation", given that there is no legal security with regard to the perpetuity of this protection, and the latter because it is an option created to circumvent the government's administrative capacity to regularize the legal situation of conservation units, undermining the ecological functions of legal reserves (BRASIL, 2013).

If the Supreme Court decides that sections of this legislation are unconstitutional, discussions may have to start from scratch (PGO, 2013). In any case, the debate on reformulating the Brazilian forestry legislation will continue. The academic community has contributed considerably so that the current legislation can bridge the gap between environmental conservation interests and agricultural production, particularly with regard to the compensation of legal reservations.

Final considerations

A legal reserve compensation is a mechanism which could potentially address the trade-off between development and conservation in private properties in Brazil. It is an instrument capable of promoting environmental conservation by facilitating the preservation of remnant native vegetation in rural areas, at lower implementation and opportunity costs.

However, this equilibrium is influenced by the territorial unit which forms the basis for the market of legal reserve compensations. The larger the area where compensation is possible, the greater the economic benefits due to an increase in the number of transactions at lower costs. On the other hand, the more restricted the geographical limits, the greater the chances of preserving local biodiversity, despite the fact that a lower supply of legal reserves may make transactions more difficult.

Therefore, the criteria used to guide these exchanges must ensure not only the viability of the legal reserve market but also make sure that economic interests do not prevail over the expected environmental returns of this mechanism. Otherwise, compensation will become purely a mechanism for environmental regularization regardless of associated environmental costs.

Considering the promotion of biodiversity conservation, it is recommended that the application of the compensation mechanism should be based on less extensive geographical areas, such as a group of neighbouring municipalities within the same river basin, respecting the ecological equivalence of the areas involved in the exchange in order to guarantee the representation of different phyto-physiognomies and vegetation communities within a regional scale.

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THE LEGAL RESERVE AREAS COMPENSATION MECHANISM AND ITS ECONOMIC AND ENVIRONMENTAL IMPLICATIONS

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***Resumo*:** A reserva legal é um mecanismo de conservação da biodiversidade em propriedades rurais brasileiras de caráter obrigatório. Todavia, seu cumprimento não é efetivo e aspectos econômicos são apontados para justificar a não manutenção. Como alternativa de regularização, a lei permite ao proprietário rural compensar a reserva legal fora dos limites dos imóveis rurais. O artigo analisa as principais implicações econômicas e ambientais do mecanismo de compensação, considerando os critérios atualmente válidos para o seu norteamento e aspectos funcionais das reservas legais. Conclui-se que compensação pode trazer benefícios reais para a natureza ao incentivar a manutenção de áreas naturais em terras privadas com menores custos de oportunidade e de implementação. Contudo, a abrangência da unidade territorial em que são permitidas as trocas entre propriedades, estabelecida por meio dos critérios legais, é fundamental para evitar que interesses econômicos prevaleçam sobre os benefícios ambientais esperados.
Palavras-chave: Conservação da biodiversidade; Reserva legal; Compensação."

Resumen: Reserva legal es una figura de protección de carácter obligatorio para tierras privadas brasileras y importante para la conservación de la biodiversidad. Sin embargo, su cumplimiento no es efectivo y razones econômicas justifican la falta de mantenimiento. Como alternativa de regulación, la ley permite al propietario rural compensar la reserva legal fuera de los límites de los inmuebles rurales. Este artículo analiza las principales implicaciones económicas y ambientales del mecanismo de compensación, considerando los criterios válidos para su norte amiento y los aspectos funcionales de las reservas legales. En conclusión, la compensación puede traer beneficios reales para la naturaleza al incentivar la manutención de áreas naturales en tierras privadas con menores costos de oportunidad y de implementación. Con esto, la amplitud de la unidad territorial en la cual son permitidos los intercambios, establecidos por medio de la ley, son fundamentales para evitar que intereses económicos prevalezcan sobre los beneficios ambientales.

***Palabras-clave*:** Conservación de la biodiversidad; Reserva legal; Compensación.

***Abstract*:** A legal reserve area is a mandatory practice instrument on Brazilian private land which has recognized importance for biodiversity conservation. Its implementation has not been effective and economic aspects have been identified as a reason for its non-maintenance. As an alternative, the law allows landowners to have legal reserves outside the boundaries of their properties, a practice known as compensation. This paper analyzes the main economic and environmental implications of applying this compensation mechanism, taking into account the criteria currently employed to guide its application and the functional aspects of legal reserves. We conclude that compensation is able to bring real benefits to the environment by encouraging the maintenance of natural areas on private property with lower opportunity and implementation costs. On the other hand, the choice of the type of territorial unit for applying this mechanism is crucial to prevent economic interests prevailing over environmental benefits.

***Keywords*:** biodiversity conservation, legal reserve area, compensation.