

Biodiversity offsets in Brazil: an indicative map for compensation of legal reserve in the São Paulo State.

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Brazilian federal law n° 12.651/2012 enforces that a certain percentage of rural properties must keep its natural vegetation cover – the legal reserve (LR) – as a manner to achieve biodiversity conservation goals. Despite that, there is a low level of law enforcement and a widespread accumulation of LR deficits. In order to solve that, this law includes a market based compensation mechanism that allows landowners to compensate the LR deficits by protecting natural vegetation outside their own properties. However, Brazilian guidelines for LR offsetting is considered inadequate to ensure two important aspects of biodiversity offset mechanisms: (i) the proximity of offset relative to the impact site and (ii) the ecological equivalence of the offsets. In this context, this work sought to develop an indicative map for compensation of LR in the State of São Paulo (BRA), considering the aspects described above. The map was established in order to group the municipalities of the same watersheds, which are similar in their types of dominant phytophysionomies, soil and climate. The final map shows 94 groups for compensation of LR, distributed in the 22 watersheds of the State. Each watershed has from 1 to 7 groups, which in turn gather from 2 to 29 municipalities. By representing geographically the criteria, reconsidering the spatial scale for LR compensation rules, we expect to contribute for a better biodiversity offset through compensation processes that occur between neighboring areas, which are likely to be more environmentally uniform and, consequently, more similar in terms of vegetal composition.

1. Introduction

Offsets policies are increasingly being used as a least cost way of achieving environmental objectives, balancing economic development growth and conservation (BEKESSY et al., 2010; MARON et al., 2012). Biodiversity offsetting programs with different scopes, methodologies, requirements and in different stages of implementation can be observed in many countries around the world, including United States, Australia, Colombia, South Africa, Netherlands, Sweden, and United Kingdom (MADSEN et al., 2010; MCKENNEY & KIESECKER, 2010).

In Brazil, an opportunity for the application of offset policies is the regularization of forest cover legally required on rural properties. Brazilian federal law n° 12.651/2012, which replaces the Forest Code (1965), enforces that landowners must keep a certain percentage of natural vegetation on their land – the legal reserve (LR). The LR requirement varies from 80% to 35% of rural property areas in the Legal Amazon Region, and outside the Legal Amazon Region the proportion is 20%. Some productive uses compatible with natural vegetation preservation are permitted in the LR by the law, but no clear cutting is allowed (SPAROVEK et al., 2012).

Despite the importance of LR for the Brazilian goals of biodiversity conservation, many landowners failed to comply with legal requirements. Less than 10% of the rural properties in Brazil have LR, and even those who remain do not respect the percentages (BACHA, 2004; ANDRADE & MAY, 2012). As an alternative to bring farms in line with environmental requirements, the federal law n° 12.651/2012 includes a market based compensation mechanism that allows landowners to compensate the LR deficits of their properties by protecting the surplus native vegetation cover of another property.

The compensation of LR can take place just within the same Biome where the farm is located. However, Brazil is divided into six large Biomes, which means that landowners may compensate the LR deficits by protecting natural land thousands of kilometers away from their farm (SPAROVEK et al., 2012). Additionally, each Biome presents a great diversity of vegetation types, characterized by differences in species composition and structure of ecosystems (RIBEIRO et al., 2009). Accordingly, the compensations may lead to exchanges between areas that have no ecological equivalence in terms of species composition, structure or function (SBPC/ABC, 2012).

Thus, considering that the proximity of offset relative to the impact site and the ecological equivalence are two key issues for implementing offsets schemes (BEKESY et al., 2010; MCKENNEY & KIESECKER, 2010; MARON et al., 2012), this paper presents an indicative map for compensation of LR in the State of São Paulo (Brazil), which was developed considering the aspects described above. By reconsidering the spatial scale for LR compensation rules and geographically representing it, we expect to contribute for a more effective biodiversity offset through compensation processes between neighboring areas, which are likely to be more environmentally uniform and, consequently, more similar in terms of vegetal composition.

2. Methodology

The map containing equivalent areas for LR offsets of São Paulo state (Brazil) was established in order to group municipalities by watershed, as enforced by the Brazilian Forest Law, considering aspects such as proximity (contiguity) and similarity of remnant vegetation (physiognomies), and environmental conditions, such as soil and climate properties (Board I).

These aspects were considered since the environmental heterogeneity (such as soil, topographic and climatic conditions) that occurs between sites strongly influences the composition of vegetal communities in the São Paulo State, besides the proximity and the historical disturbance of the areas (DURIGAN et al., 2003; SALIS et al., 1995).

We also considered the number of municipalities that were grouped, avoiding small areas for compensating LR, which could affect whole process.

Board I. Database planning for establishment of offset areas in São Paulo state (Brazil).

Component	Description	Source
Vegetation	Vegetal physiognomies Map of São Paulo; scale 1:50.000	Instituto Florestal; Biota-Fapesp (2004)
Borderlines	Municipalities borderlines; scale 1: 50.000	Projeto Biota-Fapesp
	Watersheds borderlines; scale 1:50.000	
Pedology	Soil map of Brazil; scale 1: 5.000.000	Embrapa (2011)
Climate	Köppen Climatic Classification (by municipality)	Alvares et al. (2013)

2.1 Procedures

Classification of municipalities based on thematic maps features was made considering each watershed at a time. Thus, those municipalities composed by two or more watersheds shall be classified in different groups in some situations.

By overlapping cities and watersheds borderlines with vegetal physiognomies maps, municipalities were classified according to predominant vegetation type, based on visual interpretation of Geographic Information Systems (GIS). Groups within contiguous municipalities sharing same predominant vegetation were created. Municipalities showing two or more vegetal physiognomies without predominance were classified as “heterogeneous” (Figure 1).

The same procedures were repeated for the classification of cities according to the predominant soil type, based on classes identified by Brazilian Agricultural Research Center (EMBRAPA, 2012). The next step was the overlapping of these two intermediary maps (municipalities in the same watershed grouped by vegetation and soil similarity) (Figure 1).

Concerning the Koppen climatic classification, it was considered only for watershed named Aguapeí. For the other watersheds it was not applied or because there was no climatic variation within pre-established groups (ALVARES et al., 2013), or because grouping operation resulted in reduced number of municipalities, with low extent area for compensation.

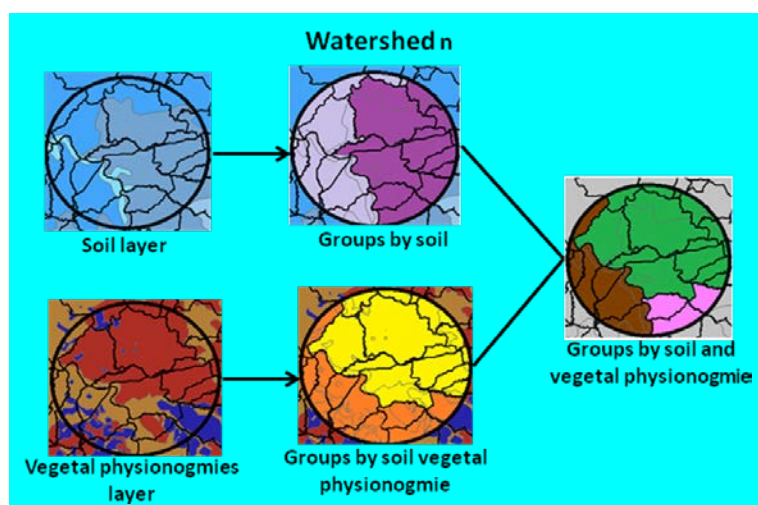


Figure 1. Methodological scheme

For the metropolitan region of São Paulo city (MRSP), municipalities were organized by means of West, Central and East regions. This was justified because MRSP is very urbanized and groups formed were too small in extent, comparing them to other watersheds.

3. Result

The final map (Figure 2) presents 94 groups for LR offsetting in 22 watersheds at this territory. Each watershed has 1 to 7 groups, composed by 2 to 29 municipalities (Board II).

Board II. Number of municipalities and watershed extent in São Paulo state (Brazil) and groups for LR offsetting.

	Watershed		Groups by Watershed		
	Number of cities	Area (km ²)	Number of cities	Area (km ²)	Number of groups
Minimum	5	664	2	298	1
Maximum	86	22.665	29	9.761	7
Mean	44,5	11.217	10	2.607	4
Total	645	246.785	645	246.785	94

The groups in the final map gather contiguous cities which are similar in terms of predominant vegetation and soil types, but also in the same river basin, criterion that provides a greater proximity between offsetting areas (origin and destination). Geographic distance is a key factor to be considered in Brazil in cases which LR offsets are made, due to its territorial extent (850Mha) and biomes distribution. The offsets made in smaller geographical cuts prevent only remnant vegetation in remote and low agricultural potential areas to be protected, where there is no pressure for land use change (SPAROVEK et al., 2012).

This trend has already been observed in cases of LR offsets in the state of São Paulo, even before the repeal of the Forest Code, when compensation should be performed in the same watershed. The absence of ecological equivalence was observed in 72 of the 117 studied cases, considering the Biome or the vegetation types. Besides, 38% of the LRs are very distant from the origin of the deficit (it varied from 200 to 400km of distance), reinforcing contrasts in the landscape (SILVA, 2013).

Therefore, the map presented here can contribute for technicians and directors of environmental agencies in defining appropriate areas for LR offsets, given the lack of clear guidelines that determine the “ecological equivalence”.

4. Final remarks

This map was established based on the finest scale information available for whole State. As seen to any cartographic product, limitations arising from geographic scale features are intrinsic to methodology, which means that producing finer scale databases is relevant and they should be incorporated to new maps.

It is noteworthy that within the formed groups for each watershed, we recommend that offsetting should occur between equivalent vegetation. This means that areas for LR offset must be at the same vegetal physiognomy of original property.

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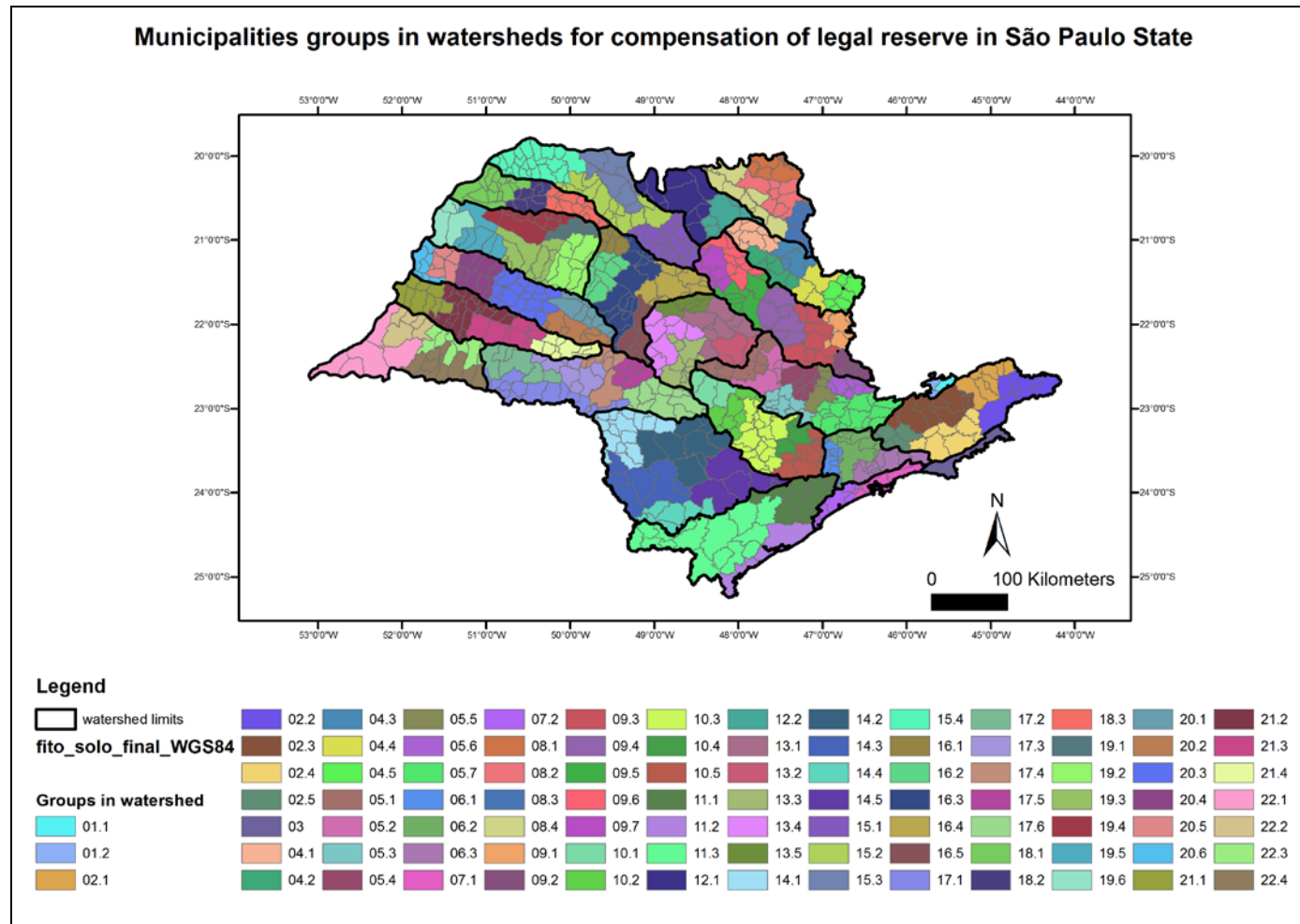


Figure 2. Final map of equivalent municipalities for LR offsetting by watershed in São Paulo State (Brazil).

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