Forest Ecology and Management 278 (2012) 80–89

Contents lists available at SciVerse ScienceDirect

Forest Ecology and Management

journal homepage: www.elsevier.com/locate/foreco

Land-use and land-cover change in Atlantic Forest landscapes

Paula K. Lira [a,*], Leandro R. Tambosi [a], Robert M. Ewers [b], Jean Paul Metzger [a]

[a] Departamento de Ecologia, Instituto de Biociências, Universidade de São Paulo, Rua do Matão, 321, Travessa 14, 101, 05508-900 São Paulo, SP, Brazil
[b] Imperial College London, Silwood Park Campus, Ascot, Berkshire SL5 7PY, UK

ARTICLE INFO

Article history:
Received 6 February 2012
Received in revised form 6 May 2012
Accepted 8 May 2012
Available online 5 June 2012

Keywords:
Landscape dynamics
Deforestation
Regeneration
Landscape structure
Forest age
Forest transition

ABSTRACT

The Atlantic Forest is one of the most threatened tropical biomes, with much of the standing forest in small (less than 50 ha), disturbed and isolated patches. The pattern of land-use and land-cover change (LULCC) which has resulted in this critical scenario has not yet been fully investigated. Here, we describe the LULCC in three Atlantic Forest fragmented landscapes (São Paulo, Brazil) between 1960–1980s and 1980–2000s. The three studied landscapes differ in the current proportion of forest cover, having 10%, 30% and 50% respectively. Between the 1960s and 1980s, forest cover of two landscapes was reduced while the forest cover in the third landscape increased slightly. The opposite trend was observed between the 1980s and 2000s; forest regeneration was greater than deforestation at the landscapes with 10% and 50% of forest cover and, as a consequence, forest cover increased. By contrast, the percentage of forest cover at the landscape with 30% of forest cover was drastically reduced between the 1980s and 2000s. LULCC deviated from a random trajectory, were not constant through time in two study landscapes and were not constant across space in a given time period. This landscape dynamism in single locations over small temporal scales is a key factor to be considered in models of LULCC to accurately simulate future changes for the Atlantic Forest. In general, forest patches became more isolated when deforestation was greater than forest regeneration and became more connected when forest regeneration was greater than deforestation. As a result of the dynamic experienced by the study landscapes, individual forest patches currently consist of a mosaic of different forest age classes which is likely to impact biodiversity. Furthermore, landscape dynamics suggests the beginning of a forest transition in some Atlantic Forest regions, what could be of great importance for biodiversity conservation due to the potential effects of young secondary forests in reducing forest isolation and maintaining a significant amount of the original biodiversity.

1. Introduction

The Brazilian Atlantic Forest supports one of the highest degrees of species richness and rates of endemism on the planet (Mittermeier et al., 2005; Myers et al., 2000). Nonetheless, a recent broad-scale study (Ribeiro et al., 2009) revealed a serious situation about the spatial structure of Atlantic Forest remnants: more than 80% of the Atlantic Forest patches are less than 50 ha, almost half the remaining forest is less than 100 m from a forest edge and the average distance between forest patches is 1440 m. In addition, much of the standing Atlantic Forest is secondary rather than primary forest (Ribeiro et al., 2009).

This critical scenario of the Atlantic Forest with small, disturbed and isolated forest patches is a consequence of five centuries of intense human occupation (Dean, 1996). The pattern of land-use and land-cover change (LULCC) which has directly resulted in this critical scenario for the Atlantic Forest has not yet been fully investigated (but see Teixeira et al., 2009), contrary to the large number of studies on landscape dynamics for the Brazilian Amazon (e.g. Ewers and Laurance, 2006; Ewers et al., 2008; Michalski et al., 2008; Soares-Filho et al., 2004, 2006). The understanding of how LULCC varies both temporally and spatially and how it affects landscape structure and forest age is extremely important for managing ecosystem services and species conservation in new human-dominated landscapes, and thus to prevent or minimize undesirable ecological impacts (Barlow et al., 2007a,b; Echeverria et al., 2006; Etter et al., 2005).

LULCC in a given landscape can be a random process if transitions among land-use/cover classes are proportional to the size of classes but can also be a systematic process if transitions among classes are not dictated by their sizes (Pontius et al., 2004). Knowing if LULCC is a random or a systematic process is the first step towards the understanding of how land-use will affect land-cover and thus to guide conservation actions (Braimoh, 2006; Pontius et al., 2004). Additionally, it is also important to understand how LULCC varies temporally and spatially to accurately simulate future

* Corresponding author. Tel.: +55 21 88428188.
E-mail addresses: pklira@hotmail.com (P.K. Lira), letambosi@yahoo.com.br (L.R. Tambosi), r.ewers@imperial.ac.uk (R.M. Ewers), jpm@ib.usp.br (J.P. Metzger).

0378-1127/$ - see front matter © 2012 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.foreco.2012.05.008

changes in land-cover and thus on biodiversity conservation and ecosystem services.

The effects of the LULCC on landscape structure are also important. It is well known that changes on size, shape and degree of connectivity of forest patches are likely to impact species distribution in fragmented landscapes (Ewers and Didham, 2006). But the ecological consequences of LULCC depend not only on the resulting landscape structure and on how this varies both temporally and spatially (Echeverria et al., 2006), but also on the resulting proportion of forest with different ages of regeneration (Barlow et al., 2007a,b; Etter et al., 2005). Secondary forests patches can sustain a significant amount of biodiversity, but many species need more pristine forest patches to survive (Barlow et al., 2007b; Laurance, 2005). Consequently, population of many species are now thought to be on a deterministic path to extinction in Atlantic Forest landscapes (Brooks et al., 1999; Brooks and Balmford, 1996; Metzger et al., 2009). Both landscape structure and the age structure of forest are important determinants of the maintenance of species in human-modified landscapes (Gardner et al., 2009), and therefore important components of land-cover to consider when assessing landscape conditions.

In this context, this study aimed to describe the LULCC of three Atlantic Forest fragmented landscapes (São Paulo, Brazil) between 1960–1980s and 1980–2000s in order to: (1) evaluate if LULCC deviate from a random trajectory; (2) determine if trajectories of LULCC are constant through time and across space; (3) investigate the effects of the LULCC on landscape structure in terms of size, shape and degree of isolation of forest patches; and (4) verify the effects of LULCC on the current proportion and distribution of forest stands with different regeneration ages.

2. Materials and methods

2.1. Study area

This study was conducted in three 10,000-ha Atlantic Forest fragmented landscapes located in the Atlantic Plateau of São Paulo, Brazil. The whole region of the Atlantic Plateau was once covered with Atlantic Forest classified as Lower Montane Atlantic Rain Forest (Oliveira-Filho and Fontes, 2000), but nowadays much of the region is reduced to secondary forest patches in different stages of regeneration (Ribeiro et al., 2009; Teixeira et al., 2009). The altitude in the Atlantic Plateau of São Paulo varies between 700 and 1100 m above sea level with steep hillslopes, mountain with moderate to gentle hillslopes, and alluvial plains (Poçano et al., 1981);

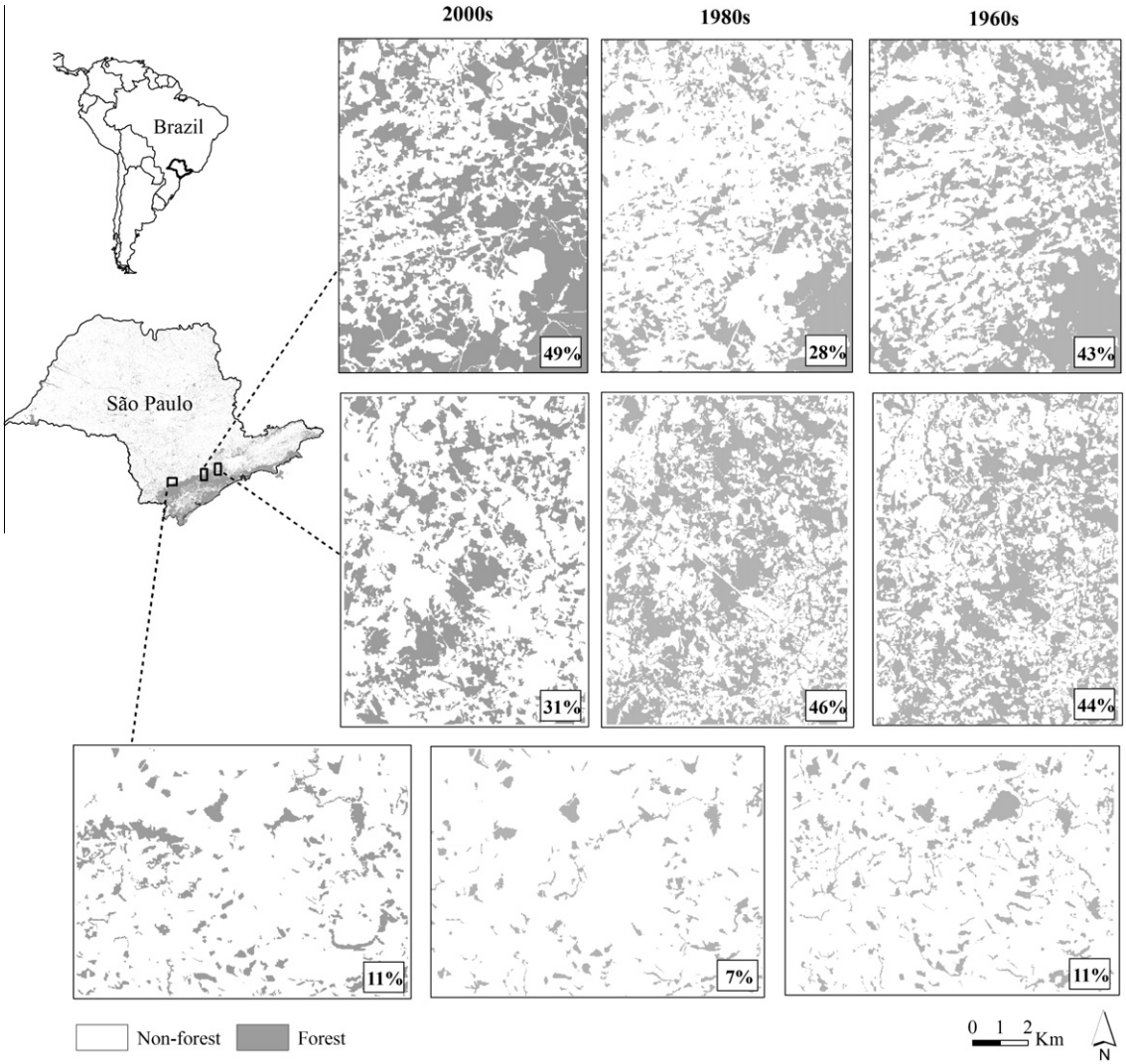

Fig. 1. Location of the three studied Atlantic Forest fragmented landscapes in the State of São Paulo (south-eastern – Brazil) and their forest cover dynamics between the 1960s and 2000s (from right to left). The percentage of forest cover is shown at the bottom of each forest cover map.