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Application of the diffusive-logistic equation to model forest recovery in Southern Brazil

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1 Introduction

The importance of forested areas to the conservation of biodiversity, water quantity and quality, to the preservation of climate and maintenance of environmental conditions have been widely and increasingly recognized worldwide. In this paper, we calibrate, validate and apply the diffusive-logistic equation, proposed in [1], to study the adherence of the model to a preservation region in the surroundings of Machadinho Dam reservoir. As the calibration and validation succeed, we simulated regeneration for up to 30 years ahead.

2 Materials and methods

The region under study is located at latitude $-27^o32'05"$, longitude $-51^o47'24"$ and between 396 and 500 meters altitude in the municipality of Maximiliano de Almeida. By the time of Machadinho Dam reservoir filling, between 1999 and 2000, the region was turned into an area of permanent conservation, which allowed the native vegetation to undergo a regeneration process. The diffusive-logistic equation applied in the modeling was the modified equation by Fisher [1] given by

$$\frac{\partial u}{\partial t} = D_u \frac{\partial^2 u}{\partial x^2} + D_u \frac{\partial^2 u}{\partial y^2} + r_u u(1 - \frac{u}{k_u}). \quad (1)$$

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where r_u, D_u end k_u are the growth rate, diffusion coefficient and carrying capacity, respectively, and u is the forest proportion taking values in the interval [0,1]. The equation was discretized by means of the Crank-Nicolson scheme. Towards the calibration of the model, two Landsat 4-5TM images from 2000 and 2011 for the same period of the year were obtained, converted to reflectance in the software GRASS GIS 7.0 and then converted to vegetation density by means of the Enhanced Vegetation Index (EVI) [2]. The calibration process was performed using half of the images and consisted of searching for the parameters r_u, D_u that would minimize the Root Mean Square Error between the real and simulated images. The validation process was performed using the other half and was aimed at checking the accuracy of the model. The carrying capacity was admitted as $k_u = 1$.

3 Results

The parameters were obtained as $r_u = 0.03 year^{-1}$ and $D_u = 2.3 \times 10^{-14} m^2.year^{-1}$, with RMSE of the order of 10^{-3}, thus showing that diffusion had little influence upon the regeneration process thus far. The similarity between the real and simulated forest densities, presented in Figure 1 (a)-(b), also suggests that the model is accurate.

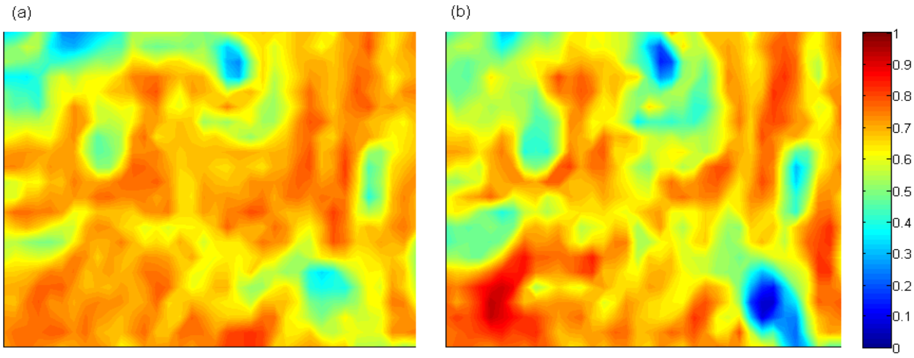

Figura 1: Forest density maps: (a) real, (b) simulated.

Further simulations for 5, 10, 15, 20, 25 and 30 years ahead suggest that the regeneration process is likely to stabilize in about 25 years, thus suggesting that the regeneration process will be nearly completed.

Referências

[1] M. A. Acevedo, M. Marcano, R. J. Fletcher. A diffusive logistic growth model to describe forest recovery. *Ecological Modelling*, v. 244, p. 13-19, 2012.

[2] A. R. Huete, H. Q. Liu, K. Barchily, W. A Leeuwen. Comparison of vegetation index over a global set of TM images for EOS-MODIS. *Remote Sensing of Environment*. p. 440-451, 1997.

