2ND BBEST
Brazilian BioEnergy Science and Technology Conference
20-24 October, 2014

Spatial dynamic modeling and economic valuation of land use and cover changes related to sugarcane expansion

Macedo, RC[1]; Almeida, CM[2]; Santos, JR[2]; Rudorff, BFT[3]; Soares Filho, BS[4]; Rodrigues, H[4]; Sousa Jr., WC[5]

[1]Instituto Brasileiro de Geografia e Estatística (IBGE), Florianópolis, SC
[2]Instituto Nacional de Pesquisas Espaciais (INPE), São José dos Campos, SP
[3]Agrosatélite, Florianópolis, SC
[4]Universidade Federal de Minas Gerais (UFMG), Belo Horizonte, MG
[5]Instituto de Tecnologia Aeronáutica (ITA), São José dos Campos, SP

Keywords: Sugarcane expansion, dynamic spatial modeling, environmental valuation

The problem dealt with in this work is the proposition of a spatial dynamic model coupled to an economic valuation of land use and cover change (LUCC). The aim is to generate future monetized LUCC scenarios related to sugarcane expansion. The study area is Arealva, a municipality located in the central-west of São Paulo estate, southeast of Brazil. The proposed scenarios considered the revegetation of conservation areas as a strategy for minimizing environmental impacts as well as for recovering environmental services under threat. Three sets of scenarios were defined: i) stationary scenarios, where transition rates observed in the analyzed period were maintained and the detected changes reproduced historical trend (business as usual), ii) nonstationary scenarios, with a 70% recovery of vegetation in conservation areas along water streams by 2020, and iii) non-stationary scenarios, with a 100% recovery of vegetation in conservation areas along water streams by 2020. For the generation of stationary and non-stationary scenarios, we designed a dynamic spatially explicit LUCC model, comprising the following driving variables: distance to roads, distance to rivers, distance to Tietê waterway, slope and soil type. In order to parameterize, calibrate and validate the model, past simulations were accomplished for the period from 2005 to 2010. Such simulations were adjusted so as to achieve a satisfactory fit in relation to the reference map (real land use and cover map in 2010). The economic valuation considered operational profit and the main environmental impacts associated with sugar cane and pasture, besides key ecosystem services provided by native vegetation. The selected ecosystem services are related to soil and water conservation and are meant to minimize erosion and silting-up risks, which precisely regard the analyzed environmental impacts. The most significant changes are related to sugarcane expansion and decrease in pastures. The environmental readjustment reduce operating profit by about 6% (R$460,000.00.year^{-1}), representing approximately R$165.00.year^{-1}.ha^{-1}. All environmental impacts are regarded as dependent on the estimated amount of soil loss, i.e., the greater the potential erosion, the greater the environmental impact magnitude. The scenarios of environmental recovery can reduce environmental impacts by as much as 16% (R$260,000.00.year^{-1}). This mitigation of environmental impacts could contribute to R$56.52.ha^{-1}.year^{-1}, competitive value with some degraded pastures. The environmental recovery causes reduced opportunity cost (sacrified income). On the other hand, its. benefits are twofold: it increases the supply of ecosystem services and reduces the risk of future undesirable environmental impacts. Both benefits are external to the market, therefore it is difficult for economic agents to acknowledge them. The design of economic policies targeted to valorize ecosystem services together with the endorsement of legal tools for internalizing potential environmental impacts would certainly enable feasible and competitive environmental recovery.

Financial Support: Brazilian National Agency for the Upgrade of Graduate Personnel (CAPES) and the São Paulo State Foundation for Research Support (FAPESP), Grant n. 08/56252-0.