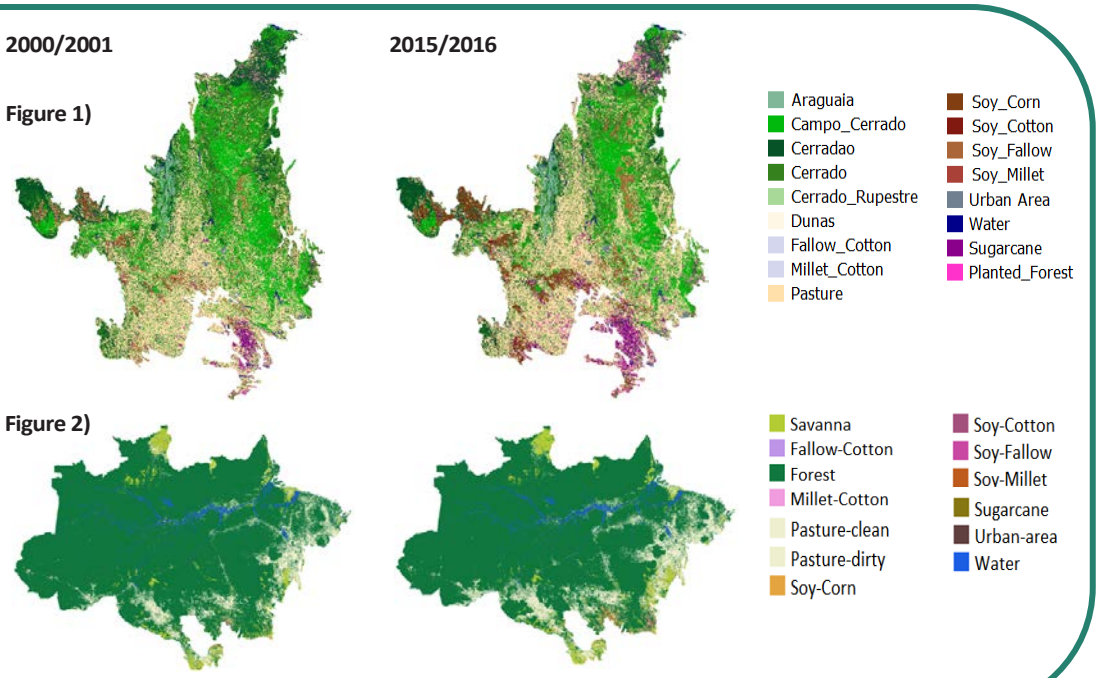
Cerrado and Amazon biomes LU and LC maps 2001-2016

RESTORE+ Brief



Source: INPE - Instituto Nacional de Pesquisas Espaciais

Figures: 1) Cerrado (top) and 2) Amazon (bottom) biomes land use and land cover maps for the years 2000/2001 (left) - 2015/2016 (right)

- Innovative deep learning approach is used to identify natural vegetation, pasture, and individual (single and double) crops
- The developed tools are open source and freely available to any researcher interested in building and analyzing land use and cover maps for any country or region of the globe
- The maps will help the development of Brazil's national scenarios of forest restoration and sustainable food/energy crop production on degraded and non-productive lands

Approach and aim

Earth observation satellites provide a regular and consistent set of information about the land and oceans of the planet. Time series of remote sensing data show that land cover can occur not only in a progressive and gradual way, but also show discontinuities with abrupt changes. The analysis of multiyear time series of land surface attributes, their fine-scale spatial patterns, and their seasonal evolution leads to a broader view of land cover change.

Methodological novelty

Within the scope of the RESTORE+ project, an innovative deep learning approach was developed by INPE to classify unlabeled data to produce land use and cover classification maps using satellite image time series. Such classifications can be validated using other data sources or subsets of the input samples.

The method classifies yearly time series data using MODIS product. The land use and cover maps are based on time series analysis of over 24,000 images covering Amazon and Cerrado biomes, with resolution of 250m. This represents more than 440 million time series that were classified into land cover classes. Covering more than 70% of the Brazilian territory, both biomes are responsible for most of the land change dynamics in the last decades.

The classification method uses Deep Learning to generate land use and cover maps. Deep Learning uses layers of neurons to associate an input data (in this work, time series) with a set of outputs values (in this work, land use and cover classes). The first (input) and last (output) layers are connected by hidden layers of neurons.

To provide a unified support to these activities, this work developed an open source software for R language called *sits*. The package includes time series data retrieval from Web services, time series data visualization tools, as well as functions to generate classification models from different machine learning techniques.

Results

The results in Cerrado indicate that, from 2000 to 2015, there was a reduction of 26.8Mha of natural Savanna, associated with an increase of 10.3Mha of crops (mainly soy and corn, including double cropping), 12.4Mha of grassland, and 3.5Mha of planted forest areas. Within Amazon, the maps show trends similar to TerraClass/PRODES, the official monitoring data, but they also discriminate agriculture classes and identifies land use and cover classes within areas whose pristine vegetation were not forest (which are not mapped by TerraClass and PRODES).

These results enable an informed assessment of the interplay between production and protection in the Brazilian Amazon and Cerrado, being relevant to support land use and cover planning and public policies for forest restoration and sustainable food/energy crop production, such as the estimation of greenhouse gas (GHG) emissions for the implementation of Brazil's NDCs.

Further reading: Simões, R., Camara, G., Andrade, P.R., Carvalho, A., Santos, L., Ferreira, K., Queiroz, G., 2020. SITS: Data Analysis and Machine Learning for Data Cubes using Satellite Image Time Series.

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