

# Land use mapping in the Brazilian Amazon with remote sensing time series

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## Abstract:

Land cover/use data are important in many socio-ecological applications, for example in developing scenarios for land use and as an input for climate change models. However, for some regions with highly recognized ecological importance, like the Brazilian Amazon, the available land cover/use products either have coarse spatial resolution or they are sparsely mapped over time.

Here we propose a time-weighted Dynamic Time Warping (DTW) for spatiotemporal land cover/use mapping using satellite image time series. This algorithm compares two time series and finds their optimal alignment, providing a robust dissimilarity measure as a result. It also allows similar patterns to match even if they are out of phase in the time axis or if they have irregular sampling frequency.

We ran a case study in Porto dos Gaúchos municipality, Mato Grosso, Brazil. This area has approximately 7,000 km<sup>2</sup> inside of the Amazon Biome and showed a strong deforestation and cropland expansion in the last decade. We used time series of Enhanced Vegetation Index (EVI) from 2000 to 2014 based on Moderate Resolution Imaging Spectroradiometer (MODIS) product MOD13-Q1 16 day 250 m. Our patterns training sample for classification come from field observations of forest, pasture, single cropping and double cropping. We validated the time-weighted DTW classification by comparing with 325 samples identified by visual classification of Landsat images that are independent of the training samples. The global accuracy of the method was 86.38%, with sensitivity of 91.49% for forest, 88.89% for single cropping, 88.61% for double cropping and 81.25% for pasture. The cropland area estimated with time-weighted DTW was in line with the Brazilian national cropland surveys.

The results of the time-weighted DTW are spatially distributed, and can contribute to improve Brazil's agricultural statistics. This approach is flexible to account for multiyear crops, double and triple cropping, as well as forest and pasture. The method works with a small amount of patterns training samples and is suitable for generating land cover and land use maps at continental scale using global data sets such as the EVI time series from the MODIS sensor.

**Key words:** Land use intensification, Land use trajectories, Agriculture monitoring, MODIS time series, Dynamic Time Warping.