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Monitoring the brazilian pasturelands: A new mapping approach based on the landsat 8 spectral and temporal domains

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ABSTRACT

In a world marked by a rapid population expansion and an unprecedented increase in *per capita* income and consumption, sustainable food production is certainly the most pressing issue affecting mankind. Within this context, the brazilian pasturelands, the main land-use form in the country, constitute a particularly important asset as a land reserve, which, through improved land-use strategies and intensification, can meet food security goals and contribute to the mitigation of greenhouse gas emissions. In this study, we utilized the entire set of Landsat 8 images available for Brazil in 2015, from which dozens of seasonal metrics were derived, to produce, through objective criteria and automated classification strategies, a new pasture map for the country. Based on the Random Forest algorithm, individually modelled and applied to each one of the 380 Landsat scenes covering the Brazilian territory, our map showed an overall accuracy of 87%. Another result of this study was the thorough spatial and temporal assessment of Landsat 8 data availability in Brazil, which indicated that about 80% of the country had 12 or fewer observations free of clouds or cloud shadows in 2015.

1. Introduction

Sustainable food security goals are directly related to livestock production, which accounts for most of the land use on the planet, with approximately 30% of the terrestrial land being used for animal feeding (FAO, 2013). Among the group of developing countries, Brazil plays a central role in the global production of food of animal origin, with the second largest commercial cattle herd in the world (USDA, 2016), fed, mostly, by approximately 160 million hectares of pasture (IBGE, 2006), the main land use form in the country.

Currently, Brazil is the largest exporter of beef in the world (CNA, 2016), and in order to meet the foreign market demands, the country had to substantially expand its beef and soy production in the last decades. The increase in beef production was achieved through the conversion of natural ecosystems into planted pastures, drastically altering the Amazon and Cerrado biomes, while the growth of soybean production, intensified after 2000, occurred on natural ecosystems and planted pastures (Lapola et al., 2013). Despite the extensification history of Brazil, more recent data indicate that this process has been reduced and the intensification of converted areas is increasing for the production of both commodities (Dias et al., 2016). Considering this territorial dynamics, the Brazilian pasturelands constitute an important resource for the country, since it can be used as both a land reserve, especially for the production of grain, and as food for its cattle herd (Lambin et al., 2013). And such land use strategies present a great potential for mitigation of greenhouse gas emissions (Bustamante et al., 2012; Herrero et al., 2016).

However, the absence of recent, accurate, and spatially explicit mappings of these areas makes it difficult to implement public policies at regional and property levels. So far, the land cover maps produced under the Brazilian Program for the Conservation and Sustainable Use of the Brazilian Biodiversity – PROBIO (MMA, 2002) constitute the only spatially explicit mean for the identification of pastures throughout the Brazilian territory. After 2002, there were localized efforts to produce updated information, such as the TerraClass Amazônia (Coutinho et al., 2013) and the TerraClass Cerrado (MMA, 2015) projects, elaborated through the segmentation and visual inspection of Landsat scenes, i.e. following the same PROBIO methodology.

Considering the recent breakthroughs in remote sensing science and applications regarding large-scale land-cover mappings (e.g. Hansen et al., 2013), in this work we take advantage of cloud computing techniques to produce a new pasture map for entire Brazil, based on the

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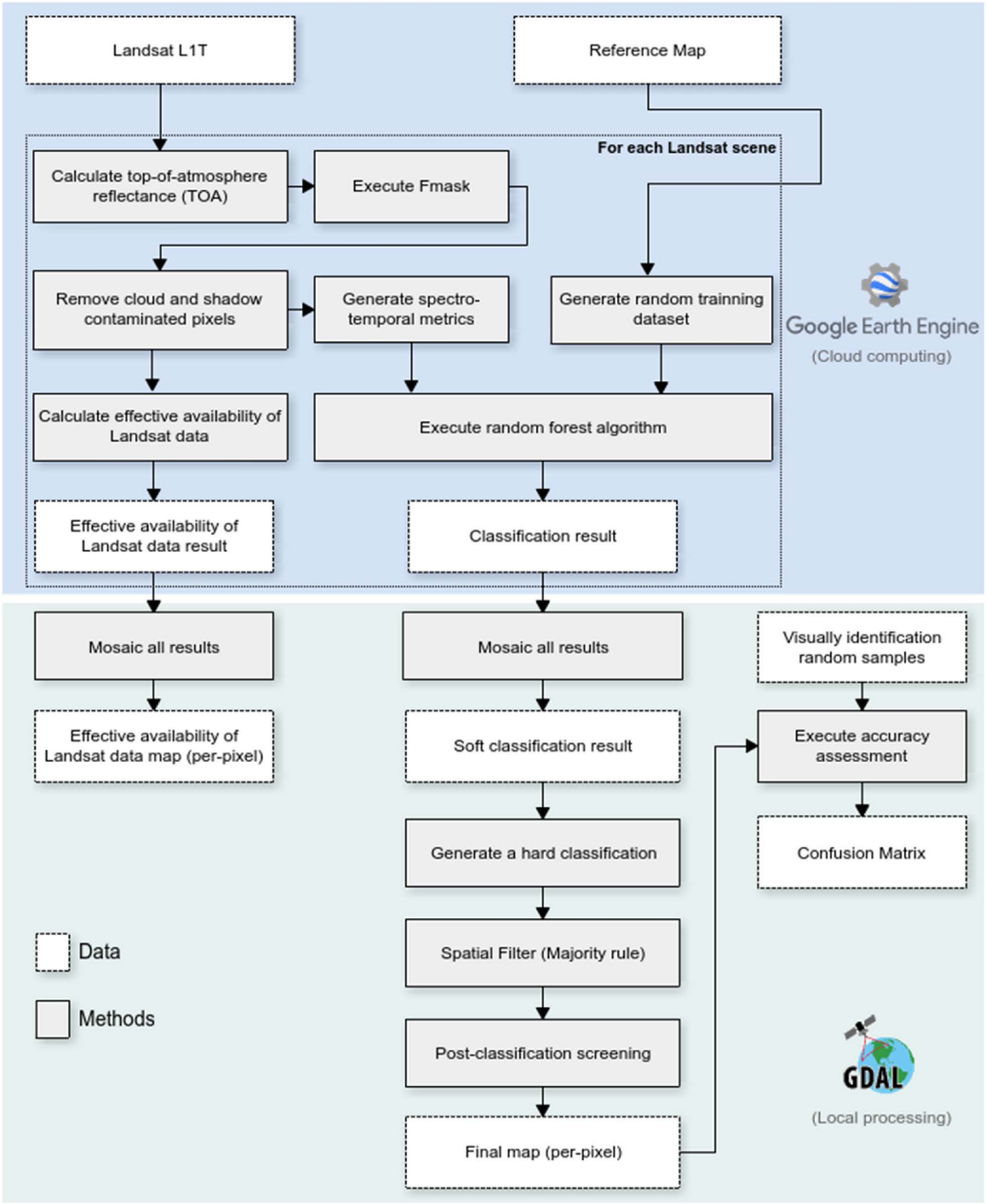

Fig. 1. Flowchart depicting the datasets and methods utilized for mapping the Brazilian pasturelands (which considered both the Google Earth Engine and the use of the open source GDAL software – Geospatial Data Abstraction Library – in a local workstation).

use of Landsat 8 images and supported by objective criteria and fully automated strategies. As we attempt to demonstrate, the novel approaches proposed in this study can be easily generalized to other regions and/or classes of interest, as well as to a variety of satellite datasets, in order to monitor, in a fast-track and low-cost manner, the severe anthropic transformations affecting the earth's surface.

2. Data and methods

The main steps involved in mapping the pasture areas of Brazil, as discussed in this study, including the organization, processing, and analysis of distinct datasets, are depicted in the flowchart shown in Fig. 1.