# DATA OF BRAZILIAN PASTURES QUALITY MAPPING BETWEEN 2000 AND 2020

Document elaborated by the Pasture Research Nucleus of the Image Processing and Geoprocessing Laboratory (Lapig) of the Federal University of Goiás (UFG), coordinated by professor Laerte Guimarães Ferreira. This and other methods relative to data production and pastures information are available in the Atlas of Pastures platform.

Goiânia, January 2022.

## 1. Contextualization

The world's biggest commercial cattle herd is in Brazil, which is also the second biggest meat producer and exporter (IBGE, 2020). This significant position is guaranteed by a predominant extensive livestock production, where the biggest part of the cattle herd is created in the pasture (Dias-Filho, 2011). For this reason, the pasture occupies a territorial scope of nearly 20% of the national territory (Parente et al., 2019). There was a significant growth of livestock activity in the last decades, which by the 2020's it was followed by a huge sprawl in the areas occupied by pastures (Vieira-Filho e Fishlow, 2017; Parente et al., 2019), confirming the importance of the pastures to maintain the livestock productivity.

In this context, the comprehension of space-time patterns in the quality of this class of land use can contribute to improving the efficiency of Brazilian territory use. The orbital remote sensing is essential to this process, allowing the assessment of the use changes and the land coverage, the monitoring of the area covered by pasture dynamic, and the qualitative analyses of this land use. In this context, many actions pursuing to assess the pastures quality use data obtained by remote sensing and are performed in regional range (Andrade et al., 2013) or that cover biomes (Pereira et al., 2018), and sometimes, the national territory (Aguiar et al., 2017; Arantes et al., 2018). However, there wasn't yet a series of good national pasture maps that would allow the understanding of this land use dynamics.

In this context, we developed an analyses approach to the pasture's quality mapping and monitoring, by means of the vegetation indexes obtained from the orbital sensors. We applied it in all the areas classified as pastures in the country between 2000 and 2020.

## 2. Analyses approach

### *2.1. Pasture quality classification*

The classification of the land coverage in pasture was obtained from a study that mapped and analyzed Brazilian pasture areas dynamic from 1985 to 2020 (Parente et al., 2019). In order to obtain this classification, it was considered all Landsat satellites data from the mapping period and also the Random Forest classifier, which is a learning machine algorithm that is trained from 31.4 thousand visually inspected points.

The quality of Brazilian pastures was estimated based on the initial propose by Gao et al., (2006). Later, some adjustments were done on this method in three studies in Brazil that assessed: pastures degradation status in three hydrological micro watersheds in the State of São Paulo (Andrade et al., 2013); pastures annual dynamic characterization in a hydrological watershed in Minas Gerais (Pereira et al., 2018 [luís]); and pastures quality dynamic in rural settlement in Goiás (Gosch et al., 2020).

The pastures quality classification in the Brazilian territory used on this work was formed by three sequential steps: (1) Vegetation indexes pre-processing focusing to improve the time consistency and remove possible abnormalities that might interfere in the determination of the pasture's degradation status over the series. This step filled the information gaps (TMWM) and removed the seasonal data effects (STL); (2) Images stratification into Pasture's Degradation Classes of each analyzed year; (3) Comparison of classified maps to analyze the classes dynamics over the years.

### 2.2. *Pre-processing*

The pasture's status classification was based on EVI values – Enhanced Vegetation Index, provided by MODIS MOD13Q1 product (Huete et al., 2002). Vegetation indexes presented positive correlation with vegetation vigor (equation 1). Consequently, vegetation indexes have been used to assess the degradation status and pasture's biomass estimates (Eckert et al., 2014; Pereira et al., 2018; Gargiulo et al., 2020).

Equation 1

$$EVI = G * \frac{NIR - RED}{NIR + C1 * RED - C2 * BLUE + L}$$

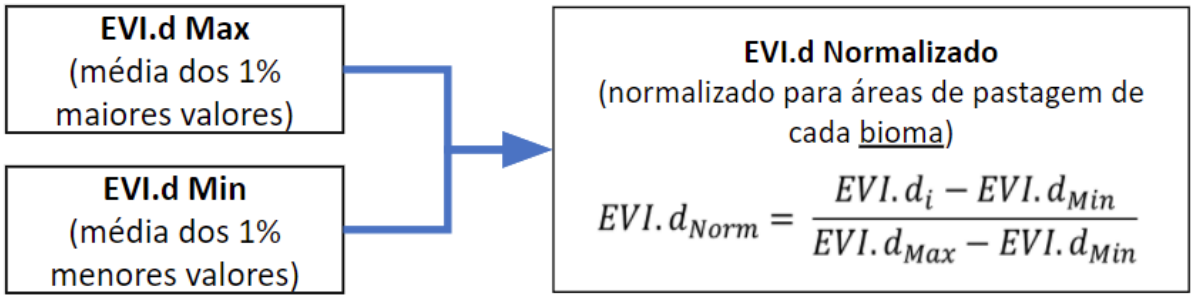
Where EVI is the enhanced vegetation index; NIR is the electromagnetic radiation reflectance in the near infrared spectrum; RED is the electromagnetic radiation reflectance in the red-light spectrum; C1 and C2 are coefficients of aerosol resistance; and L is the canopy background adjust, which is the nonlinear radiation transference between NIR and RED through a canopy. The coefficients adopted to the MODIS-EVI data processing are: L = 1, C1 = 6, C2 = 7.5, and G (gain factor) = 2.5.

In order to classify the pasture's areas into the analyzed period (2000 to 2020) MOD13Q1 EVI annual data, produced with normalized bimonthly average, was used.

### 2.3. *Pasture's degradation classes*

Annual average EVI images were normalized by biomes to reduce expected differences in this parameter values due to edaphoclimatic conditions, which makes the index equivalent among different biomes (equation 2).

Equation 2




Where EVI.dNorm is the EVI.d normalized, with range between 0 and 1; EVI.d is the Enhanced Vegetation Index "DE seasonalized"; EVI.dMin is the 1% average of the lowest values of all EVI.d data in the analysis' unity, and EVI.dMax is the 1% average of the highest values of the analysis' unity.

The resulting annual EVI.dNorm images were stratified in classes of pasture's degradation status. Andrade et al., (2013) evaluated four pasture degradation status classes: (Absent [> 0,6], Light [>0,5 and ⩽0,6], Moderate [>0,4 and ⩽0,5], and Severe [⩽0,4]), and concluded that the method is efficient to identify Absent and Moderate classes, however it does not distinguish Light and Moderate classes between them. Therefore, Light and Moderate classes were grouped so we were able to work only with three degradation status classes that the method was efficient to differentiate (Non-Degraded [>0,6], Intermediary [ >0,4 and ⩽0,6], and Severally Degraded [⩽0,4]) (figure 1). From now on, degradation classes will be referred to by their initials D0 (Non-Degraded), D1 (Intermediary), D2 (Severally Degraded).

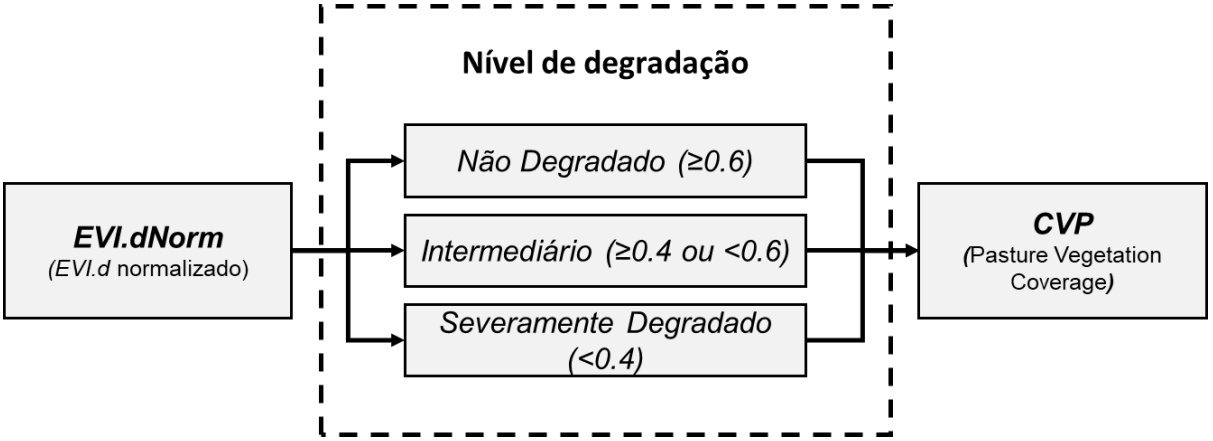



**Figure 1.** Fluxogram that illustrates the *EVI.dNorm* stratification into three degradation classes - Absent, Intermediate and Severe.

## 3. Brazilian Pasture's Quality space-time dynamic

The estimated areas covered by pasture between 2000 and 2020 resulted in similar values, ~166.4 Mha and 162.9 Mha, respectively. It was observed a loss of 3.5 Mha in the area classified as pasture over the period of this study (figure 2). On the other hand, an area equivalent to 46.1 Mha has not been classified as pasture since 2020 because it was converted into other uses or coverages, while 42.6 Mha were incorporated to this land's class use in the same year.

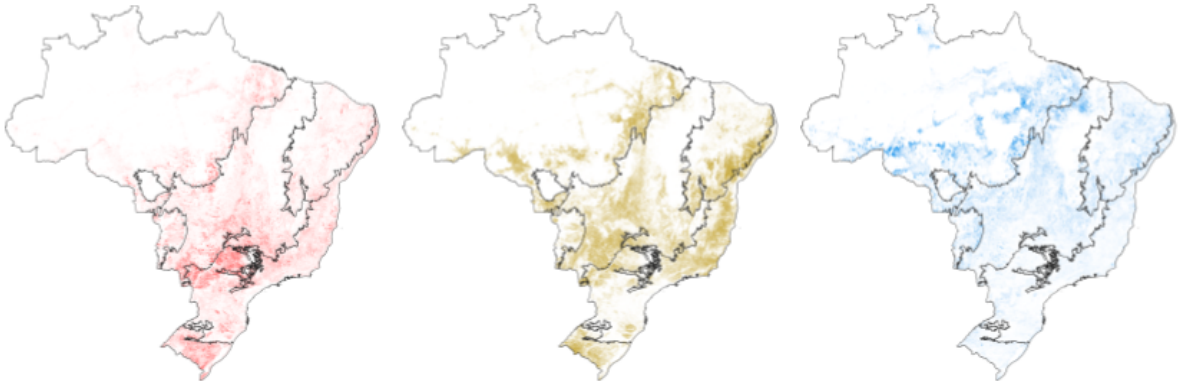



**Figure 2.** Areas occupied by pastures in Brazil in 2000 and 2020 (https://atlasdaspastagens.ufg.br). *[46.1 Mha (million hectares) ceased to be pasture between 2000 and 2020; 120.3 Mha mapped in 2000 and 2020 remained pasture; 42.6 Mha new pastures were mapped between 2000 and 2020]*

The discrimination of the pastures areas into classes allowed us to notice that even with the small variation of the total pasture coverage between 2000 and 2020, there was a significant change among the degradation status classes. In 2000, the area classified as Non-Degraded (N0) corresponded to 28.61% of the pastures, while 41.25% was classified as Intermediary (D1), and 30.15% as Severely Degraded (D2) (figure 3). However, the D0, D1, and D2 proportions at the end of the assessment period were 45,33%, 38,89%, and 15,78%, respectively. Therefore, it was observed an increase of the occupied area by pasture of higher quality, because there was an upgrade in 2020 of D0 (from 47,6 to 73,9 Mha), and a drop of D1 (from 68,6 to 63,3 Mha) and D2 (from 50,2 to 25,7 Mha).

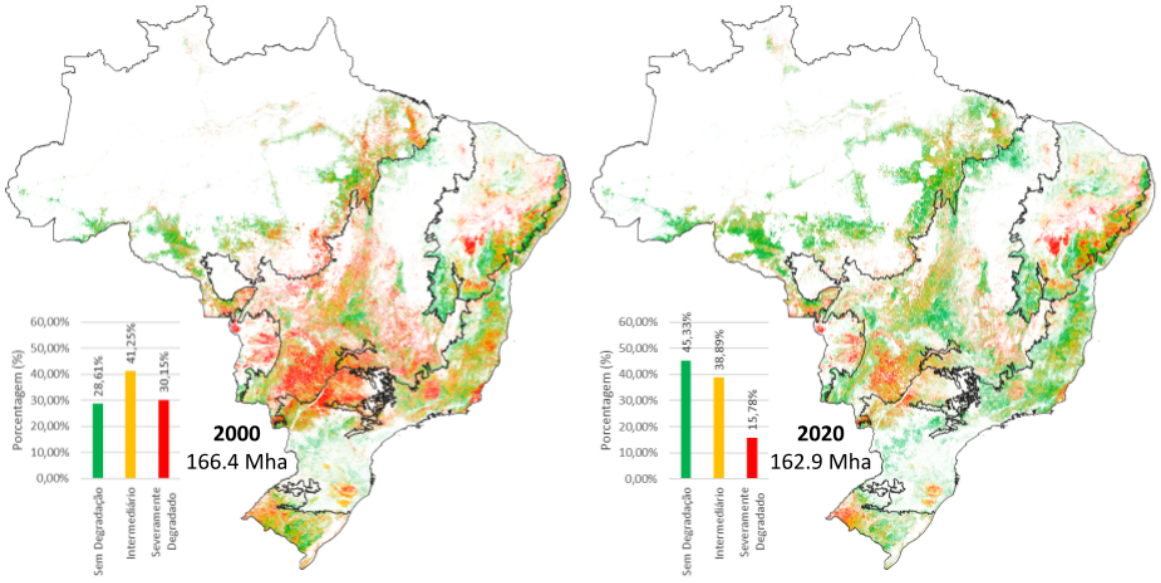



**Figure 3.** Brazilian pasture area, classified into three degradation classes (D0: non-degraded, D1: intermediate; and D2: severely degraded), for the years of 2000 and 2020.

## References


Aguiar, D.; Mello, M.; Nogueira, S.; Gonçalves, F.; Adami, M.; Rudorff, B. MODIS Time Series to Detect Anthropogenic Interventions and Degradation Processes in Tropical Pasture. *Remote Sens*. **2017**, 9, 73.

Andrade, R.; Rodrigues, C.; Sanches, Torresan, F.; Quartaroli, C. Uso de técnicas de sensoriamento remoto na detecção de processos de degradação de pastagens. *Eng. na Agric.* **2013**, 21, 234–243.

Arantes, A.; Couto, V.; Sano, E.; Ferreira, L. Livestock intensification potential in Brazil based on agricultural census and satellite data analysis. *Pesq. Agrop. Bras.* **2018**, 53, 1053–1060.

Dias-Filho, M.B. *Degradação de Pastagens: Processos, Causas e Estratégias de Recuperação*, 4th ed.; Embrapa Amazônia Oriental: Belém, Brazil, **2011**; p. 215.

Eckert, S.; Hüsler, F.; Liniger, H.; Hodel, E. Trend analysis of MODIS NDVI time series for detecting land degradation and regeneration in Mongolia. *J. Arid Environ.* **2015**, 113, 16–28.

Gao, Q.; Li, Y.; Wan, Y.; Lin, E.; Xiong, W.; Jiangcun, W.; Wang, B.; Li, W. Grassland degradation in Northern Tibet based on remote sensing data. *J. Geogr. Sci.* **2006**, 16, 165–173.

Gargiulo, J.; Clark, C.; Lyons, N.; Veyrac, G.; Beale, P.; Garcia, S. Spatial and temporal pasture biomass estimation integrating electronic plate meter, planet cubesats and sentinel-2 satellite data. *Remote Sens.* **2020**, 12, 1–16.

Gosch, M.; Parente, L.; Ferreira, N.; Oliveira, A.; FERREIRA, L. Pastagens degradadas, uma herança dos imóveis rurais desapropriados para os assentamentos rurais do Cerrado goiano. *Rev. Campo-Território*. **2020**, 15, 202–229.

Huete, A., Didan, K., Miura, T., Rodriguez, E. Overview of the radiometric and biophysical performance of the MODIS vegetation indices. Remote Sensing of Environment, v. 83, n. 1–2, p. 195–213, **2002**.

IBGE, *Pesquisa Pecuária Municipal*. https://sidra.ibge.gov.br/pesquisa/ppm/quadros/brasil/2019, Aceso em dez-2020, **2021**.

Parente, L.; Mesquita, V.; Miziara, F.; Baumann, L.; Ferreira, L. Assessing the pasturelands and livestock dynamics in Brazil, from 1985 to 2017: A novel approach based on high spatial resolution imagery and Google Earth Engine cloud computing. *Remote Sens. Environ.* **2019**, 232, 111301.

Pereira, L.; Ferreira, C.; Guimarães, R. Manejo, Qualidade E Dinâmica Da Degradação De Pastagens Na Mata Atlântica De Minas Gerais - Brasil. *Nativa*, **2018** 6, 370.

Pereira, O.; Ferreira, L.; Pinto, F.; Baumgarten, L. Assessing Pasture Degradation in the Brazilian Cerrado Based on the Analysis of MODIS NDVI Time-Series. *Remote Sens.* **2018**, 10, 1761.

Vieira-Filho e Fishlow, *Agricultura e Indústria no Brasil Inovação e Competitividade*, Brasília, IPEA **2017**. p305