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Organizadores
Roberto Giolo de Almeida (Coordenador)
Patrícia Perondi Anchão Oliveira
Maurício Saito
Cleber Oliveira Soares
Lucas Galvan
Lucimara Chiari
Fabiana Villa Alves
Davi José Bungenstab

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Av. Rádio Maia, 830, Zona Rural, Campo Grande, MS, 79106-550
Fone: (67) 3368 2000
Fax: (67) 3368 2150
http://www.embrapa.br/gado-de-corte
https://www.embrapa.br/fale-conosco/sac

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Revisão de texto e Editoração Eletrônica: *Rodrigo Carvalho Alva e Adionir Blem*
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Estimation biomass of pasture areas using WorldView-2 data

Ricardo Guimarães ANDRADE[1], Daniel de Castro VICTORIA[2], Sandra Furlan NOGUEIRA[3], Célia Regina GREGO[3], Giovana Maranhão BETTIOL[4], Patricia Perondi Anchão de OLIVEIRA[4]*

[1]Embrapa Gado de Leite, [2]Embrapa Informática Agropecuária, [3]Embrapa Monitoramento por Satélite, [4]Embrapa Pecuária Sudeste
sandra.nogueira@embrapa.br*

Introduction

The sustainable use of pastures is of fundamental importance, given that a considerable part of the Brazilian pastures may be in process of degradation or degraded (Andrade et al., 2016). In general, the use of pastures is characterized by extractivism, with few producers who invest in the recovery of the productive potential of pastures and adopting less impactful technologies to the environment. Thus, the intensification of pastoral production systems can be adopted as a viable option to minimize the pressure on opening new areas of agricultural production and reduce the emission of gases causing the greenhouse effect (Barcellos et al., 2008). However, identify areas of pasture that have low production potential can be one of the challenges for large--scale implementation of efficient government policies with the adoption of strategic mitigation measures. In this context, remote sensing data can assist with relevant information for decision making in various scales of time and space. Given the above, aimed to apply data from WorldView-2 sensor and meteorological data to estimate the biomass of pasture areas.

Material and Methods

This study was conducted in the experimental area of GeoPecus project located in the farm of Embrapa Southeast Livestock, São Carlos, Brazil. Therefore, daily meteorological data collected in the weather station of the National Institute of Meteorology (INMET) and World-View-2 image (2013/08/25) were used. Initially, steps radiometric calibration and estimation the surface reflectance with the correction of atmospheric effects by MODTRAN algorithm were carried. Then we calculated the Normalized Difference Vegetation Index (NDVI) (Rouse et al., 1973) and applied the simple linear regression model proposed by Kamble et al. (2013) for estimating crop coefficient (Kc):

$$Kc_{NDVI} = 1.457 \times NDVI - 0{,}1725$$

(3)

To estimate the crop evapotranspiration (ET_c, millimeters per day) used the equation:

$$ET_C = Kc_{NDVI} \times ET_o$$

(4)

Where, ET_o is the reference evapotranspiration (millimeters per day), estimated by the Penman-Monteith method, detailed in the bulletin of FAO Nº 56 (Allen et al., 1998).

The vegetation biomass was estimated by the equation:

$$BIO = \sum \left(\varepsilon_{max} \times E_f \times APAR \times 0.864 \right)$$

(5)

Where, BIO is the accumulation of biomass of vegetation (kg ha^{-1}), ε_{max} is the maximum efficiency of the use of radiation, was considered the value of 2.5 g MJ^{-1} (Bastiaanssen e Ali, 2003), E_f is the ratio of the latent heat flux (λE, em W m^{-2}) and net radiation (W m^{-2}) (Teixeira et al., 2012). In this case, λE variable was estimated by the evapotranspiration of culture (ET_c), transforming millimeters per day in watts per square meter. Net radiation was calculated using the daily data collected from the weather station. APAR parameter is the absorbed photosynthetically active radiation (W m^{-2}), estimated by the equation (Teixeira et al., 2009):

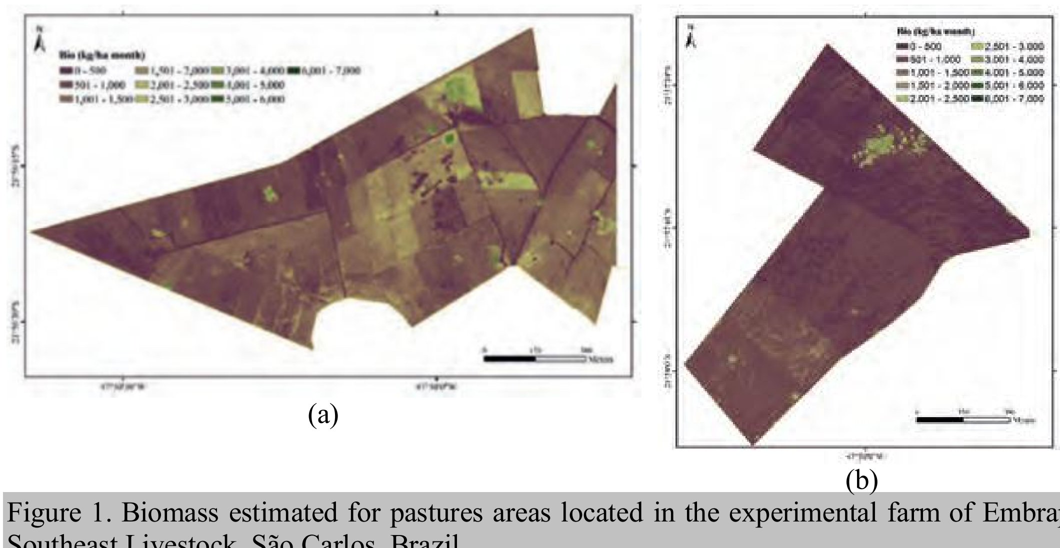
$$APAR = \left(-0.161 + 1.257 \times NDVI \right) \times 0{,}44 \times R_G$$

(6)

Where, RG is the global solar radiation (W m^{-2}) and 0.44 is the scalar used in the estimation of photosynthetically active radiation (PAR).

Results and Conclusions

We observed that the biomass above soil ranged from 0 to 7000 kg/ha month (Figures 1a and 1b). Biomass values estimated between 500 and 2000 kg/ha month were predominant. However, in some cases, values greater than 4000 kg/ha month (green tones) were mainly observed in representative areas of tree canopy. Biomass values predominantly lower than 1100 kg/ha month (August and September) and greater than 1500 kg/ha month (June and July) were estimated by Andrade et al. (2015) in pastures areas in the municipality of Aquidauana, Mato Grosso do Sul, Brazil. Mean values 2200 kg/ha of total biomass were observed by Zanchi et al. (2009) in pastures of Rondônia State. In this case, the pastures had well-defined seasonal cycle with influence of climatic variations and water availability in the soil. The authors also report that the intensity of grazing can reduce or enhance the growth of forage.



(a) (b)

Figure 1. Biomass estimated for pastures areas located in the experimental farm of Embrapa Southeast Livestock, São Carlos, Brazil.

By analyzing estimates biomass of pastures with indicative of degradation, Andrade et al. (2014) observed that the classes not degraded and low degradation showed values very close, around 1550 kg/ha month. As for the moderate and strong degradation classes were estimated mean values of 1400 and 965 kg/ha month, respectively.

Although estimates of aboveground biomass be supported in the literature, further research is needed to better methodological adjustment. Preliminarily, it can be concluded that the technique has great potential for application in biomass quantification studies of pastures.

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