LAND QUALITY AND LANDSCAPE PROCESSES

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Abstract
This monograph contains a selection of scientific papers presented on the conference on Land Quality and Landscape Processes, hold in Keszthely, Hungary. It covers topics related to various aspects of land quality including: concepts of assessment; evaluation of biomass productivity; bioindicators of land quality; quality assessment of degraded land; land use related data processing.

Estimation of phytomass stock through satellite imagery in a semiarid area in Pernambuco state, Brazil

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Introduction

The vegetation of the semiarid area of Northeast Brazil, which covers about one million km^2, has been extensively substituted by agricultural fields and has been used as native pasture and for fuel wood production (Sampaio, 2010). Lately, agricultural area has been decreasing due to its low productivity and fuel wood production increasing in the abandoned fields. As a consequence, the native vegetation, caatinga, is a mosaic of semi-arid forests in different regeneration phases. In Pernambuco state, besides domestic and small industry fuel wood consumers (bakeries, ceramics, etc) there is intensive consumption by the gypsum industry pole, located in the western part of the state. This consumption has depleted most of the caatinga in its vicinity and wood extraction is moving east. To guaranty a sustainable use ,a planned program is necessary and it is essential to estimate the available biomass stocks over the large semiarid area of the state. Determining these stocks is also an obligation of the Brazilian government in relation to global CO_2 balance and climate change evaluations. To develop a methodology that can provide this information, we estimated biomass in different plots and related this biomass to different vegetation indices obtained from satellite images. These indices are periodically calculated for the whole region and, if they could be used to estimate biomass, programs to monitor caatinga stocks could be established. The objective of our study was to developed equations to estimate vegetation biomass based on satellite data and to apply these equations to the vegetation in a 35000 km^2 pilot area in the semiarid region of Pernambuco state.

Material and methods

The study area extends over 68 municipalities (7.55 to 9.08 ^{o}S and 38.43 to 36.36 ^{o}W) in Pernambuco state and it was covered by two

Resourcesat 1/LISS III satellite images. The native vegetation cover was delimited by photointerpretation of digital images obtained during the rainy period, separating two caatinga types (dense and sparse) at a 1:100,000 scale. The digital data were processed using Erdas Imagine®, version 9.1, and ArcGIS Desktop®, version 10. The pixel digital number was converted to radiance and then normalized to the top atmospheric reflectance. First order atmospheric effect (path radiation) was removed using the dark pixel technique. Normalized Difference Vegetation Index (NDVI), Soil Adjusted Vegetation Index (SAVI) and Sample Ratio (RS) were regressed against biomass values of eighty 20 x 20 m plots. Biomass of each tree and shrub in the plot was estimated using allometric equations (Sampaio and Silva, 2005). The best fitting equation was chosen based on the least and average square of residuals, p value and Akaike information criteria. The best equation was used to estimate biomass of the native vegetation in the 35,000 km^2 area.

Results and discussion

Biomass in the plots varied from 4.4 to 75.5 Mg ha^{-1}, with an average of 33.2 Mg ha^{-1}. Separating those classified as dense and as sparce caatingas, the averages were 38.6 and 17.0 Mg ha^{-1}, respectively. Stem basal areas were also about double in the dense caatingas (10.2 and 4.0 m^2ha^{-1}) but plant densities were less different (1953 and 1350 plants ha^{-1}).

Using data of all plots, biomass was significantly related to NDVI and RS but not to SAVI. When the data were separated according the caatinga classification, only those of dense caatinga were significantly related to the indices. The lack of significance for the sparse caatinga was influenced by the lower number of plots (20) under this category. The best fitting equation related biomass of all plots with NDVI (Biomass, Mg ha^{-1}= 5,805 + 48.7763 NDVI). Although significant (p = 0.00003), the proportion of variation explained by NDVI was relatively low (R^2 = 0.36)

and this low adjustment was explained by large variations in the two extremes of the biomass range (below 22 and above 50 Mg ha^{-1}). In the intermediate range, the error in the estimates of biomass was only 17%. Since this intermediate range corresponds to most of the vegetation in the analyzed area (slightly above 80%) we proceeded to estimate the biomass in the whole area using this equation.

The area covered with native shrub and tree vegetation was 22,927 km^2, corresponding to 64.5% of the study area, and was mostly concentrated in the western portion. This portion receives less and more erratic rainfall than the eastern portion, a fact recognized by their classification as different phsyiographic regions (locally called as "Sertão" and "Agreste"). Therefore, the western portion has less crop and cultivated pasture fields, which are the main land uses of the areas not covered with native vegetation.

The areas with highest phytomasses were located in the highest and more inaccessible places and probably represent vegetation regenerating for longer periods. A large part, notably in the southwestern corner of the studied area, has low phytomass and may correspond to areas where agricultural uses were discontinued in recent periods (less than 10 years). The whole native vegetation stock was estimated at 64.7 million Mg, corresponding to an average of 28.2 Mg ha^{-1}. This average is lower than previously estimations for Northeastern caatinga areas (about 40 Mg ha^{-1}; Sampaio and Costa, 2011) but the vegetated area is larger, indicating that the average is reduced by the incorporation of the recently abandoned fields. The increase in native vegetation represents a good opportunity to plan its adequate use.

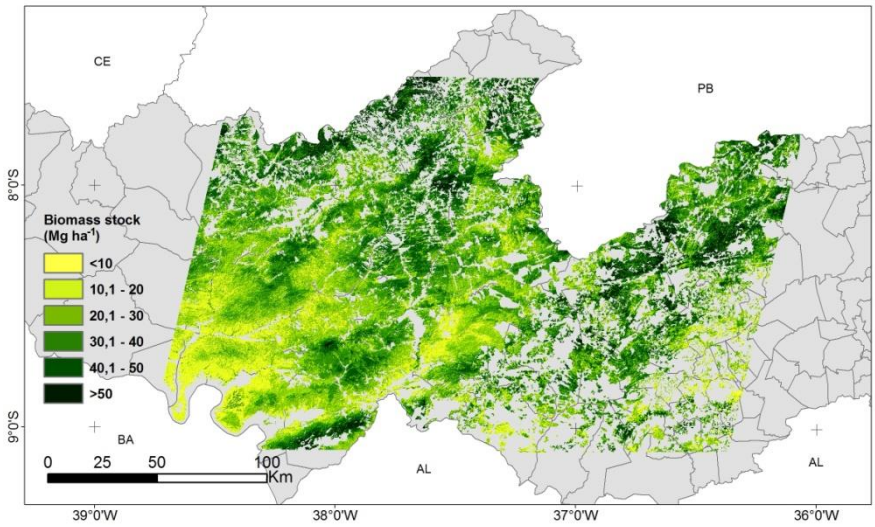

Figure 1.Estimated phytomass stocks of the native vegetation (caatinga) in the central area of Pernambuco state, Brazil

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