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Nonlinear mixed model applied to the analysis of longitudinal data in a soil located in Paragominas, PA

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Introduction

The areas conversion with the cutting and burning of natural vegetation, followed by soil cultivation, resulting in changes in the organic matter dynamics of soil (OMS) (SIX et al., 2002). The emission of large amounts of greenhouse gases has as main factor the fire in the Brazilian Amazon, this arises from different processes such as burning of forests in areas that are being cleared for agriculture and livestock, grazing, forests fire, among others. With the fire, we have the release of gases such as carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O) (FEARNSIDE, 2002), and these can influence the average temperature rise and hence to global climate change.

Thus, more and more there is interest in evaluating and to model the content of chemical components such as Nitrogen (N) in the ground, since if they are stored, are not contributing to the greenhouse effect phenomena.

The approach of non-linear models are becoming increasingly common as, for example, in studies by Oliveira et al. (2000) which compares models to describe the growth of female Guzerat, Paz et al. (2004) setting models to study the association between genetic polymorphisms and growth in cattle and Zeviani et al. (2012) using non-linear models to describe the release of nutrients in the soil, among others.

In this context, statistical approaches with non-linear mixed models becomes increasingly important to evaluate and explain the nature phenomena. Thus, this paper proposes to use this modeling and soil data to explain the dynamics of the stock of carbon and nitrogen over space in areas that have changed management over time.

Material and Methods

The research was conducted at Vitória farm, in the municipality of Paragominas in the southeast of Pará state, bounded by geographical coordinates 2º59'58,37 "SW 47º21 '21.29"

W. We studied three different use and land cover patterns: i: pastoral system; ii: agrosilvopastoral system and iii: secondary forest. Soil sampling was done in 2013, on occasion opened a trench in each study area, where the samples were collected on three walls between the layers 0-10, 10-20, 20-30, 30-40, 40-60, 60-80, 80-100, 100-130 and 130-150 cm.

For the evaluation of the nitrogen content (g kg-1), soil samples (TFSA) were sieved through a 0.25mm mesh, macerated and inserted into tin capsules. Subsequently, the samples were analyzed by mass spectrometry in continuous flow on a Carlo Erba CHN 1110 elemental analyzer. These data were used to test non-linear mixed model to describe the average behavior of the nitrogen concentration responses (N) in different production systems, and the area with secondary forest. It was considered as a repeated measure in space (depth) and heterogeneity of variances in this space. In general, the content of N element in the i-th sample (individual), the j-th depth of the u-th system can be represented by $y_{iju} = \beta_{0u} x_{ij}^{-\beta_{1u}} + \varepsilon_{iju}$, where x_{ij} is the i-th sample (i = 1, ..., N), in jth depth (j = 1, ..., n_i). In terms of mixed models, one has to $y_{iju} = \beta_{0u} x_{ij}^{-(\beta_{1u} + b_{1i})} + \varepsilon_{iju}$, where β_{0u} is the average value of the content of study in the system, β_{1u} is the accumulation rate this content, b_{1i} is the random effect associated with β_{1u}, independent and identically distributed as $N(0, \sigma^2_b)$ and σ_{iju} is the random error associated with y_{iju}, independent and identically distributed as $N(0, \sigma^2_\varepsilon)$, and independent of b_{1i}. Thus, the random effect enters as non-linearly in the model.

Results and Conclusions

There was high variability in the upper layers of nitrogen content in the soil. We tested several models, from the likelihood ratio test by modifying structures of intra- individual covariates matrix. After modifications, it could be verified that the model with power function of variances was the best one that suited to the data.

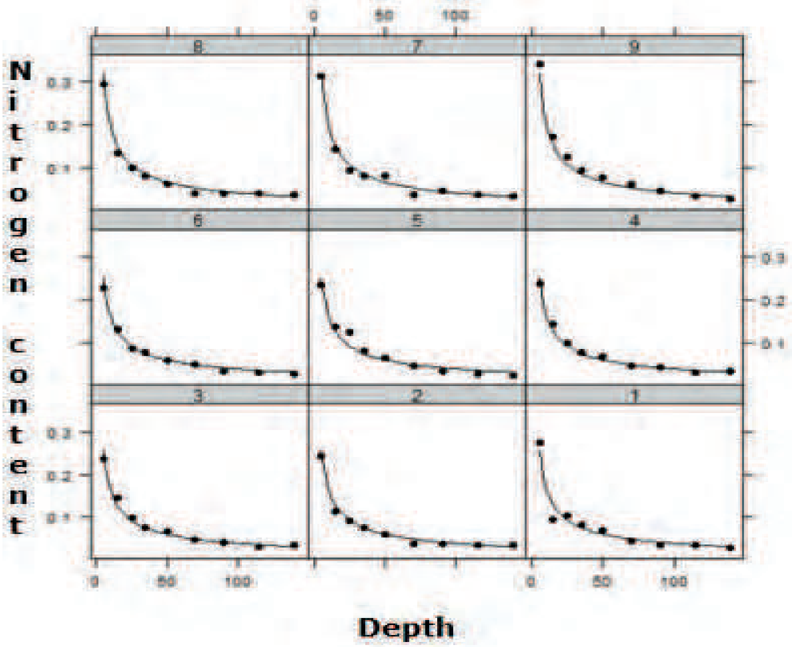

Figure 1: Observed values and fitted model to the nitrogen content of data per depth and sample

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