

A Segmentation Approach to Delineate within-Field Zones for Differential Potash Interventions

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Introduction:

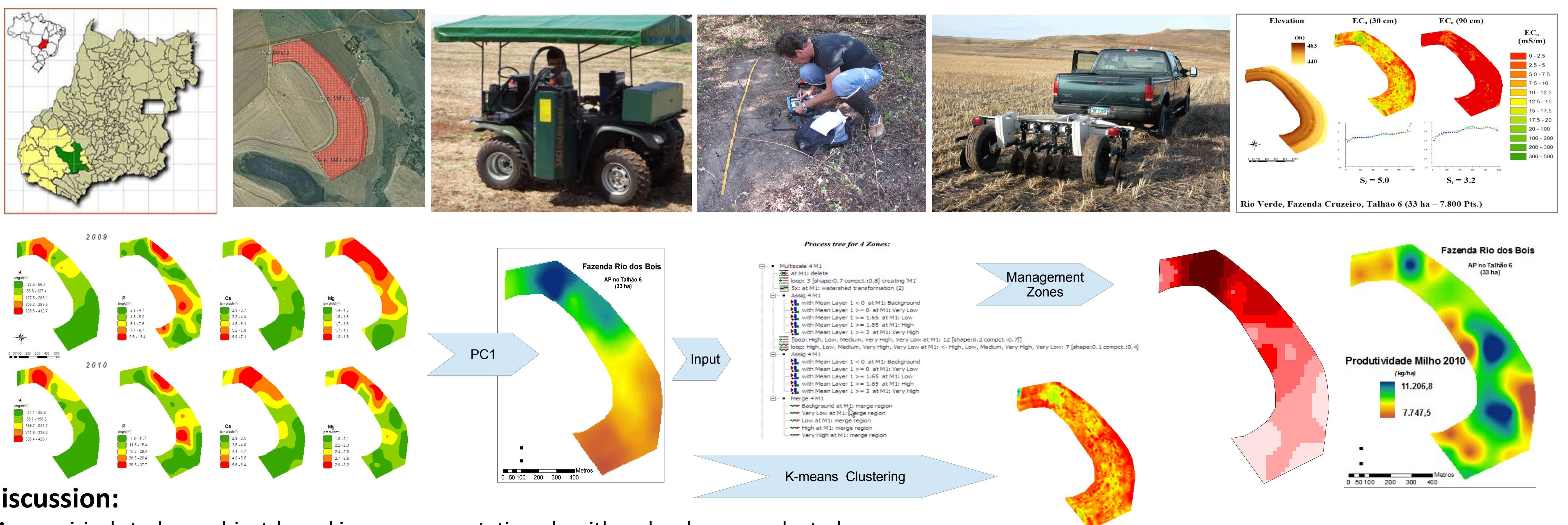
- Data integration from proximal soil sensor platforms using multivariate analysis is expected to support the adoption of Precision Farming (PF) technologies.
- Soil intensive monitoring data is used as input for delineation of within-field management zones that may better explaining crop yield variations.
- The overall research is to evaluate potential techniques supporting decisions on the adoption of PF for no-till crop systems in the Brazilian Cerrado Region.
- This on going work evaluates an object-based segmentation approach as one step of analysis in a decision support process for the opportunity of PF adoption.
- Multiple soil attribute and yield maps are considered for principal component analysis, as better characterizing more stable spatial variations on soil nutrient requirements.
- A sequence of segmentation algorithms were combined empirically to foresee basic factors for an opportunity of adoption index, which is composed on two factors. One evaluating the magnitude of crop yield variation within delineated management zones, and the second calculating the minimum area for operational interventions as a function of machinery dimensions (i.e.: platform size, operational speed and rate variation delay).
- A simple economic evaluation is conducted to compare delineation methods aiming at variable-rate nitrogen applications costs.
- Results show that a procedure combining multi-resolution, watershed and region growing segmentation algorithms has systematically resulted in greater net worth.
- It is suggested that segmentation methods have potential application for zone management delineations supporting contiguous patterns, as better characterizing more stable spatial variations on soil nutrient requirements.

Methodology:

An object-based image segmentation methods combining multi-resolution segmentation, watershed transformation and region growing algorithms is evaluated as previously suggested in PF literature (Roudier et al., 2008; Oliveira & Whelan; 2013). The soil attribute data was gathered using different proximal soil sensors (i.e.: Soil Apparent Electrical Resistivity, Gamma Radiation and Electronic Penetrograph) in addition to soil core samples. Geostatistical analysis were conducted to generated all maps over a common high density output grid. Multivariate analysis algorithms were addressed to obtain a final Principal Component map that could explain 82% of the overall spatial soil attribute variation in its first component (PC1). The PC1 map was used as input of an empirical process evaluating different segmentation algorithms and some of their combined. To evaluate the resulting delineation of management zones a simple economic evaluation was conducted to segmentation outputs, aiming costs of variable-rate potash applications. The use of the multi-resolution segmentation was taken as the first step in the composite process for image information extraction, which would avoid over-segmentation issues as previously reported when using the standard watershed transformation algorithm to zone management partitioning. Unsupervised multi-resolution object segmentation was executed with process parameters that could generate small size objects preserving general patterns on the input. This process provides different scale parameters and segment homogeneity criterion (i.e. shape and compactness). The idea in this process was to generate primitive objects as related to the agronomic process involved, approximately 100 m².

Results:

- Results indicated that a pipeline process of multi-resolution, watershed and region growing algorithms has systematically resulted in greater net return for differential zone management (not shown) when compared with classic K-means method applied only on the quantitative data.
- Analysis considering the first principal component of the overall soil attribute variations as input was likely to characterize greater net advantages for single intervention for variable-rate potash application.
- The resulting spatial correlation map for Potash variable rate application was of a $r^2 = 0.78$, and the indicated management zones were validated by expertize knowledge on soil fertility management and tacit operational experience.



Discussion:

- An empirical study on object-based image segmentation algorithms has been conducted.
- Outcomes have shown great potential applying image segmentation algorithms for the delineation of management zones.
- It is observed that object-based segmentation have produced more contiguous homogenous zone over classic pixel based K-means clustering classifications.
- A hybrid segmentation process has supported decisions on the opportunity for the adoption of precision agriculture in a semi-automated fashion...
- However, this application has missing quantitative means on segmentation metrics or benchmarks in order to validate the proposed Geobia approach.

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