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MAPEAMENTO DA APTIDÃO À MECANIZAÇÃO AGRÍCOLA NA REGIÃO DO CARIRI

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RESUMO: A mecanização agrícola acelerou os processos agrícolas e o manejo dos recursos, por meio de tecnologias que substituem o trabalho manual por completo ou parcialmente, trazendo uma redução da carga de trabalho nas fazendas. Portanto, o presente trabalho teve como objetivo avaliar e classificar áreas aptas a mecanização agrícola por meio de ferramentas SIG (Sistema de Informações Geográficas) para a elaboração de mapas e com o auxílio da análise multicritério na região Cariri-CE. Para avaliação, empregou-se mapas e dados de declividade, uso e ocupação do solo e classe textural do solo. Outrossim, foram atribuídos pesos aos critérios através do método AHP (*Analytic Hierarchy Process*) e no fim resultou em um mapa de aptidão à mecanização agrícola. Para a região do Cariri-CE, as classes de aptidão "muito alta" e "alta", alcançaram valores de 19,03% e 48,32%, respectivamente. Os resultados demonstram que as ferramentas SIG são viáveis para geração de mapas de aptidão à mecanização.

Palavras-chave: metodologia ahp, geoprocessamento, análise multicritério

MAPPING OF AGRICULTURAL MECHANIZATION SUITABILITY IN THE CARIRI REGION

ABSTRACT: Agricultural mechanization has accelerated agricultural processes and resource management through technologies that partially or entirely replace manual labor, reducing the workload on farms. Therefore, the present study aimed to evaluate and classify areas suitable for agricultural mechanization using geographic information system (GIS) tools for map creation, supported by multicriteria analysis in the Cariri-CE region. For the evaluation, maps and data on slope, land use and land cover, and soil texture class were employed. Furthermore, weights were assigned to the criteria using the AHP (Analytic Hierarchy Process) method, resulting in a map of agricultural mechanization suitability. For the Cariri-CE region, the "very high" and "high" suitability classes accounted for 19.03% and 48.32%, respectively. The results demonstrate that GIS tools are viable for generating mechanization suitability maps.

Keywords: ahp methodology, geoprocessing, multi-criteria analysis

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1 INTRODUCTION

Agricultural mechanization can be interpreted as the replacement of manual labor through the introduction of tools or machines that assist in field management, regardless of the level of technological sophistication in agricultural production (Azogu 2009). According to Amare and Endalew (2016), agricultural mechanization has increased the production of inputs and profitability in the field, combined with better work quality and more efficient use of resources; in addition, there has been a slight increase in labor and a reduction in working time on the farm.

A study conducted by Barros *et al.* (2019) highlighted that the multicriteria analysis methodology is extremely effective in classifying agricultural suitability, in which, through the AHP (analytic hygiienism testing) methodology, the hierarchy process enables the creation of maps and the execution of multicriteria analysis in an environment. SIG. Schettino *et al.* (2019) reported that multicriteria analysis is essential in the decision-making process, making its use as a planning tool possible.

This study aims to map and measure the areas of the Cariri region of Ceará with respect to impediments to agricultural mechanization through the use of multicriteria analysis associated with geoprocessing and the analytic hierarchy process (AHP) methodology. Hierarchy (Process), aiming to contribute to the agronomic planning of the region through the development of a map of suitability for agricultural mechanization.

2. MATERIALS AND METHODS

The study area comprises the Cariri microregion, which is located in the state of Ceará (longitude 39° 27' 8.45" W and latitude 7° 0' 33.45" S), and an area of 452,600 ha. The region's climate, according to the Köppen classification, is type Aw, defined as a savanna climate with an average temperature of 24.8 °C across the municipalities (Lima *et al*., 2017).

For this research, soil maps obtained from the IBGE map portal website at a scale of 1:250,000 were used, allowing for the classification of soils present in the Cariri region and the distinction of each one. A Copernicus *DEM digital elevation model* with 30 m spatial resolution was used, which was obtained through the *OpenTopography plugin* and using the geoprocessing tools presented in QGIS 3.34.3 software.

The land use and land cover map was obtained from the MapBiomas Brazil website, where a model for the Cariri region from the year 2023 was acquired. With these data, it was possible to evaluate the occupation zones in the Cariri-CE region in terms of its main land use classes.

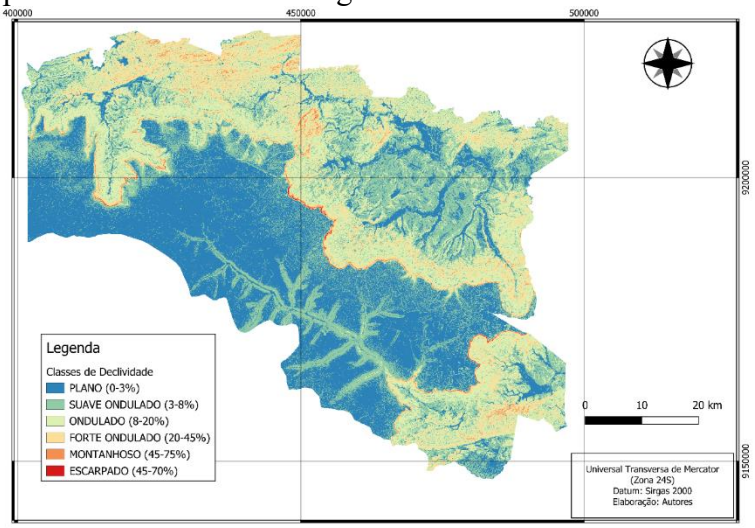
To study the suitability for agricultural mechanization, a multicriteria analysis was performed with the AHP (*analytic hygienist) methodology. Hierarchy The process* allows for the weighting of the criteria used (slope, textural class, and land use and occupation) through the calculation of the consistency ratio (CR), which varies from 0 to 1 (Bazzan; Reckziegel, 2024). The maps for each criterion were created using QGIS 3.34.3 software, which is associated with the GRASS GIS 8.3.1 plugin.

Through the elaboration of the paired comparison matrix, it was possible to obtain the maximum value λ obtained in Equation 1. The consistency index (CI) and the consistency ratio (CR) were subsequently calculated by dividing the consistency index (CI) by the constant of the randomness index (RI), according to the methods of Barros *et al.* (2019).

3. RESULTS AND DISCUSSION

The slope map (Figure 1) allowed the identification and classification of 6 classes (0–3%, 3–8%, 8–20%, 20–45%, 45–75%, >75%) established by Embrapa (2018). The map shows areas that possibly present difficulties for agricultural mechanization where the slope is above 20% according to the research of Höfig and Araujo-Junior (2015).

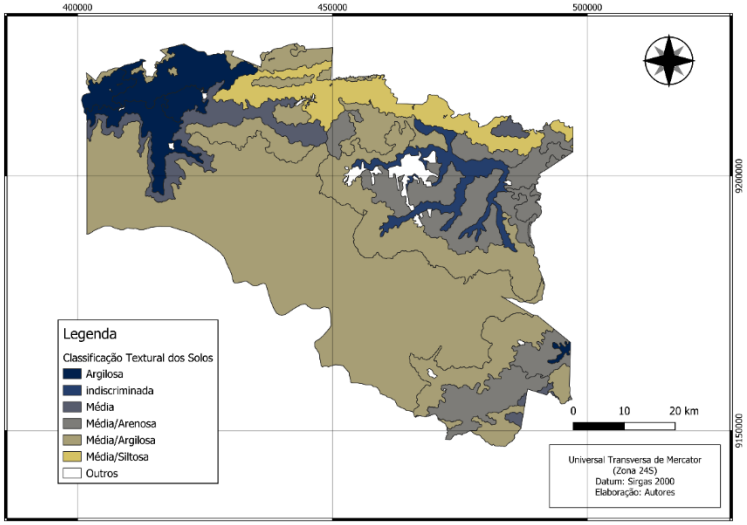
Figure 1. Map of slope classes in the Cariri Region



Source: Authors (2024)

The soil map (Figure 2) shows the textural classes of the study area (Clayey, Medium, Medium/Sandy, Medium/Clayey, Medium/Silty, Undifferentiated, and others). The "undifferentiated" class represents areas with a heterogeneous mixture of particles or anthropogenic interference in the natural soil profile, whereas the "other" class corresponds to urbanized areas and water bodies.

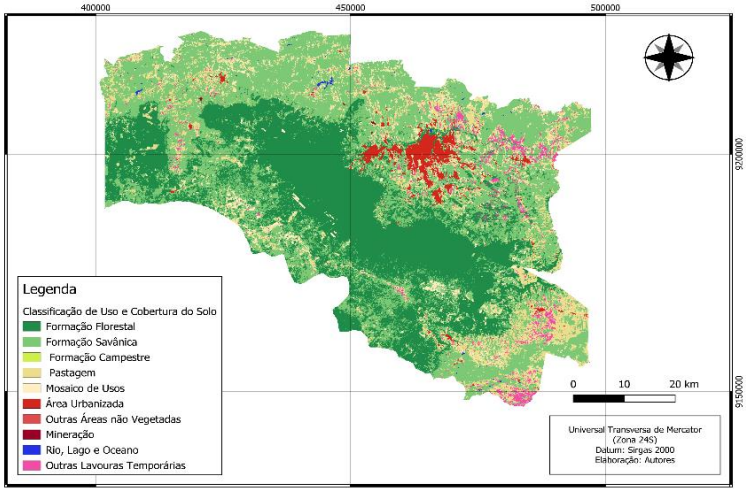
Figure 2. Textural Classification Map of Soils in the Cariri Region



Source: Authors (2024)

The land use and land cover map of the Cariri region (Figure 3) presented 10 classes, which were determined and classified according to the Embrapa standard (2018).

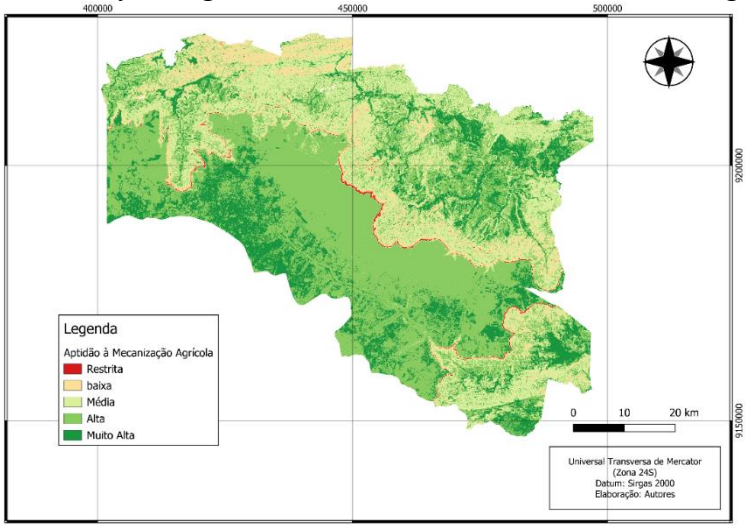
Figure 3. Land Use and Occupation Map of the Cariri Region



Source: Authors (2024)

The suitability classes for agricultural mechanization were divided into 5 categories (restricted, low, medium, high, and very high). Table 1 shows the areas suitable for agricultural mechanization on the basis of their respective land areas.

Figure 4. Map of the suitability for agricultural mechanization in the Cariri region



Source: Authors (2024)

Table 1. Agricultural Mechanization Readiness Report

Aptitude for Mechanization	Area (ha)	% of Total
Very High	85,953.86	19.03
High	218,212.25	48.32
Average	113,896.12	25.22
Low	31,241.33	6.92
Restricted	2,330.80	0.52
Total	451,634.36	100.00%

Source: Authors (2024)

The analysis revealed that 67.35% of the studied area in Cariri has high or very high suitability for agricultural mechanization, with a predominance of moderate slopes and medium and medium/clayey textured soils suitable for the use of machinery. Areas with slopes above 20% and with human interference presented restrictions, corresponding to only 0.52% of the region. The results highlight the efficiency of GIS tools in agricultural planning, allowing for sustainable decisions aligned with local conditions.

4 CONCLUSIONS

Multicriteria analysis proved efficient in identifying and classifying areas suitable for agricultural mechanization. In Cariri-CE, areas with high suitability predominate, with 19.03% classified as “very high” and 48.32% as “high”, highlighting the potential for mechanized practices.

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