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Mapping Agronomic Suitability of Soils in Forest Savannah Transition Zone in Cameroon: A Case Study from Bokito District of the Central Region †

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Abstract: Food security is a crucial issue in Cameroon. The Ministry of Agriculture and Rural Development, with the help of the University of Yaoundé 1 and the National Institute of Cartography, aims to produce an agronomic aptitude map of the country. The pilot site of Bokito was selected. The formula used is as follows: AA = pH × RU × K × CEC. The objective is to propose a simple, quick and inexpensive method of land evaluation that can boost the transition to second-generation agriculture. The results show that the yellowish ferrallitic soils of Bokito have good agronomic suitability.

Keywords: soils; agriculture; agronomic suitability

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1. Introduction

Cameroon is an agricultural country [1] and food security is a fundamental component of the sustainable development process. Numerous studies have demonstrated the importance of a soil-suitability map for the development of agriculture [2]. The "Office of Scientific and Technical Research Overseas (ORSTOM)" has previously mapped the suitability of soils in certain areas of Cameroon, but these maps are old and do not cover large areas. Cameroon aims to transition to second-generation agriculture, which requires an accurate estimate of the spatial variability in soil components. The Ministry of Agriculture and Rural Development, with the help of the University of Yaoundé 1 and the National Institute of Cartography, aims to produce a map of agronomic suitability. Its implementation requires a reliable and low-cost approach. The objective of this study is, therefore, to present and discuss a means of calculating the agronomic suitability of tropical soils, which are simple, relevant and light, and can easily be implemented in a larger territory. It aims to quantify the relationships between soil variables to map agronomic suitability using a geographic information system [3].

2. Materials and Methods

The study area was located in the Bokito district, Center region of Cameroon, with latitudes between 4°20′ and 4°40′ N and longitudes between 11°00′ and 11°20′ E (Figure 1).

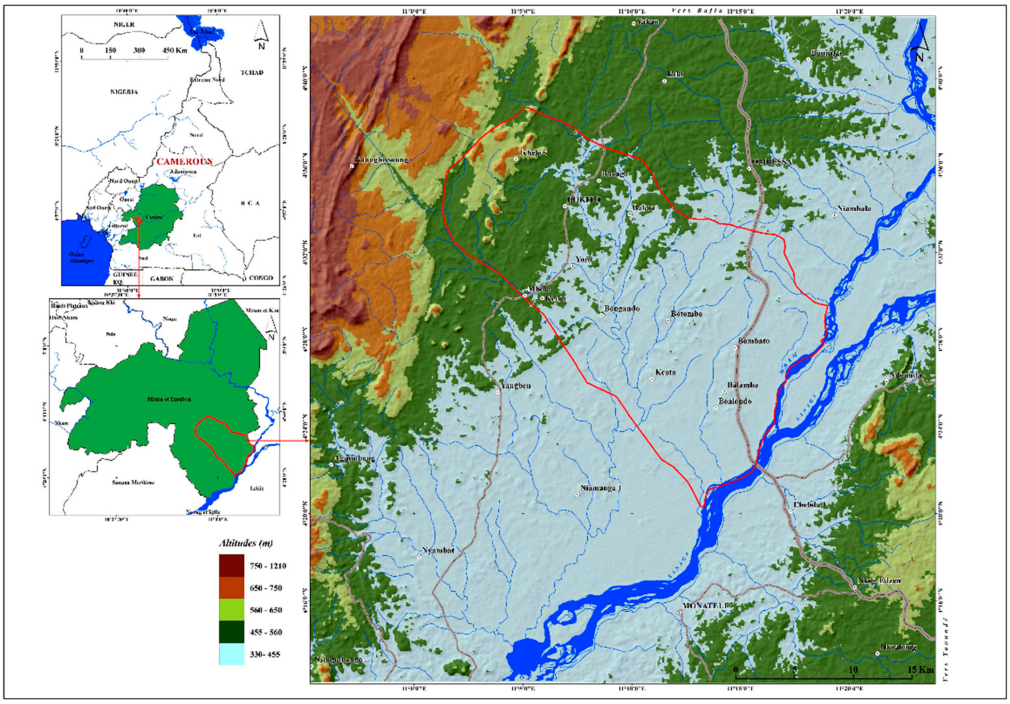

Figure 1. Location of the study area.

To map agronomic suitability, soil samples were collected from a pit ranging from 1.50 to 2.0 m deep, and laboratory analysis was carried out. The particle size and pH were determined in the soil laboratory of the Department of Soil Sciences of the University of Yaoundé 1. Organic carbon (OC) and total nitrogen content were carried out in the soil laboratory of the International Institute of Tropical Agriculture (IITA) in Yaoundé. The agronomic suitability map of the soils was produced using the following formula: AA = pH $\times$ RU $\times$ K $\times$ CEC where, AA: agronomic suitability; pH: hydrogen potential; RU: useful water reserve; K: erodibility factor; CEC: cation exchange capacity. Soil pH was spatialized using kriging. Useful soil water reserve (RU) was computed using the equation in Remy [4]: RU = H $\times$ TE $\times$ (1 $-$ (EG/100)), where RU: useful reserve water express in millimeters; H: thickness expressed in centimeters; TE: textural index determined from the texture class; EG: coarse elements expressed as a percentage. The soil thickness (H) was measured along the profile using a tape. The texture classes were determined with the USDA texture diagram. The texture index (TE) was classified using the methodology proposed by Jamagne [5]. The quantity of coarse elements was determined using the methodology proposed by Bouma and Van Lanen [6].

Soil erodibility factor (K) was calculated according to the formula provided by Wischmeier and Smith [7]: $1000\ K = 2.8 \times 10^{-4}\ (12\text{-}\%MO) \times M^{1.4} + 3.25\ (S\text{-}2) + 2.5\ (P\text{-}3)$ where, MO: organic matter in percentage; M = (% sands + % silt) $\times$ (100 $-$ % clay); S: code on the soil structure; P: infiltration capacity. Soil structure (S) was determined using the texture diagram [6]. The obtained texture classes were then transferred to the correspondence table of [7] to obtain the numerical value of the structure code S (Table 1).

Table 1. Meaning of codes on soil structure.

Code	Soil Structure (S)
1	Very fine
2	Fine
3	Medium
4	Very coarse

Soil permeability (P) was determined using the USDA diagram (Figure 2) and the correspondence was established in the table below [8] (Table 2).

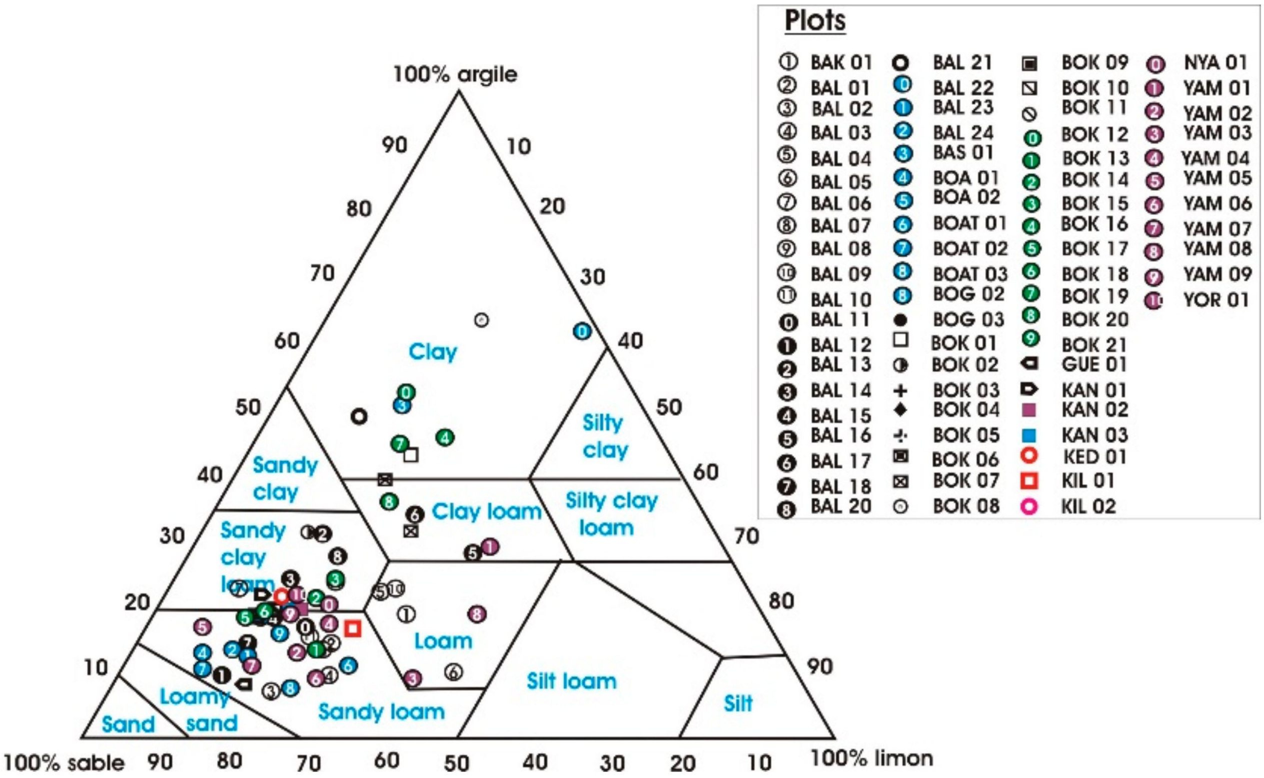

Figure 2. USDA textural diagram.

Table 2. Meaning of permeability (P) codes.

Code	Textural Class	Permeability (p)
1	Clay < 18% and Sand > 65	Fast
2	18% < Clay < 35% and Sand > 15% or 15% < Sand < 65% and Clay < 18%	Medium to fast
3	Clay < 35% and Sand < 15%	Average
4	35% < Clay < 60%	Slow to average
5	Clay > 60%	Slow

The CEC factor was calculated in the laboratory.

3. Results

Results showed that the Bokito soils range from sandy loam to sandy clay loam (Figure 2), which is dominated by coarse material (Figure 3). The yellow ferrallitic soils are moderately acidic (Figure 4A) with a good useful water reserve (Figure 4B). The CEC is maximum (Figure 4C) and the erodibility rate is high (Figure 4D). These soils have a very good agronomic suitability (Figure 4E).

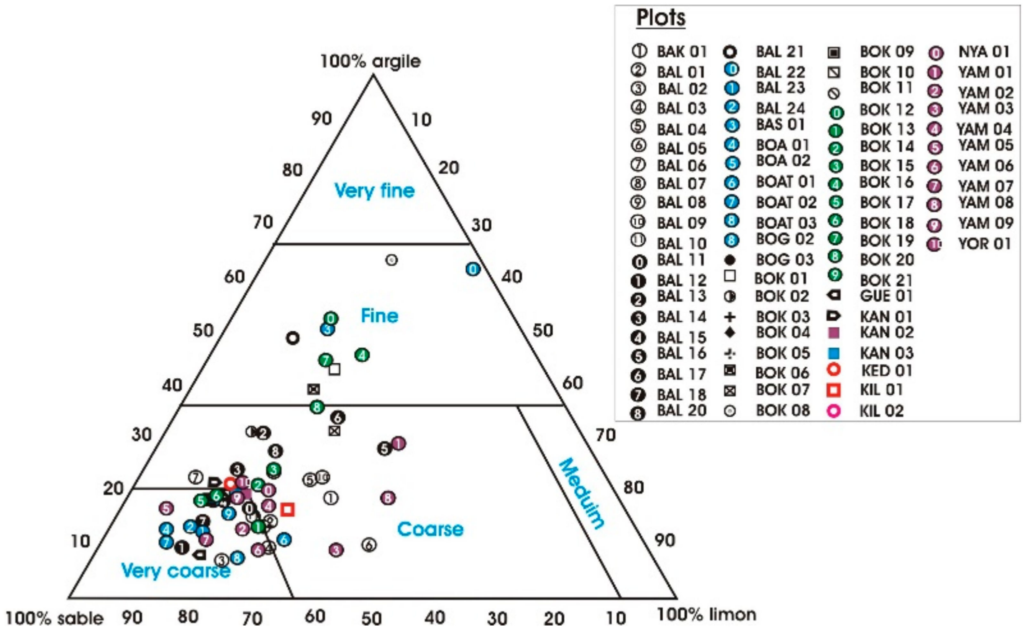

Figure 3. Textural diagram of Jamagne.

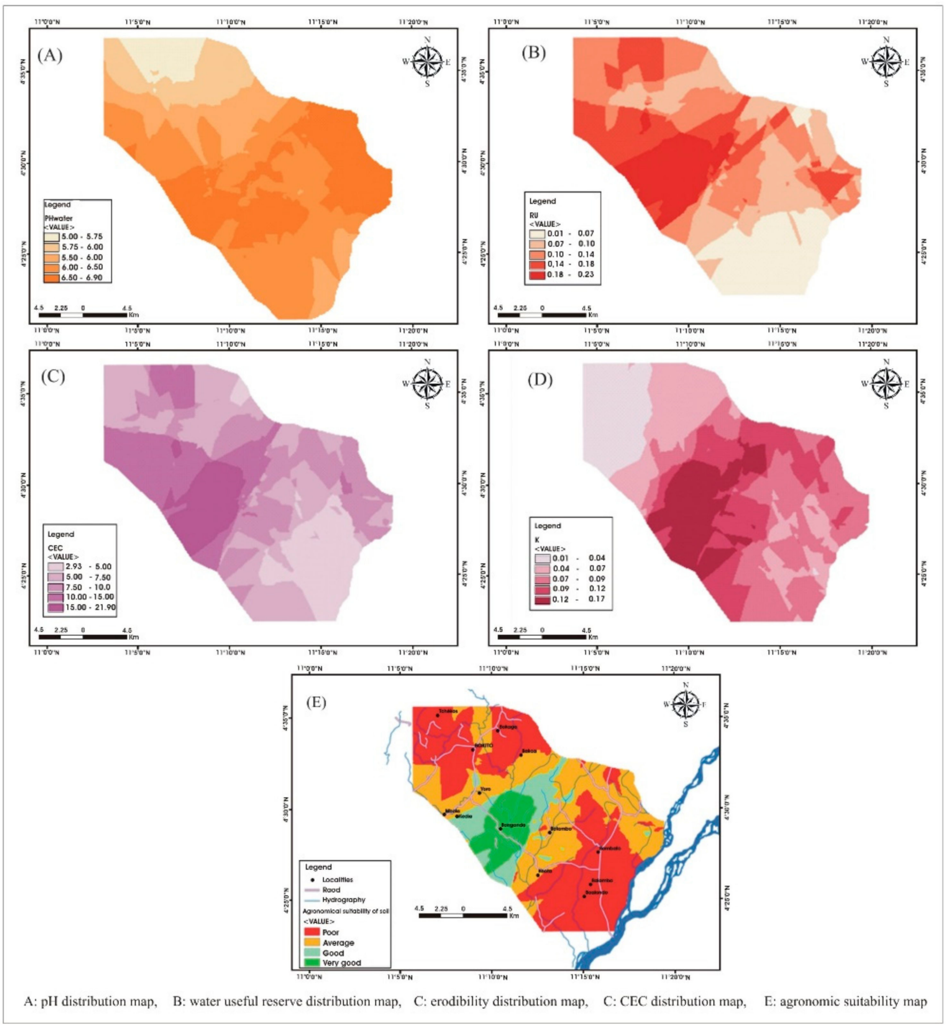

Figure 4. Agricultural suitability map.

4. Discussion

The yellow ferrallitic soils of Bokito have a very good agronomic aptitude. Their pH varies between 6 and 6.22. These thresholds are favorable for fertilizing elements and soil microorganisms' activity [9,10]. At a depth of 30 cm, the useful water reserve is at its maximum (0.229 mm) due to their high silt content [11,12]. The CEC reaches 6.65 meq/100 g soil. The very high erodibility in these soils is characteristic of humid tropical environments [13]. A field trip allowed for us to verify the obtained results. Indeed, agricultural yields are high in the yellow ferrallitic soils of Boganda village. This could support the choice of input parameters for the model.

5. Conclusions

Cameroon has agronomically suitable land that needs to be located and characterized. Their development could contribute to food security and environmental preservation. The proposed methodological approach allows for large-area mapping over a short period of time and could accelerate Cameroon's transition to second-generation agriculture.

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