A general assessment of soil resources and soil fertility constraints in Cameroon on the basis of FAO-UNESCO soil map analysis.

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Summary

Based on the FAO-UNESCO soil map of Africa, the extent of the various soil types occuring in Cameroon, as well as the importance of major soil fertility constraints in this country, are evaluated with regards to the 4 agroecological regions which are first identified.

Résumé

En se basant sur la carte FAO-UNESCO des sols Africains, l'étendue des différents types de sols présents au Cameroun ainsi que l'importance des principaux facteurs liés à la faible fertilité des sols sont évaluées, suivant les 4 régions agroécologiques qui sont au préalable identifiées.

Introduction

Due to the need to feed a fast growing population, land is, in the tropics, a very crucial factor of production. In terms of extent, land is not a constraint per se in this part of the world. The per capita agricultural output is however very low in the tropics. This is due to various constraints among which soil related ones need to be emphasised, and are the focus of this paper.

Carried out in the specific case of Cameroon, the present study intended to assess the soil resources of this country, and to diagnose and estimate the extent of major soil related constraints to food production. Because of the notorious heterogeneity of the Cameroon environment, it was important to make all appraisals with reference to the various agroecological regions that we first attempted to identify.

Main agroecological regions in Cameroon

Four principal agroecological regions were identified. Their approximate delimitations are indicated in Fig. 1. These regions are:

Northern region (or Northern Savannah)

It is made up of low altitude plains, many of which are flooded during the rainy season, which lasts for less than 6 months. The mean annual temperature is 28°C. The vegetation consists of sahelo-sudanian savannah and flooded prairie. Animal production (mainly cattle) is the most important agricultural activity. Major food crops are millets, maize and peanut.

Adamaoua region (or Adamaoua Plateau)

It consists of a high plateau (average altitude is 1100m). The dry season lasts for 4 to 6 months, and the mean annual temperature is 23°C. The vegetation consists of sudano-guinean savannah. Main food crops are millets and maize. Cattle production is less important than in the previous region.

Southern region (or Souther Forest)

This region is made up of a vast low altitude plain (mean alti-

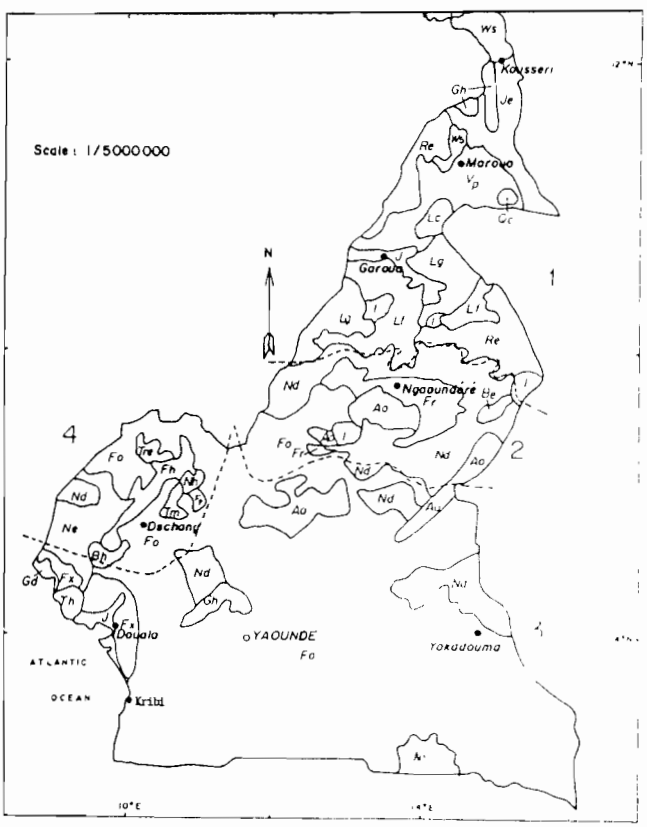

Figure 1 — Soil map of Cameroon (Source: FAO-UNESCO, 1977) and delimitations of the 4 main agroecological regions.

Legend for Fig. 1

----- Limits of agroecological regions

1	Northern region	Nd	Dystric Nitosols	J	Fluvisols
2	Adamaoua region	Ne	Eutric Nitosols	Je	Eutric Fluvisols
3	Southern region	Nh	Humic Nitosols	I	Lithosols
4	Western region	Lf	Ferric Luvisols	Ws	Solodic Planosols
		Lc	Chromic Luvisols	Tm	Mollic Andosols
Fo	Orthic Ferralsols	Ao	Orthic Acrisols	Th	Humic Andosols
Fx	Xanthic Ferralsols	Vp	Pellic Vertisols	Be	Eutric Cambisols
Fh	Humic Ferralsols	Re	Eutric Regosols	Bh	Humic Cambisols
Fp	Plinthic Ferralsols	Gh	Humic Gleysols	Qc	Chromic Arenosols
Fr	Rhodic Ferralsols	Gd	Dystric Gleysols	Lg	Gleyic Luvisols

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tude is 650 m). It is primarily characterised by a green forest vegetation and by abundant precipitations. There are basically 2 rainy seasons and 2 dry seasons. However it rains almost all year long in many parts of the region. In general, mean annual temperature is 25°C. Slash-and-burn is a very common technique of cultivation. Main food crops are cassava, plantains, peanuts, and yams. There is almost no animal production.

Western region (or Western Highlands)

It features many high plateaus (1000-1800m), very high altitude mountains, and a very high population density (more than 300 inhabitants/km² in many areas. Annual rainfall generally exceeds 2000 mm. The mean annual temperature is 21°C. Continuous cultivation is practiced in this region, with some use of fertilizers. Main food crops are corn, cocoyams, potatoes, peanuts, beans, and yams.

Soil resources of Cameroon

The main reference for this section was the FAO-UNESCO soil map of Africa (2). Due to the small scale of this map (1 : 5 000 000), only the dominant soils were taken into consideration in each mapping unit. Extent of various soil groups occuring in Cameroon is given in Table 1.

TABLE 1

Distribution and extent of major soil groups in Cameroon.

Soil groups	Northern region	Adamaoua region	Southern region	Western region	Overall
	percentage of land				
Ferralsols	—*	27	82	43	55.2
Nitosols	—	49	9	39	15.5
Luvisols	33	5	—	—	6.7
Acrisols	—	15	6	—	5.3
Vertisols	19	—	—	—	3.5
Regosols	18	—	—	—	3.4
Gleysols	5	—	2	9	3.0
Fluvisols	10	—	1	—	2.6
Leptosols	6	3	—	1	1.7
Planosols	7	—	—	—	1.3
Andosols	—	—	1	4	0.8
Cambisols	—	2	0	4	0.6
Arenosols	2	—	—	—	0.4
Total land (× 1000 ha)**	8743	6318	26742	5286	47289

* Percentage less than 1.

** Figures in this row must be multiplied by 1000 in order to obtain correct figures in hectares.

Data in this table indicate that the Southern region is made up mainly of Ferralsols, the Adamaoua region of Nitosols, the Northern region of Luvisols, Vertisols, Regosols, and Fluvisols, and the Western region of a mixture of Ferralsols and Nitosols, most of which contain a large amount of volcanic ash. Andosols, though representing only 4% of the soils in this region, are of a very important agricultural value.

Soil fertility constraints to food production in Cameroon

Fertility constraints were evaluated based on the properties of the dominant soils (3), on soil moisture and temperature regimes as calculated by Van Wambeke (7), and on various soil test results from extension work available in the soil fertility laboratory of the University Center of Dschang. Definition of some constraints and their extent are presented in Tables 2 and 3 respectively.

TABLE 2

Definitions of soil fertility constraints as used in this paper.

Constraints	Definitions	Notes*
Shallow depth	Root restricting layer within top 50 cm. Leptosols.	1
Poor drainage	Aquic soil moisture regime	1
Erosion hazard	very slopy topography, poor structure, abrupt textural change, or both.	2
Drought stress	Ustic soil moisture regime	1
Low water holding capacity	High infiltration rate	2
Vertic properties	sticky, plastic and cracking clays. Vertisols.	1
Low CEC**	ECEC < 4 meq/100 g in top 50 cm	1
Al toxicity	Al saturation > 60% of the ECEC*** in top 50 cm.	1
K deficiency	Exchangeable K < 0.2 meq/100 g in top 50 cm	1
P deficiency	Evidence of high P fixation potential. Widespraid occurence of P level below critical value.	2
Excess Na	Na saturation > 15% of the ECEC. Natric phase	1
Salinity	Electrical conductivity > 4 mmho/cm. Saline phase.	1
Alkalinity	Free $CaCO_3$ within top 50 cm.	1

* 1. From Sanchez et al., 1981
2: Personnal definition.

** CEC = cation exchange capacity.

*** ECEC = effective cation exchange capacity.

TABLE 3

Extent and distribution of major soil fertility constraints in Cameroon.

Constraints	Northern region	Southern region	Western region	Adamaoua region	Overall
	percentage of land				
Low CEC	38	91	30	81	78
K deficiency	9	90	30	77	70
Al toxicity	—	80	30	66	57
P deficiency	—	80	47	26	54
Low water holding capacity	25	62	28	22	46
Drought stress	100	—	—	100	32
Erosion hazard	24	6	37	21	15
Poor drainage	30	6	11	1	11
Alkalinity	25	—	—	—	4
Vertic properties	19	—	—	—	4
Excess Na	9	2	—	—	3
Shallow depth	6	—	1	3	2
Salinity	2	2	—	—	1
Total land (× 1000 ha)	8743	26942	5286	6318	47289

Physical constraints

Drought stress is the most severe problem in the Northern

region, and may explain why this region has specialised in animal production. The Adamaoua region also faces this problem, but to a smaller degree.

Erosion hazard is encountered mainly in the Northern and in the Western regions. Wind erosion is pronounced in the Northern region, especially during the dry season, and is favoured by the lack of a dense vegetation cover. Rain erosion in this region is also important because of the poor structure of the soils, and of the high intensity of the rains. This form of erosion however has its greatest impact in the Western region were many cultivated lands have slope of 30% or more.

Poor drainage problem is extensively found in the Northern region, where Vertisols, Solodic Planosols and Gleysols are predominant. In the Western region, large flood plains such as the Mbos Plain and the Noun Plain also feature this constraint. Although poor drainage is usually considered as a limitation (anaerobic conditions, low reduction potential, denitrification potential, etc...), it may turn out to be beneficial sometimes since it confers good potential for rice and for dry season crop production.

Low water holding capacity is a property associated with most soils of the Southern Forest, due to their high sexquioxides content. These oxides aggregate the soil into sand-like particles and therefore make them very permeable. This is however not an important limitation since in this region it rains almost all year long. Low water holding capacity is particularly a serious problem in the Northern region, because not only many soils in this region are light, but more over rainfall is insufficient and very unevenly distributed over time.

Soils with vertic properties are exclusively encountered in the Northern region. Shallow soils are found mainly in this region, and to a smaller extent in the Adamaoua region. Such soils are not adequate for tree crop cultivation.

Chemical constraints

High leaching potential, K deficiency potential and especially Al toxicity potential are, by far, the most widespraid chemical constraints.

In the Southern and Adamaoua regions, the frequent occurence of these constraints is due to the large extent of highly weathered soils. Despite the extensive occurence of such soils in the Western region, these constraints are alleviated there by a pronounced influence of volcanic ash on most surface soils, and by a high organic matter (OM) content. The frequent occurence of low CEC soils in the Northern region is explained by the low clay and low OM content of many soils (Regosols and Arenosols particularly). Phosphorus deficiency is a widespraid constraint also. Data on soils from the Southern region reveal P levels below critical values (1,4). Phosphorus deficiency may primarily be due to the high P retention capacity of many Cameroonian soils, as a result of high levels of Fe and Al oxides (Forest region) or due to the presence of allophanes (Western region).

Nitrogen, Sulfur and micronutrients deficiencies were not assessed because of limited data. Sulfur deficiency has been reported in some soils of the Western region in pot experiments (5). The occurence of S deficiency may, in the future, be accentuated because of the substitution of ammonium sulfate by urea in this region since 1989. Sulfur deficiency may be encountered in the Southern Forest as a result of the practice of slah-and-burn technique, which leads to S volatilization by fire. Lightly textured soils of the Northern region are also susceptible to S deficiency because of their low OM content. In this region, N deficiency is likely to be very common due to low OM content of soils, poor drainage conditions, and alternating waterlogging and drying conditions.

The 4 agroecological region therefore differ greatly with regards to the occurence of various fertility constraints, or at least with regards to the importance of each of these constraints. In the Northern region, the most crucial limitation is water. Chemical constraints are of a minimum importance here. In the Southern region, physical constraints have a minimum importance. In contrast, Al toxicity, P deficiency and K deficiency are more pronounced in this region than in any other region. The Adamaoua region has intermediate features as compared to the 2 previous regions. The Western region has fewer chemical constraints as compared to the Southern and Adamaoua regions. It is however the region which is the most susceptible to rain erosion.

Conclusion

This paper has revealed the pronounced heterogeneity of Cameroon as regards its soils and its fertility constraints to food production. The difficulties encountered, difficulties resulting from the small scale of the soil map, bring out the crucial need for a systematic inventory of soil resources of this country. There is also a tremendous need for extensive applied research related to nutrient availability, fertilizer trials applied at various agroecological locations, and screening of cultivars tolerant to important soil fertility constraints such as Al toxicity and low P level.

The availability of data from such applied research as well as of large scale soil maps will help improve the accuracy of fertility assessment, and will enable to convey precise informations with regards proper soil management requirements at local levels.

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