SOIL AND LAND USE OF THE KAIBO AREA

AT MEDIUM SCALE

by M.A. Mulders

Wageningen Agricultural University

Soil Science and Geology

August 1996

Aménagement et Gestion de L'Espace Sylvo-Pastoral au Sahel
Antenne Sahélienne de l'Université Agronomique Wageningen
Pays Bas et de l'Université de Ouagadougou Burkina Faso

ISN 27086

CONTENTS

For summary: see paragraph 7.1.

4.1. Landcover and land use identification.

For landcover identification, the interpretation of aerial photographs (Laguna, 1994) was used in conjunction with terrain observations.
The database on terrain observations contain data on % of trees, shrubs, herbs, bare soil and agricultural fields, enabling description of land cover per interpretation unit, where necessary supported by aerial photo-interpretation.
Land use is an interpretation of land cover based on additional field observations and landcover features, such as % of trees and agricultural fields.

4.2. Soils and physiography.

For identification of soil units, the aerial photographs were studied to estimate different land units and components. The land unit identification was based on drainage pattern, the identification of components was based on detailed analysis of site and position in the toposequence e.g. plateau, slope, valley bottom.
Drainage pattern is given on map 2. To define the characteristics of drainage pattern, the decisions were made at different orders (see appendix 2: legend of the physiographic map):

phys. unit nr	type of drainage pattern	nr of order
1	subradial	1st and 2nd
2	strongly angular	1st-2nd
3	asym. angular with mod. density	1st-2nd
4	subparallel	2nd
5	sym. angular	1st-2nd
6	parallel	2nd
7	asym. angular with low density	2nd
8	parallel with angular tendency	2nd and 3rd
9	very low density	1st

The database on soil properties was studied, that is every physiographic unit was described by slope, surface stoniness and - gravel, cracks, gilgai, soil code, - texture and - colour.

4.3. Database structure

The available database was structured as follows:

column nr	subject	column nr	subject
1	nr of observation	19	colour dominant mottling
2	x coordinate	20	colour minor mottling
3	y coordinate	21	auger depth
4	physiographic code	22	% of trees
5	nr physiographic unit	23	% of shrubs
6	soil code	24	% of herbs
7	vegetation code	25	% of agric. fields
8	nr vegation unit	26	% of bare soil
9	texture 0-20 cm	27	% of rock outcrops
10	texture 20-40 cm	28	% of stones at surface
11	texture 40-60 cm	29	% of gravel at surface
12	texture 60-80 cm	30	% of slope
13	texture 80-120 cm	31	direction of slope
14	matrix colour 0-20 cm	32	width of cracks in mm
15	matrix colour 20-40 cm	33	depth of cracks in cm
16	matrix colour 40-60 cm	34	height gilgai relief in cm
17	matrix colour 60-80 cm	35	parent material
18	matrix colour 80-120 cm		

Possible improvements of this data base are suggested in conclusion.

5. LAND COVER MAP AND INTERPRETATION ON LAND USE.

5.1. Land cover.

In DBase, the percentages on coverage by trees, shrubs, herbs, bare soil, rock outcrops, surface stoniness (> 6cm) and gravel (0.2-6 cm) were determined for the vegetation units, discriminated in aerial photo-interpretation by Laguna (1994).

There are various reasons for a low correlation between field data on land cover collected during a soil survey and data on land cover obtained by interpretation of aerial photographs and satellite imagery. These are:
a) field data lack a synoptic view on land cover, since observation lines are primarily directed by physiography; field estimates on land cover are based on variation within 1 ha, while the basic unit at a scale of 1 : 30 000 is 2.25 ha; the results on land cover, therefore have to be interpreted and corrected where necessary;
b) the estimations on land cover in the field have to be tested for errors e.g. the estimation of coverage by herbs and debris can be systematically be too high at the cost of bare soil;
c) the estimation of coverage by shrubs using aerial photographs of scale 1 : 50 000 is

inaccurate in contrast to that of trees;
d) the time of acquisition of Remote Sensing data is very important for the results on Near Infrared reflection and therefore interpretation; field data and aerial photographs have to be used to explain its variation but the field observations are seldomly obtained at the same time as acquisition of Remote sensing data;
e) the scale of TM data is too small to reach classification detail suitable for 1 : 30 000 mapping in the area under consideration.

To get better matching between field data on land cover (acquisition: November 1992-April 1993) and the information derived from aerial photographs scale 1 : 50 000 (acquisition: January 1985), the following corrections were applied:
a) field data on coverage by herbs (+debris) are multiplied by 0.75 and those of bare soil are added by 0.25 x coverage by herbs (+debris);
b) after a sample description of land cover units obtained by Aerial Photo-Interpretation, it was decided to describe more accurately by API the units 3, 6-8, 10 and 12 to get better data on percentage of trees and agricultural fields.

The results of this synthesis between API and field data on land cover are given in Table 3. The results are represented in average (a) and range (r) as determined by average + and - standard deviation within the limits tolerated by minimum and maximum values.
Exept for land cover unit 1, all units have been described in the terrain, only two units with less than 10 observations.

Table 3. Description of land cover units based on field data and aerial photo-interpretation.

unit nr.	freq	ar	trees %	shrubs %	herbs +debr. %	bare soil %	rock out crops %	stone %	gravel %	bare terr. %	agric. fields %
2	9	a	3.9	3.3	57.9	19.0	0.6	8.1	6.6	34.9	12.5
		r	2- 6	1- 6	47-70	12-27	0-3	2-14	2-11		2-23
3	50	a	7.0	5.2	60.2	19.5	2.0	2.0	3.6	27.1	2.0
		r	1-13	1-10	46-74	4-35	0-9	0- 7	0-14		0- 7
4	151	a	4.7	4.5	55.9	20.0	1.4	5.1	8.4	34.9	11.3
		r	1- 8	0- 9	44-75	8-32	0-5	0-12	0-25		0-29
5	161	a	6.1	3.5	59.0	22.2	1.1	3.3	4.6	31.2	15.5
		r	1-11	0- 7	41-77	1-43	0-3	0- 9	0-12		0-37
6	16	a	4.7	3.1	65.8	11.6	2.3	3.5	8.6	26.0	22.0
		r	1- 9	0-6	52-80	8-15	0-6	0- 7	0-24		2-43
7	21	a	3.9	4.1	65.3	16.3	1.2	2.2	6.7	26.4	25.0
		r	2- 6	0-8	52-69	13-20	0-5	0- 7	0-22		0-45
8	77	a	6.0	5.8	52.3	25.4	0.9	4.2	5.4	35.9	75.0

		r	0-14	0-13	35-69	12-38	0-3	0-11	0-15		60-90
9	41	a	9.3	3.6	58.9	23.4	0.6	2.2	2.0	28.2	8.6
		r	1-18	1- 6	46-72	13-34	0-3	0- 6	0-6	0-6	0-22
10	14	a	12.9	2.9	56.4	21.4	0.4	2.2	3.3	27.3	6.9
		r	6-20	1- 6	51-62	13-30	0-2	0- 6	0- 8		0-15
11	14	a	5.5	3.8	66.3	23.8	0.0	0.0	0.6	24.4	2.7
		r	2- 9	1-6	60-72	22-25			0-1		0- 8
12	2	a	4.4	0.4	52.0	23.6	0.0	12.6	6.3	42.5	45.0
13	14	a	6.2	2.4	50.0	29.0	0.0	2.5	9.8	41.3	85.0
		r	1-12	0-5	33-67	14-44		0- 5	1-19		80-90

Notes Table 3: a = average, r = range between minimum and maximum of a-s and a+s, where s = standard deviation; bare terrain = sum bare soil, rock outcrops, stones and gravel; bold figures are estimates made by API.

The standard deviation in Table 3 can be approximated by the highest value obtained from: [range maximum - average] or [average - range minimum].
The range in Table 3 enables to estimate variability up to a certain extent. The coefficient of variation [(s/a) x 100] of coverage by herbs is about 25 % or less; bare soil often shows a relatively low coefficient of variation, others, however, show normally standard deviations higher than the average, which means great spreading of values.
For normal distributions a-s and a+s cover about 70 % of the cases. Skewed distributions may be recognized in Table 3, where the average is out of centre of range e.g. 0.6 % for rock outcrops in the range 0-3 means that more cases are between 0 and 0.6 than between 0.6 and 3.

Considering the data for classification of land cover, the following conclusions were made on possible values for subdivision:
- tree coverage on values 5 and 10;
- shrubs on values 0.5 and 4;
- bare soil on value 20;
- rock outcrops on values 1 and 2;
- stones on values 2 and 5;
- gravel on values 5 and 10;
- agricultural fields on values 10, 25, 50 and 70.

There is a need for classification. A first entry is offered by Cissé and Breman (1991). They discriminate four types of savanna vegetation:
- wooded savanna or savane boisée;
- tree savanna or savane arborée;
- shrub savanna or savane arbustive;
- grassy savanna or savane herbeuse.

The author proposes a criterium for physiognomic appraisal of tree coverage:

vegetation type	% of coverage by trees (> 5m)
forest	> = 40
wooded savanna	20-40
tree savanna	
high density (très dense)	10-20
medium density (dense)	5-10
low density (peu dense)	2- 5
shrub and grassy savannas	< 2

Using this criterium and data given in the report of the Kaya Region (Mulders, 1995), the following appraisal of coverage by land cover features is proposed and used for classification in Table 4:

- abbreviations: 0 = absent, a = almost absent, v = very low, l = low, m = moderate, h = high, e = very high percentage of coverage;
- tree coverage - 0, 0.1-0.5 (a), 0.5-2 (v), 2-5 (l), 5-10 (m), 10-20 (h), > = 20 (e);
- shrub coverage - 0, 0.1-0.5 (a), 0.5-2 (v), 2-4 (l), 4-10 (m), 10-20 (h), > = 20 (e);
- herb+debris coverage - 0, 0.1-1 (a), 1-10 (v), 10-30 (l), 30-50 (m), 50-70 (h), > = 70(e);
- bare soil - 0, 0.1-1 (a), 1-10 (v), 10-20 (l), 20-30 (m), 30-50 (h), > = 50 (e);
- rock outcrops - 0, 0.1-0.3 (a), 0.3-1 (v), 1-2 (l), 2-5 (m), 5-10 (h), > = 10 (e);
- stones - 0, 0.1-0.5 (a), 0.5-2 (v), 2-5 (l), 5-15 (m), 15-30 (h), > = 30 (e)
- gravel - 0, 0.1-0.5 (a), 0.5-5 (v), 5-10 (l), 10-30 (m), 30-50 (h), > = 50 (e);
- bare terrain - 0, 0.1-2 (a), 2-10 (v), 10-20 (l), 20-40 (m), 40-70 (h), > = 70 (e);
- agricultural fields- 0, 0.1-1 (a), 1-10 (v), 10-25 (l), 25-50 (m), 50-70 (h), > = 70 (e).

The following descriptions of the land cover classes are proposed, as defined by the data of Table 3 and the classification in Table 4 and locally with physiographic indications:

1) Eroded surfaces with very low vegetation coverage (areas too small to discriminate on the land cover map);
2) Hills, ironcaps and footslopes with Tree Savanna of low density, low coverage by agricultural fields, high coverage by bare terrain and moderate coverage by stones;
3) Tree Savanna of medium density and very low coverage by agricultural fields;
4) Tree Savanna of low density, low coverage by agricultural fields, high coverage by bare terrain and moderate amounts of stones, gravel and bare soil;
5) Tree Savanna of medium density and low coverage by agricultural fields;
6) Tree Savanna of low density, low coverage by agricultural fields and moderate coverage by rock outcrops;
7) Tree Savanna of low density and moderate coverage by agricultural fields;
8) Agricultural land with medium tree density and moderate coverage by shrubs;
9) Valley bottoms with Tree Savanna of low density and very low coverage by agricultural fields;
10) Valley bottoms with Tree Savanna of high density and very low coverage by agricultural fields;

11) Valley bottoms with Tree Savanna of medium density and very low coverage by agricultural fields;
12) Tree Savanna of low density with moderate coverage of agricultural fields, shrubs being almost absent;
13) Agricultural land near to the villages with medium tree density and low coverage by shrubs.

Table 4. Classification of land cover features.

unit nr.	trees	shrubs	herbs+ debris	bare soil	rock outcrops	stones	gravel	bare terr.	agric fields
2	l	l	h	l	v	m	l	h	l
3	m	m	h	l	m	l	v	m	v
4	l	m	h	m	l	m	l	h	l
5	m	l	h	m	l	l	v	h	l
6	l	l	h	l	m	l	l	m	l
7	l	m	h	l	l	l	l	m	m
8	m	m	h	m	v	l	l	h	e
9	m	l	h	m	v	l	v	m	l
10	h	l	h	m	v	l	v	m	l
11	m	l	h	m	o	o	v	m	l
12	l	a	h	m	o	m	l	h	m
13	m	l	h	m	o	l	l	h	e

Unless specified differently, the units belong to almost level plateauland. A complete description is provided for in Tables 3 and 4. In this summation of land cover units, the most outstanding features (tree coverage and agricultural fields) were selcted first. Where there was no difference, other features are checked and added to the description such as shrub coverage to discriminate units 8 and 13 and features with moderate or high coverage for units 2, 4 and 6. Since land cover is represented by a large number of surface features, the most pure description would be a code as defined by coverage of the different features (Table 4) but this will always be possible in using these data.

5.2. Land Use.

It is always fissy to interpret data on land cover for their significance to land use. A number of assumptions have to be made.
Unit 8 is considered to be part of the arable land, technically and scientifically supported by PDI/Z and the provincial authorities. On the aerial photographs, the regular lay out of parcels is highly characteristic and suggests a more permanent use of the land.
Unit 13 is the land with the socalled "champs de cases et de village" with a higher fertilization level than the "champs de brousse", contained in the other units. The former are more permanently used, the latter are left idle for years to enable regeneration. A possible exeption on this statement are the units 7 and 12, which show a moderate coverage by agricultural fields of a more permanent character than the champs de brousse.
An activity covering nearly all units is extensive pastoralism with the only limitation of availability of drinking water for cattle: LUT EP.
Definition of LUTs/management levels for rainfed crop cultivation (acc. Sys et al., 1991):
LUT AH: intermediate to high input level for the production of cotton, millet and sorghum;
LUT AI: intermediate input level for the production of cotton, millet and sorghum;
LUT AL: low input level for the production of millet and sorghum, subdivided into
- LUT ALV: "champs de cases et de village" with regular supply of manure and with additional crops maize, vegetables groundnuts and tabac;
- LUT ALB: "champs de brousse", shifting cultivation with occasional supply of manure.

These 5 different Land Utilization Types are detailed according to their extension in Table 5. If the extend is less than 10 %, the activity is not indicated. The five classes, which come to existence when using their type and extent as characteristics are:
- EP (units 3 and 9-11);
- EP with ALB to a low extent (units 2 and 4-6);
- EP with AI (units 7 and 12);
- AH with EP to a low extent (unit 8);
- ALV with EP to a low extent (unit 13.

It is worthwile to compare this outcome with other results on land use inventory and complete the definitions on LUTs with more details to develop methods on land use survey. The rapid method surely will start with identification of land cover.

Table 5. Land Utilization Types Kaibo area.

land cover unit	Extent of Land Utilization Types >= 50 %	25-50 %	10-25 %
2	EP		ALB
3	EP		
4	EP		ALB
5	EP		ALB
6	EP		ALB
7	EP	AI	
8	AH		EP
9	EP		
10	EP		
11	EP		
12	EP	AI	
13	ALV		EP

6. SOIL MAP.

6.1. First steps in analysis of the database.

The first step in analyzing the soil data is the representation of numeric data of auger depth, rock outcrops, stones and gravel at the surface, slope %, cracks wideness and depth, height of gilgai-like features as noted in the terrain. The data are given per physiographic unit in Appendix 1. The same presentation of a and r was used as in Table 3.
No blocage within 120 cm was treated as maximum auger depth of 120 cm. The averages of auger depth are thus underestimated.

In Table 6, the data of appendix 1 are classified according to the following rules.
Auger depth was classified with the criteria used at present for the 1 : 100 000 survey and those of the 1: 30 000 survey (in this specific case in order to have relationship with the soil code), as follows:

auger depth (cm) acc. 1 : 100 000	class	auger depth (cm) acc. 1 : 30 000	class
> 60	D	> 80	a
30-60	C	40-80	b
10-30	B	20-40	c
< 10	A	< 20	d

MAP 2: DRAINAGE PATTERN.

MULDERS, M.A. 1996 (data used from Laguna Gómez, 1994)

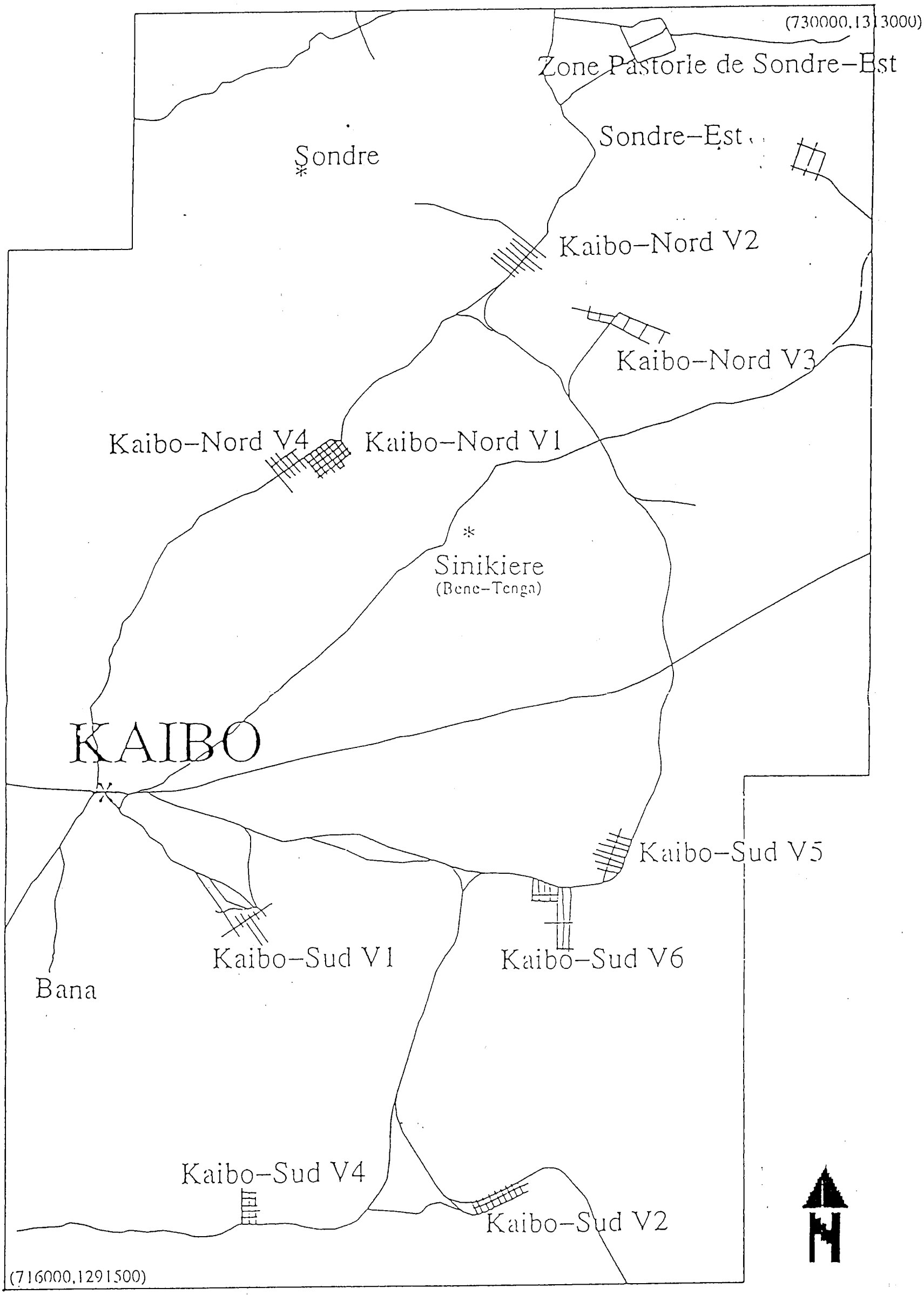
SPS: Aménagement et Gestion de l'Espace Sylvo-pastoral au Sahel.

Antenne Sahélienne de l'Université Agronomique Wageningen Pays Bas
et de l'Université de Ouagadougou Burkina Faso

0 4Km

KAIBO AREA

MAP 1: STUDY AREA WITH MAIN VILLAGES AND ROADS.



MULDERS, M.A. 1996 (data used from Laguna Gómez, 1994)

SPS: Aménagement et Gestion de l'Espace Sylvo-pastoral au Sahel.

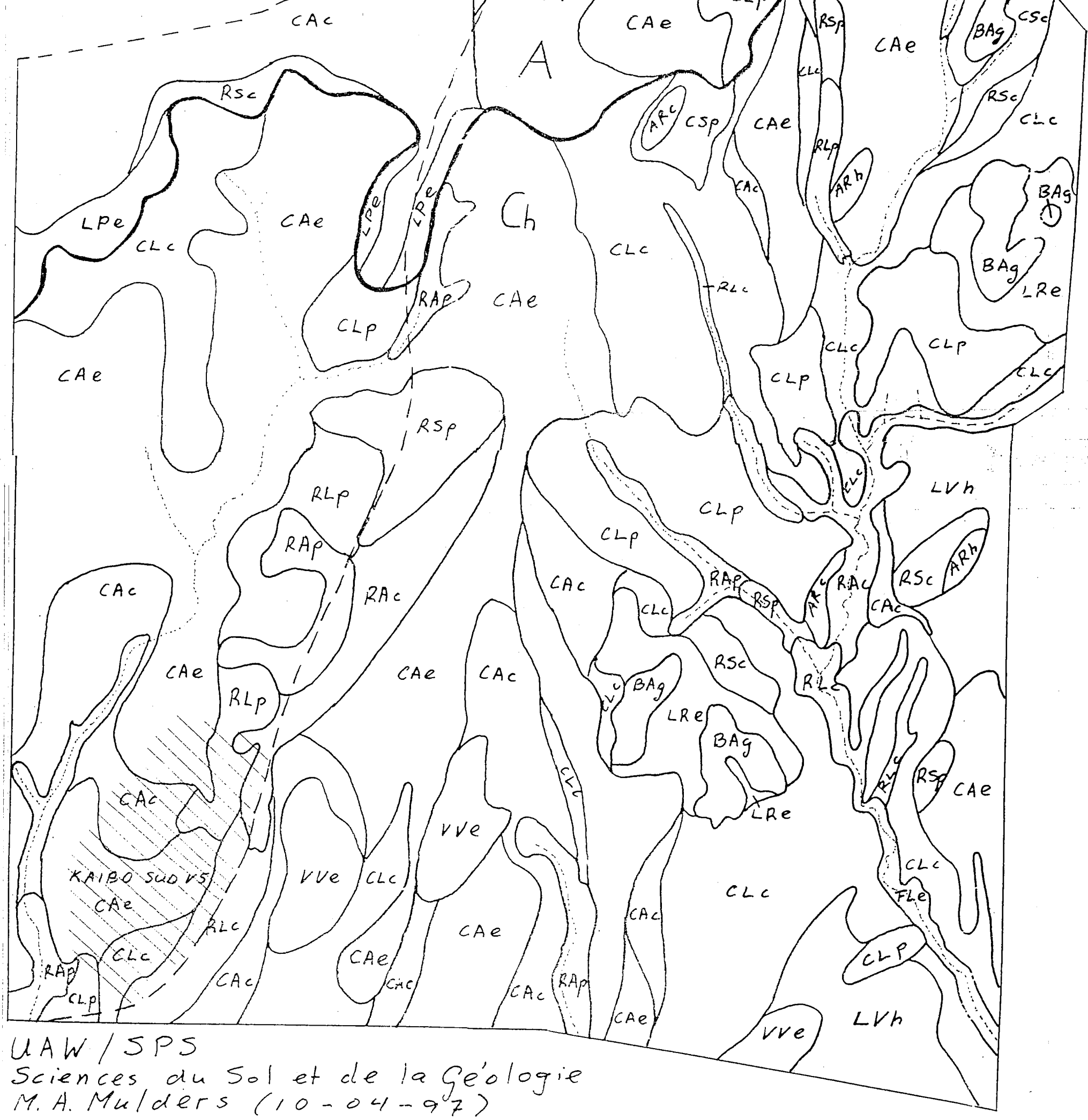
Antenne Sahélienne de l'Université Agronomique Wageningen Pays Bas
et de l'Université de Ouagadougou Burkina Faso

0 4Km

KAIBO AREA

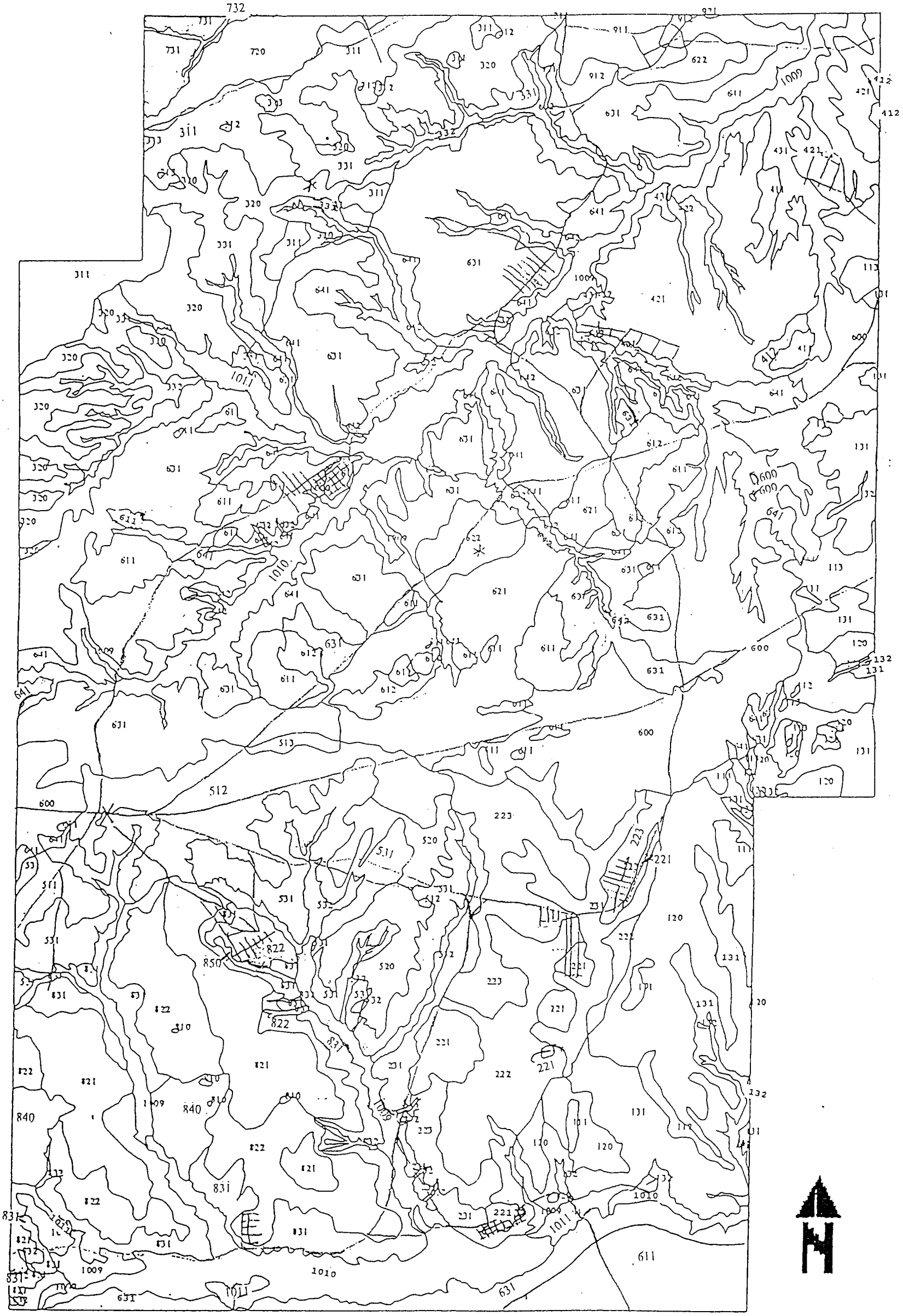
CARTE DE SOLS
KAIBO SUD V5
échelle 1 : 10.000

N



UAW / SPS
Sciences du Sol et de la Géologie
M. A. Mulders (10-04-97)

MAP 4: PHYSIOGRAPHY.



MULDERS, M.A. 1996 (data used from Laguna Gómez, 1994)

SPS: Aménagement et Gestion de l'Espace Sylvo-pastoral au Sahel.

Antenne Sahélienne de l'Université Agronomique Wageningen Pays Bas et de l'Université de Ouagadougou Burkina Faso

0 4Km

KAIBO AREA

DOCUMENT 39

MAP 3: LAND COVER.

MULDERS, M.A. 1996 (data used from Laguna Gómez, 1994)

SPS: Aménagement et Gestion de l'Espace Sylvo-pastoral au Sahel.

Antenne Sahélienne de l'Université Agronomique Wageningen Pays Bas et de l'Université de Ouagadougou Burkina Faso

0 4Km

KAIBO AREA