AG : BOT/85/011
FIELD DOCUMENT 14
Annex 1

Soil Mapping and Advisory Services

Botswana

THE SOILS OF SOUTHEAST NGAMILAND

FOOD & AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

UNITED NATIONS DEVELOPMENT PROGRAMME

REPUBLIC OF BOTSWANA

GABORONE, 1988

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THE SOILS OF SOUTHEAST NGAMILAND

K. Verbeek

Food and Agricultural Organization of the United Nations

United Nations Development Programme

Republic of Botswana

Gaborone, 1989

The conclusions given in this report are those considered appropriate at the time of its preparation.
They may be modified in the light of further knowledge gained at subsequent stages of this project.

CONTENTS

1 CLIMATIC DATA FOR MAUN

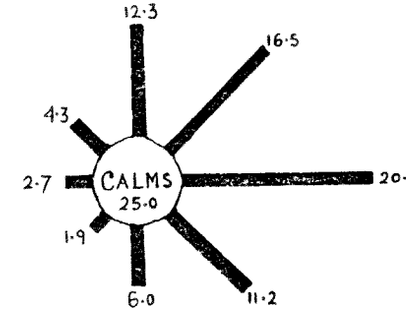
MAUN

Latitude: 19°59′S; Longitude: 23°25′E; Elevation: 900m

Month	TEMPERATURE (C°) Mean Max	Mean Min	Extreme Max	Extreme Min	RELATIVE HUMIDITY (%) 0800LT	1400LT	PRECIPITATION (mm) Mean	Max	Min	Max 24hr	No of days ≥0.1	≥1.0	≥10.0	≥20.0	Percentage variability of rainfall	Sunshine hrs/day	Evap (mm) Open Tank 'Class A'	P.E.T. (mm) (Penman)
July	25.1	6.9	31.3	- 3.6	62	25	0.1	5.8	0	3.5	x	x	x	0	-	9.8	183	86
August	28.3	9.8	35.2	3.5	52	20	0.8	27.6	0	18.0	0.2	0.2	x	0	-	10.3	218	119
September	32.2	14.8	38.6	3.9	40	19	2.5	29.2	0	25.8	0.6	0.3	x	x	-	10.1	263	167
October	34.1	18.6	41.4	9.0	44	23	15.7	99.7	0	54.6	3.2	2.4	0.4	0.2	-	9.5	307	200
November	33.0	19.4	41.7	9.4	57	32	49.1	169.6	0.8	54.4	7.1	5.3	1.6	0.5	75	8.6	256	176
December	32.1	19.4	40.6	8.4	69	42	79.2	264.0	13.0	71.1	9.8	7.8	2.8	1.2	64	8.3	235	169
January	31.6	19.5	40.0	9.2	76	48	113.7	395.9	17.9	101.8	11.7	9.6	3.6	1.8	62	8.0	236	158
February	31.4	18.9	37.2	10.6	78	45	106.1	365.7	11.2	139.5	11.1	9.1	3.4	1.5	78	8.1	209	136
March	31.3	17.8	39.5	6.2	75	42	76.2	273.8	0	120.4	8.1	6.6	2.4	1.0	91	8.5	212	142
April	29.9	15.0	35.0	4.4	70	36	26.5	120.4	0	46.8	3.9	3.1	0.8	0.3	-	9.1	199	114
May	27.5	9.6	33.0	- 1.1	64	27	6.1	64.3	0	23.9	1.0	0.8	x	x	-	10.0	189	95
June	25.0	6.9	30.6	- 5.8	64	27	0.9	17.1	0	15.5	0.2	0.2	x	0	-	9.5	158	76
Annual	30.1	14.7	41.7	- 5.8	63	32	476.8	1183.9	193.0	139.5	56.9	45.4	15.0	6.5	38	9.2	2,665	1,638
Record (Years)	(1959-80)		(1941-80)		(1964-79)		(1921-80)				(1926-80)				(1921-80)	(1959-80)	(1958-76)	(1967-80)

MAUN (Contd.)

Month	Mean Station Level Pressure (mb)			SOIL TEMPERATURES (C°) 0900			1400			2000			Mean Wind Speed	Wind Direction Rose (Annual) (% Frequencies)
	0900	1400	2000	10cm	20cm	60cm	10cm	20cm	60cm	10cm	20cm	60cm	(km/hr)	
July	917.7	917.0	916.7	13.4	17.4	19.6	22.7	19.0	19.7	20.7	19.9	19.5	9.6	
August	916.1	915.1	914.2	16.7	19.8	21.7	25.9	21.7	21.3	23.7	23.0	21.4	10.4	
September	914.2	912.4	912.0	20.9	24.7	24.7	30.9	25.7	24.7	28.4	27.3	24.7	12.3	
October	912.7	910.7	910.4	25.0	27.4	27.7	34.6	29.9	28.3	31.5	30.0	29.3	13.8	
November	912.4	910.8	909.6	25.4	27.7	28.6	36.0	30.9	29.1	33.3	31.7	29.2	12.1	
December	911.4	910.0	909.0	25.7	26.5	28.8	34.1	30.5	28.9	31.2	30.2	29.2	10.7	
January	910.6	909.6	908.5	25.4	25.3	28.7	34.6	31.1	29.2	30.6	31.5	29.7	9.4	
February	910.4	910.1	908.6	24.7	24.2	28.2	32.9	29.7	28.3	29.4	30.1	28.5	9.0	
March	912.4	911.9	910.1	23.8	23.8	28.0	32.5	29.3	28.2	29.7	30.4	28.1	9.4	
April	914.0	913.3	912.5	21.7	23.5	26.2	30.6	27.2	26.6	27.5	27.9	26.8	8.9	
May	915.6	914.8	914.7	17.3	19.7	23.1	26.1	22.9	24.0	23.9	24.4	23.8	7.6	
June	917.5	916.8	916.6	14.1	17.6	20.5	22.3	19.2	20.2	20.2	20.3	20.1	9.1	(0500+0800+1100+1400+1700+2000 hrs)
Annual	913.8	912.7	911.9	21.2	24.6	25.5	30.3	26.4	25.7	27.5	27.4	25.8	10.3	
Record (Years)	(1966-1970)			(1969-1980)									(1967-80)	(1969-78)



2 METHODS

2.1 Soil Chemical Analysis

Methods of soil chemical analysis are fully described and discussed by Breitbart (1987). Short descriptions of the methods used are as follows:

pH determination
Two pH values are determined, pH-H_2O and pH-$CaCl_2$. For the latter a 0.01N solution is used. Soil suspension ratio is 1:2.5. Values are determined electrometric with an "onion" Ag/AgCL electrode and a Zeiss 300 pH meter.

Electrical conductivity
EC is determined in a soil/water suspension of 1:5, only for samples with a pH>7. A Philips PW9506 conductivity meter is used.

Phosphorus
Extractable phosphorous is determined following the Bray and Kurtz (1945) method. The extracting solution is 0.03N NH_4F in 0.025N HCL. P concentration is determined colorimetrically with a modification of the molybdenum blue method of Diekmann and Bray (1940) at 660nm.

Oxidizable organic carbon (organic matter)
In order to obtain results with a better reproducibility, the original Walkley and Black (1934) method was modified. A solution of 3.4N sodium dichromate ($Na_2Cr_2O_7$) in 10N H_2SO_4 is added to the soil and heated for 1h to 150$\pm$5^oC. The green colour of Cr^{3+} is determined colorimetrically at 570nm. A standard curve is prepared with glucose.

CEC by ammonium acetate method pH 7.0
This procedure is based on the method of Peech et al. (1947). It has been modified by the USDA National Soil Survey Laboratory for use with 24 place automatic extractors. Soil is leached with ammonium acetate to remove exchangeable cations and to saturate the exchange sites with the ammonium ion. The excess ammonium is removed by leaching with ethanol and the remaining exchangeable ammonium ion is removed by distillation and determined by titration.

Exchangeable cations
Na, K, Ca and Mg are determined with a Varian atomic absorption spectrometer.

Particle-size determination

Clay and silt fraction: For the particle-size distribution of the clay and silt fractions both the pipette method and the hydrometer method are used. The pipette method is more accurate than the hydrometer method, but the output is much higher with the latter. 24 analyses versus 6 are possible per day, for this reason the routine analyses is carried out with the hydrometer method.
Sand fraction: Particles coarser than 50mu are segregated by dry sieving. The sandfraction is divided into five subfractions, following the USDA system: 2000-1000mu, 1000-500mu, 500-250mu, 250-100mu, 100-50mu. Clay and silt are separated from the sand fraction by wet sieving through a 50mu sieve. The sand fraction is dried in an oven before sieving.

With the pipette method the clay and silt fraction is washed into sedimentation cylinders for determination. With the hydrometer method, clay and silt are determined within the complete sample. The sand fraction is separated after the determination, clay and silt are discarded.

Pretreatement and dispersion: Soils which contain considerable amounts of organic matter, soluble salts or gypsum, may not disperse adequately. These components are removed first by treating the soil with hydrogenperoxide to destroy the organic matter and, if applicable, filtration and washing with enough water to dissolve soluble salts and gypsum. For dispersion samples are shaken for more than 12 hours in a dilute alkaline solution of sodium hexametaphosphate. According to Tyner (1940) and Kilmer and Alexander (1949) mixtures of sodium hexametaphosphate and sodium carbonate have proved to disperse also calcareous soils without prior removal of alkaline earth carbonates.

Pipette method: This method was adopted in 1929 by the International Society of Soil Science (Intern. Soc. Sci, 1929). The pipette method for particle-size analyses is a sedimentation procedure which utilizes pipette sampling at controlled depths and times, calculated with Stokes' equation. The determination is performed in a constant temperature waterbath controlled to $\pm 0.5^{o}C$.

Hydrometer method: The hydrometer method is a sedimentation procedure for clay and silt, introduced by Bouycous (1926, 1927). The hydrometer method, like the pipette method, depends fundamentally upon Stokes' equation. The determination is performed in a constant temperature bath controlled to $\pm 0.5^{o}C$.

2.2 Soil Physical Analysis

Infiltration: The double ring infiltration method is used to measure the water intake characteristics of soils. Open ended cylinders of diameter 25-35 cms and height 30cms are driven into the soil to a depth of 15cms. Around each cylinder, another cylinder larger in diameter is driven concentrically into the soil to the same depth. The intake of water in the inner cylinder is measured for progressively increasing time intervals while keeping the space between the inner and outer cylinder always ponded with water. At each site three to five replicate measurements are made (for detailed procedures see reference No 1).

Bulk density: Bulk density is determined by obtaining an undisturbed soil sample of known volume (100cc) and dividing the oven dry soil mass by the field volume of the sample. Stainless steel cylinders of diameter 5cms and height 5 cms are driven into the soil by a heavy hammer to obtain the cylindrical undisturbed core samples. Five replicate measurements are made for each soil horizon. (for detailed procedure see reference No 1).

Soil moisture retention: Soil moisture characteristics (moisture retention) are done on undisturbed soil core samples for tensions between 0.03 bar and 1.0 bar and on 2mm sieved samples for tensions between 5 bars and 15bars. For tensions of 0.03 bar and 0.05 bar, hanging water column technique, using a

sand table. For higher tensions, a pressure plate apparatus is used. Generally moisture contents are measured at 0.03, 0.05, 0.1, 0.3, 1.0, 3.0, 5.0 and 15. bar tensions in duplicate.

Structural stability index

The relative structural stability of soils to wetting is assessed by comparing the degree of collapse of samples of air dried soils when rapidly wetted as opposed to slow wetting under a tension. The degree of collapse is estimated by the relative change in pore-size distribution which in turn is determined from the moisture release characteristics.

Air dry sieved soil samples of 50cc volume and size range between 1mm and 2mm are placed in two sintered glass Buchner funnels connected to burettes by flexible tubing. One sample is wetted slowly at a tensions of 10cms of water for 24 hours. The second sample is wetted fast by raising the water level in burette to saturate the soil. After both samples have been equilibrated at zero tension, moisture release at different tensions are measured by lowering the burettes and noting the increase in volume of water in the burettes (for detailed procedures see reference No 2).

References

1. Methods of soil analyses. American Society of Agronomy Monograph 9 (1965)
2. Drainage testing, FAO Irrigation and Drainage paper No 28 (1976)

2.3 Survey Methods

After Remmelzwaal, 1988b.
The used procedures, methods, formats and organization of the survey are summarized in the following sections.

Mapping scale
The category of mapping chosen is reconnaissance mapping at a scale of 1:250.000. The maps are produced on a regular sheet by sheet basis, following the lay-out of the topographical maps at that scale. The topographical sheets 1:250.000 used are Maun and Toteng.

Aerial Photography
Air photos were available for the whole area, in one large block at scale 1:50.000, 1983 Okavango Block.
The interpretation enabled the determination of relevant physiographic units, including aspects of soils, geology and hydrology.

Satellite imagery
Landsat or other satellite imagery is extremely useful in semi-arid countries as Botswana, which have a relatively thin vegetation cover. Some of the advantages are:
(1) synoptic view (comprehensive view of 185x185km per full image)
(2) planimetric view (facilitates direct mapping on a reliable base map)
(3) sequential coverage (repetition every 18 days). Images can be selected for the most appropriate seasons.

Landsat images proved indispensable in this reconnaissance soil survey. Systematically corrected and edge enhanced colour composites at scale 1:250000 were used.

Interpretation of Landsat Imagery and Aerial Photography

Stage 1 Preliminary interpretation .
Landsat is at the same scale as the final soil maps. The photos are more useful for precise location of the observation points in the field. The interpretation includes the use of geological maps and other data. The first field reconnaissance, mainly follows transects.The first aim is the identification of the main physiographic units and major soil groups, and the relation with the vegetation.

Stage 2 Reinterpretation, using the results of the first field trips. In the first survey areas this is the most important interpretation phase, but in the later stages of the survey there is more experience with the Landsat patterns and the first interpretation very often needs only little modification. This is the main field routine phase, with ground truth checking of as many of the soil mapping units as possible. Of course, not all of them can be checked, and selection depends of confidence in extrapolation and on accessibility, but also on time available.

Stage 3 Final interpretation and field check.
This may be necessary when soil patterns are very complex, or when the analytical results do not confirm the field data.

Stage 4 Finalization of the first draft map on a transparent overlay on the Landsat 1:250.000 image. This includes the final check of all mapping units and boundaries.

Stage 5 Final construction of the map legend and soil mapping units. Symbols are placed in all mapping units. This stage includes the matching of soil unit classification and analytical data.

Stage 6 Transfer of the draft soil map on Landsat to the 1:250.00 topographical base map, which has been amended by the surveyor for roads and other relevant topographical features. The final draft is now ready for production by the cartographer.

Routine soil description and storage
The method of describing soil profiles is according to the Botswana Soil Database - Guidelines for Soil Profile Description (Remmelzwaal and Van Waveren, 1988), which is based on the Guidelines for Soil Description (FAO, 1974). Colours were described using the Munsell Soil Color Charts (1975)

All data, including analytical results, are stored in the Botswana Soil Database.

Field Methods
The procedure in the 1:250.000 reconnaissance soil mapping is the free survey method, which is largely based on the recognition of physiographic patterns. The selection of observation points is to a great deal determined by accessibility. In the hardveld accessibility is generally fairly good, but in the sandveld relatively few tracks exist. However, the variety of soils in the sandveld is not great, and therefore less observations are needed. To a certain extent cross country traveling on transects was applied, but location becomes problematic when the vegetation is dense or when there are few recognizable features in the landscape.
Soil observations were done from pits that were dug, from existing exposures in borrow pits and gullies and from augerings or combinations of pits and augerings. During the extended dry periods in the previous drought years, it was often not possible to make augerings, due to the hardness and compaction of the soil.

The number of described and registered observations is about 950, but the total number including the short observations, mainly for boundary checks and recorded only in the logbooks, is much higher.

When executing a soil survey, one should bear in mind the size of areas that can still be represented on the final soil map. Vink (1963) gives as the smallest reproducable mapping unit, the basic mapping unit of 5x5mm or 10x2.5mm ($25mm^2$). He also indicates the number of observations per km^2 for various scales. Forbes, Rossiter and Van Wambeke (1982) suggest a minimum legible area on the map of $40mm^2$, which is $2.5km^2$ on a 1:250.000 map. The implication is that areas smaller than about 1.5 x 1.5km cannot be represented on the final map. Elongate mapping units have a maximum width of 500m. sometimes features important for location, such as hills or pans are included.

3 SOIL PROFILE DESCRIPTIONS AND ANALYTICAL RESULTS

3.1 Introduction

Following soil profiles have been selected as representative for the soil units occurring in the study area. A complete set of soil profiles for southeast Ngamiland are stored in the National Soil Database.

Soil Unit	Profile No	Soil Classification (FAO, 1974)
A7	MA902	Gleyic Luvisol
A9	MA450	Calcic Luvisol
A9a	TO904	Arenic Calcic Luvisol
A15a	MA904	Arenic Orthic Luvisol
A24	MA123	Eutric Fluvisol
A24a	TO800	Arenic Eutric Fluvisol
A31a	MA903	Eutric Gleysol
A40	TO903	Eutric Arenosol
A40a	MA418	Eutric Arenosol
A44	TO861	Albic Luvisol
A47	TO896	Gleyic Phaeosem
C5c	TO831	Calcic Luvic Xerosol
L7	TO901	Eutric Gleysol
L11	TO665	Calcic Arenosol
L24a	MA106	Calcic Luvisol, sodic
L36	MA421	Calcic Chernozem
L37	TO318	Mollic Gleysol
(K)S3	MA60	Ferralic Arenosol
KS5b	MA718	Luvic Arenosol
KS6a	TO828	Luvic Arenosol
KS17	TO902	Eutric Arensol

SOIL PROFILE DESCRIPTION

Profile: MA 0902 Unit: A7 Status: 1

SHEET : 1923D3
LOCATION : Maun-Daonara, 21km NE from Maun.
AUTHOR(S): A.B.Price M.D.Mays A.Remmelzwaal
CLASSIFICATION FAO: Gleyic Luvisol(1988) Gleyic Luvisol (1974)
ST : Mollic Ochraqualf ; fine loamy mixed hyperthermic
LANDFORM : alluvial plain
TOPOGRAPHY: almost flat
SURF. CHAR: slight sealing, no cracks, nil evidence of salt,
LAND USE: traditional grazing
SPECIES : Trees -
: Shrubs -
: Grasses/forbs-
PARENT MATERIAL: alluvium
MOIST. COND: dry 0 - 184, slightly moist 184 - 200 cm
SURF.STONES: none
EROSION : slight sheet erosion

GRID : - -
COORD: 19-50-44-S 23-32-09-E
DATE : 22/03/86

LAND ELEMENT : flood plain
MICRO TOPOGRAPHY: even

VEGETATION: grassland

ROCK TYPE:

ROCK OUTCROP: none

AGRO CLIM.ZONE: 2C2
ELEVATION : 930 m

SMR: aquic

POSITION: lower part
SLOPE : 0 - 0.5%

GRASSCOVER:

GEOL.UNIT:
DRAINAGE : imperfectly drained

HUMAN INF: nil

REMARKS: USDA pedon no 6 (Aquic Argiustoll)with modifications. Excursionsite FAO-EASC meeting 6/4/87. Near profile MA229.Occasionally flooded.Epipedon not considered as mollic because-of very hard consistency.

SAMPLES: A: 0 - 16 B: 16 - 55 C: 55 - 94 D: 94 - 127 E: 127 - 184 F: 184 - 200

A 0 - 16 cm 10YR 2/1 (moist) and 10YR 4/1 (dry), fine sandy loam (15% clay), weak fine and medium subangular blocky structure, hard friable, sticky slightly plastic, many very fine pores, non calcareous, many fine and medium and common coarse roots, abrupt wavy boundary.

Btg1 16 - 55 cm 10YR 3/1 (moist) and 10YR 4/1 (dry), sandy clay loam (32% clay), moderate very coarse prismatic falling apart into weak very coarse subangular and angular blocky structure, very hard firm, sticky plastic, patchy thin clay cutans random, few very fine pores, non calcareous, common very fine and few fine roots, gradual wavy boundary.

Btg2 55 - 94 cm 10YR 3/1 (moist) and 10YR 4/1 (dry), few fine distinct clear brown mottles, sandy clay loam (32% clay), weak very coarse prismatic falling apart into weak very coarse subangular and angular blocky structure, very hard firm, sticky plastic, patchy thin clay cutans random, few very fine pores, non calcareous, common very fine and few fine roots, gradual wavy boundary.

Btg3 94 - 127 cm 10YR 3/1 (moist) and 10YR 4/1 (dry), sandy clay loam (32% clay), very weak coarse subangular blocky structure, extremely hard very firm, sticky plastic, patchy thin clay cutans random, few very fine pores, non calcareous, few very fine and fine roots, clear wavy boundary.

Btg4 127 - 184 cm 2.5Y 5/2 (moist) and 2.5Y 6/2 (dry), few fine distinct clear yellowish-brown mottles, sandy clay loam to sandy clay (35% clay), very weak coarse subangular blocky structure, extremely hard very firm, sticky plastic, few very fine pores, non calcareous, few very fine roots, gradual wavy boundary.

Cg 184 - 200 cm 2.5Y 5/2 (moist) and 2.5Y 6/2 (dry), few fine distinct diffuse brownish mottles, sandy clay loam to sandy clay (35% clay), strongly coherent massive structure, extremely hard firm, sticky plastic, few very fine pores, very few soft siliceous white nodules, non calcareous, few very fine roots,

S T A N D A R D S O I L A N A L Y S I S R E S U L T S

PROFILE: MA 0902

SAMPLE	DEPTH		pH		EC	P	C	CEC	Ca	Mg	K	Na	PBS	Particle size (weight %)								CECclay	METH	PRETR
			H2O	CaCL2	mS/cm	ppm	weight %	ù----- meq/100gr soil ------ù					%	vcS	cS	mS	fS	vfS	cSi	fSi	Clay	meq/100gr		
A	0	16	5.7	5.1	0.0	3	3.5	14.5	10.5	1.9	0.4	0.3	90	0	2	7	50	10	2	9	19	3		
B	16	55	7.0	6.1	0.1	2	0.4	15.7	11.4	3.3	0.6	0.3	99	0	1	13	43	6	1	2	34	41		
C	55	94	7.5	6.4	0.0	1	0.2	15.1	11.6	3.3	0.6	0.3	>100	0	1	11	45	7	1	2	34	42		
D	94	127	7.7	6.8	0.0	1	0.1	13.6	11.0	2.9	0.6	0.3	>100	0	1	12	46	6	0	2	33	40		
E	127	184	8.0	7.1	0.0	1	0.1	12.6	10.9	2.5	0.6	0.3	>100	0	1	13	49	7	3	1	27	45		
F	184	200	8.2	7.5	0.0	2	0.1	13.2	12.9	2.3	0.6	0.3	>100	1	1	14	48	7	3	4	23	56		

Soil Survey of Botswana FAO/BOT/85/011 Print date: 24/05/89

PART.SIZE DETERMINATION METHOD: H = Hydrometer Method, P = Pipette Method, * = Not Known
PRETREATMENT: O = Organic Matter, F = Free Iron Oxides, C = Carbonates, S = Soluble Salts N = None

SOIL PROFILE DESCRIPTION

Profile: MA 0450 Unit: A09 Status: 2

SHEET : 1923B3
LOCATION : 4.3km N of South gate, Moremi.
AUTHOR(S): G.Baert K.Verbeek R.Kelebemang
CLASSIFICATION FAO: Calcic Luvisol(1988) Calcic Luvisol (1974)
ST : Typic Haplustalf
LANDFORM : alluvial plain
TOPOGRAPHY: almost flat
SURF. CHAR: slight sealing, no cracks, nil evidence of salt,
LAND USE: game reserve
SPECIES : Trees - Colophospermum mopane (dom.)
: Shrubs -
: Grasses/forbs-
PARENT MATERIAL: alluvium
MOIST. COND: moist 0 - 10 , dry 10 - 130 cm
SURF.STONES: none
EROSION : nil

REMARKS: Augering from 90+.

SAMPLES: A: 0 - 5 B: 20 - 40 C: 60 - 80 D: 110 - 130

GRID : - -
COORD: 19-23-25-S 23-39-30-E
DATE : 18/10/85

LAND ELEMENT : depression
MICRO TOPOGRAPHY: low hummocks

VEGETATION: woodland

ROCK TYPE:

ROCK OUTCROP: none

AGRO CLIM.ZONE: 1B2
ELEVATION :

SMR: ustic

POSITION: lower part
SLOPE : 0 - 1 %

GRASSCOVER:

GEOL.UNIT:
DRAINAGE : imperfectly drained

HUMAN INF: nil

A	0 - 5 cm	10YR 3/1.5 (moist), loamy fine sand to fine sandy loam, weak medium and coarse subangular blocky structure, very friable, many fine and medium pores, non calcareous, many very fine and fine roots, clear wavy boundary.
Bt1	5 - 50 cm	10YR 3/1.5 (moist) and 10YR 4/1.5 (dry), fine sandy loam, weak very coarse prismatic falling apart into weak coarse and very coarse subangular blocky structure, slightly hard to hard, patchy thin clay cutans on pedfaces, many fine and medium pores, non calcareous, few medium and coarse roots, clear smooth boundary.
Bt2	50 - 90 cm	10YR 3/2 (moist) and 10YR 4/2 (dry), sandy clay loam, very weak coarse and very coarse subangular blocky structure, extremely hard, broken moderately thick clay cutans on pedfaces, common fine and medium pores, non calcareous, very few coarse roots, clear smooth boundary.
Ck	90 - 130 cm	10YR 3/2 (moist) and 10YR 4/2 (dry), sandy clay loam, massive structure, hard, few fine soft calcareous white soft segregations, strongly calcareous, no roots,

S T A N D A R D S O I L A N A L Y S I S R E S U L T S

PROFILE: MA 0450

SAMPLE	DEPTH		pH		EC	P	C	CEC	Ca	Mg	K	Na	PBS	Particle size (weight %)								CECclay	METH	PRETR
			H2O	CaCL2	mS/cm	ppm	weight %	ù-----	meq/100gr soil			------ù	%	vcS	cS	mS	fS	vfS	cSi	fSi	Clay	meq/100gr		
A	0	5	6.2	5.5	0.1	0	0.3	6.8	4.7	0.1	0.2	0.1	75	0	4	32	36	6	3	6	15	39	H	OM
B	20	40	6.5	6.2	0.1	0	0.4	7.4	5.6	0.3	0.7	0.1	91	0	4	30	35	6	4	4	17	33	H	OM
C	60	80	6.8	6.2	0.1	0	0.2	12.6	9.8	0.4	1.2	0.2	92	0	3	23	26	6	3	6	34	35	H	OM
D	110	130	7.1	6.9	0.3	0	0.4	11.9	30.4	0.4	1.1	0.2	100	0	4	27	26	5	4	7	27	38	H	OM

Soil Survey of Botswana FAO/BOT/85/011

Print date: 24/05/89

PART.SIZE DETERMINATION METHOD: H = Hydrometer Method, P = Pipette Method, * = Not Known
PRETREATMENT: O = Organic Matter, F = Free Iron Oxides, C = Carbonates, S = Soluble Salts N = None

SOIL PROFILE DESCRIPTION

Profile: TO 0904 Unit: A09a Status: 1

SHEET : 2023A3
LOCATION : Maun-Toteng, 50km from Maun, 0.4km SE.
AUTHOR(S): A.Remmelzwaal K.Verbeek G.Baert B.Kopelo
CLASSIFICATION FAO: Areni-Calcic Luvisol(1988) Arenic Calcic Luvisol (1974)
ST : Psammentic Haplustalf
LANDFORM : alluvial plain
TOPOGRAPHY: almost flat
SURF. CHAR: no sealing, no cracks, nil evidence of salt, bleached sand on surface
LAND USE: traditional grazing
SPECIES : Trees -
: Shrubs - Dichrostachys cinerea (dom.) Croton gratissimus Grewia bicolor Acacia erubescens
: Grasses/forbs-
PARENT MATERIAL: alluvium
MOIST. COND: dry 0 - 165 cm
SURF.STONES: none
EROSION : nil

GRID : - -
COORD: 20-17-00-S 23-05-06-E
DATE : 15/04/86

LAND ELEMENT : depression
MICRO TOPOGRAPHY: low hummocks

VEGETATION: dense shrub savanna

ROCK TYPE:

ROCK OUTCROP: none

AGRO CLIM.ZONE: 2C3
ELEVATION : 930 m

SMR: ustic

POSITION: intermediate part
SLOPE : 0 - 1 %

GRASSCOVER:

GEOL.UNIT:
DRAINAGE : moderately well drained

HUMAN INF: nil

REMARKS: Same position as TO0397.

SAMPLES: A: 0 - 30 B: 30 - 65 C: 65 - 100 D: 100 - 130 E: 130 - 165

A 0 - 30 cm 10YR 3/1.5 (moist) and 10YR 4/1.5 (dry), fine sand, very weak medium and coarse subangular blocky structure, slightly hard, common very fine and fine pores, non calcareous, few fine and medium roots, clear smooth boundary.

Bt 30 - 65 cm 10YR 4/1.5 (moist) and 10YR 5/1.5 (dry), loamy fine sand, weak very coarse prismatic falling apart into very weak coarse and very coarse subangular blocky structure, hard, patchy thin clay cutans on pedfaces, common very fine and fine pores, few medium irregular soft calcareous white nodules, non calcareous, few fine and medium and few coarse roots, gradual smooth boundary.

Btk1 65 - 100 cm 10YR 3/2 (moist) and 10YR 4/2 (dry), fine sandy loam, weak very coarse prismatic falling apart into very weak very coarse subangular blocky structure, hard, broken thin clay cutans on pedfaces, common very fine and fine pores, frequent medium irregular soft calcareous white nodules, non calcareous, few fine and medium roots, diffuse smooth boundary.

Btk2 100 - 130 cm 10YR 3/2 (moist) and 10YR 4/2 (dry), fine sandy loam, very weak very coarse subangular blocky structure, hard, patchy thin clay cutans on pedfaces, common very fine and fine pores, frequent medium irregular soft calcareous white nodules, non calcareous, very few fine roots, diffuse smooth boundary.

Btk3 130 - 165 cm 10YR 5/2 (moist) and 10YR 6/2 (dry), fine sandy loam, massive structure, hard, patchy thin clay cutans random, common very fine and fine pores, frequent coarse irregular soft calcareous white nodules and few coarse spherical soft calcareous white nodules, non calcareous, very few fine roots,

STANDARD SOIL ANALYSIS RESULTS

PROFILE: TO 0904

SAMPLE	DEPTH		pH		EC	P	C	CEC	Ca	Mg	K	Na	PBS	Particle size (weight %)								CECclay	METH	PRETR
			H2O	CaCL2	mS/cm	ppm	weight %	ù-----	meq/100gr soil			------ù	%	vcS	cS	mS	fS	vfS	cSi	fSi	Clay	meq/100gr		
A	0	30	6.2	4.7	0.0	2	0.1	5.4	2.9	0.7	0.1	0.1	70	0	1	15	68	9	1	1	6	83	H	OM
B	30	65	6.9	5.8	0.0	1	0.1	4.4	4.3	1.3	0.2	0.1	100	0	1	15	63	8	2	1	10	42	H	OM
C	65	100	7.5	6.3	0.0	1	0.1	9.7	5.5	1.6	0.2	0.1	76	0	1	17	59	8	2	3	11	85	H	OM
D	100	130	8.1	6.7	0.0	1	0.1	10.3	5.7	1.5	0.2	0.1	73	0	1	16	60	7	1	3	13	79	H	OM
E	130	165	8.7	7.3	0.0	1	0.1	10.9	6.8	1.6	0.3	0.1	81	0	1	13	61	9	2	1	15	72	H	OM

Soil Survey of Botswana FAO/BOT/85/011

Print date: 24/05/89

PART.SIZE DETERMINATION METHOD: H = Hydrometer Method, P = Pipette Method, * = Not Known
PRETREATMENT: O = Organic Matter, F = Free Iron Oxides, C = Carbonates, S = Soluble Salts N = None

SOIL PROFILE DESCRIPTION

Profile: MA 0904 Unit: A15a Status: 3

SHEET : 1923D3
LOCATION : Nxamathama molapo MDP research plot.
AUTHOR(S): K.Verbeek P.Jamagne
CLASSIFICATION FAO: Areni-Haplic Luvisol(1988) Arenic Orthic Luvisol (1974)
ST : Psammentic Haplustalf
LANDFORM : alluvial plain
TOPOGRAPHY: almost flat
SURF. CHAR: no sealing, no cracks, nil evidence of salt, bleached sand on surface
LAND USE: improved trad. dryland farming, crops: maize, sorghum
SPECIES : Trees -
: Shrubs -
: Grasses/forbs-
PARENT MATERIAL: alluvium
MOIST. COND: moist 0 - 60 , slightly moist 60 - 100, moist 100 - 130 cm
SURF.STONES: none
EROSION : slight sheet erosion

GRID : - -
COORD: 19-46-32-S 23-37-32-E
DATE : 22/02/88

LAND ELEMENT : flood plain
MICRO TOPOGRAPHY: even

VEGETATION: Nil

ROCK TYPE:

ROCK OUTCROP: none

AGRO CLIM.ZONE: 2C2
ELEVATION : 930 m

SMR: ustic

POSITION: upper slope
SLOPE : 1 - 2 % straight

GRASSCOVER: < 10 %

GEOL.UNIT:
DRAINAGE : moderately well to imperfectly drained

HUMAN INF: ploughing

REMARKS: Upper part sauce shaped depression, slope down from island (100m away). Dry molapo farming - no flooding this year. Flooded most years,period of flooding shorter than MA0905-
. 2C hor.:consists of lenses white windblown sand. Nodules are non calcareous.

SAMPLES:

Ap	0 - 22 cm	10YR 2/1 (moist) and 10YR 3.5/1 (dry), fine sand (8% clay), weak medium and coarse subangular blocky structure, slightly hard very friable, non sticky non plastic, common very fine and fine pores, non calcareous, common termite/ant activity, common very fine and fine roots, clear broken boundary.
2C	22 - 26 cm	10YR 6/2.5 (moist) and 10YR 7/2.5 (dry), fine sand (3% clay), single grain structure, loose loose, non sticky non plastic, few very fine and fine pores, non calcareous, common termite/ant activity, very few very fine roots, clear broken boundary.
3Bt1	26 - 80 cm	10YR 3.5/1.5 (moist) and 10YR 4.5/1.5 (dry), loamy fine sand (13% clay), weak very coarse prismatic falling apart into weak very coarse subangular and angular blocky structure, hard very firm, non sticky slightly plastic, patchy thin clay cutans on pedfaces, few very fine and fine pores, few fine spherical hard and soft greyish nodules, non calcareous, common termite/ant activity, few very fine roots, gradual smooth boundary.
3Bt2	80 - 130 cm	10YR 3.5/2 (moist) and 10YR 5/2 (dry), common fine distinct clear greyish mottles, fine sandy loam (15% clay), weak medium and coarse subangular blocky structure, slightly hard to hard friable to firm, non sticky slightly plastic, broken thin clay cutans on pedfaces, few very fine and fine pores, few fine spherical hard and soft greyish nodules, non calcareous, few very fine roots,

SOIL PROFILE DESCRIPTION

Profile: MA 0123 Unit: A24 Status: 2

SHEET : 1923D3
LOCATION : Xhwaa molapo.
AUTHOR(S): G.J.Rhebergen G.Baert K.Verbeek B.Kopelo
CLASSIFICATION FAO: Orthi-Eutric Gleysol(1988) Eutric Fluvisol (1974)
ST : Mollic Haplaquent
LANDFORM : alluvial plain
TOPOGRAPHY: flat
SURF. CHAR: no cracks, nil evidence of salt,
LAND USE: improved Molapo farming, crops: sorghum, maize
SPECIES : Trees -
: Shrubs -
: Grasses/forbs-
PARENT MATERIAL: alluvium
MOIST. COND: moist 0 - 270 cm
SURF.STONES: none
EROSION : slight accumulation by water

GRID : - -
COORD: 19-45-50-S 23-35-09-E
DATE : 27/02/85

LAND ELEMENT : flood plain
MICRO TOPOGRAPHY: even

VEGETATION: grassland

ROCK TYPE:

ROCK OUTCROP: none

AGRO CLIM.ZONE: 2C2
ELEVATION : 930 m

SMR: aquic

POSITION: lower part
SLOPE : 0 - 0.5%

GRASSCOVER:

GEOL.UNIT:
DRAINAGE : imperfectly to poorly drained

HUMAN INF: ploughing

REMARKS: 3.80m depth groundwater reached by augering.

SAMPLES: A: 0 - 20 B: 40 - 60 C: 90 - 110 D: 140 - 160 E: 190 - 210 F: 240 - 260

A 0 - 20 cm 10YR 2/1 (moist) and 10YR 3.5/1 (dry), sandy clay loam, weak medium and coarse subangular blocky structure, very hard friable, common very fine and fine pores, non calcareous, common very fine and fine roots, clear smooth boundary.

Cg1 20 - 70 cm 10YR 3/1 (moist) and 10YR 4/1 (dry), few fine faint clear reddish-brown mottles, sandy clay loam, strongly coherent massive structure, firm to very firm, few very fine and fine pores, non calcareous, few fine roots, gradual smooth boundary.

Cg2 70 - 170 cm 2.5Y 3/2 (moist), many fine distinct clear reddish-brown mottles, sandy clay loam, strongly coherent massive structure, firm, few very fine and fine pores, non calcareous, no roots, gradual smooth boundary.

Cgk 170 - 270 cm 2.5Y 5.5/2 (moist), many fine faint clear reddish-brown mottles, sandy clay loam to sandy clay, strongly coherent massive structure, friable, few very fine and fine pores, frequent fine irregular hard and soft calcareous white nodules, strongly calcareous, no roots,

S T A N D A R D S O I L A N A L Y S I S R E S U L T S

PROFILE: MA 0123

SAMPLE	DEPTH		pH		EC	P	C	CEC	Ca	Mg	K	Na	PBS	Particle size (weight %)								CECclay	METH	PRETR
			H2O	CaCL2	mS/cm	ppm	weight %	ù-----	meq/100gr soil			------ù	%	vcS	cS	mS	fS	vfS	cSi	fSi	Clay	meq/100gr		
A	0	20	6.0	5.8	0.0	12	1.4	20.0	9.6	1.9	1.8	0.2	68	0	1	10	46	7	4	8	25	57	H	OM
B	40	60	7.3	6.5	0.0	3	0.1	18.2	9.3	2.3	1.2	0.5	73	0	1	9	43	7	5	7	30	60	H	OM
C	90	110	6.6	5.8	0.0	1	0.1	15.0	6.2	1.8	1.1	0.5	64	1	1	13	49	6	4	3	23	63	H	OM
D	140	160	7.2	6.7	0.0	2	0.1	19.3	10.3	2.1	1.4	0.4	74	0	1	11	44	6	5	4	29	65	H	OM
E	190	210	8.0	7.6	1.1	0	0.1	23.9	53.7	3.5	1.4	0.6	100	0	1	7	29	6	6	11	39	60	H	OM
F	240	260	8.5	7.7	0.3	0	0.0	18.3	48.4	3.2	0.8	0.2	100	1	1	10	42	7	4	6	29	65	H	OM

Soil Survey of Botswana FAO/BOT/85/011

Print date: 24/05/89

PART.SIZE DETERMINATION METHOD: H = Hydrometer Method, P = Pipette Method, * = Not Known
PRETREATMENT: O = Organic Matter, F = Free Iron Oxides, C = Carbonates, S = Soluble Salts N = None

SOIL PROFILE DESCRIPTION | Profile: TO 0800 Unit: A24a Status: 3

SHEET : 2023A1
LOCATION : Nxaraga RTC.
AUTHOR(S): G.Baert
CLASSIFICATION FAO: Gleyic Arenosol(1988) Arenic Eutric Fluvisol (1974)
ST : Typic Psammaquent
LANDFORM : alluvial plain
TOPOGRAPHY: almost flat
SURF. CHAR: no sealing, no cracks, nil evidence of salt, bleached sand on surface
LAND USE: traditional grazing
SPECIES : Trees -
: Shrubs -
: Grasses/forbs-
PARENT MATERIAL: alluvium
MOIST. COND: moist 0 - 30 , dry 30 - 110, moist 110 - 125 cm
SURF.STONES: none
EROSION : nil

GRID : - -
COORD: 20-07-55-S 23-09-05-E
DATE : 31/10/86

LAND ELEMENT : flood plain
MICRO TOPOGRAPHY: termite mounds

VEGETATION: grassland

ROCK TYPE:

ROCK OUTCROP: none

AGRO CLIM.ZONE: 2C3
ELEVATION :

SMR: aquic

POSITION: intermediate part
SLOPE : 0 - 1 % straight

GRASSCOVER:

GEOL.UNIT:
DRAINAGE : moderately well drained

HUMAN INF: nil

REMARKS: Augering 125+ watertable at 180cm. Sand throughout

SAMPLES:

A 0 - 23 cm 10YR 3.5/2 (moist), fine sand, very weak fine and medium subangular blocky structure, very friable, common very fine and fine pores, non calcareous, many very fine and fine roots, clear wavy boundary.

C1 23 - 72 cm 10YR 5/1 (moist) and 10YR 6.5/1 (dry), fine sand, weakly coherent massive structure, soft to slightly hard, few very fine and fine pores, non calcareous, common very fine and fine roots, abrupt wavy boundary.

C2 72 - 110 cm 10YR 5/2 (moist) and 10YR 6/2 (dry), fine sand to loamy sand, massive structure, hard, common very fine and fine pores, non calcareous, few very fine and fine roots, gradual smooth boundary.

C3 110 - 125 cm 10YR 6/2 (moist), fine sand to sand, weakly coherent massive structure, very friable, common very fine and fine pores, non calcareous, few very fine and fine roots,

SOIL PROFILE DESCRIPTION

Profile: MA 0903 Unit: A31a Status: 1

SHEET : 1923D3
LOCATION : Maun-Daonara, 21km NE from Maun, 1.5km E.
AUTHOR(S): A.Remmelzwaal K.Verbeek G.Baert
CLASSIFICATION FAO: Eutric Gleysol(1988) Eutric Gleysol (1974)
ST : Mollic Haplaquept ; fine loamy mixed hyperthermic
LANDFORM : alluvial plain
TOPOGRAPHY: almost flat
SURF. CHAR: slight sealing, no cracks, nil evidence of salt,
LAND USE: traditional grazing
SPECIES : Trees -
: Shrubs -
: Grasses/forbs- Sesbania spp. (dom)
PARENT MATERIAL: alluvium
MOIST. COND: dry 0 - 100, slightly moist 100 - 160 cm
SURF.STONES: none
EROSION : slight accumulation by water

GRID : - -
COORD: 19-50-58-S 23-32-00-E
DATE : 03/07/86

LAND ELEMENT : flood plain
MICRO TOPOGRAPHY: even

VEGETATION: forbland

ROCK TYPE:

ROCK OUTCROP: none

AGRO CLIM.ZONE: 2C2
ELEVATION : 928 m

SMR: aquic

POSITION: lower part
SLOPE : 0 - 0.5%

GRASSCOVER:

GEOL.UNIT:
DRAINAGE : poorly drained

HUMAN INF: nil

REMARKS: USDA pedon 21 (Typic Argiaquoll) with modifications. Excursionsite FAO-EASC meeting 6/4/87,on slightly higher position:second hor.(sedimentary white sand)interpreted as albic-E(Mollic Planosol). Regularly flooded.White sand in cracks Bg1 hor.Near MA0230

SAMPLES: A: 0 - 12 B: 12 - 32 C: 32 - 65 D: 65 - 100 E: 100 - 130 F: 130 - 160

A 0 - 12 cm 10YR 3/1.5 (moist) and 10YR 4/1.5 (dry), sandy clay loam, weak medium and coarse subangular blocky structure, slightly hard firm, slightly sticky plastic, many very fine and fine and few medium pores, non calcareous, many very fine and fine roots, abrupt wavy boundary.

Bg1 12 - 32 cm 10YR 3.5/1- (moist) and 10YR 4.5/1- (dry), sandy clay to clay, weak very coarse prismatic falling apart into weak coarse and very coarse angular and subangular blocky structure, very hard very firm, slightly sticky plastic, few very fine and fine pores, non calcareous, few very fine roots, clear wavy boundary.

Bg2 32 - 65 cm 10YR 3.5/1- (moist) and 10YR 4.5/1- (dry), sandy clay to clay, weak very coarse prismatic falling apart into weak very coarse angular and subangular blocky structure, very hard very firm, slightly sticky plastic, few very fine and fine pores, non calcareous, few very fine roots, gradual smooth boundary.

Bg3 65 - 100 cm 10YR 3/1- (moist) and 10YR 4.5/1- (dry), clay, very weak very coarse prismatic falling apart into very weak very coarse angular and subangular blocky structure, very hard very firm, slightly sticky plastic, broken pressure faces, few very fine and fine pores, non calcareous, few very fine roots, gradual wavy boundary.

Cg1 100 - 130 cm 10YR 3/1- (moist) and 10YR 5/1- (dry), common medium distinct clear yellowish-brown mottles, sandy clay to clay, strongly coherent massive structure, very hard very firm, slightly sticky plastic, few very fine pores, non calcareous, very few very fine roots, gradual irregular boundary.

Cg2 130 - 160 cm 10YR 3.5/1- (moist) and 10YR 5/1- (dry), many medium distinct clear yellowish-brown mottles, sandy clay, strongly coherent massive structure, very hard very firm, slightly sticky plastic, few very fine pores, very few medium soft calcareous white nodules and very few coarse soft calcareous white nodules, non calcareous, very few very fine roots,

S T A N D A R D S O I L A N A L Y S I S R E S U L T S

PROFILE: MA 0903

SAMPLE	DEPTH		pH		EC	P	C	CEC	Ca	Mg	K	Na	PBS	Particle size (weight %)								CECclay	METH	PRETR
			H2O	CaCL2	mS/cm	ppm	weight %	ù-----	meq/100gr soil			------ù	%	vcS	cS	mS	fS	vfS	cSi	fSi	Clay	meq/100gr		
A	0	12	6.3	5.8	0.0	2	3.3	17.6	12.1	3.1	1.4	0.0	94	0	1	11	42	6	2	7	31	14		
B	12	32	6.5	6.0	0.0	5	0.9	21.9	15.1	4.6	1.3	0.1	96	0	0	7	32	6	2	8	44	42		
C	32	65	6.8	6.2	0.0	6	0.9	22.2	14.5	4.6	1.3	0.1	92	0	1	8	32	6	2	9	43	43		
D	65	100	7.2	6.5	0.0	4	0.3	21.2	14.8	4.5	1.2	0.1	97	0	1	7	32	6	1	3	51	39		
E	100	130	7.3	6.5	0.0	5	0.2	20.1	13.7	4.2	1.1	0.2	96	0	1	8	33	6	3	6	44	44		
F	130	160	7.2	6.4	0.0	3	0.1	19.5	12.7	3.8	1.0	0.1	90	0	1	10	38	6	2	4	39	49		

Soil Survey of Botswana FAO/BOT/85/011 Print date: 24/05/89

PART.SIZE DETERMINATION METHOD: H = Hydrometer Method, P = Pipette Method, * = Not Known
PRETREATMENT: O = Organic Matter, F = Free Iron Oxides, C = Carbonates, S = Soluble Salts N = None

SOIL PROFILE DESCRIPTION

Profile: TO 0903 Unit: A40 Status: 1

SHEET : 2023A3
LOCATION : Maun-Toteng, 50km from Maun,4km SE.
AUTHOR(S): A.Remmelzwaal G.Baert K.Verbeek B.Kopelo
CLASSIFICATION FAO: Eutri-Haplic Arenosol(1988) Eutric Arenosol (1974)
ST : Ustic Quartzipsamment
LANDFORM : alluvial plain
TOPOGRAPHY: almost flat
SURF. CHAR: no sealing, no cracks, nil evidence of salt,
LAND USE: traditional grazing
SPECIES : Trees - Lonchocarpus nelsii (dom.) Acacia erioloba Terminalia sericea Combretum apiculatum
: Shrubs - Ximenia americana (dom.) Acacia fleckii Combretum apiculatum
: Grasses/forbs-
PARENT MATERIAL: alluvium
MOIST. COND: moist 0 - 90 , dry 90 - 150 cm
SURF.STONES: none
EROSION : nil

GRID : - -
COORD: 20-18-45-S 23-05-45-E
DATE : 15/04/86

LAND ELEMENT : terrace
MICRO TOPOGRAPHY: even

VEGETATION: dense tree savanna

ROCK TYPE:

ROCK OUTCROP: none

AGRO CLIM.ZONE: 2C3
ELEVATION : 930 m

SMR: ustic

POSITION: intermediate part
SLOPE : 0 - 1 %

GRASSCOVER:

GEOL.UNIT:
DRAINAGE : somewhat excessively drained

HUMAN INF: nil

REMARKS: Elongate, white, small to large mottles occur partially along rootchannels also.

SAMPLES: A: 0 - 30 B: 30 - 60 C: 60 - 90 D: 90 - 120 E: 120 - 150

A	0 - 30 cm	10YR 2.5/2 (moist) and 10YR 3.5/2 (dry), few fine faint clear white mottles, fine sand, weak medium and coarse subangular blocky structure, soft very friable, non sticky non plastic, few very fine and fine pores, non calcareous, common very fine and fine and very few coarse roots, gradual smooth boundary.
AC	30 - 60 cm	10YR 3/2 (moist) and 10YR 4/2 (dry), common medium distinct clear white mottles, fine sand, very weak coarse and very coarse subangular blocky structure, soft very friable, non sticky non plastic, few very fine and fine pores, non calcareous, few fine and medium roots, diffuse smooth boundary.
C1	60 - 90 cm	10YR 4/2 (moist) and 10YR 5/2 (dry), common medium distinct clear white mottles, fine sand, weakly coherent massive structure, slightly hard very friable to friable, non sticky non plastic, few very fine and fine pores, non calcareous, few medium roots, diffuse smooth boundary.
C2	90 - 120 cm	10YR 5/2 (moist) and 10YR 5.5/2 (dry), few medium distinct clear white mottles, fine sand, massive structure, slightly hard to hard friable, non sticky non plastic, few very fine pores, non calcareous, very few fine and medium roots, diffuse smooth boundary.
C3	120 - 150 cm	10YR 5.5/2 (moist) and 10YR 6.5/2 (dry), fine sand, massive structure, slightly hard to hard friable, non sticky non plastic, few very fine pores, non calcareous, very few fine and medium roots,

S T A N D A R D S O I L A N A L Y S I S R E S U L T S

PROFILE: TO 0903

SAMPLE	DEPTH		pH		EC	P	C	CEC	Ca	Mg	K	Na	PBS	Particle size (weight %)								CECclay	METH	PRETR
			H2O	CaCL2	mS/cm	ppm	weight %	ù-----	meq/100gr soil			------ù	%	vcS	cS	mS	fS	vfS	cSi	fSi	Clay	meq/100gr		
A	0	30	6.4	5.2	0.0	1	0.1	5.9	3.0	0.2	0.0	0.1	56	0	1	20	67	7	5	5	-5	***	H	
B	30	60	6.5	5.3	0.0	1	0.1	4.1	2.9	0.3	0.0	0.1	80	0	2	26	63	5	0	0	4	95	H	
C	60	90	6.8	5.7	0.0	1	0.1	3.9	2.8	0.3	0.0	0.1	82	0	2	23	65	6	0	0	4	90	H	
D	90	120	6.9	6.3	0.0	1	0.0	4.1	2.9	0.3	0.0	0.1	80	0	1	22	65	7	1	1	2	178	H	
E	120	150	7.0	6.3	0.0	1	0.0	5.5	2.8	0.2	0.0	0.1	56	0	2	20	68	6	1	1	3	172	H	

Soil Survey of Botswana FAO/BOT/85/011 Print date: 24/05/89

PART.SIZE DETERMINATION METHOD: H = Hydrometer Method, P = Pipette Method, * = Not Known
PRETREATMENT: O = Organic Matter, F = Free Iron Oxides, C = Carbonates, S = Soluble Salts N = None

SOIL PROFILE DESCRIPTION

Profile: MA 0418 Unit: A40a Status: 2

SHEET : 1923B2
LOCATION : 7.5km N of Khwai river lodge.
AUTHOR(S): A.Remmelzwaal G.J.Rhebergen G.Baert K.Verbeek
CLASSIFICATION FAO: Haplic Arenosol(1988) Eutric Arenosol (1974)
ST : Ustic Quartzipsamment
LANDFORM : plain
TOPOGRAPHY: gently undulating
SURF. CHAR: no cracks, nil evidence of salt, bleached sand on surface
LAND USE: wildlife management area
SPECIES : Trees - Acacia erioloba (dom.) Colophospermum mopane Lonchocarpus capassa Combretum imberbe Combretum hereroense
: Shrubs - Acacia hebeclada (dom.) Acacia tortilis subs. heterocantha
: Grasses/forbs-
PARENT MATERIAL: alluvium
MOIST. COND: dry 0 - 110 cm
SURF.STONES: none
EROSION : nil

GRID : - -
COORD: 19-04-55-S 23-50-00-E
DATE : 11/07/85

LAND ELEMENT : terrace
MICRO TOPOGRAPHY: low hummocks

VEGETATION: tree savanna

ROCK TYPE:

ROCK OUTCROP: none

AGRO CLIM.ZONE: 1B2
ELEVATION :

SMR: ustic

POSITION: intermediate part
SLOPE : 0.5 - 1 %

GRASSCOVER:

GEOL.UNIT:
DRAINAGE : well drained

HUMAN INF: nil

REMARKS: Hard consisteny,not structureless as unit A40.

SAMPLES: A: 0 - 20 B: 90 - 110

A 0 - 10 cm 10YR 3.5/2 (moist) and 10YR 5/1.5 (dry), sand to fine sand, very weak medium subangular blocky structure, slightly hard, few very fine and fine pores, non calcareous, very few roots, clear smooth boundary.

C 10 - 110 cm 10YR 3.5/1.5 (moist) and 10YR 4.5/1.5 (dry), sand to fine sand, massive structure, hard, few very fine and fine pores, non calcareous, very few roots,

S T A N D A R D S O I L A N A L Y S I S R E S U L T S

PROFILE: MA 0418

SAMPLE	DEPTH		pH		EC	P	C	CEC	Ca	Mg	K	Na	PBS	Particle size (weight %)								CECclay	METH	PRETR
			H2O	CaCL2	mS/cm	ppm	weight %	ù-----	meq/100gr soil			------ù	%	vcS	cS	mS	fS	vfS	cSi	fSi	Clay	meq/100gr		
A	0	20	5.8	5.2	0.0	1	0.4	4.0	1.4	0.8	3.4	0.0	100	0	1	14	65	9	2	4	4	60	H	
B	90	110	6.2	5.8	0.0	1	0.1	4.2	1.8	1.0	3.2	0.1	100	0	1	18	63	7	1	1	9	42	H	

Soil Survey of Botswana FAO/BOT/85/011 Print date: 14/04/89

PART.SIZE DETERMINATION METHOD: H = Hydrometer Method, P = Pipette Method, * = Not Known
PRETREATMENT: O = Organic Matter, F = Free Iron Oxides, C = Carbonates, S = Soluble Salts N = None

SOIL PROFILE DESCRIPTION

Profile: TO 0861 Unit: A44 Status: 1

SHEET :
LOCATION : 22.3km along cutline North West of Toteng.
AUTHOR(S): K.Verbeek R.Kelebemang P.Jamagne
CLASSIFICATION FAO: Areni-Albic Luvisol(1988) Albic Luvisol (1974) sodic phase
ST : Arenic Haplustalf
LANDFORM : dune field
TOPOGRAPHY: almost flat
SURF. CHAR: no sealing, no cracks, nil evidence of salt, bleached sand on surface
LAND USE: traditional grazing
SPECIES : Trees - Acacia luederitzii var.luederitzii (dom.) Colophospermum mopane Boscia albitrunca
: Shrubs - Colophospermum mopane (dom.) Acacia mellifera Grewia flava
: Grasses/forbs-
PARENT MATERIAL: alluvium
MOIST. COND: dry 0 - 120 cm
SURF.STONES: none
EROSION : slight wind erosion/deposition

GRID : - -
COORD: 20-10-30-S 22-52-10-E
DATE : 03/11/87

LAND ELEMENT : depression
MICRO TOPOGRAPHY: low hummocks

VEGETATION: dense tree savanna

ROCK TYPE:

ROCK OUTCROP: none

AGRO CLIM.ZONE: 2C3
ELEVATION :

SMR: ustic

POSITION: intermediate part
SLOPE : 0 - 1 % straight

GRASSCOVER: 10 - 30 %

GEOL.UNIT:
DRAINAGE : excessively drained

HUMAN INF: nil

REMARKS: In association with A40 on higher located areas ,more open Terminalia sericea tree savanna.

SAMPLES: A: 0 - 20 B: 30 - 50 C: 65 - 85 D: 90 - 110

A1 0 - 20 cm 10YR 4.5/2 (moist) and 10YR 6.5/2 (dry), fine sand (5% clay), weak medium and coarse subangular blocky structure, soft, many very fine and fine pores, non calcareous, many very fine and fine roots, clear smooth boundary.

A2 20 - 60 cm 10YR 4.5/2 (moist) and 10YR 6.5/2 (dry), fine sand (5% clay), weak very coarse angular and subangular blocky falling apart into weak medium and coarse angular and subangular blocky structure, slightly hard, common very fine and fine pores, non calcareous, common very fine and fine and common medium roots, clear smooth boundary.

E 60 - 85 cm 10YR 5/2 (moist) and 10YR 7/2 (dry), fine sand (3% clay), weak medium to very coarse angular and subangular blocky structure, slightly hard, common very fine and fine pores, non calcareous, common very fine and fine roots, abrupt smooth boundary.

2Bt 85 - 120 cm 10YR 4/3 (moist) and 10YR 5/3 (dry), common medium faint diffuse greyish mottles, loamy fine sand (10% clay), strongly coherent massive structure, extremely hard, patchy thin clay cutans on pedfaces, partly cemented, few very fine and fine pores, non calcareous, no roots,

S T A N D A R D S O I L A N A L Y S I S R E S U L T S

PROFILE: TO 0861

SAMPLE	DEPTH		pH		EC	P	C	CEC	Ca	Mg	K	Na	PBS	Particle size (weight %)								CECclay	METH	PRETR
			H2O	CaCL2	mS/cm	ppm	weight %	ù-----	meq/100gr soil			------ù	%	vcS	cS	mS	fS	vfS	cSi	fSi	Clay	meq/100gr		
A	0	20	6.0	5.9	0.1	4	0.4	2.4	1.5	0.3	0.2	0.1	88	0	1	25	59	8	4	1	3	28	H	
B	30	50	5.0	4.7	0.1	2	0.2	2.3	0.7	0.3	0.2	0.1	57	0	1	22	61	9	3	2	2	62	H	
C	65	85	5.4	5.0	0.1	1	0.2	1.8	0.3	0.1	0.0	0.2	33	2	1	22	55	7	5	4	4	24	H	
D	90	110	7.4	7.1	0.1	1	0.2	6.2	1.0	0.5	0.3	4.2	97	0	1	23	53	7	3	4	9	59	H	

Soil Survey of Botswana FAO/BOT/85/011

Print date: 24/05/89

PART.SIZE DETERMINATION METHOD: H = Hydrometer Method, P = Pipette Method, * = Not Known
PRETREATMENT: O = Organic Matter, F = Free Iron Oxides, C = Carbonates, S = Soluble Salts N = None

SOIL PROFILE DESCRIPTION

Profile: TO 0831 Unit: C05c Status: 1

SHEET :
LOCATION : Kuke fence 55.1km West of Kuke from Kuke corner.
AUTHOR(S): D.Kwape E.Van Waveren
CLASSIFICATION FAO: Petric Calcisol(1988) Calcic Luvisol (1974) petrocalcic phase
ST : Petrocalcic Paleustalf
LANDFORM : dune field
TOPOGRAPHY: gently undulating
SURF. CHAR: slight sealing, no cracks, nil evidence of salt,
LAND USE: commercial grazing
SPECIES : Trees -
: Shrubs - Catophractes alexandri (dom.) Grewia flava Acacia hebeclada Dichrostachys cinerea
: Grasses/forbs-
PARENT MATERIAL: lacustrine
MOIST. COND: dry 0 - 40 cm
SURF.STONES: none
EROSION : slight wind erosion

GRID : - -
COORD: 20-59-00-S 23-21-40-E
DATE : 16/05/87

LAND ELEMENT : interdunal depression
MICRO TOPOGRAPHY: medium hummocks

VEGETATION: open low shrub savanna

ROCK TYPE:

ROCK OUTCROP: none

AGRO CLIM.ZONE: 3C3
ELEVATION :

SMR: aridic

POSITION: lower part
SLOPE : 0 - 1 % concave

GRASSCOVER: < 10 %

GEOL.UNIT:
DRAINAGE : imperfectly drained

HUMAN INF: nil

REMARKS: Location on 1:250 000 to topographical sheet SF 34.4,no other map exist.Clay increase not confirmed by Lab analysis.

SAMPLES: A: 0 - 20 B: 20 - 40

A	0 - 20 cm	10YR 3/2 (moist) and 10YR 5/2 (dry), fine sand, weak medium and coarse subangular blocky structure, slightly hard, many very fine and few fine pores, non calcareous, many very fine and few fine and medium roots, gradual smooth boundary.
Btk	20 - 40 cm	10YR 3/2 (moist) and 10YR 4/2 (dry), loamy fine sand, weak medium and coarse subangular blocky structure, slightly hard, patchy thin clay cutans on pedfaces, many very fine and few fine pores, few fine spherical hard calcareous white nodules, strongly calcareous, many very fine and fine and few medium roots, abrupt wavy boundary.
Cck	40 cm +	10YR 7/2 (moist) and 10YR 8/1 (dry), weakly coherent massive structure, soft, dominant medium irregular hard and soft calcareous white nodules, strongly calcareous, no roots,

S T A N D A R D S O I L A N A L Y S I S R E S U L T S

PROFILE: TO 0831

SAMPLE	DEPTH		pH		EC	P	C	CEC	Ca	Mg	K	Na	PBS	Particle size (weight %)								CECclay	METH	PRETR
			H2O	CaCL2	mS/cm	ppm	weight %	ù-----	meq/100gr soil			------ù	%	vcS	cS	mS	fS	vfS	cSi	fSi	Clay	meq/100gr		
A	0	20	7.5	7.4	0.1	3	0.4	5.2	8.2	1.3	0.2	0.0	100	0	4	20	48	9	2	1	16	23	H	
B	20	40	7.7	7.5	0.1	2	0.4	4.7	17.1	1.3	0.2	0.0	100	0	4	19	45	9	3	2	18	18	H	

Soil Survey of Botswana FAO/BOT/85/011 Print date: 24/05/89

PART.SIZE DETERMINATION METHOD: H = Hydrometer Method, P = Pipette Method, * = Not Known
PRETREATMENT: O = Organic Matter, F = Free Iron Oxides, C = Carbonates, S = Soluble Salts N = None

SOIL PROFILE DESCRIPTION

Profile: TO 0901 Unit: L7 Status: 1

SHEET : 2022B4
LOCATION : Lake Ngami.
AUTHOR(S): A.B.Price M.D.Mays A.Remmelzwaal
CLASSIFICATION FAO: Eutric Gleysol(1988) Eutric Gleysol (1974)
ST : Typic Haplaquept ; very fine mixed hyperthermic
LANDFORM : lacustrine plain
TOPOGRAPHY: flat
SURF. CHAR: no sealing, no cracks, nil evidence of salt,
LAND USE: traditional grazing
SPECIES : Trees -
: Shrubs -
: Grasses/forbs- Sesbania spp. (dom)
PARENT MATERIAL: lacustrine
MOIST. COND: moist 0 - 150 cm
SURF.STONES: none
EROSION : slight accumulation by water

GRID : - -
COORD: 20-25-10-S 22-49-50-E
DATE : 24/03/86

LAND ELEMENT : not applicable
MICRO TOPOGRAPHY: even

VEGETATION: forbland

ROCK TYPE:

ROCK OUTCROP: none

AGRO CLIM.ZONE: 3C3
ELEVATION : 920 m

SMR: aquic

POSITION: lower part
SLOPE : 0 - %

GRASSCOVER:

GEOL.UNIT:
DRAINAGE : poorly drained

HUMAN INF: nil

REMARKS: USDA pedon 7 (Eutric Fluvisol) with modifications. Land element:lake bottom,dry since 1983.Platy stucture in C horizon is sedimentary. Rusty mottles along rootchannels. - 2cm loam layer at 64cm.

SAMPLES: A: 0 - 9 B: 9 - 29 C: 29 - 64 D: 64 - 110 E: 110 - 128 F: 128 - 150

A	0 - 9 cm	2.5Y 4/2 (moist) and 2.5Y 6/2 (dry), many fine distinct clear yellowish-brown mottles, clay, moderate medium subangular blocky falling apart into weak fine granular structure, very hard firm, sticky plastic, many very fine pores, non calcareous, many very fine roots, clear wavy boundary.
Bg	9 - 29 cm	2.5Y 3/1 (moist) and 2.5Y 6/1 (dry), many coarse prominent sharp yellowish-brown mottles, clay, weak very coarse prismatic falling apart into weak coarse subangular and angular blocky structure, slightly hard friable, sticky plastic, few very fine pores, non calcareous, common very fine and fine roots, clear wavy boundary.
CBg	29 - 64 cm	2.5Y 3/0.5 (moist) and 2.5Y 6/1 (dry), many coarse prominent sharp yellowish-brown mottles, clay, moderate medium platy to very weak very coarse prismatic structure, extremely hard very firm, sticky plastic, non calcareous, common very fine roots, clear smooth boundary.
2Cg1	64 - 110 cm	2.5Y 2/0.5 (moist) and 2.5Y 6/1 (dry), common coarse prominent sharp brown mottles, clay, massive structure, hard firm, sticky plastic, few very fine pores, non calcareous, few very fine and fine roots, clear wavy boundary.
2Cg2	110 - 128 cm	2.5Y 4/1 (moist) and 2.5Y 6/1 (dry), many coarse distinct diffuse brownish mottles, sandy clay to clay, strongly coherent massive structure, very hard firm, sticky plastic, few very fine and fine pores, non calcareous, few very fine and fine roots, gradual wavy boundary.
2Cg3	128 - 150 cm	2.5Y 4/1 (moist) and 2.5Y 7/1 (dry), common coarse prominent clear brown mottles, clay, strongly coherent massive structure, extremely hard very firm, sticky plastic, few fine and medium pores, non calcareous, few very fine roots,

S T A N D A R D S O I L A N A L Y S I S R E S U L T S

PROFILE: TO 0901

SAMPLE	DEPTH		pH		EC	P	C	CEC	Ca	Mg	K	Na	PBS	Particle size (weight %)								CECclay	METH	PRETR
			H2O	CaCL2	mS/cm	ppm	weight %	ù-----	meq/100gr soil			------ù	%	vcS	cS	mS	fS	vfS	cSi	fSi	Clay	meq/100gr		
A	0	9	4.0	3.9	0.0	5	8.0	41.0	18.1	5.4	1.6	0.8	63	2	2	1	2	2	4	21	67	13		
B	9	29	3.8	3.6	0.0	7	6.8	44.8	13.1	4.2	1.0	0.4	42	2	1	1	1	1	2	16	76	23		
C	29	64	3.9	3.7	0.0	3	3.7	43.4	16.5	5.4	1.1	0.6	54	1	3	4	4	3	2	23	61	47		
D	64	110	3.7	3.4	0.0	1	1.5	24.1	8.5	2.3	0.8	0.6	51	2	2	1	5	3	3	2	81	22		
E	110	128	4.0	3.4	0.0	5	0.6	14.5	7.1	1.8	0.5	0.3	67	0	0	2	33	5	3	14	44	28		
F	128	150	4.3	3.9	0.0	4	0.4	24.0	14.8	3.7	1.0	0.3	82	0	0	2	12	3	4	14	65	34		

Soil Survey of Botswana FAO/BOT/85/011 Print date: 24/05/89

PART.SIZE DETERMINATION METHOD: H = Hydrometer Method, P = Pipette Method, * = Not Known
PRETREATMENT: O = Organic Matter, F = Free Iron Oxides, C = Carbonates, S = Soluble Salts N = None

SOIL PROFILE DESCRIPTION

Profile: TO 0665 Unit: L11 Status: 1

SHEET : 2023B4
LOCATION : 5.6km from Makalamabedi South gate to BH.5016.
AUTHOR(S): K.Verbeek R.Kelebemang
CLASSIFICATION FAO: Epi-Calcic Arenosol(1988) Calcic Arenosol (1974)
ST : Grossarenic Ustochrept
LANDFORM : lacustrine plain
TOPOGRAPHY: almost flat
SURF. CHAR: no sealing, no cracks, nil evidence of salt, bleached sand on surface
LAND USE: traditional grazing
SPECIES : Trees - Terminalia prunioides (dom.) Acacia sp.
: Shrubs - Dichrostachys cinerea (dom.)
: Grasses/forbs-
PARENT MATERIAL: lacustrine
MOIST. COND: dry 0 - 120 cm
SURF.STONES: none
EROSION : nil

GRID : GN-988-452
COORD: 20-22-10-S 23-51-45-E
DATE : 14/10/86

LAND ELEMENT : delta
MICRO TOPOGRAPHY: termite mounds

VEGETATION: dense tree savanna

ROCK TYPE:

ROCK OUTCROP: none

AGRO CLIM.ZONE: 2C3
ELEVATION :

SMR: ustic

POSITION: higher part
SLOPE : 0 - 1 % straight

GRASSCOVER:

GEOL.UNIT:
DRAINAGE : well drained

HUMAN INF: nil

REMARKS: Slight clay increase in depth

SAMPLES: A: 0 - 10 B: 10 - 40 C: 40 - 75 D: 90 - 110

A 0 - 10 cm 2.5Y 4/2 (moist) and 2.5Y 5.5/2 (dry), fine sand, weak medium and coarse subangular blocky structure, slightly hard, common very fine and fine pores, strongly calcareous, many very fine and fine roots, clear smooth boundary.

Bk1 10 - 40 cm 2.5Y 4/3 (moist) and 2.5Y 6/3 (dry), fine sand, weak medium and coarse subangular blocky structure, slightly hard, many very fine and fine pores, frequent fine spherical soft calcareous white nodules, strongly calcareous, many very fine and fine roots, gradual smooth boundary.

Bk2 40 - 75 cm 2.5Y 4/3 (moist) and 2.5Y 5.5/3 (dry), fine sand, weak medium subangular blocky structure, slightly hard, many very fine and fine pores, frequent fine spherical soft calcareous white nodules, strongly calcareous, many very fine and few medium roots, clear smooth boundary.

Ck 75 - 120 cm 2.5Y 5/2.5 (moist) and 2.5Y 6.5/2 (dry), fine sand, massive structure, slightly hard to hard, many very fine and fine pores, frequent fine spherical soft calcareous white nodules, extremely calcareous, very few very fine and fine roots,

S T A N D A R D S O I L A N A L Y S I S R E S U L T S

PROFILE: TO 0665

SAMPLE	DEPTH		pH		EC	P	C	CEC	Ca	Mg	K	Na	PBS	Particle size (weight %)								CECclay	METH	PRETR
			H2O	CaCL2	mS/cm	ppm	weight %	ù-----	meq/100gr soil			------ù	%	vcS	cS	mS	fS	vfS	cSi	fSi	Clay	meq/100gr		
A	0	10	8.4	7.5	0.1	6	0.3	2.1	25.1	3.3	0.4	0.8	100	0	0	17	62	7	2	2	11	8	H	
B	10	40	8.5	7.7	0.1	3	0.2	1.9	25.5	3.9	0.3	0.8	100	0	1	15	67	6	2	2	7	16	H	
C	40	75	8.5	7.6	0.2	4	0.2	1.7	24.4	2.9	0.2	0.9	100	1	1	15	61	7	3	1	11	8	H	
D	90	110	8.7	7.9	0.1	1	0.1	1.8	35.4	3.6	0.3	0.8	100	0	0	18	57	6	2	1	15	9	H	

Soil Survey of Botswana FAO/BOT/85/011 Print date: 24/05/89

PART.SIZE DETERMINATION METHOD: H = Hydrometer Method, P = Pipette Method, * = Not Known
PRETREATMENT: O = Organic Matter, F = Free Iron Oxides, C = Carbonates, S = Soluble Salts N = None

SOIL PROFILE DESCRIPTION

Profile: MA 0106 Unit: L24a Status: 1

SHEET : 1923D3
LOCATION : Xhwaa molapo.
AUTHOR(S): K.Verbeek G.Baert
CLASSIFICATION FAO: Luvic Calcisol(1988) Calcic Luvisol (1974) sodic phase
ST : Typic Haplustalf
LANDFORM : alluvial plain
TOPOGRAPHY: almost flat
SURF. CHAR: no cracks, nil evidence of salt,
LAND USE: traditional grazing
SPECIES : Trees -
: Shrubs -
: Grasses/forbs-
PARENT MATERIAL: lacustrine
MOIST. COND: dry 0 - 10 , moist 10 - 110 cm
SURF.STONES: none
EROSION : nil

GRID : - -
COORD: 19-45-38-S 23-37-47-E
DATE : 14/02/85

LAND ELEMENT : island
MICRO TOPOGRAPHY: even

VEGETATION: grassland

ROCK TYPE:

ROCK OUTCROP: none

AGRO CLIM.ZONE: 2C2
ELEVATION :

SMR: ustic

POSITION: lower part
SLOPE : 0 - 1 %

GRASSCOVER:

GEOL.UNIT:
DRAINAGE : imperfectly drained

HUMAN INF: nil

REMARKS: Depression on island. Repeat EC, check for saline phase.

SAMPLES: A: 0 - 10 B: 20 - 40 C: 80 - 100

A 0 - 15 cm 10YR 5.5/1.5 (moist) and 10YR 6.5/1 (dry), fine sand to loamy fine sand, weak medium subangular blocky structure, slightly hard, strongly calcareous, few roots, abrupt smooth boundary.

Btk1 15 - 50 cm 10YR 4/2 (moist), common coarse distinct diffuse black mottles, sandy loam, weak coarse and very coarse subangular blocky structure, firm, broken thin clay cutans on pedfaces, strongly calcareous, few roots, clear smooth boundary.

Btk2 50 - 110 cm 10YR 3/2 (moist), many coarse distinct diffuse black mottles, sandy clay loam, weak coarse subangular blocky structure, very firm, broken thin clay cutans on pedfaces, strongly calcareous, very few roots,

S T A N D A R D S O I L A N A L Y S I S R E S U L T S

PROFILE: MA 0106

SAMPLE	DEPTH		pH		EC	P	C	CEC	Ca	Mg	K	Na	PBS	Particle size (weight %)								CECclay	METH	PRETR
			H2O	CaCL2	mS/cm	ppm	weight %	ù-----	meq/100gr soil			------ù	%	vcS	cS	mS	fS	vfS	cSi	fSi	Clay	meq/100gr		
A	0	10	10.1	8.9	0.7	3	0.2	7.4	12.5	1.0	2.0	6.2	100	0	1	24	46	9	4	7	10	66	H	
B	20	40	10.4	9.8	1.2	6	0.1	10.9	5.5	0.7	1.5	6.9	100	0	1	10	53	8	3	10	16	64	H	
C	80	100	10.6	9.2	3.5	28	0.1	14.0	3.1	0.4	1.6	14.0	100	0	1	10	52	7	2	4	24	57	H	

Soil Survey of Botswana FAO/BOT/85/011 Print date: 14/04/89

PART.SIZE DETERMINATION METHOD: H = Hydrometer Method, P = Pipette Method, * = Not Known
PRETREATMENT: O = Organic Matter, F = Free Iron Oxides, C = Carbonates, S = Soluble Salts N = None

SOIL PROFILE DESCRIPTION

Profile: MA 0421 Unit: L36 Status: 2

SHEET :
LOCATION : Mababe depression E-W cutline.
AUTHOR(S): G.Baert K.Verbeek R.Kelebemang
CLASSIFICATION FAO: Calcic Chernozem(1988) Calcic Chernozem (1974)
ST : Typic Calciaquoll
LANDFORM : lacustrine plain
TOPOGRAPHY: almost flat
SURF. CHAR: no cracks, nil evidence of salt,
LAND USE: no apparent management system
SPECIES : Trees -
: Shrubs - Acacia tortilis subs. heterocantha (dom.)
: Grasses/forbs-
PARENT MATERIAL: lacustrine
MOIST. COND: dry 0 - 120 cm
SURF.STONES: none
EROSION : slight wind erosion/deposition

GRID : - -
COORD: 19-01-28-S 24-00-22-E
DATE : 17/09/85

LAND ELEMENT : not applicable
MICRO TOPOGRAPHY: even

VEGETATION: open shrub savanna

ROCK TYPE:

ROCK OUTCROP: none

AGRO CLIM.ZONE: 1B2
ELEVATION :

SMR: ustic-aquic

POSITION: intermediate part
SLOPE : 0 - 0.5%

GRASSCOVER:

GEOL.UNIT:
DRAINAGE : imperfectly drained

HUMAN INF: nil

REMARKS: Lime nodules at surface.Horizon CK is nearly pure lime.Augering from 80cm onwards.

SAMPLES: A: 0 - 25 B: 30 - 50 C: 90 - 120

A	0 - 25 cm	10YR 2/1- (moist) and 10YR 4/1- (dry), clay, moderate fine to coarse subangular and angular blocky structure, very hard, common fine and medium pores, few fine spherical soft calcareous white nodules, non calcareous, common fine and medium roots, clear wavy boundary.
Btk1	25 - 55 cm	10YR 3.5/1 (moist) and 10YR 4.5/1 (dry), clay, moderate fine subangular blocky structure, slightly hard to hard, common fine and medium pores, frequent coarse irregular soft calcareous white nodules, strongly calcareous, very few roots, clear smooth boundary.
Btk2	55 - 120 cm	10YR 3.5/2 (moist) and 10YR 7.5/1.5 (dry), clay, weak medium and coarse subangular blocky structure, hard, common very fine and fine pores, frequent coarse irregular soft calcareous white nodules and frequent fine irregular soft calcareous white nodules, strongly calcareous, very few roots, gradual smooth boundary.
Ck	120 cm +	10YR 5.5/2 (moist) and 10YR 8/2 (dry), clay, massive structure, hard, strongly calcareous, no roots,

S T A N D A R D S O I L A N A L Y S I S R E S U L T S

PROFILE: MA 0421

SAMPLE	DEPTH		pH		EC	P	C	CEC	Ca	Mg	K	Na	PBS	Particle size (weight %)								CECclay	METH	PRETR
			H2O	CaCL2	mS/cm	ppm	weight %	ù-----	meq/100gr soil			------ù	%	vcS	cS	mS	fS	vfS	cSi	fSi	Clay	meq/100gr		
A	0	25	7.2	6.6	0.0	4	1.5	32.2	66.6	3.4	1.7	0.2	100	0	0	1	4	10	11	22	53	50	H	
B	30	50	7.5	7.3	0.0	1	0.5	25.0	74.6	3.8	0.9	0.4	100	0	0	1	3	8	9	24	55	42	H	
C	90	120	7.8	7.5	0.0	1	0.4	24.1	68.8	7.6	1.0	3.4	100	0	1	1	3	11	8	14	63	36	H	

Soil Survey of Botswana FAO/BOT/85/011 Print date: 24/05/89

PART.SIZE DETERMINATION METHOD: H = Hydrometer Method, P = Pipette Method, * = Not Known
PRETREATMENT: O = Organic Matter, F = Free Iron Oxides, C = Carbonates, S = Soluble Salts N = None

SOIL PROFILE DESCRIPTION

Profile: TO 0318 Unit: L37 Status: 1

SHEET : 2222B4
LOCATION : Lake Ngami.
AUTHOR(S): T.D.Mafoko R.Kelebemang
CLASSIFICATION FAO: Mollic Gleysol (1974)
ST : Haplaquoll
LANDFORM : lacustrine plain
TOPOGRAPHY: almost flat
SURF. CHAR: slight sealing, no cracks, nil evidence of salt,
LAND USE: no apparent management system
SPECIES : Trees -
: Shrubs -
: Grasses/forbs-
PARENT MATERIAL: lacustrine
MOIST. COND: moist 0 - 210 cm
SURF.STONES: none
EROSION : slight accumulation by water

GRID : - -
COORD: 20-29-02-S 22-46-00-E
DATE : 11/02/86

LAND ELEMENT : not applicable
MICRO TOPOGRAPHY: even

VEGETATION: forbland

ROCK TYPE:

ROCK OUTCROP: none

AGRO CLIM.ZONE: 2C3
ELEVATION : 920 m

SMR: aridic

POSITION:
SLOPE : 0 - 0.5%

GRASSCOVER:

GEOL.UNIT:
DRAINAGE : poorly drained

HUMAN INF: nil

REMARKS: Bg sedimentary structure: horizontally laminated. Augering from 160+ watertable at 210cm.

SAMPLES: A: 0 - 20 B: 30 - 50 C: 80 - 100 D: 190 - 210

A 0 - 25 cm 10YR 3/1- (moist), many coarse prominent sharp reddish mottles, clay, moderate fine and medium subangular blocky structure, firm, common fine pores, non calcareous, many fine roots, clear wavy boundary.

Bg 25 - 150 cm 10YR 3/1 (moist), many coarse prominent sharp reddish mottles, clay, weak very coarse prismatic falling apart into moderate fine to coarse angular blocky structure, extremely firm, few fine pores, non calcareous, common roots, abrupt smooth boundary.

C 150 - 210 cm 10YR 3/1 (moist), clay, non calcareous,

S T A N D A R D S O I L A N A L Y S I S R E S U L T S

PROFILE: TO 0318

SAMPLE	DEPTH		pH		EC	P	C	CEC	Ca	Mg	K	Na	PBS	Particle size (weight %)								CECclay	METH	PRETR
			H2O	CaCL2	mS/cm	ppm	weight %	ù-----	meq/100gr soil			------ù	%	vcS	cS	mS	fS	vfS	cSi	fSi	Clay	meq/100gr		
A	0	20	5.0	4.4	0.0	2	1.9	53.8	18.4	6.8	2.3	0.4	52	0	0	0	1	1	3	17	77	60	H	
B	30	50	4.1	3.5	0.0	2	1.8	43.5	14.9	5.4	1.0	0.2	49	0	0	0	1	1	2	14	82	44	H	
C	80	100	3.8	3.4	0.0	2	1.8	43.9	14.8	5.4	0.9	0.2	49	0	0	0	1	1	4	11	83	44	H	
D	190	210	4.5	4.1	0.0	8	1.7	25.8	8.6	2.5	0.9	0.2	47	0	0	1	3	2	6	24	63	30	H	

Soil Survey of Botswana FAO/BOT/85/011 Print date: 08/05/89

PART.SIZE DETERMINATION METHOD: H = Hydrometer Method, P = Pipette Method, * = Not Known
PRETREATMENT: O = Organic Matter, F = Free Iron Oxides, C = Carbonates, S = Soluble Salts N = None

SOIL PROFILE DESCRIPTION

Profile: MA 0060 Unit: KS3 Status: 3

SHEET : 1923D4
LOCATION : 36.5km E of Shorobe, along W-E fence.
AUTHOR(S): G.Baert K.Verbeek
CLASSIFICATION FAO: Ferralic Arenosol(1988) Ferralic Arenosol (1974)
ST : Ustic Quartzipsamment
LANDFORM : sand plain
TOPOGRAPHY: almost flat
SURF. CHAR: no cracks, nil evidence of salt,
LAND USE: traditional grazing
SPECIES : Trees - Terminalia sericea (dom.)
: Shrubs - Terminalia sericea (dom.) Grewia sp.
: Grasses/forbs-
PARENT MATERIAL: aeolian red sand
MOIST. COND: moist 0 - 25 , dry 25 - 100 cm
SURF.STONES: none
EROSION : slight wind erosion/deposition

REMARKS:

SAMPLES: A: 0 - 15 B: 80 - 100

GRID : HP-136-079
COORD: 19-48-06-S 23-59-36-E
DATE : 28/11/84

LAND ELEMENT : not applicable
MICRO TOPOGRAPHY: medium hummocks

VEGETATION: savanna

ROCK TYPE:

ROCK OUTCROP: none

AGRO CLIM.ZONE: 2C2
ELEVATION :

SMR: ustic

POSITION: intermediate part
SLOPE : 0 - 1 %

GRASSCOVER:

GEOL.UNIT:
DRAINAGE : somewhat excessively drained

HUMAN INF: nil

A 0 - 16 cm 10YR 4/3.5 (moist) and 10YR 4.5/3.5 (dry), fine sand, very weak medium subangular blocky structure, slightly hard, common very fine and fine pores, non calcareous, common roots, clear wavy boundary.

16 - 100 cm 7.5R 4/5 (moist) and 7.5R 5/6 (dry), common fine distinct sharp grey mottles, fine sand, very weak medium subangular blocky structure, slightly hard to hard, few very fine and fine pores, non calcareous, few roots,

S T A N D A R D S O I L A N A L Y S I S R E S U L T S

PROFILE: MA 0060

SAMPLE	DEPTH		pH		EC	P	C	CEC	Ca	Mg	K	Na	PBS	Particle size (weight %)								CECclay	METH	PRETR
			H2O	CaCL2	mS/cm	ppm	weight %	ù-----	meq/100gr soil			------ù	%	vcS	cS	mS	fS	vfS	cSi	fSi	Clay	meq/100gr		
A	0	15	6.1	5.3	0.0	1	0.2	4.3	3.0	0.9	0.2	0.0	95	0	1	27	61	7	0	0	5	73	H	
B	80	100	5.2	3.8	0.0	1	0.1	3.8	2.0	0.8	0.1	0.0	76	0	1	26	60	7	0	1	5	76	H	

Soil Survey of Botswana FAO/BOT/85/011

Print date: 08/05/89

PART.SIZE DETERMINATION METHOD: H = Hydrometer Method, P = Pipette Method, * = Not Known
PRETREATMENT: O = Organic Matter, F = Free Iron Oxides, C = Carbonates, S = Soluble Salts N = None

SOIL PROFILE DESCRIPTION

Profile: TO 0718 Unit: S05b Status: 1

SHEET :
LOCATION : Haina Veld 4.2km North East from BH.5028.
AUTHOR(S): K.Verbeek R.Kelebemang
CLASSIFICATION FAO: Lamelli-Luvic Arenosol(1988) Luvic Arenosol (1974)
ST : Alfic Quartzipsamment
LANDFORM : sand plain
TOPOGRAPHY: almost flat
SURF. CHAR: slight sealing, no cracks, nil evidence of salt, bleached sand on surface
LAND USE: commercial grazing
SPECIES : Trees - Lonchocarpus nelsii (dom.)
: Shrubs - Bauhinia petersiana (dom.) Burkea africana Grewia flava Terminalia sericea
: Grasses/forbs-
PARENT MATERIAL: aeolian pale sand
MOIST. COND: dry 0 - 180 cm
SURF.STONES: none
EROSION : nil

GRID : - -
COORD: 20-09-20-S 23-47-20-E
DATE : 25/11/86

LAND ELEMENT : not applicable
MICRO TOPOGRAPHY: low hummocks

VEGETATION: shrubland

ROCK TYPE:

ROCK OUTCROP: none

AGRO CLIM.ZONE: 3C3
ELEVATION :

SMR: aridic

POSITION: intermediate part
SLOPE : 0 - 1 % straight

GRASSCOVER:

GEOL.UNIT:
DRAINAGE : well drained

HUMAN INF: nil

REMARKS: Augering 120+. Colour claybands in Bt 7.5YR 4/4.Location on 1:250000 topographical sheet SF.34.4, no other maps of the area exist.

SAMPLES: A: 0 - 30 B: 60 - 80 C: 120 - 150

A 0 - 40 cm 10YR 3.5/2 (moist) and 10YR 5/2 (dry), fine sand, very weak medium and coarse subangular blocky structure, slightly hard, common very fine and fine pores, non calcareous, common very fine and fine roots, diffuse smooth boundary.

B 40 - 110 cm 10YR 5/2.5 (moist) and 10YR 6/2.5 (dry), fine sand, massive structure, hard, few very fine and fine pores, non calcareous, very few fine roots, clear wavy boundary.

Bt1 110 - 160 cm 10YR 5/3 (moist) and 10YR 6/3 (dry), fine sand, massive structure, hard, moderately thick clay lamellae, few very fine and fine pores, non calcareous, no roots, clear wavy boundary.

Bt2 160 - 180 cm 10YR 5/3 (moist) and 10YR 6/3 (dry), loamy fine sand, hard, non calcareous, no roots,

S T A N D A R D S O I L A N A L Y S I S R E S U L T S

PROFILE: TO 0718

SAMPLE	DEPTH		pH		EC	P	C	CEC	Ca	Mg	K	Na	PBS	Particle size (weight %)								CECclay	METH	PRETR
			H2O	CaCL2	mS/cm	ppm	weight %	ù-----	meq/100gr	soil		------ù	%	vcS	cS	mS	fS	vfS	cSi	fSi	Clay	meq/100gr		
A	0	30	6.5	6.1	0.0	2	0.0	3.7	1.6	0.8	0.1	0.0	68	0	2	28	63	3	1	1	2	161	H	
B	60	80	5.9	5.7	0.0	1	0.0	4.0	1.3	0.8	0.1	0.0	55	0	1	19	66	4	2	2	5	85	H	
C	120	150	5.9	5.8	0.0	1	0.1	5.6	2.1	1.3	0.2	0.1	66	0	2	25	62	4	1	1	7	76	H	

Soil Survey of Botswana FAO/BOT/85/011 Print date: 08/05/89

PART.SIZE DETERMINATION METHOD: H = Hydrometer Method, P = Pipette Method, * = Not Known
PRETREATMENT: O = Organic Matter, F = Free Iron Oxides, C = Carbonates, S = Soluble Salts N = None

SOIL PROFILE DESCRIPTION | Profile: TO 0828 Unit: S06a Status: 1

SHEET :
LOCATION : Kuke fence,41.1km West,from Kuke corner.
AUTHOR(S): A.Remmelzwaal K.Verbeek J.Huesken E.Van Waveren
CLASSIFICATION FAO: Lamelli-Luvic Arenosol(1988) Luvic Arenosol (1974)
ST : Alfic Quartzipsamment
LANDFORM : dune field
TOPOGRAPHY: rolling
SURF. CHAR: no sealing, no cracks, nil evidence of salt, bleached sand on surface
LAND USE: commercial grazing
SPECIES : Trees - Terminalia prunioides (dom.) Boscia albitrunca
: Shrubs - Grewia flava (dom.) Croton gratissimus
: Grasses/forbs-
PARENT MATERIAL: aeolian red sand
MOIST. COND: dry 0 - 120 cm
SURF.STONES: none
EROSION : moderate wind erosion/deposition

GRID : - -
COORD: 21-00-00-S 23-29-15-E
DATE : 16/05/87
LAND ELEMENT : longitudinal dune
MICRO TOPOGRAPHY: even
VEGETATION: dense savanna
ROCK TYPE:
ROCK OUTCROP: none

AGRO CLIM.ZONE: 3C3
ELEVATION :
SMR: aridic
POSITION: crest
SLOPE : 1 - 2 % convex
GRASSCOVER: < 10 %
GEOL.UNIT:
DRAINAGE : excessively drained
HUMAN INF: nil

REMARKS: Overgrazing. Claylamellae from 65cm on every 10-15cm 7.5YR5/6D.Location is on 1:250000 topographical sheet SF 34.4 no other map exist.

SAMPLES: A: 0 - 25 B: 30 - 60 C: 60 - 80 D: 90 - 110

A 0 - 25 cm 10YR 4/3 (moist) and 10YR 5/3 (dry), fine sand, weak medium and coarse subangular blocky structure, soft, many very fine and fine pores, non calcareous, common very fine and fine roots, clear wavy boundary.

B 25 - 60 cm 7.5YR 5/ 4 (moist) and 7.5YR 6/ 4 (dry), fine sand, very weak coarse and very coarse subangular blocky structure, soft to slightly hard, many very fine and fine pores, non calcareous, common fine and medium roots, gradual smooth boundary.

Bt1 60 - 80 cm 8YR 5/4 (moist) and 8YR 6/4 (dry), fine sand, weakly coherent massive structure, slightly hard, thin clay lamellae, few very fine and fine pores, non calcareous, few very fine and fine roots, gradual smooth boundary.

Bt2 80 - 120 cm 8YR 5/4 (moist) and 8YR 6/4 (dry), fine sand, weakly coherent massive structure, slightly hard, few very fine and fine pores, non calcareous, very few very fine and fine roots,

S T A N D A R D S O I L A N A L Y S I S R E S U L T S

PROFILE: TO 0828

SAMPLE	DEPTH		pH		EC	P	C	CEC	Ca	Mg	K	Na	PBS	Particle size (weight %)								CECclay	METH	PRETR
			H2O	CaCL2	mS/cm	ppm	weight %	ù-----	meq/100gr soil			------ù	%	vcS	cS	mS	fS	vfS	cSi	fSi	Clay	meq/100gr		
A	0	25	6.4	6.4	0.0	6	0.1	3.1	1.7	0.6	0.1	0.0	77	0	4	28	53	8	1	2	4	77	H	
B	30	60	5.1	4.9	0.0	2	0.0	3.3	0.5	0.6	0.1	0.0	36	0	6	27	54	8	1	1	4	85	H	
C	60	80	4.7	4.7	0.0	2	0.0	3.4	0.4	0.6	0.1	0.0	32	0	6	28	52	8	1	1	5	74	H	
D	90	110	5.0	5.0	0.0	2	0.0	3.5	0.9	0.8	0.1	0.0	51	0	7	27	52	8	0	1	4	88	H	

Soil Survey of Botswana FAO/BOT/85/011 Print date: 08/05/89

PART.SIZE DETERMINATION METHOD: H = Hydrometer Method, P = Pipette Method, * = Not Known
PRETREATMENT: O = Organic Matter, F = Free Iron Oxides, C = Carbonates, S = Soluble Salts N = None

SOIL PROFILE DESCRIPTION

Profile: TO 0902 Unit: S17 Status: 1

SHEET : 2023A3
LOCATION : Maun-Toteng road, 46.5km from Maun,8km SE.
AUTHOR(S): A.Remmelzwaal K.Verbeek G.Baert B.Kopelo
CLASSIFICATION FAO: Eutri-Haplic Arenosol(1988) Eutric Arenosol (1974)
ST : Ustic Quartzipsamment
LANDFORM : sand plain
TOPOGRAPHY: gently undulating
SURF. CHAR: no sealing, no cracks, nil evidence of salt,
LAND USE: traditional grazing
SPECIES : Trees - Terminalia prunioides (dom.) Acacia erioloba
: Shrubs - Acacia mellifera (dom.) Acacia erioloba Dichrostachys cinerea Ximenia americana
: Grasses/forbs-
PARENT MATERIAL: aeolian sand
MOIST. COND: dry 0 - 170 cm
SURF.STONES: none
EROSION : nil

GRID : - -
COORD: 20-19-18-S 23-09-11-E
DATE : 15/04/86

LAND ELEMENT : not applicable
MICRO TOPOGRAPHY: medium hummocks

VEGETATION: savanna

ROCK TYPE:

ROCK OUTCROP: none

AGRO CLIM.ZONE: 2C3
ELEVATION : 930 m

SMR: ustic

POSITION: intermediate part
SLOPE : 0 - 1 %

GRASSCOVER:

GEOL.UNIT:
DRAINAGE : well drained

HUMAN INF: nil

REMARKS: Same position as TO0390. Burrows are calcareous in C1 and C2.

SAMPLES: A: 0 - 32 B: 32 - 57 C: 57 - 80 D: 80 - 105 E: 105 - 140 F: 140 - 170

A 0 - 32 cm 10YR 3/2 (moist) and 10YR 4/2 (dry), fine sand, very weak medium subangular blocky structure, soft very friable, non sticky non plastic, few very fine and fine and few medium pores, non calcareous, many fine and medium roots, gradual smooth boundary.

AC 32 - 57 cm 10YR 3.5/2 (moist) and 10YR 4.5/2 (dry), fine sand, very weak coarse subangular blocky structure, soft to slightly hard very friable, non sticky non plastic, few very fine and fine pores, non calcareous, common fine and medium roots, gradual smooth boundary.

C1 57 - 80 cm 10YR 3.5/2 (moist) and 10YR 4.5/2 (dry), fine sand, weakly coherent massive structure, soft to slightly hard very friable, non sticky non plastic, few very fine pores, non calcareous, few infilled burrows, few fine roots, diffuse smooth boundary.

C2 80 - 105 cm 10YR 4/2 (moist) and 10YR 5/2 (dry), fine sand, weakly coherent massive structure, soft very friable, non sticky non plastic, few very fine pores, very few fine spherical soft calcareous white nodules, non calcareous, few infilled burrows, few fine roots, diffuse wavy boundary.

C3 105 - 140 cm 10YR 4.5/2 (moist) and 10YR 6/2 (dry), fine sand, weakly coherent massive structure, soft very friable, non sticky non plastic, few very fine pores, few fine spherical soft calcareous white nodules, non calcareous, few fine roots, clear smooth boundary.

Ck 140 - 170 cm 10YR 5.5/2 (moist) and 10YR 7/2 (dry), fine sand, weakly coherent massive structure, soft very friable, non sticky non plastic, few very fine pores, frequent fine spherical soft calcareous white nodules, strongly calcareous, few fine roots,

STANDARD SOIL ANALYSIS RESULTS

PROFILE: TO 0902

SAMPLE	DEPTH		pH		EC	P	C	CEC	Ca	Mg	K	Na	PBS	Particle size (weight %)								CECclay	METH	PRETR
			H2O	CaCL2	mS/cm	ppm	weight %	ù----- meq/100gr soil ------ù					%	vcS	cS	mS	fS	vfS	cSi	fSi	Clay	meq/100gr		
A	0	32	8.9	7.5	0.0	2	0.3	7.0	9.7	0.8	0.2	0.0	100	0	5	23	56	9	3	4	1	725	H	
B	32	57	9.0	7.6	0.0	1	0.1	7.5	5.9	0.4	0.1	0.1	87	2	1	20	58	10	3	3	3	237	H	
C	57	80	8.7	7.8	0.0	1	0.1	6.9	5.4	0.5	0.0	0.1	87	0	4	23	53	10	4	3	3	197	H	
D	80	105	8.9	7.6	0.0	1	0.1	6.4	5.1	0.5	0.1	0.1	91	0	4	20	57	10	3	3	3	188	H	
E	105	140	8.9	7.9	0.0	1	0.1	6.7	5.6	0.7	0.1	0.1	97	0	3	19	58	10	3	3	3	197	H	
F	140	170	8.9	7.9	0.0	1	0.2	6.6	31.1	0.8	0.0	0.1	100	0	1	20	57	10	1	5	6	91	H	

Soil Survey of Botswana FAO/BOT/85/011 Print date: 08/05/89

PART.SIZE DETERMINATION METHOD: H = Hydrometer Method, P = Pipette Method, * = Not Known
PRETREATMENT: O = Organic Matter, F = Free Iron Oxides, C = Carbonates, S = Soluble Salts N = None

4 AREA ESTIMATES FOR SOIL UNITS IN MAUN AND TOTENG

Area calculations for the 1:250000 reconnaissance soil maps of Maun and Toteng.

Note: These figures were derived from a dot-planimeter overlay on the map sheet. Quantities therefore should not be regarded as exact. They indicate approximate extents since the percentage of the soil units per mapping unit is an estimate.

Soil Unit	Maun (km^2)	Toteng (km^2)	Total(km^2)
A7	289	-	289
A7a	85	7	92
A7b	16	123	139
A9	223	28	251
A9a	329	345	674
A9b	-	103	103
A14a	137	92	229
A15a	1049	424	1473
A21	567	390	957
A21a	-	81	81
A24	102	-	102
A24a	4	29	33
A24b	986	138	1124
A24d	10	36	46
A31a	299	16	315
A31b	234	40	274
A40	2443	1049	3492
A40a	617	42	659
A40b	333	122	455
A40c	-	43	43
A41	859	336	1195
A44	-	33	33
A47	-	82	82
x	207	-	207
y	1582	72	1654
Total	**10371**	**3631**	**14002**

C units - Soils on highly calcareous material

C1	-	31	31
C3	-	397	397
C4a	-	84	84
C5b	-	63	63
C5c	-	212	212
Total	-	787	787

L units - Soils on lacustrine deposits

L6a	-	94	94
L7	-	171	171
L11	10	72	82
L11a	-	277	277
L11b	-	84	84
L12	-	126	126
L12b	168	871	1039
L16	93	1245	1338
L22a	-	432	432
L22c	-	646	646
L23	7	-	7
L24	214	34	248
L24a	11	25	36
L24b	-	73	73
L24c	-	243	243
L24d	-	572	572
L24e	-	61	61
L28	-	5	5
L36	11	-	11
L37	-	48	48
L38	-	64	64
L40	-	25	25
L43	-	33	33
Total	**514**	**5201**	**5715**

S units - soils on coarse grained sedimentary rocks

S1b	-	336	336
S3	507	1339	1846
S5	-	22	22
S5a	-	60	60
S5b	-	305	305
S6	-	163	163
S6a	-	558	558
S6b	-	281	281
S11a	-	7	7
S12a	-	18	18
S13	47	32	79
S13a	181	410	591
S17	674	3404	4078
S17d	16	95	111
Total	**1425**	**7030**	**8455**

Units G, D, B, R, soils of the hardveld

G1c	-	65	65
G4	-	47	47
G13a	-	37	37
D1b	-	141	141
B5c	-	22	22
R	-	92	92
Total	-	404	404
Total area calculated	12310	17053	29363

Swamp area 4700 km²
(the approximate area of swamp mapped, as calculated from the totals and in relation with the sattelite imagery used).

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6/89 - .05 M