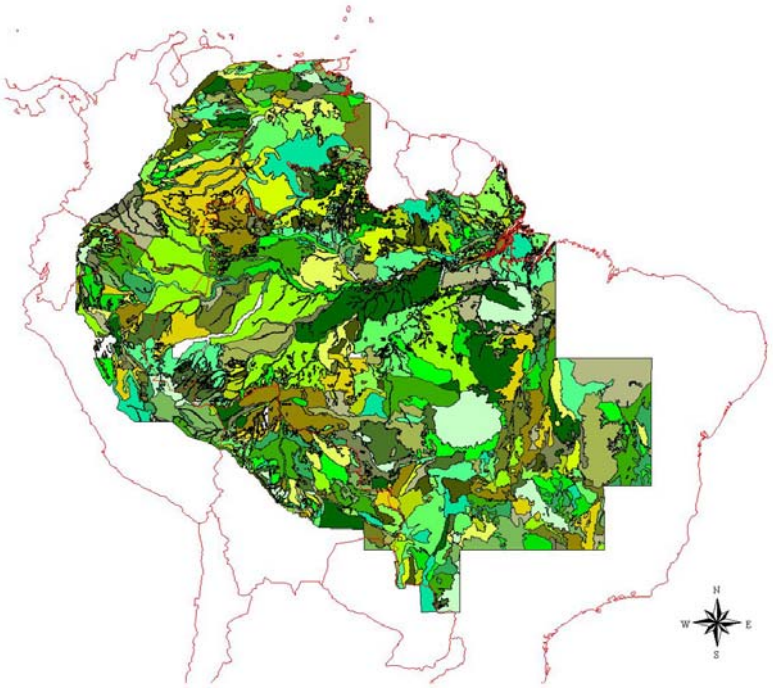
Manual

PERSONAL COMPUTER VERSION WITH DATABASE OF THE STUDY "LAND IN TROPICAL AMERICA".

Version para PC's del estúdio "La Tierra em América Tropical" con banco de datos

Versão para PC's do estudo "A Terra em América Tropical" com banco de dados



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1. INTRODUCTION AND BACKGROUND

In 1977 the senior author was contracted by the International Center for Tropical Agriculture CIAT, to carry out a land resource study of the savanna and forest regions of tropical South America (Figure 1). The purpose of the work was to "meet the growing concern with deviation from the expected performances of so-called improved varieties of tropical crops when they were grown in locations different from where they were developed" (Metz and Brady, 1980). Consequently the work was to provide a geographical and agro-ecological base to guide selection and breeding priorities for crops. The work was carried out with the collaboration of the Ministries of Agriculture of Colombia, Bolivia, Ecuador, Peru and especially the – Empresa Brasileira de Pesquisa Agropecuária - Centro de Pesquisa Agropecuária dos Cerrados (EMBRAPA-CPAC), Brazil.

Figure 1. Land Systems map of the Amazon region.

The methodology used for the study was an adaptation of Christian and Stewart's "land systems" approach for the study of the Katherine-Darwin region of Northern Australia (1953). It summarized land resource information on a common base by defining a land system as "an area or group of areas throughout which there is a recurring pattern of climate, landscape and soils". The methodology was adapted to computerization by developing a Land Resource Geographic Information System (LR-GIS) (Cochrane et al. 1981). This was essentially a database for recording the many terrain, soil, vegetation, meteorological and land use attributes (features) that was linkable to a land system map database (Figure 1). The attribute database was compiled in SAS that used the Relational Database Concept (Barr et al., 1976). Features were linked to raster maps of the land systems. The latter were designed by the authors using the FORTRAN programming language with 4 x 5 minute rectangular pixels. (Digital mapping software was not available at the time the work was started.)

The methodology is detailed in the introduction to Volume 1 of the printed version of "Land in Tropical America", which has been recorded as a part of the digital version of the text of "Land in Tropical America". Details of the computerized database descriptors or "attributes" may be found in the "glossary to coding", Part 1 of Volume 3, which records the computer print-outs of the Land System properties and a series of representative soil profiles. For the convenience of readers, this glossary has also been recorded with this booklet under section 3, entitled "Glossary of the coding of the land systems attribute database".

The delineation of the land systems was facilitated using the then recently available 1:1,000,000 satellite imagery (black and white photographic prints of spectral bands 5 and 7), together with the side-looking radar imagery that covered a large part of the Brazilian Amazon (Projeto RadamBrasil, 1973), and some larger scale aerial photography. The land systems were drawn on the imagery and transposed to maps with a Lambert Conical Conformal Projection derived from the World Aeronautical Charts of the region. These were subsequently digitized. Fieldwork was carried out to record the characteristics of the land systems on computer input forms and to revise boundaries (Cochrane et al. 1981). A Piper Super Cub STOL (Short Take Off and Landing) aircraft was piloted by the senior author over representative transects of the Amazon during the course of the studies, and numerous spot checks were made on the ground.

Although by modern Geographic Information System GIS, standards the LR-GIS developed was rudimentary, it in fact incorporated the basic components of modern GIS. The original study was completed in 1981 and published 4 years latter in book-form with the title "Land in Tropical America" (Cochrane et al. 1985). At that time the database was only available to institutions with access to mainframe computers. However, in this version of the study, the map files have been re-digitized for use in ArcView (ESRI, 1998) and Idrisi (Eastman, 1993), and the attribute database has been re-digitized for use in MS Access.

2. THE DIGITAL VERSION OF THE TEXT, DATABASES, AND MAPS OF "LAND IN TROPICAL AMERICA"

The digital version of "Land in Tropical America" is a set of files that contain the text of the original published version of "Land in Tropical America", the databases associated with the land systems, and maps in ArcView, Idrisi, and Cartalinx format. The purpose of the Personal Computer version with Database of the study Land in Tropical America is to provide workers access to that study via their Personal Computers, and especially to the land system map and attribute database that was previously only accessible via mainframe computers. It should be noted that the original study was largely based on information available in the late 1970s. Nevertheless, it contains a wealth of valuable data, and should serve as a benchmark study to compare land use change in tropical South America, including the Amazon and the savanna lands of central Brazil over the past 20 odd years. It contains information for agronomists, foresters, ecologists and administrators alike.

As a sequel to the study, the authors are currently working on an update, which should be completed within the next 2 years. In the mean time, the present PC version of the original study provides much useful information.

All the text files, databases, and GIS maps, have been recorded on a CD-ROM.

2.1. CONTENTS OF THE CD-ROM

The CD attached to this booklet contains 3 sets of files.

1. Text files prepared for reading with Adobe Acrobat Reader that reproduces most of the original text of "Land in Tropical America". It also contains a "**Manual.pdf**" file that is a copy of the present text.

2. The database map files prepared for use in Geographic Information System software, specifically ArcView, Idrisi, and the mapping program Cartalinx. These include sets of the original 6^0 longitude by 4^0 latitude land systems maps, a concatenated land systems map covering the entire region studied and a selection of some thematic maps.

3. The attribute database files that describe the many properties of the land systems and their principal facets, which have been prepared for use in MS Access.

The CD created is an Auto-run CD which should bring up Microsoft Internet Explorer when it is placed in the CD-ROM drive. The files have been organized into the following directories on the CD:

a) **Programs**: The following two Freeware programs have been included with the CD: Adobe Acrobat Reader and ArcExplorer 2.0. The Adobe Acrobat reader is used to view all text files in the CD in PDF format. ArcExplorer is used to view the ArcView shape map files. However, the following additional programs are needed to view the database and maps: MS ACCESS, ArcView and/or IDRISI and Cartalinx.

b) **Book Version**: The text for the book is divided into 3 Volumes. The files are in HTML and ADOBE Acrobat PDF format, which requires the use of internet explorer and Adobe Reader.

c) **GIS Maps**: GIS maps have been provided in three different formats.

   1. ARCVIEW MAPS (ArcView shape files)
   2. CARTALINX MAPS (Cartalinx file sets)
   3. Idrisi MAPS (Idrisi file sets in two formats, Idrisi 16 and 32)

d) **Database**: MS Access file LANDSYS.MDB contains the entire database for the "Land in Tropical America" study. The attribute database can be linked with the map files of either ArcView or Idrisi.

e) **Manual**: Contains this manual.

f) **Photo_gallery**: Contains regional maps and other images for use in the Book version.

A schematic of the content of the CD-ROM is presented in Figure 2.

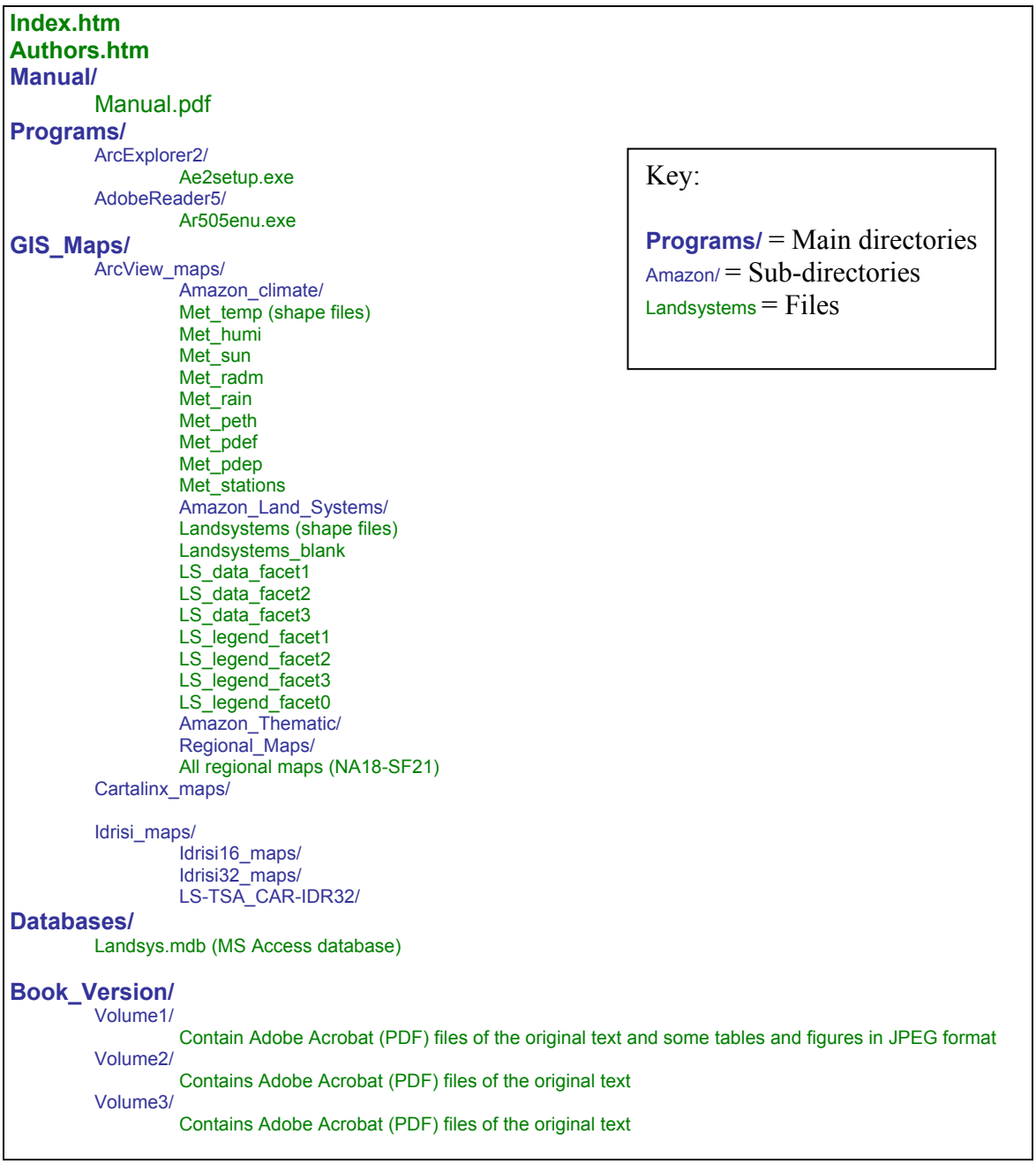

Figure 2. CD-ROM content directory and file structure.

2.2. BOOK VERSION

The original text was re-digitalized and saved in Adobe Acrobat PDF format and is presented interactively through a WEB browser. Each chapter within each volume was

saved under a separate file name. The following is a description of the contents of the directories.

1) **Volume 1**. This reproduces the original text of Volume 1 of 'Land in Tropical America". Volume 1 summarizes some important findings of the study, but by no means is an exhaustive analysis of the work. Each chapter is presented as a separate Adobe PDF file.

2) **Volume 2**
Part 1 of Volume 2 is a ready reference legend of the soils of the land systems and can be used with printouts of the land systems maps or with the Land Systems Map summarizing the physiography, climate, vegetation topography and soils of the central lowlands of tropical South America.
Part 2 of Volume 2 contains the black and white printed land systems maps covering the study region as 6^0 longitude by 4^0 latitude segments (36 maps) which were reduced in scale from the original 1:1,000,000 scale maps for recording as Volume 2 Part 2 of the original printed study, are reproduced in this file. It should be noted however, that the set of Land System maps in Volume 2 Part 2 of the original published study have also been recorded as map files prepared for use in Geographic Information Systems (GIS). (Refer to the subheading, "GIS Maps" for further details).

2) **Land Systems map.** This directory contains the files that reproduce the colored printed map at the scale of 1:5,000,000 that was appended to Volume 2 titled "LAND SYSTEMS MAP - Physiography, Climate, Vegetation, Topography and Soils of the Central Lowlands of Tropical South America". It has been prepared as a series of segment maps "A to T" starting from the top left hand portion of the original map.

3) **Volume 3**.
Part 1 of Volume 3 of the original published study is essentially a series of the original printouts of the database information of the land systems. This information has been re-prepared as the attribute database for used in MS Access, as detailed below. Part 1 also contains a Glossary of the descriptors (attributes) used to describe the land systems.
Part 2 of Volume 3 is a series of selected meteorological printouts. It should be noted that that this data has also been digitized as an integral part of the attribute database.
Part 3 of Volume 3 is a series of typical soil profile descriptions found throughout the region.

2.3. THE ATTRIBUTE DATABASE.

The attribute database has been prepared as the MS Access file **Landsys.mdb.** This contains the following tables:

- **data_landscape_facets_engl :** database of all facets within land Systems describing physical and chemical attributes (in English)

- **data_landscape_facets_port :** database of all facets within land Systems describing physical and chemical attributes (in Portuguese)
- **data_landsystems_legend :** Land Systems legend database describing climate, land form, altitude, texture, fertility class, US Taxonomy Great Group soils, and FAO legend soils.
- **data_landsystems_met :** database showing Land System and Meteorological climate stations associated to each land system.
- **data_landsystems_sumario_port :** Land Systems summary database in Portuguese.
- **data_landsystems_summary_engl:** Land Systems summary database in English.
- **data_meteorological :** database with monthly data from each meteorological station.
- **data_met_stations :** description of each meteorological station.

The following figure shows the division of Land Systems into terrain Facets:

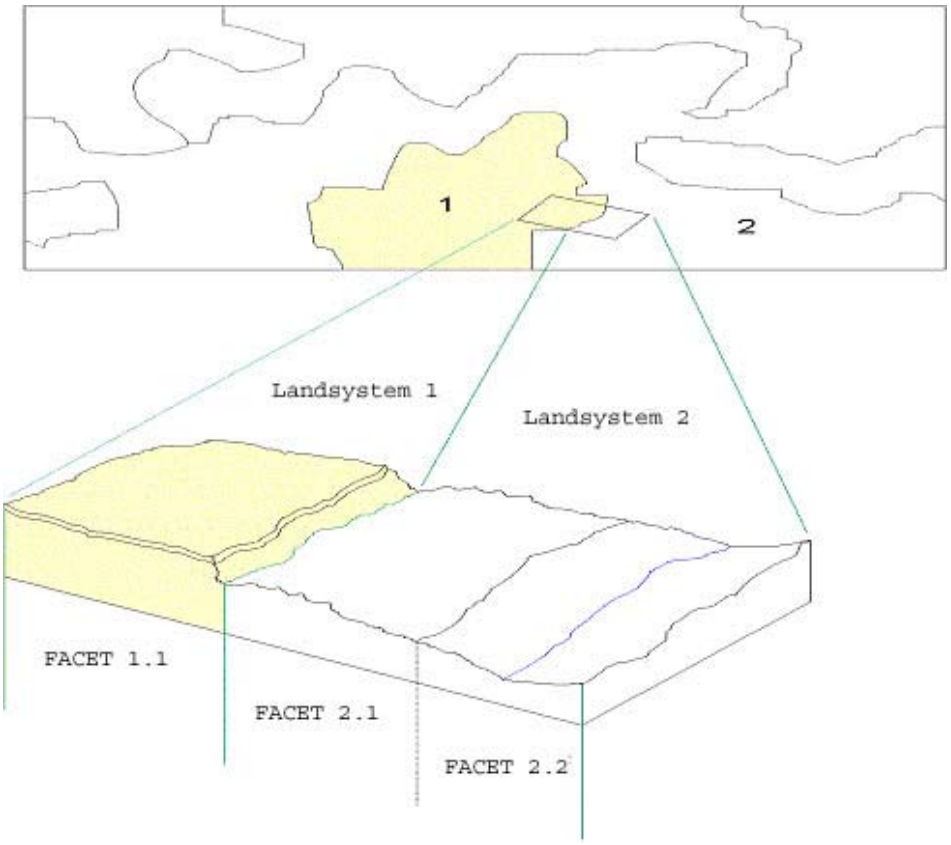

Figure 3. Delineation of Facets from Land Systems.

Coding tables enables actual descriptions to be substituted in place of the attribute codes. The coding tables have been created in 3 main languages (English, Spanish, and Portugues).

This database can be linked with either ArcView or Idrisi GIS's, or used independently for analyzing the characteristics of the region. The thematic maps produced with this work, are examples of the linkage of the database to the GIS's.

2.4. GIS MAPS

The land system map database files were prepared for use in ArcView, Idrisi, and CARTALINX.

The following sets of 36 files of the original 1:1,000,000 land system maps covering the region studied (Figure 4) have been prepared for use in ArcView, Idrisi, and Cartalinx respectively with the following prefixes:

NC19.xxx (Caracas)
NC20.xxx (Boca del Orinoco)
NB18.xxx (Bogotá)
NB19.xxx (Río Meta)
NB20.xxx (Roraima)
NA18.xxx (Cali)
NA19.xxx (Pico da Neblina)
NA20.xxx (Boa Vista)
NA21.xxx (Tumucumaque)
NA22.xxx (Macapá)
SA18.xxx (Iquitos)
SA19.xxx (Içá)
SA20.xxx (Manaus)
SA21.xxx (Santarem)
SA22.xxx (Belém)
SB18.xxx (Javari)
SB19.xxx (Juruá)
SB20.xxx (Purus)
SB21.xxx (Tapajos)
SB22.xxx (Araguaia)
SC18.xxx (Contamana)
SC19.xxx (Río Branco)
SC20.xxx (Porto Velho)
SC21.xxx (Juruena)
SC22.xxx (Tocantins)
SC23.xxx (Río São Francisco)
SD19.xxx (Puno – Rio Beni)

SD20.xxx (Guapore)
SD21.xxx (Cuiabá)
SD22.xxx (Goiás)
SD23.xxx (Brasília)
SE20.xxx (Sucre)
SE21.xxx (Corumbá)
SE22.xxx (Goiânia)
SE23.xxx (Belo Horizonte)
S**F21.xxx** (Río Apa)

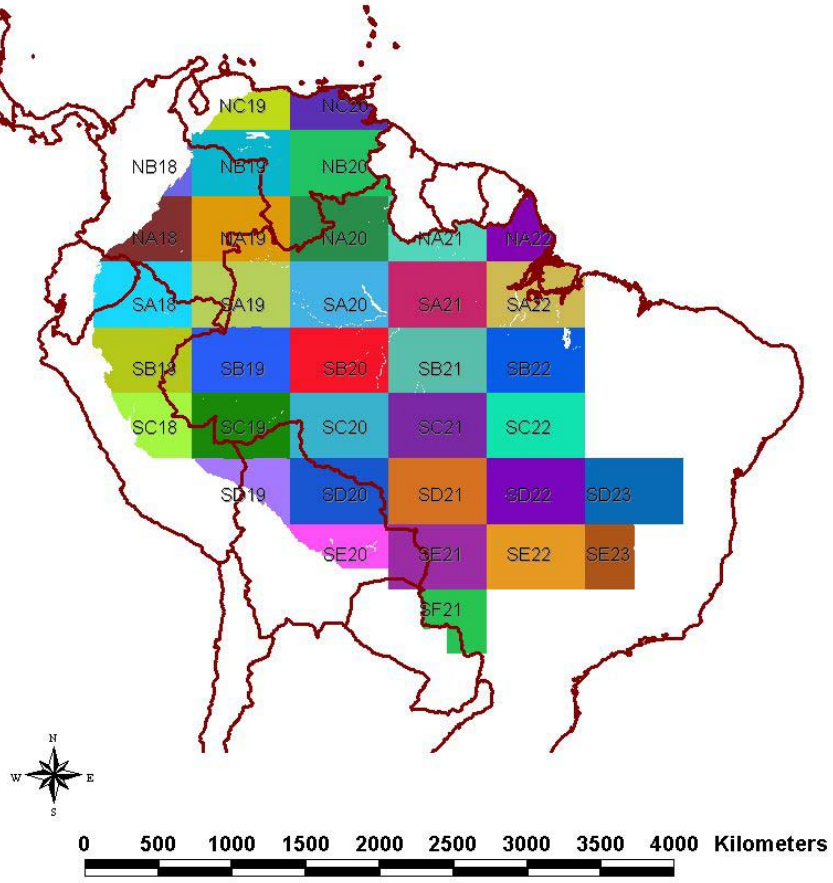

Figure 4. Regional map sets.

b) Files that are concatenations of the above sector map files covering the entire region studied have also been prepared for use in ArcView and Idrisi, and are useful for the production of thematic maps to diagnose and illustrate overall characteristics of the region. Clearly workers may wish to prepare alterative concatenations of parts of the region, and this can readily be carried out using the individual map segments.

Alternatively, "windows" may be extracted from the concatenated maps covering the entire region studied.

c) In addition to the concatenated Land Systems maps, some example thematic maps have been prepared for use in ArcView by assigning a chosen attribute to the land systems.

2.5. ARCVIEW MAPS

A set of ArcView shape maps was created based on the set of 36 files of the original 1:1,000,000 land system maps covering the region studied. These files are presented in the CD-ROM as part of the ArcView Maps. A complied ArcView Shape map of the Amazon was created based on the original delineation of these 36 maps with land systems units. Additional compiled ArcView Shape maps were then created using the various databases associated to the Land Systems. These maps can be viewed using the Arc Explorer program in the CD-ROM. However for additional analyses and interpretations of these maps, ArcView 3.2 or later should be used. The following sections of this manual describe the complied ArcView Shape maps.

2.5.1. Land Systems map

The base Land Systems map, complied from the 36 original regional maps, is recorded in the CD-ROM with the following name:

Land_systems_blank.shp (plus accompanying ArcView files).

This ArcView Shape file only contains the polygons representing the land systems units and its land system unit identification number.

An additional file was created that contains the overall description of the land systems called:

landsystems.shp (plus accompanying ArcView files)

This ArcView Shape file contains the database field names and descriptions shown in Table 1. The actual description of attributes within each field can be obtained from the "Glossary of the coding of the land systems attributes" (section 3) or from the coding tables in the database. This ArcView shape file was created from the database table: **data_landsystems_sumario_port.**

Table 1. Database field names and description of data associated with ArcView Shape file "landsystems.xxx".

Database Field Name	ArcView Database Field Name	Description
---	Shape	ArcView shape field
---	Land_sys	Land Systems (numerical)
---	Count	ArcView count field
Sist Terra	Sist_Terr	Land Systems (as string)
Reg-fisio	Reg_Fisio	Physiographic region
Cód Reg-fisio	Cód_Reg_f	Physiographic region code
Unid-fis	Unid_fis	Physiographic unit
Cód Unid-fis	Cód_Unid_f	Physiographic unit code
Reg Clim	Reg_Clim	Region climate
Clas Reg-clim	Cla_Reg_cl	Region climate class code
Estação meteo	Estação_me	Meteorological climate station
Des Sis Terra	Des_Sis_Te	Terrain system description

2.5.2. Land Systems Facets legend maps

Each Land System unit was subdivided into regions with common characteristics, which were termed land FACETS. Within each land system unit there are a maximum of 3 land facets is described, representing variations in the landscape features. These variations, although not mapped because of scale limitations of the original study, are described in the databases provided here. The portion (percentage) of each land facet within the land systems was estimated from a study of the imagery.

ArcView Shape maps were created for each of these facets. The following files represent the facets. The data contained in each of these maps is shown in Table 2.

Ls_legend_facet1.shp
Ls_legend_facet2.shp
Ls_legend_facet3.shp
Ls_legend_facet0.shp

"Ls_legend_facet1.shp" contains the information of the main facet of the land system unit and the other maps represent the subsequent facets 2 and 3. Each land system unit may contain 1, 2, or 3 facets. Facet 0 represents land systems containing no data at the time of the study. This ArcView Shape file was created from the database table: **data_landsystems_legend.**

Table 2. Database field names and description of the land facet summary legend data associated with ArcView Shape files "Ls_legend_facet*.xxx"

Database Field Name	ArcView Database Field Name	Description
	Shape	ArcView shape field
	Landsys	Land Systems (numerical)
	Count	ArcView count field
REG-FIS	REG_FIS	Physiographic region
SIS-TER	SIS_TER	Land Systems (as string)
REG-CLI	REG_CLI	Regional Climate classification
FACETA	FACETA	Land Facet
%FACETA	P_FACETA	Percent of land system comprised by the land facet
FORM-TER	FORM_TER	Land form
ALTITUDE	ALTITUDE	Altitude
TEXT-A/S	TEXTURA	Soil texture
CLAS-FER	CLAS_FER	Fertility classification
ST-GG	ST_GG	Soil Taxonomy classification
LEG-FAO	LEG_FAO	FAO soil legend classification

2.5.3. Land Systems Facet data maps

Detailed data for each facet are presented in the following ArcView Shape maps:

Ls_data_facet1.shp
Ls_data_facet2.shp
Ls_data_facet3.shp

The database field names and descriptions of these maps representing the facets, are shown in Table 3. The main data categories are as follows:

- **Generalized Landscape Information**
- **Landscape Facet Information**
- **Original Vegetation Classification**
- **Induced Vegetation**
- **Soil Classification**
- **Soil Physical Properties**
- **Soil Chemical Properties**
- **Elements of Importance mainly to Animal Nutrition**
- **Fertility Capability Classification**

Further description of the attribute database of each of these fields is presented in the "Glossary of the coding of the land systems attributes" (section 3).

Table 3. Database field names and description of the land facet complete data associated with ArcView Shape files "Ls_data_facet*.xxx"

Database Field Name	ArcView Database Field Name	Description
Generalized Landscape Information		
Faceta	Faceta	Land Facet
Faceta_ID	Faceta_ID	Land Facet ID
Sist Terra	Sist_Terra	Land Systems
Landscape Facet Information		
Form-ter	Form_ter	Landform description
Cód form-ter	Cód_form_t	Landform code
% Sist Terra	P_Sist_Ter	Percent of land system comprised by the land facet
% mal dren	P_mal_dren	Percent of land facet comprised of soils with poor drainage
% decliv <8%	P_decliv_8	Percent of land facet with well-drained soils almost flat, slope <8%
% decliv 8-30%	P_dec_8_30	Percent of land facet with undulating to rolling, slope 8-30%
% decliv >30%	P_dec_30	Percent of land facet with steep, slope >30%
Alt em metros	Altura	Approximate median altitude for each land facet
Original Vegetation Classification		
% Tem In Pamp	P_Tem_In_ P	Percent seasonally inundated pampas (poorly drained savannas)
% CL + CS	P_CL_CS	Percent Campo limpo (grassland) and campo sujo (grassland with occasional shrubs) (well drained savannas)
% Campo Cer	P_Camp_Cer	Percent Campo Cerrado (open savanna) (well drained savannas)
% Cerrado	P_Cerrado	Percent Cerrado (intermediate savanna) (well drained savannas)
% Cerradão	P_Cerradão	Percent Cerradão (closed savanna with almost continuous forest canopy) (well drained savannas)
% Fl Tr Chuv	P_Fl_Tr_Ch	Percent Tropical rain forest
% Fl Tr SS Ve	P_Fl_Tr_SV	Percent Semi-evergreen seasonal forest
% Fl Tr S Dec	P_Fl_Tr_SD	Percent (semi)-deciduous seasonal forest
% CAAT	P_CAAT	Percent Caatinga (scrubby woodland with some savanna species)
% Outra Veget	P_Outra_Vê	Percent other vegetation
Induced Vegetation		
% Past Cultiv	P_Past_Cul	Percent Pastures (Estimated from satellite imagery 1977-1981)
% Colheitas	P_Colheita	Percent Crops (Estimated from satellite imagery 1977-1981)

Soil Classification		
ST Ordens	ST_Ordens	U.S. Soil Taxonomy (soil Survey Staff, 1975) classification of Order
ST Sub-orden	ST_Sub_ord	U.S. Soil Taxonomy (soil Survey Staff, 1975) classification of Suborders
ST Grupo Gran	ST_Gr_Gran	U.S. Soil Taxonomy (soil Survey Staff, 1975) classification of Great Group
FAO Leg Solos	FAO_Leg	FAO soil legend classification
Soil Physical Properties		
Declive	Declive	Slope
Prof do solo	Prof_solo	Depth
Taxa infil in	Taxa_infil	Initial infiltration rate
Cond hydraul	Cond_hydr	Hydraulic conductivity
Drenagem	Drenagem	Drainage
Cap ret água	Cap_ret_ag	Moisture-holding capacity
Regime temp	Regime_t	Temperature Regime according to U.S. Soil Taxonomy
Regime umidad	Regime_um	Moisture Regime according to U.S. Soil taxonomy
Argilas expan	Argilas_ex	Expanding clays
Text sup solo	Text_sup	Topsoil texture (0-20cm)
Text subsolo	Text_sub	Subsoil texture (21-50cm)
Mat gros super	Mat_gr_sup	Topsoil coarse material (0-20cm)
Mat gros sub	Mat_gr_sub	Subsoil coarse material (21-50cm)
Soil Chemical Properties		
pH super solo	pH_super	Topsoil pH (1:1 soil to water ratio)
pH sub solo	pH_sub	Subsoil pH (1:1 soil to water ratio)
Sat Al super	Sat_Al_sup	Topsoil Aluminum (Al) saturation
Sat Al sub	Sat_Al_sub	Subsoil Aluminum (Al) saturation
Al troc super	Al_tr_sup	Topsoil Exchangeable Aluminum (Al)
Al troc sub	Al_tr_sub	Subsoil Exchangeable Aluminum (Al)
Ca troc super	Ca_tr_sup	Topsoil Exchangeable calcium (Ca)
Ca troc sub	Ca_tr_sub	Subsoil Exchangeable calcium (Ca)
Mg troc super	Mg_tr_sup	Topsoil Exchangeable magnesium (Mg)
Mg troc sub	Mg_tr_sub	Subsoil Exchangeable magnesium (Mg)
K troc super	K_tr_sup	Topsoil Exchangeable potassium (K)
K troc sub	K_tr_sub	Subsoil Exchangeable potassium (K)
Na troc super	Na_tr_sup	Topsoil Exchangeable sodium (Na)
Na troc sub	Na_tr_sub	Subsoil Exchangeable sodium (Na)
TBTsuper	TBT_super	Topsoil Total exchangeable bases
TBT subsolo	TBT_sub	Subsoil Total exchangeable bases
CTCE super	CTCE_super	Topsoil Effective cation-exchange capacity
CTC subsolo	CTCE_sub	Subsoil Effective cation-exchange capacity
MO super	MO_super	Topsoil Organic matter
MO subsolo	MO_sub	Subsoil Organic matter

P super	P_super	Topsoil Phosphorus
P subsolo	P_sub	Subsoil Phosphorus
P fixação	P_fix	Phosphorus fixation
Mn	Mn	Manganese
S	S	Sulphur
Zn	Zn	Zinc
Fé	Fe	Iron
Cu	Cu	Copper
B	B	Boron
Mo	Mo	Molybdenum
Carb Livres	Carb_Livre	Free carbonates
Salinidade	Salin	Salinity
Sódico	Sódico	Natric
Argila "cat"	Argila_cat	Cat Clay
Amor raios X	Am_raio_X	X-ray amorphous
Elements of Importance mainly to Animal Nutrition		
Cobolto	Cobolto	Cobalt
L	L	Iodine
Se	Se	Selenium
Cr	Cr	Chromium
Ni	Ni	Nickel
Fertility Capability Classification		
CCF tipo	CCF_tipo	Type and substrata types
CCF modific	CCF_mod	Modifiers

2.5.4. Meteorological Stations

Data from over 1100 meteorological stations was compiled as an integral part of the study "Land in Tropical America" (Hancock et al., 1979). This computerized data formed the core of CIAT's SAMM-DATA (South America Meteorological Data) computer file (Cochrane et al., 1985). A small subset of typical meteorological data was recorded in the book version of "Land in Tropical America" and for the convenience of the readers, this subset data has been mapped using latitude and longitude information. The following ArcView point Shape map was created with the database presented in Table 4:

Met_stations.shp

Caution should be taken when using these, since the accuracy of the latitude/longitude coordinates used may vary.

Table 4. Meteorological database field names and description for use with ArcView Shape file "met_stations.xxx"

Database Field Name	ArcView Database Field Name	Description
STNA	STNA	Station name
STID	STID	Station ID
PAIS	PAIS	Country
LATI	LATI	Latitude (degrees)
LONG	LONG	Longitude (degrees)
ALTI	ALTI	Elevation (meters)

The data from the meteorological weather stations were then related to individual land systems units. The relationship database between land systems units and the meteorological station is presented in Table 5. An ArcView point Shape file called "LS_MET" was also created showing this relationship.

Table 5. Relationship database between land system and meteorological station "ls_met.xxx".

Database Field Name	ArcView Database Field Name	Description
LSID	LSID	Land system
STID	STID	Station ID (meteorological station)
STNA	STNA	Station name

2.5.5. Meteorological Data Maps

A variety of ArcView maps were created using available data from the meteorological stations. These maps are described in Table 6. The data each map contains is presented in Table 7. This data is presented for each meteorological station as an ArcView point Shape file, which can be interpolated by the user to obtain thematic maps of the region for the desired meteorological parameter.

Table 6. ArcView file names and descriptions for Meteorological data.

Database Field Name	ArcView File Name	Description
TEMP	Met_temp.shp	Mean Temperature
HUMI	Met_humi.shp	Mean Relative Humidity

SUN%	Met_sun.shp	Percent of possible sunshine
RADM	Met_radm.shp	Mean solar radiation (Langleys/day)
RAIN	Met_rain.shp	Mean Precipitation (mm)
PETH	Met_peth.shp	Potential Evapotranspiration (mm)
PDEF	Met_pdef.shp	Precipitation deficit (mm): RAIN-PETH
PDEP	Met_pdep.shp	Dependable precipitation (mm): 75% probability level of precipitation occurrence
MAI	Met_mai.shp	Moisture availability index: PDEP/PETH

Table 7. Meteorological data field names and descriptions for ArcView files "met_*.xxx"

Database Field Name	ArcView Database Field Name	Description
STID	STID	Station ID
ID_TIPO	ID_TIPO	
KIND	KIND	Data type (kind of data)
SOID	SOID	
NYRS	NYRS	(blank - number of years of data)
JANU	JANU	January
FEBR	FEBR	February
MARC	MARC	March
APRI	APRI	April
MAY	MAY	May
JUNE	JUNE	June
JULY	JULY	July
AUGU	AUGU	August
SEPT	SEPT	September
OCTO	OCTO	October
NOVE	NOVE	November
DECE	DECE	December
ANNU	ANNU	Annual mean

2.6. IDRISI MAPS

Raster and Vector Idrisi maps have been prepared for the Idrisi 16 bit version and for the Idrisi 32 bit versions. Files with the suffix "LS_TSA" refer to the concatenated land systems map of the Amazon, which are in both raster and vector format.

Important notes:

a. The "LS-TSA_CAR-IDR32" directory refers to files exported from Cartalinx to Idrisi, which contain a database for the numerical identifiers of the land units.

b. Idrisi 32 files have to be copied to a folder in a computer Hard Drive and the read only file property removed.

c. Note that most Idrisi raster files are in compacted format and must be changed to binary format to be displayed.

2.7. CARTALINX MAPS

Cartalinx maps of the original 36 regional maps have been digitized as well as a land systems map that is a concatenation of all the regional maps.

3. GLOSSARY OF THE CODING OF THE LAND SYSTEMS ATTRIBUTES

The glossary of the coding of the land systems is presented in the next 8 pages. It is an exact copy of the material in Volume 3 of the "Land in Tropical America" book text. It is presented here as a guide to the database and the ArcView maps. However, all coding has now been included in the database. This coding enables to print reports in the 3 languages (English, Spanish, and Portugues).

Glossary of Coding in the Land Systems Printouts

This glossary details the coding used on the computer printouts. Explanations of the criteria used are contained in Chapter 6 of Vol. 1, *Land in Tropical America*.

Generalized Landscape Information

Climate

The number is the computer reference to the meteorological data set compiled from data taken from the meteorological station at the site named (Hancock et al., 1979). These are the stations either in or nearest to the land systems. A land system distant from a named station occasionally has a climatic code that is different from that deducible from the meteorological data, due to observed differences in the field.

e.g.:

2070	=	metereological data set number
Luziânia	=	metereological station name

Area

The area in hectares (ha) of the land system, calculated by measurements made from the original 1:1,000,000 maps.

Physiographic unit number descriptors

BRAZIL

Central-West Brazil

1 Pratinha surface highlands
2 Pratinha eroded surface highlands
3 Tocantins highlands
4 Araguaia plains
5 Tocantins peneplain
6 Natividade highlands
7 Espigão Mestre sand-covered tablelands
8 Rio São Francisco complex
9 Goiânia peripheral depression
10 Northern basalt tablelands
11 Sand-covered basaltic tablelands
12 Campo Grande tablelands
13 Alcantilados tablelands
14 Xavantina complex
15 Araguaia pampas
16 North Mato Grosso savanna tablelands
17 North Mato Grosso forest tablelands
18 Cuiabá plains
19 Pantanal
20 **Serra de Lageado highlands**
21 Bodoquena surface
22 North Cuiabá eroded surface
23 Cáceres plains
24 Rio Paraná basin
25 Paracatu

Amazônia

27 Southern Guayana inter-tableland depression
28 Macapá fluviomarine plains
29 Macapá cerrados
30 Amapá flat-topped hills
31 Amapá residual tablelands
32 Northern Pará peripheral depression
33 Amazon-Orinoco interfluvial tablelands
34 Northern Amazonian dissected tablelands
35 Rio Branco–Rio Negro peneplain
36 Amazonian low tablelands
37 Amazonian plains
38 Amazonian sedimentary basin tablelands
39 Rio Trombetas–Rio Negro dissected tablelands
40 Tapajós-Xingú tablelands
41 Southern Pará dissected tablelands
42 Pará-Maranhão tablelands
43 Middle Tocantins ortoclinal depression
44 Southern Pará peripheral depression
45 Cachimbo sierras and high plains
46 Tapajós residual tablelands
47 Rio Acre–Rio Javari depression
48 Guaporé residual tablelands
49 Dissected southern Amazonian tablelands
50 Mid-Amazonian depression
51 Central-Western Brazilian peneplain

PERU ECUADOR

101 Ecuadorian Amazonian clayey hills
102 Ecuadorian foothill fans
103 Peruvian-Ecuadorian sub-Andean foothills
104 Well-drained Amazonian plains
105 Poorly drained Amazonian plains
106 Low hills of the southern Peruvian Amazon
107 Southern Peruvian Amazonian plains
108 Piedmont
109 Intermontane valleys
110 Recent alluvial lands

COLOMBIA

151 Flat, well-drained savannas *(altillanuras)*
152 Undulating to hilly savannas *(altillanuras)*
153 Fluvial terraces
154 Piedmont
155 Old flood plains
156 Forest-covered plains
157 Piedmont forest lands
158 Hilly forest lands
159 Flooded forest lands
160 Recent alluvial lands

VENEZUELA

201 Andean foothills
202 Coastal mountain belt
203 Piedmont and well-drained western plains
204 Poorly drained western plains
205 Central rolling plains
206 Eastern plains
207 Poorly drained delta region
208 Guyana shield region
209 Alluvial deposits of the Orinoco river system

BOLIVIA

251 Sub-Andean foothills
252 Sub-Andean plains
253 Pampas (savannas) of Mojos
254 Brazilian shield
255 Pando tertiary plains
256 Guayamerin plains
257 Santa Cruz plains
258 North Brazilian shield plains
259 Chiquitana mountain range
260 Chaco plains

Altitude

An approximation of the altitude in meters (m) of the major part of the land system.

Physiographic Unit Number

A number assigned to locally recognized physiographic subdivisions of the physiographic regions. [These codes are not the same as those coded A to R on the Land Systems Map which identify broad physiographic regions.] (See codes on preceding page.)

Generalized Classification

A quick and approximate description of the overall landscape of a land system. Listed in the order:

Altitude
Drainage
Slope
Vegetation

Distance between Perennial Streams

In kilometers (km). Provides additional information on hydrology of the landscape and year-round water availability for livestock.

Depth of Wells, Main Land Facet

In meters (m). The approximate depth of wells used by inhabitants for year-round drinking water; and some additional information on hydrology of the predominant land surfaces.

Landform Diagram Information

Subdivision of landscape into facets. The vegetation code used on the landform diagrams.

Landform diagram descriptors

⫫ =	Seasonally inundated *pampas* (grasslands)
\\\ =	*Campo limpo + campo sujo* (grassland on well-drained lands with occasional shrubs)
\\\ ⚲ =	*Campo cerrado* (open savanna)
⚲ =	*Cerrado* (intermediate savanna)
⚲ =	*Cerradão* (closed savanna)
⚲ =	Tropical rain forest
⚲ =	Semi-evergreen seasonal forest
⚲ =	(Semi-)deciduous seasonal forest
⚲ =	Caatinga (scrubby xerophillic woodland)
⚲ =	Palm forest
⚲ =	Other vegetation

Landscape Facet Information

General Description

The general description of the landform.

Landform descriptors

A	plateau
B	valley bottom
C	rolling terrain, slopes <30%
D	depression
E	escarpment
M	hilly terrain, slopes >30%
N	concave sloping terrain
O	others[a]
P	plain
R	crest
T	terrace
V	valley
X	convex sloping terrain

a. Recorded on original coding formats on file at CIAT.

Percentage of Land System (L.S.)

Percentage of the area in a land system comprised by the land facet. Estimated during the delineation of the land systems on the original satellite or side-looking radar imagery. (Land systems were the smallest mapping units.)

Topographic Classification (CLASS.)

Percentage of the land facet in each of four topography classes, chosen to provide a practical guide to topographic differences four use in estimating costs of mechanization.

Topographic descriptors

		Land Systems Map pattern codes
FLAT POOR DRAIN	flat, soils with poor drainage	
<8%	<8%, well-drained soils almost flat, slopes	
8–30%	undulating to rolling, slopes 8–30%	
>30%	hilly to steep, slopes >30%	

Altitude in Meters (m)

The approximate media altitude of each land facet.

Original Vegetation Classification (CLASS.)

Probable percentage of the land facet in each of 10 broad physiognomic vegetation classes. Determined from the original satellite imagery.

Vegetation descriptors

		Land Systems Map color codes
SEAS.IN.P.	seasonally inundated *pampas* [poorly drained savannas]	grey
CL + CS	*campo limpo* (grassland) and *campo sujo* (grassland with occasional shrubs)[a] [well-drained savannas]	red
CC	*campo cerrado* (open savanna)[a] [well-drained savannas]	red
C	*cerrado* (intermediate savanna)[a] [well-drained savannas]	red
CD	*cerradão* (closed savanna with almost continuous forest canopy)[a] [well-drained savannas]	red
TRF	tropical rain forest[b]	forest green
SESF	semi-evergreen seasonal forest[b]	yellow green
SDSF	(semi-)deciduous seasonal forest[b]	brown
CAAT	caatinga (scrubby woodland with some savanna species)[c]	yellow
OTHER	other vegetation	blue-green and violet

a. Brazilian terms commonly used to clarify savanna vegetation (Eiten, 1972).
b. Terms used to classify well-drained forests (Eyre, 1968).
c. Defined by Eiten, 1972.

Induced Vegetation

Approximate percentage of two types of induced vegetation in each land facet:

PASTURES
CROPS

Estimated from original satellite imagery over 4-year period (1977–1981); can be used as guide to overall magnitude of land usage during that period.

Soil Classification

According to U.S. Soil Taxonomy (Soil Survey Staff, 1975). As explained in Chapter 2 of the book, *Land in Tropical America*, the code is accumulative:

Orders	***O***	**Oxisol**
Suborders	OUS	Ustox
Great Group	OUSAC	Acrustox

Soil classification descriptors

Order		Suborder		Great Group
Alfisols	A	Aqualfs	AQ	Natraqualfs Tropaqualfs
		Udalfs	UD	Hapludalfs Rhodudalfs Tropudalfs
		Ustalfs	US	Paleustalfs Rhodustalfs Haplustalfs Natrustalfs Tropustalfs
		Xeralfs	XE	Haploxeralfs
Aridisols	D	Orthids	OR	Camborthids
Entisols	E	Aquents	AQ	Fluvaquents Haplaquents Hydraquents Psammaquents Tropaquents
		Fluvents	FL	Tropofluvents Ustifluvents Xerofluvents
		Orthents	OR	Troporthents Ustorthents
		Psamments	PS	Quartzipsamments Tropopsamments Ustipsamments
Inceptisols	I	Andepts	AN	Dystrandepts Hydrandepts
		Aquepts	AQ	Haplaquepts Humaquepts

Continued

Continued

Order		Suborder		Great Group
		Tropepts	TR	Plinthaquepts Sulfaquepts Tropaquepts Dystropepts Eutropepts Ustropepts
Mollisols	M	Aquolls	AQ	Haplaquolls
		Udolls	UD	Arqiudolls
			US	Haplustolls
Oxisols	O	Aquox	AQ	Plinthaquox
		Orthox	OR	Acrorthox Eutrorthox Haplorthox Umbriorthox
		Ustox	US	Acrustox Eutrustox Haplustox
Spodosols	S	Aquods	AQ	Tropaquods
Ultisols	U	Aquults	AQ	Albaquults Paleaquults Plinthalquults Tropaquults
		Udults	UD	Hapludults Paleudults Plinthudults Rhodudults Tropodults
		Ustults	US	Haplustults Paleustults Rhodustults
Vertisols	V	Uderts	UD	Chromuderts

Soil Physical Properties

Descriptions of 11 variables.

Slope. In percentages. Parallel to the three topographic classes with slopes.

Slope descriptors

		-%-
A	*alto*, high	>30
M	medium	8–30
B	*bajo*, low	<8

Depth. In centimeters. Measure of depth of soil where there are no physical inhibitions to roots, including bedrock, hardpans, or water tables.

Depth descriptors

		-cm-
L	lithic	<20
S	superficial	20–50
M	medium	51–150
P	*profundo*, deep	>150

Initial infiltration rate (INIT. INFIL. RATE). Ability of a mulched soil to absorb water during the first hour of rainfall (after the upper 50 cm has dried out). This rating expresses the potential of a soil to absorb rain water at the start of a wet season or during a dry period of the year, rather than losing it as runoff. For soils on slopes, it reflects a certain predisposition to erosion. This is the authors' "value judgment" rather than a quantitative measure.

Initial infiltration rate descriptors

A	*alto*, high
M	medium
B	*bajo*, low

Hydraulic conductivity (HYDRAUL. CONDUCT.). Ability of soil to continue absorbing water over a prolonged period of time. This description is important in regions with high rainfall where some soils, such as the Alfisols and Ultisols in plains areas, may become waterlogged. A "value judgment" rather than a quantitative measure.

Hydraulic conductivity descriptors

A	*alto*, high
M	medium
B	*bajo*, low

Drainage. Amount of waterlogging, or the occurrence of anaerobic conditions. Generally, waterlogging implies the long-term presence of a water table within 60 cm of the soil surface; it may also refer to annual flooding.

Drainage descriptors

B	*bueno*, good	insignificant amount of waterlogging
D	deficient	some waterlogging of importance to the growth of susceptible plants
G[a]	gleyey, poor	waterlogging to the extent that all but very water-tolerant plants are seriously affected

a. See Fertility Capability Classification (Buol et al., 1975): g = gley condition within 60 cm of soil surface, as indication of water saturation. Also parallel to Aquic soil moisture regime definition in U.S. Soil Taxonomy (Soil Survey Staff, 1975).

Moisture-holding capacity (MOIST. HOLD. CAP.). In mm/100 cm soil depth.

Moisture-holding capacity descriptors

		-mm/100 cm soil-
A	*alto*, high	>150
M	medium	75–150
B	*bajo*, low	<75

Temperature regime (TEMP. REGIME). Classified according to U.S. Soil Taxonomy (Soil Survey Staff, 1975).

Temperature regime descriptors

		Mean annual temperature	Temperature variation[a]
		-°C-	°C-
H	hyperthermic	>22	>5
T	thermic	15–22	>5
S	isohyperthermic	>22	<5
I	isothermic	15–22	<5

a. The temperature variation is that between the three hottest months and the three coolest months of the year at a soil depth of 50 cm.

Moisture regime (MOIST. REGIME). In number of consecutive months. Approximate classifications according to U.S. Soil Taxonomy (Soil Survey Staff, 1975). Because it is rarely possible to obtain measured figures for these regimes, the subdivisions were based on monthly water balance figures calculated by Hargreaves' method (1971). This defines a dry month as one with an MAI (moisture availability index) of less than 0.34 [see Chapter 3 in Vol. 1 of *Land in Tropical America*]. The moisture-holding capacity of the soil was considered in marginal cases.

Moisture regime descriptors

		Soil Taxonomy classification	FCC condition[a]	MAI < 0.34
				-no. consec. mos.-
U	udic	Aquic, Udic		<3
SD	ustic	Ustic	d	3–6
XD	xeric	Aridic, Torric, Xeric	d	>6

a. See Fertility Capability Classification (Buol et al., 1975): d = annual dry season of 60 days.

Expanding clays. Describes soils with significant amounts of expanding clays, particularly montmorillimite.

Expanding clays descriptors

V[a]	soils with >35% clay with 50% of this clay 2:1 expanding clays; coefficient of linear expansion >0.09
O	less than V

a. See Fertility Capability Classification (Boul et al., 1975): v = vertic.

Texture. In both topsoil (first letter) and subsoil (second letter). Topsoil = 0–20 cm depth; subsoil = 21–50 cm depth. Defined according to Fertility Capability Classification (Boul et al., 1975).

Texture descriptors

C	clayey	>35% clay
L	loamy	<35% clay, but not loamy sand or sand
S	sandy	loamy sand and sand
R	rocky	rocks or other root-restricting layer
O	organic	>30% organic matter to a depth of 50 cm or more (coded with topsoil texture for convenience)

Coarse material. Percentage of presence of rock particles greater than 2 mm in diameter. In both topsoil (first letter) and subsoil (second letter). Topsoil = 0–20 cm depth; subsoil = 21–50 cm depth.

Coarse material descriptors

		-%-
A	*alto*, high	>35
M	medium	15–35
B	*bajo*, low	<15

Soil Chemical Properties

Descriptions of both topsoil (first letter = 0–20 cm depth) and subsoil (second letter = 21–50 cm depth) for first 11 variables, and in the topsoil and subsoil combined for second 12 variables. The last variable is topsoil only.

pH. In water, 1:1 soil to water ratio.

pH descriptors

A	*alto*, high	>7.3
M	medium	5.3–7.3
H[a]	low	<5.3

a. Approximates Fertility Capability Classification (Buol et al., 1975): h = acid.

Aluminum (Al) saturation. Percentage of Al saturation of the ECEC (effective cation-exchange capacity).

Al saturation descriptors

		-%-
A[a]	very high	>70
H	high	40–70
M	medium	10–40
B	*bajo*, low	<10
U	unknown	

a. See Fertility Capability Classification (Buol et al., 1975): a = Al toxic.

Exchangeable aluminum (Al). In meq/100 g soil, 1*N* KCl extraction.

Exchangeable Al descriptors

		-meq/100 g soil-
A	*alto*, high	>1.5
M	medium	0.5–1.5
B	*bajo*, low	<0.5
U	unknown	

Exchangeable calcium (Ca). In meq/100 g soil, 1*N* KCl extraction.

Exchangeable Ca descriptors

		-meq/100 g soil-
A	*alto*, high	>4.0
M	medium	0.4–4.0
B	*bajo*, low	<0.4
U	unknown	

Exchangeable magnesium (Mg). In meq/100 g soil, 1*N* KCl extraction.

Exchangeable Mg descriptors

		-meq/100 g soil-
A	*alto*, high	>0.8
M	medium	0.2–0.8
B	*bajo*, low	<0.2
U	unknown	

Exchangeable potassium (K). In meq/100 g soil, 1*N* NH_4Cl extraction.

Exchangeable K descriptors

		-meq/100 g soil-
A	*alto*, high	>0.3
M	medium	0.15–0.3
K[a]	low	<0.15
U	unknown	

a. Approximates Fertility Capability Classification (Buol et al., 1975): k = K deficient.

Exchangeable sodium (Na). In meq/100 soil, 1*N* KCl extraction.

Exchangeable Na descriptors

		-meq/100 g soil-
A	*alto*, high	>0.2
M	medium	0.1–0.2
B	*bajo*, low	<0.1
U	unknown	

Total exchangeable bases (TOTAL EXCH. BASES). In meq/100 g soil.

Total exchangeable bases descriptors

		-meq/100 g soil-
A	*alto*, high	>6
M	medium	2–6
B	*bajo*, low	<2
U	unknown	

Effective cation-exchange capacity (CATION EXCH. CAPAC.). In meq/100 g soil.

ECEC descriptors

		-meq/100 g soil-
A	*alto*, high	>8
M	medium	4–8
E[a]	low	<4
U	unknown	

a. Approximates Fertility Capability Classification (Boul et al., 1975): e = low ECEC.

Percentage of (%) organic matter. In meq/100 g soil.

Organic matter descriptors

		-meq/100 g soil-
A	*alto*, high	>4.5
M	medium	1.5–4.5
B	*bajo*, low	<1.5
U	unknown	

Phosphorus. In ppm, by Bray II method (Bray and Kurtz, 1945).

P descriptors

		-ppm-
A	*alto*, high	>7
M	medium	3–7
B	*bajo*, low	<3
U	unknown	

Phosphorus fixation. Possibility of P fixation.

P fixation descriptors

I[a]	significant	soils with >35% clay, ratio of % free Fe_2O_3 to % clay = 0:15
O	insignificant	less than above
U	unknown	

a. See Fertility Capability Classification (Buol et al., 1975): i = P fixation.

Manganese. In ppm, 1*N* KCl extraction.

Mn descriptors

		-ppm-
B	*bajo*, low	<8
S	satisfactory	8–35
T	toxic	>35
U	unknown	

Sulphur. According to agronomic tests. A "value judgment" rather than a quantitative measure.

S descriptors

A	*alto*, high
S	satisfactory
B	*bajo*, low
U	unknown

Zinc. In ppm, 1*N* KCl extraction.

Zn descriptors

		-ppm-
B	*bajo*, low	< 1.5
S	satisfactory	> 1.5
U	unknown	

Iron. In ppm, 1*N* KCl extraction.

Fe descriptors

		-ppm-
A	*alto*, high	> 80
S	satisfactory	10–80
B	*bajo*, low	< 10
U	unknown	

Copper. In ppm, 1*N* KCl extraction.

Cu descriptors

		-ppm-
B	*bajo*, low	< 0.15
S	satisfactory	> 0.15
U	unknown	

Boron. In ppm, extraction by refluxing soil with boiling water for 10 minutes.

B descriptors

		-ppm-
B	*bajo*, low	< 0.3
S	satisfactory	> 0.3
U	unknown	

Molybdenum. In ppm, 1*N* KCl extraction.

Mo descriptors

		-ppm-
B	*bajo*, low	< 0.5
S	satisfactory	> 0.5
U	unknown	

Free carbonates. Observation after treatment of (mini)samples to 50-cm depth with 30% HCl.

Free carbonate descriptors

A	no CO_2 efferverscence
B[a]	CO_2 effervescence
U	unknown

a. See Fertility Capability Classification (Buol et al., 1975): b = basic reaction.

Salinity. In mmhos, salinity of saturated extract of soil samples to 1-meter depth. Levels according to U.S. Soil Salinity Laboratory Staff (1954).

Salinity descriptors

		-mmhos-
B	*bajo*, low	0–4
S[a]	saline	> 4
U	unknown	

a. See Fertility Capability Classification (Buol et al., 1975): s = saline.

Natric. In percentages (%), natric saturation of CEC to 50-cm soil depth. Levels according to U.S. Soil Salinity Laboratory Staff (1954).

Natric descriptors

		%
B	*bajo*, low	0–15
N[a]	natric	> 15
U	unknown	

a. See Fertility Capability Classification (Buol et al., 1975): n = natric.

Cat clay. Presence or absence of acid sulphate clay in soil to 60-cm depth. Defined as cat clay when pH in 1:1 soil-to-water extract is > 3.5 after drying soil, or when contains jarosite mottles with hues 2.5Y or yellower and chromas 6 or more.

Cat clay descriptors

C[a]	cat clay present
N	no cat clay
U	unknown

a. See Fertility Capability Classification (Buol et al., 1975): c = cat clay.

X-ray amorphous. In the topsoil. Defined as > 35% clay and pH > 10 in 1*N* NaF extraction, or positive to field NaF test or other indirect evidence of allophane dominance in clay fraction.

X-ray amorphous descriptors

N	not x-ray amorphous
X[a]	x-ray amorphous
U	unknown

a. See Fertility Capability Classification (Buol et al., 1975): x = x-ray amorphous.

Elements of Importance mainly to Animal Nutrition

Summarized from studies related to the various elements. Include:

CO	Cobalt (Co)
I	Iodine (I)
SE	Selenium (Se)
CR	Chromium (Cr)
NI	Nickel (Ni)
Others	

Descriptors for elements important in animal nutrition

D	deficient
S	satisfactory
U	unknown

Fertility Capability Classification

Type and substrata types. Same as used in Texture coding.

Modifiers. According to Fertility Capability Classification (Buol et al., 1975), except in all capitals rather than lower-case letters.

FCC descriptors[a]

a	Al toxic
b	free carbonates basic reaction
c	cat clay
d	dry
e	low ECEC
g	gleyey
h	acidic
i	low P fixation
k	K deficient
n	natric
s	salinity
v	vertic, Vertisol
x	x-ray amorphous

a. These descriptions differ somewhat from those in Buol et al., 1975. Letters corresponding to the FCC system were used when the definition approximated that in Buol et al.

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