



Soils of East Africa

1 : 1 Million scale

User's Guide

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INDEX

1. INTRODUCTION.....	1-1
1.1 INSTALLATION	1-1
1.2 SYSTEM REQUIREMENTS	1-2
2. THE SEA DATABASES AND MAPS.....	2-4
2.1 GENERAL SOIL AND TERRAIN INFORMATION.....	2-5
2.2 GENERAL SOIL UNIT INFORMATION	2-6
2.3 SOIL HORIZON INFORMATION.....	2-6
2.4 SOIL MAPS.....	2-7
3. DATA VISUALIZATION AND INTERPRETATION	3-9
3.1 INTRODUCTION.....	3-9
3.2 MAPPING UNIT SELECTION	3-9
3.3 DATABASE VIEWERS.....	3-10
3.4 DATABASE QUERYING TOOLS	3-10
3.5 INTERACTION BETWEEN MAP FEATURE SELECTION AND DATABASE ENTRIES	3-11
3.6 THEMATIC MAPS.....	3-11
3.6.1 <i>Attribute selection</i>	3-11
3.6.2 <i>Class Colours</i>	3-12
3.6.3 <i>Thematic Legend</i>	3-12
3.6.4 <i>Theme Interpretation</i>	3-12
3.7 MAP AND DATA EXPORT	3-13
4. REFERENCE	4-14
4.1 FILE MENU	4-14
4.2 EDIT MENU	4-17
4.3 SELECT MENU.....	4-18
4.4 DATA MENU	4-19
4.5 VIEW MENU.....	4-20
4.6 HELP MENU	4-23
4.7 THE TOOLBAR	4-24
5. APPENDIX.....	5-26
5.1 REFERENCES.....	5-26
5.2 THE SOIL AND TERRAIN DATABASE.....	5-27
5.2.1 <i>General Soil and Terrain data</i>	5-27
5.2.2 <i>Three most important soils</i>	5-31
5.2.3 <i>Soil profile data</i>	5-37

1. INTRODUCTION



The SEA programme is a computer system for the storage, display, interpretation and analysis of the Soil Map of East Africa at scale 1:1.000.000. The system consists of the soil and terrain database with corresponding soil maps, that are accessed by the programme for visualization in different viewer formats. Various interactive querying and selection tools provide easy access to specific parts of the database for display as thematic map, data browser or data entry form.

There are currently a variety of commercial software tools available on the market that can perform the same operations that are provided by SEA. However, these software applications are expensive, and generally require a thorough computer knowledge. The SEA programme was designed to provide potential users of the soil database easy access to data and maps for interpretation and analysis purposes, without any training necessary. For advanced use of the products, data and maps can be exported in various file formats for further processing in commercial software.

SEA runs on microcomputers based on the Intel family of microprocessors: 386, 486, Pentium and Pentium Pro, running Windows 3.1 or higher. Minimum requirements are 6 MB of free internal RAM memory and between 6 and 15 MB of hard disk space.

Summarizing, the main features of SEA are:

- multiple view of the soil and terrain database in mappers and data browsers;
- querying capabilities ranging from simple spatial selection of map features to complex SQL queries on the database;
- full interaction of database queries and map feature selection and vice versa, using a wide range of selection tools;
- a comprehensive palette of drawing tools and other functions to customize your maps;
- automatic and fully customized thematic mapping.;
- easy control over the different layers in the maps;
- export of maps in various commercial GIS software formats;
- export of data in various formats; and
- on-line context-sensitive help functions.

All information in this User's Guide can also be accessed from within the SEA programme. Context sensitive help is available from anywhere in the programme by pressing the F1 function key or by clicking the appropriate Help button.

This manual is subdivided in four parts with the first chapter giving a general introduction. The second chapter deals with an overview of the databases behind the software, while chapter three explains the different data visualization and interpretation tools available in the programme. Chapter four finally consists of a concise reference guide, where aspects of the programme are listed, according to the programme's menu layout.

The appendix gives more details on the database structure and contents.

1.1 Installation

The SEA programme and its installation programme are both Windows applications. You must already have Windows running to install the SEA programme and databases. The installation

programme creates directories as needed and copies files from the distribution CD-ROM to your hard drive.

Two installation programmes facilitate the installation of the programme and runtime libraries on your computer:

- Installation of the SEA programme files and databases; and
- Installation of the database runtime library, or the 'Borland Database Engine' (BDE) which handles the database functions.

The full set of installation files is located on the CD-ROM under \SEA for the SEA software and the databases, while the directory \SEA\BDEINST\ contains the 'Borland Database Engine' runtime library. Complete installation requires the use of the two installation programmes: one for the SEA files and one for the BDE installation. The BDE installation utility is automatically called by the SEA installation programme, when the installation of SEA files and databases is completed.

If you have installed **DBASE V for Windows** or **Paradox 5.0 for Windows** on your computer, you are not required to install the BDE. If a version of the BDE is present on your system and you are installing it again, the installation programme will overwrite the existing BDE.

The installation procedure.

Insert the CD-ROM in the CD-ROM drive and run the **INSTALL.EXE** programme from within Windows. You only need to follow the instructions on the screen. There are three installation options:

Complete installation: This option will install all programme and database files and the BDE runtime library. This requires 15 MB of hard disk space. If necessary, the configuration file (CONFIG.SYS) of your computer will be updated.

Complete installation without the BDE: This procedure will install all databases and programme files, except the BDE. Hard disk requirements are 13 MB. Use this option only, if you are sure that you have the latest version of the BDE on your computer installed already.

Customized installation : With this installation option you have full control over the databases to install. By default, customized installation is equal to complete installation, but you can click on the check-boxes, to define installation of different parts of the product. All data is organized by country.
You can check the next section of the manual for details about the size of the databases for each country.

The SEA programme will not run if the BDE is not installed on your system. If you move files or directories from the SEA system over your hard disk, you must also edit the WIN.INI and SEA.INI configuration files in your Windows directory.

1.2 System Requirements

The SEA programme is a Windows 16 bit product and requires an IBM compatible computer 80386 or better, running Windows 3.1 or higher.

- You need at least 6 MB of RAM memory, while 8 MB or more RAM is advised;

Soils of East Africa - User's-Guide

- A disk-cache will considerably speed up map and data access. You may therefore wish to install the SMARTDRV programme, which is provided with the latest DOS versions and with Windows.

The software itself occupies approximately 3.5 MB of hard disk space, while the attribute data and maps occupy between 1 and 11 MB of disk space, according to the countries installed. The table below gives an indication of the size (in KB) of maps and databases by country.

	Maps	Database
Burundi	70	100
Djibouti	40	100
Egypt	1000	320
Eritrea	300	210
Ethiopia	1900	620
Kenya	1200	770
Rwanda	100	120
Somalia	530	270
Sudan	2100	100
Uganda	480	400
SEA software	1000	
BDE	2500	
TOTAL	14500	

Hard disk requirements (in KB), necessary for the installation of the different SEA components.

2. The SEA databases and maps

This chapter gives a concise overview of the contents and structure of the SEA soil and terrain database, and related soil maps. The databases and maps are linked by the programme for interactive data representation.

The SEA soil and terrain database contains a wide range of variables related to the soil and terrain characteristics of the soil mapping units. There are 523 variables in the database, organized in three groups:

- General soil and terrain information;
- General data for the three most important soils, and two inclusions;
- Soil profile Information for the three dominant soils.

Most of the data are stored as qualitative data, where the classes describe the different class captions or where classes represent ranges of quantitative data. More details on the different classes are found in the Appendix 1.

All soil and terrain data were originally entered on standardized data entry forms, called **Mapping Unit Identification sheets** (Muidsheets). An example of this sheet is reproduced on the next page. This approach enabled an easy transfer to the digitized database presented by the programme. For the complete area covered by SEA there are 1966 sheets, while there are over 12400 mapping features.

The Mapping Unit Identification Sheets can be subdivided into 3 sections (see table on the next page).

Top right	This first section gives information about the mapping unit as an entity. Mapping unit identifiers are reflecting dominant soil type, dominant texture and dominant slope classes, providing important soil information, even without further description. Two dominant soils are given in the identifier if the two most important soils differ 10% or less in area covered within the mapping unit. If the major soil type was a Lithic Leptosol, the second soil type was given in the identifier if it covered more than 20% of the mapping unit. If the dominant soil(s) are found on more than one slope class, lowest and highest group symbol is given in the identifier. If actual textures of the dominant soil(s) cover(s) 2 or 3 texture groups, the most representative group is given. If textures cover 4 or 5 texture groups, no texture indication is given.
Top left	The left top part of the Muidsheet gives more detailed site information, for the dominant soil, soil 2 and 3 in decreasing area percentages. It lists the area percentages, slope, surface form, parent material, external drainage, surface stoniness, surface crusting, effective soil depth, and additional inclusions.
Bottom	The bottom part gives profile information concerning the three most important unit components. Whole profile information is gathered under "S", if representative profiles were available while information for separate horizons is found under "1,2,3,4". This bottom part can not be viewed in the SEA data entry form.

MAPPING UNIT DESCRIPTION SHEET PROJECT SMEA					Mapping Unit Identifier											
Soil suitability (S1/S2/N)					Reliability											
Upland crops						Complexity										
Paddy rice						ONC map sheet										
		SOIL 1	SOIL 2	SOIL 3												
Area (%)						Country										
Slope (%)						Total area										
Surface form						Landscape										
Parent material						Geology										
External drainage						Vegetation										
Surface stoniness						Altitude										
Surface crusting						Agroecological climate										
Effective soil depth						Temperature Precipitation										
Additional inclusions						Report+Year of survey										
		SOIL 1				SOIL 2				SOIL 3						
FAO classification																
Phase																
USDA classification																
Clay mineralogy																
Key profile number																
		S	1	2	3	4	S	1	2	3	4	S	1	2	3	4
Depth (cm)																
Organic carbon																
CEC soil																
CEC clay																
Base saturation																
Exchangeable Na																
Exchangeable Al																
Available P																
Carbonates																
Gypsum																
Sodicity (ESP)																
Salinity (ECe)																
pH																
Texture																
Nature of boundary structure																
Structure stability																
Colour (wet)																
Colour (dry)																
Internal drainage																
Available Water cap,																

2.1 General soil and terrain information.

The central part of the database lists the general features of the soil mapping units. Each of the soil mapping units are characterized by their **IDNUMBER** and **MUIDSHEET** code. The **IDNUMBER** is included in the database for facilitating the indexing and access to the database, while the **MUIDSHEET** number is the original number used on the data entry forms. The **IDNUMBER** can not be modified, while the **MUIDSHEET** number, together with all other variables in the database, can be edited if data editing permission is obtained. In general, the **IDNUMBER** is not displayed when browsing through the database.

The **CNTCODE** gives the country code. Since all tables are organized by country, the country code will be constant within each table.

The **MAPUNIT** variable makes the core of the soil database: it gives summary information of dominant soil type, dominant texture and dominant slope class. The dominant soil is given to third level. For instance: **ARb.or12-1ab** is an Orthic Cambic Arenosol, association number 12, sand on 0-5% slopes (see further).

DOM1 gives the first three letters of the Mapping Unit Identifier (**MAPUNIT** variable).

Considerable differences in reliability (**RELIAB**) of the sources of information occur in the different parts of the area covered by SEA. Before starting the data interpretation in SEA, it is recommended to display a thematic map of the data reliability.

The **LANDSCAPE** provides the landscape(s) of the mapping unit. Landscapes are coded in around twenty major classes, while the mapping units generally feature different landscapes. The **GEOLOGY** and the **VEGETATION** variables give an indication of the major geology and vegetation patterns in the soil mapping unit.

The database contains additional information on soil suitability assessments for irrigated upland crops and for wetland rice (paddy rice). Variables **UCS1**, **UCS2** and **UCNS** give the area of the soil mapping unit which is very suitable (S1), marginally suitable (S2) and not suitable (N) for upland crops. Variables **PRS1**, **PRS2** and **PDNS** give the same percentages for paddy rice.

2.2 General soil unit information

This section describes the variables of the three most important unit components, and two phases if present. Variable names are related to the different soils in the mapping unit, and each name contains a suffix with the soil number. For instance the variable names for the FAO classification are **FAOCLASS1** for the dominant soil, **FAOCLASS2** for the second soil etc. Soil numbers in the variable names below are represented by **x**.

The soil number **SNUMx** ranges from 1 to 3 for the main three soils in the mapping unit and 4 and 5 for the additional inclusions.

The general soil information contains the following variables:

FAOCLASSx	gives the soil class according to the FAO soil classification;
AREAPERCx	is the area percentage of the respective soil in the mapping unit; (the dominant soil always has the highest area)
SLOCLASSx	is the slope class; (additional variables are SLOPELOWx , SLOPEHIGHx and SLOPEPLUSx)
TEXTCLASSx	the texture class of the soil;
SURFAFORx	the surface form;
PARENTMATx	the soil's parent material;
EXTERDRAIx	the external drainage;
STONELOWx	describes the surface stoniness;
STONEHIGHx	describes the surface stoniness;
SLOPEPLUSx	surface stoniness
CRUSTINGx	information on surface crusting.
EDEPTHLOWx	the effective soil depth in cm.
EDEPTHHIGHx	the effective soil depth in cm.

2.3 Soil horizon information

Soils of East Africa - User's-Guide

The soil profile information in the SEA database is given for up to four horizons for each of the three dominant soils in the mapping unit. The variable names below are modified to avoid replication of variable descriptions. In variable name **SOIPROxy**, **x** represents the soil number (1 to 5) and **y** is the profile number. The profile number ranges from 0 to 4, with 0 used for the complete profile and 1 to 4 for the separate horizons if representative profile data were available.

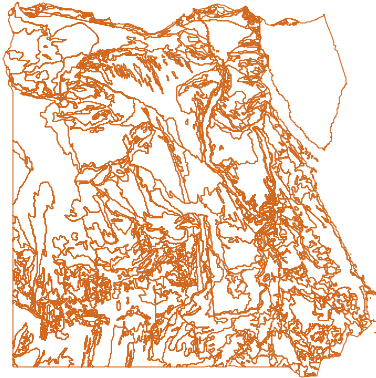
The following variables are given for each horizon:

SOIPROxy	the soil profile number from 0 to 4
HORIZONUxy	simply defines the horizon number, with 0 representing the complete profile.
DEPTHCMxy	gives the depth of the bottom boundary of the horizon in cm.
DEPTHPLUxy	
ORGCARBOxy	the Organic Carbon in Percentage weight.
CECSOILxy	the Cation Exchange Capacity in meq/100 g soil.
CECLAYxy	the Cation Exchange Capacity in meq/100 g clay.
BASESATUxy	Base saturation, related to CEC-pH7 (%)
EXCHAGENxy	Exchangeable Na in meq/100 g soil.
EXCHAALxy	Exchangeable Aluminium in % CEC.
AVAILPxy	Available Phosphorus in ppm.
CARBONATxy	Carbonates in percentage weight.
GYPSUMxy	Gypsum in percentage weight.
SODICITYxy	Sodicity (ESP) in percentage.
SALINITYxy	Salinity (ECe, mS/CM saturation extract).
PHxy	pH in water.
TEXTURExy	Texture of fine earth fraction, according the texture triangle in FAO, Guidelines for Soil Profile description (1977)
NATBUNDxy	Nature of boundaries.
STRUSIZExy	Structure size.
STRUFORxy	Structure form (type).
STRUSTAXy	Structure stabilities.
COLWETAxy	According to the Munsell Colour scale.
COLWETBxy	According to the Munsell Colour scale.
COLWETCxy	According to the Munsell Colour scale.
COLDRYAxy	According to the Munsell Colour scale.
COLDRYBxy	According to the Munsell Colour scale.
COLDRYCxy	According to the Munsell Colour scale.

2.4 Soil maps

The scale of all maps in the SEA programme is 1:1.000 000. The original soil maps were drawn on a stable material using the Operational Navigation Charts in Lambert Conformal Conic Projection. These maps have several advantages over regular topographic maps:

- A world wide coverage



- World wide obtainable
- Showing geomorphological information
- Good detail
- As an average highly reliable

The draft version of the soil map was drawn on full-transparent foil. In this way, nearly all geomorphological information was visible on the soil map, enabling easy understanding of the major soil differences, especially when related to mountains, scarps, plains, and floodplains.

The Soil Mapping Unit lines, drawn on the paper maps, were scanned, then converted into Latitude/Longitude and clipped with the Digital Chart of the World (DCW) in Arc-Info. This means that coastal lines, country boundaries, water bodies and main double edge rivers are derived from the DCW.

Figure 1 Example of the basic soil

water bodies and main double edge rivers are derived from the DCW.

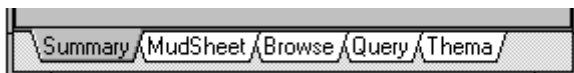
3. Data visualization and interpretation

3.1 Introduction

The main purpose of the SEA programme is to visualize the databases of the Soil Map of East Africa for inspection and interpretation. The programme provides a wide variety of tools to select map features and database records for these purposes.


All data is presented in two screens: **the main window** is the map working area, where all maps are displayed and where the map manipulation functions are carried out. **The second window** is the data screen which is a combination of five screens for displaying the soil and terrain database entries. This data screen is subdivided in the following windows:

1. the **summary screen**, which lists most important variables for the selected mapping unit;
2. the **Muidsheets form**, which is an entry form representing all general fields (variables) of the database;
3. the **data browse screen**, a worksheet-like area for browsing through the database;
4. the **SQL query screen**; and
5. the **thematic legend screen**, with the legend of the attribute data




You switch between the different pages by clicking the corresponding tab (see figure). The **Thema page** in the data screen displays the legend of the thematic map, if attribute data was selected. Section 3.6 in this chapter provides all details for loading attribute data.

3.2 Mapping Unit Selection

Soil mapping units are selected spatially from the screen by clicking the mouse with the special mouse cursor . You may need to zoom in on the map to access small mapping units. Open the **Select** option in the main menu to start the selection of mapping features.

For the selection of soil mapping units and the simultaneous display of their database contents, you should use **Select|Summary** from the main menu to display the summary soil and terrain data. This summary screen lists the main variables of the database as text, i.e. class codes are converted to full text. This option should be used to get familiar with the programme and the database, before moving to the other data viewers.

The **Select|Muidsheets** option will display the main part of the Muidsheets for the selected mapping unit. You can browse through the Muidsheets with the data navigator. This tool

consists of four buttons  which enable the user to go respectively, to the first, previous, next and last record in the database. Browsing through the sheets will select (highlight) the mapping features on the map.

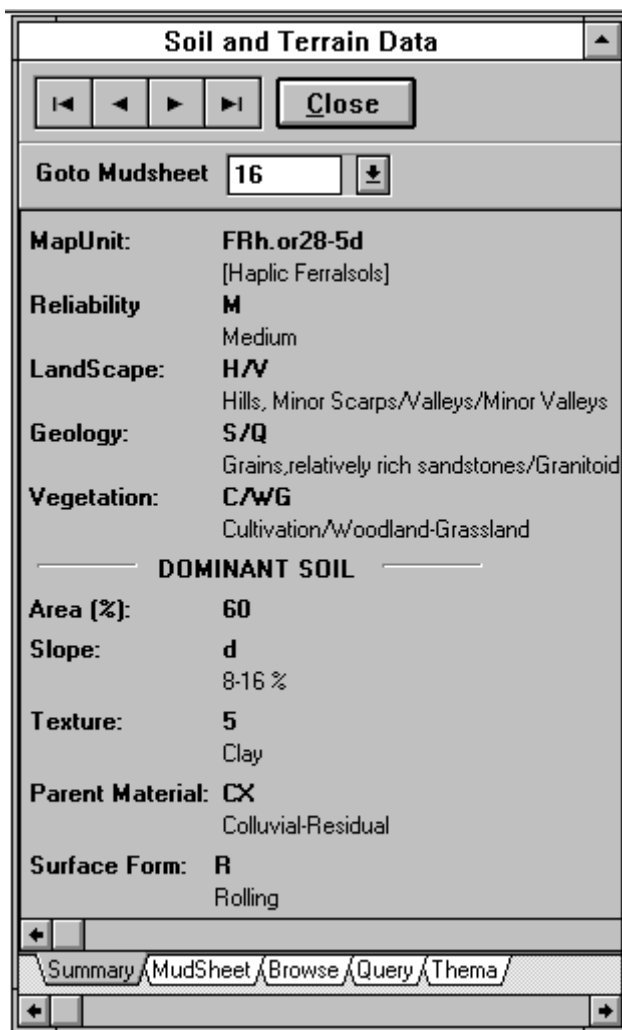


Figure 2 The data summary screen

The **Select|Area** tool is used to select a number of mapping units with display of their database entries in worksheet format. To use this tool, you are expected to draw a rectangle area by clicking and dragging the mouse over the screen. The programme will select all mapping features that are *completely* within the rectangle boundaries. You can use this tool to select a number of mapping features nearby an area of interest to compare their characteristics. There is a limit of maximum 40 mapping features in the selection.

Colours for selected mapping features are defined in the Preference Pages, which are obtained from the **File|Preference** menu.

3.3 Database viewers

SEA provides a general data viewer from the **Data|Browse** option in the menu. The main table, with the general soil information, is displayed by default, but you can open any of the four tables, by selecting the appropriate line from the database selection box. Table names are '**General soil information**', '**Soil 1**', '**Soil 2**' and '**Soil 3**', for displaying respectively the table with general data and horizon information for soil 1, 2 and 3.

The data navigator enables you to browse through the tables with simultaneous selection of the mapping units associated with the selected Mudsheet in the database.

The worksheet-like area can be used to modify the database. Editing the database requires permission through a password, which can be obtained from the Preference Pages in the **File|Preferences** menu.

Additional data viewers are the Mudsheet form (**Data|Mudsheet**) and the summary screen (**Data|Summary**). These viewers only display part of the database. The Mudsheet form shows a Mudsheet entry form, where you can also update the database. The data summary screen gives the area of the currently selected mapping unit. Areas are not computed when a number of mapping units are selected by browsing through the data table.

3.4 Database querying tools

Querying the soil and terrain database in SEA is facilitated by different automated tools. In the Summary data screen (**Data|Mudsheet**), you can enter a Mudsheet number to display its

summary information

When you enter a new Muidsheet number, the **Muidsheet page** and the **Browse page** of the data screen are also updated with the selected Muidsheet. On the map, the soil mapping units associated with the selected Muidsheet will be selected according to the selection colours in the Preference Pages.

The most powerful database querying facility is provided by the SQL query screen (**Data|SQL query**). Results of the SQL queries can also be edited or updated if data edit permission was granted. By default, the soil mapping features that were selected with a SQL query are not highlighted. In the Preferences Pages you can request the programme to select or highlight the mapping features that you select by SQL. To carry out a SQL query, you should enter the command in the SQL entry box and press **Enter** or press the **SQL button**. Detailed information on the SQL syntax is provided in the on-line Help file of the programme.

3.5 Interaction between map feature selection and database entries

All data selection tools that are available in SEA provide full interaction between maps and databases. When you select a mapping unit, the corresponding database entry is selected, and when you select database entry(ies), corresponding mapping units are selected or highlighted. The mapping unit selection colours are defined in the Preference Pages. You can un-select all the units from the map with the **Edit|Unselect All** command.

During SQL queries, you can switch the map-data interaction on or off in the Preference pages from the **File|Preferences** menu.

3.6 Thematic maps

Thematic mapping is the process of assigning different colours and fill patterns to mapping features according to a value or code. For example, you could thematically shade the soil map according to the dominant soil type, with each soil type represented by a different colour or hatch pattern.

SEA supports the creation of thematic maps from a selected number of variables of the database. Generally, the creation and interpretation of a thematic map requires the following steps:

- a) Attribute selection and classification customization
- b) Definition of the class colours
- c) Definition of the class legends
- d) Interpretation of the thematic map

The three pages (**Classification, Colours, Legends**) in the thematic mapping dialog box are used respectively for selecting attributes (a), modifying class colours (b) and defining legend captions (c). The interpretation of the thematic map (d) is done from the legend of the theme.

The SEA programme is limited to 128 classes for classifying your data. For the proper representation of more than 16 classes (16 colours), you should switch your screen driver to *TRUE COLOUR*, which means a capability to display over 32000 colours simultaneously. Consult your computer manuals on how to do this. If your computer is in 16 or 256 colour mode, the programme will build colours from the existing colours in the palette.

3.6.1 Attribute selection

You start the creation of a thematic map with selecting the attribute variables from the variable selection box. After you have selected the variable, the programme will automatically classify the data. It uses therefore the original entries in the database. The number of cases in each class is also displayed in the classification grid.

Several options are now available:

Go for the thematic map: Select the **OK button**, and the thematic map will be displayed automatically. Legend captions and class colours are defined by the programme. The default colour for the first and last class can be modified in the Preferences Page. Colours for intermediate classes are computed by the programme.

Auto simplify the classification: Press the **Auto Simplify** button to simplify the classification. This option will only retain the first relevant letter of the class. Suppose you have a Landscape class of 'F/Y', which corresponds to 'Footslopes/Piedmont plains', then the simplify command will change this entry to the first relevant value of 'F' or 'Footslopes'.

This 'simplify command' has a different result on variables containing FAO soil classification information. It will remove the third character: e.g 'FLe' becomes 'FL', or Level III to Level II. The main purpose of this command is to automatically reduce the number of classes.

Select Manual Classification: You modify the classification method in the **Classification method** selection box. In manual classification mode, you can modify the number of classes and enter new class values in the grid ('Value' column). Press the **Evaluate button** to compute the cases in each class. Classes with zero cases should be removed manually. Manual classification also requires manual legend definition.

By pressing the **Clear button**, you can remove all current thematic settings. You can use this button to remove a thematic map that was loaded before, which is also obtained from the **File|New** option in the menus.

3.6.2 Class Colours

By default, class colours are computed by the programme from the colour of the first and last class as defined in the Preference Page. In automatic colour definition mode, you can select the colour of the first class by clicking the **From button**, or the colour of the last class from the **Last Button**. Colours of intermediate classes will be computed by the programme.

If you select manual colour definition, you can modify the colours of any class, by just *left clicking* on the colour box of the class-colour you want to modify. From the colour selection screen, you can select virtually any colour that matches your hardware configuration.

3.6.3 Thematic Legend

The legend grid is a simple editor for the legend captions. You can modify the captions by clicking on them and modifying the text. When you have selected manual classification, you are required to enter all captions by hand. Press the **OK button** to draw the thematic map.

3.6.4 Thema Interpretation

The Legend of a thematic map is one of the pages in the data screen. It displays the class number, class colour, class value and legend caption for all classes. To facilitate the

interpretation of the thematic map, you can click the colour boxes in the legend. Several options for the interpretation of the thematic map are available:

- Left click** When you click the left mouse button on one of the class colour boxes, all mapping units of that class will be selected. Colours of the selected units are defined in the Preferences pages. Mapping units can be unselected with **Edit|Unselect All**.
- Right click** When you click the right mouse button on the class colour box, you can modify its colour by selecting a new colour from the colour selection tool. You must then manually redraw the map with **View|Redraw Map**.
- Shift-Left Click** Pressing the shift button and left-clicking the colour will convert the class colour to the colour for missing values as defined in the Preferences pages. Redraw the map after modifying the colours.
- Shift-Right click** Pressing the shift button and right-clicking the colour will convert the class colours of all classes, except the one you clicked, to the colour for missing values as defined in the Preferences pages. You must redraw the map to notice the modifications.

3.7 Map and data export

Maps and data can be exported from SEA in several formats for further processing in other software.

Maps can be exported directly to other applications via the Clipboard in Windows. Select **Edit|Copy to Clipboard** from the menu to copy the mapping window to the clipboard. You can then paste the map in any Windows application that is able to import a bitmap, using the **Edit|Paste** command.

Use **File|Export Maps** to export maps to external map files, in ARC-Info and IDRISI formats. *Arc-Info* is a commercial GIS software from Environmental Systems Research Institute, Inc and *IDRISI* is a popular raster GIS from Clark University. For data analysis in these packages, you can also export the attribute data from the **File|Export Data** menu command.

Thematic maps can also be exported in *IDRISI* raster file format. These raster images contain the attribute data, with the legends as defined in SEA.

SEA supports the export of data in Dbase, Paradox and ASCII (free format and delimited) formats. Dbase and Paradox are commercial software's from Borland International. ASCII files can be used to import attribute data in spreadsheets. Consult the on-line help for more details on data export.

4. Reference

This concise Reference Guide gives a complete overview of all menu commands in the SEA programme. Additional information on all these commands is found in the Help file.

4.1 File Menu

File|New

The **File|New** command loads the base map of the selected country and removes the attribute data. You get the same result when selecting the country of interest from the selection-box at the right side of the toolbar.

File|Export Map

Use the **File|Export map** to export maps (and attribute data) to a file for further processing in commercial software. SEA supports the export of three file formats: Arc-Info UNGEN, IDRISI vector VEC and IDRISI raster IMG format. Attribute data can be exported separately with the **File|Export data** command.

File|Export data

The data export dialog box appears from the **File|Export** data option from the menu. Use this option for all data export operations. It is possible to export data in ASCII fixed and delimited formats, and Dbase IV and Paradox 5 formats. All data export is relative to one of the four data tables.

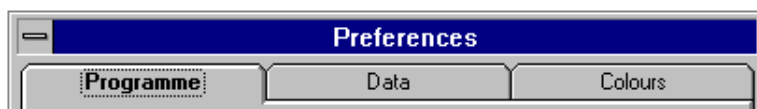
The data export screen consists of two parts:

Custom export Custom export is selected from the custom-tab in the dialog box. This export option enables you to define variables and Muidsheets for export in one of the supported formats.

Automatic export Automatic export is used to export an **SQL query table**, data for a **selected Muidsheets**, or to **convert a data table** to a format of your choice. Automatic export does not support delimited ASCII export.

File|Preferences

General programme preferences can be modified from the **File|Preferences** option in the menu. The preferences dialog box is subdivided into three parts which can be selected from the tabs at the top of the dialog box: **Programme**, **Data** and **Colour** preferences.



The Programme preference page contains the following options:

Enable pop-hints:

When you position the mouse pointer over the icons in the toolbar, and keep the mouse for about one second on the icons, a yellow pop-up hint will appear. The hint gives brief information about the icon. Note that the

Status Bar on the bottom of the screen gives more information about the icons than the pop-up hints.

Save settings on exit:

Programme settings from the Preferences dialog box, together with the map layer settings (see **View|Layer Control**), can be saved to the **INI file** of the programme. This file is loaded when SEA starts and it provides most of the settings, necessary to run the programme. Click on the option to switch it on or off respectively. When the option is active, all programme preferences settings and the map layer control settings will be saved to the INI file when the programme is quitted. Next time you start SEA, the preferences are retrieved.

Confirm on exit:

When you quit SEA, there is no request for confirming your action. By setting this option you can request for a confirmation message before quitting the programme

Link SQL queries to map selection:

SQL queries on the databases are by default independent of the selection of map features. When you want to link your SQL query with the simultaneous selection of the map features selected by your SQL command, you must set this option.

Automatic map redrawing:

Redrawing the map, each time you modify settings, can be time consuming. Two mutually exclusive settings enable you to select automatic map redrawing or manual map redrawing. The first option will always redraw the map automatically, while the next will only redraw on specific request.

Manual map redrawing:

This option is linked to the previous one, and will only redraw the map on specific request.

The data preference page contains the options:

Exclusive use of data tables

The Exclusive property is used to prevent any other user from accessing the table. In exclusive mode, when other users are accessing the same table when you try to open it, you will have to wait for those users to release it. Set the exclusive option only when you must have complete control over the table. This option is useful when databases are installed on a network. On a stand alone computer, the exclusive option will not allow to open a database in two applications that are running simultaneously.

Obtain data edit permission:

The SEA programme provides limited facilities to update or correct the soil database. It is not possible to extend the database, by adding new fields or records. To obtain permission to edit the database, you should click the mouse on the red-light icon. You will then be requested to enter a password. Without the valid password, you are not able to modify the database.

When you use external software, such as DBASE, Paradox, or Access to edit the database, you should retain the same database structure and indexes as the original database files provided with the software.

The Colours preference page contains the options:

Map feature selection colour:

A selected mapping unit is painted with a horizontal dense grid. The colour of the lines is defined by the selection colour. Use this option if you want to modify the grid colour of selected mapping features. The colour selected from the colour selection box will be converted to the closest matching solid colour. By default the selection colour is red, but if your thematic maps contain many red patterns, you are advised to change the selection colour.

Map feature selection background colour:

The background colour for selected map features is the colour on which the foreground colour will be drawn. By default, the background is white, but you may need to change this colour to better distinguish selected mapping units.

Default start colour for thematic mapping:

The automatic class colour option during thematic map preparation requires you to define the colour for the first and last class. Colours for the intermediate classes will be computed by the programme. This option enables you to define the default colour for the first class.

Default end colour for thematic mapping:

The automatic class colour definition option during thematic map preparation requires you to define the colour for the first and last class. Colours for the intermediate classes will be computed by the programme. This option enables you to define the default colour for the last class.

Colour for missing data:

Colour for missing data in thematic maps will not appear in the legend of thematic maps. You should therefore define a separate colour for all mapping units that have missing data for a particular variable. By default, the colour for missing data is white.

File|Exit

With the **File|Exit** option, you quit SEA and return to the Windows operating system. By default there is no confirmation message, but you can request confirmation from the Preferences pages (**File|Preferences**).

4.2 *Edit menu*

Edit|Copy to clipboard

The **Edit|Copy to the clipboard** option copies the current map to the clipboard in Windows BMP format. You can retrieve the map in other Windows software (such as MS-Word, Paintbrush etc..) via the **Edit|Paste** option of these packages. Data or text is never copied to the clipboard, and if you display a thematic map, the legend is not transferred to the clipboard.

Edit|Unselect All

Map features that were spatially selected or via SQL queries are highlighted with settings provided in the Preferences dialog box. This option **Edit|Unselected All** unselects all map features, by just removing their selection colour.

4.3 Select menu

Select|Summary

This option **Select|Summary** enables you to spatially select map features with the simultaneous display of a 'summary data screen'. This screen lists the general variables of the soil and terrain database, such as the mapping unit identifier, the vegetation, geology etc.

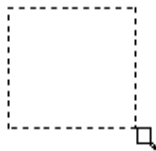
The summary data screen is the only data screen which converts the class codes to full text. It also gives the area of the selected mapping unit. It does however not compute areas when several mapping units are selected.

When you access the database through the Muidsheets, the Browse forms or the SQL forms, you will get the data in coded format, which requires a good knowledge of the databases. The summary data screen also provides a selection box to search for a particular Muidsheet. Enter the Muidsheet number of interest in the selection box, and the map features will be selected, while the data is loaded. You can remove the selection shadings with **Edit|Unselect All**. You can browse through the Muidsheets with the Data Navigator.

Select|Muidsheet

The **Select|Muidsheet** option provides an easy link between the mapping features and the Muidsheets. The Muidsheet forms can be used for updating and correcting the database. The sheets list all the data as it was represented in the original data entry sheets, except for the soil horizon information. You can browse through the sheets with the data navigator. The Muidsheet form can be re-sized with the usual window re-sizing tools. This requires redrawing the map.

Select|Area



Use the **Select|Area** to select map features that are completely within the given rectangle boundary. When you use this tool, you are expected to draw a rectangle area by clicking and dragging the mouse over the screen. SEA will select all mapping features within the rectangle boundary. The data of the selected features is represented in browse format. You can use this tool to select a number of mapping features nearby an area of interest to compare characteristics. There is a limit of maximum 40 mapping features in the selection.

4.4 Data menu

Data|Summary

The summary data screen is a browser which displays the most important variables of the Muidsheets. This command **Data|Summary** is similar to the **Select|Summary** command, but it is not interactive. You browse through the Muidsheets with the Data Navigator. During browsing, the associated mapping units are selected.

Data|Browse

The **Data|Browse** command loads the data browser screen. This screen is a worksheet like area where all variables are listed for consultation or editing. For editing, you must obtain data edit permission in the Preference Pages. You can browse through the records with the Data Navigator.

Data|Muidsheets

The **Data|Muidsheets** option opens the 'Muidsheets screen'. This screen is a Muidsheets data form, that can be used for data editing. The command is similar to the **Select|Muidsheets** command, but is not interactive. You browse through the Muidsheets with the Data Navigator. Mapping units will be selected during browsing.

Data|SQL query

The **Data|SQL query** command opens the SQL query screen. You enter the SQL query statements in the SQL statement edit box, and then click on the SQL button (or press the Enter key). All queries you performed are stored in memory and can be retrieved from the edit box, for further editing the query or for modifying it. SQL query syntax language is provided in the on-line Help file.

Data|Thematic Map

Thematic mapping is the process of assigning different colours and fill patterns to mapping features according to a value. For example, you could thematically shade the soil map according to the dominant soil type, with each soil type represented by a different colour or hatch pattern.

SEA supports the creation of thematic maps from a selected number of variables of the database.

Data|Show-Hide Legend

This option hides the Thematic legend when it is displayed and shows it, when it is hidden.

4.5 View menu

View|Reset Map

The **View|Reset Map** option resets the maps and redraws it at its original size and scale. The default scale of the map is defined by the size of the country and the resolution of your computer's screen. The current scale of the map is continuously displayed on the toolbar at the bottom of the screen.

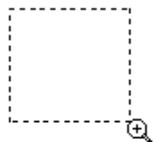
View|Redraw Map

The programme does not automatically redraw the screen every time you change a setting, because redrawing can be time consuming. This allows you to change several display settings before eventually redrawing the screen.

When you select **View|Redraw Map**, the screen is redrawn without changing any view setting. You can use this command to update the screen after you have made changes with other options, such as adding map overlays. The option **View|Reset Map** resets the full view of the map. The previous zoom settings are removed and the map is centred on the screen. A third way to reset the map view of the active window is the **File|New** command.

View|Zoom In

With the Zoom In command from the **View|Zoom In** function on the menu, you can adjust the displayed portion of the geographic file. For example, when you need a closer view of map features to facilitate data querying, you can zoom in on the map. You can return to previous view settings with the commands **Zoom Out manually**, **Zoom Out Linear** or reset the geographic file with the **View|Reset Map**.



An interactive zoom function is available to change the portion of the geographic file displayed in the map area. Therefore you must draw a rectangle around the area you want to zoom in on. Select **View|Zoom In** from the menu while a map is displayed and a zoom-pointer will appear in the middle of the map window. Move the mouse pointer to a corner of the region you wish to zoom in on. Press the left mouse button to lock that corner, and move the

mouse to the opposite corner of the area to be zoomed into. Release the left mouse button to complete the zoom.

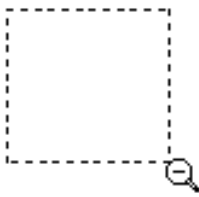
The programme automatically compensates for the difference between the proportions of the zoomed box and the map area (adaptive scaling). For example, if the zoom box is larger than it is high, the map area is filled out so that you never see less than the area you specified. Zooming also moves the centre of the map. Therefore it is important to keep the point of interest in the centre of the zoom box.

View|Zoom Out Linear

You can increase the visible area of the map by a linear factor simply by selecting the **View|Zoom Out Linear** tool. The current centre of the map remains the same. This procedure can be repeated until the desired part of the map is displayed. An interactive zooming out function is available from **View|Zoom Out manually**.

View|Zoom Out manually

The **View|Zoom-Out Manually** tool allows you to get a larger view of the map. When you want to pull back (zoom out) from your current view of the map, you can use this command.




After choosing this command, you draw a box around that part of the map that you want to zoom out. While the map is displayed, the zoom-out pointer will appear in the middle of the map window. Move the mouse pointer to a corner of the region you wish to zoom out. Press the left mouse button to lock that corner, and move the mouse to the opposite corner of the area to be zoomed out. Release the left mouse button to complete the operation. The size of the zoom-box defines the fraction of the map that is zoomed out:

a smaller zoom-box will result in a larger part of the map displayed. The centre of the zoom-box will become the new centre of the map. You can use this command when you've zoomed in too far on some features and want to pull back to get a wider view of the map.

An automatic function for zooming out from the current map view is available from **View|Zoom Out Linear**.

View|Pan

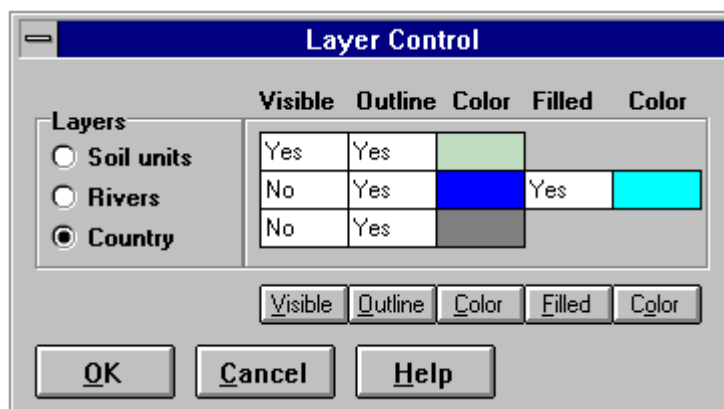
Panning a map view is used to move the centre of the actual displayed map. With panning you can scroll the map to display an area that is currently outside the map window. When you select the **View|Pan** command, you must select a point on the map that becomes the new map centre. A special mouse pointer and a  box assist in the correct identification of this map centre.

View|Layer Control

The Overlay Control command allows you to control several aspects on how your map is presented. You edit the visibility and graphic characteristics of map features of the different layers in the map in the overlay control screen. The screen is called from the **View|Layer Control** menu.

The SEA programme has three independent map layers:

- the basic soil mapping features representing the soil units;
- the rivers [the double-edge rivers are actually included in the soil map itself, but they are controlled by the artificial River layer]; and
- the country boundaries



The figure shows the overlay control dialog box. The left part shows the three map layers (Soil units, Rivers and Country). Select a layer by pushing its button, and select then one of the other buttons to modify respectively the visibility, the outline, the outline colour, and the fill flag and colour of the selected layer. The Fill flag and Fill colour are only used for the layer with

Soils of East Africa - User's-Guide

rivers and water bodies. Alternatively, you can directly click with the mouse on the boxes to switch the setting or modify the colours.

Visibility: The Visibility flag indicates if the layer is visible or not. If the visibility is off, the layer will never be displayed. If the Visibility of the soil mapping units is off, the thematic map will not be drawn.

Outline The Outline flag defines if mapping feature outlines are drawn or not. you may wish to set the outline flag off for several reasons. The drawing of the separate mapping features can be time consuming and you may prefer not to draw them. Also when you draw thematic maps, you can prefer not to draw the outlines of the mapping features. The feature outlines will be drawn in the colour of the thematic class.

Outline Colour The Outline colour defines the colour of the outlines of the mapping features. The colour is selected from the general colour selection box. If you select a not-solid colour (composed of different colours), the colour will be converted to the closest solid colour.

Fill The Fill flag is only available for the River overlay. Its setting defines if rivers and waterbodies are filled or not. The fill colour is defined by the next setting.

Fill colour Defines the filling colour for rivers and waterbodies, if the Fill flag is set. The selected colour is always converted to the nearest matching solid colour.

4.6 Help menu

Help|Contents

The Contents screen in the Help files guides you quickly through the most important topics of the Help file.

Help|Search topic

The 'Search Help on ...' dialog box allows you to search for Help on a particular topic. Enter the topic of interest and the available help items will be displayed.

Help|System Info

The system information screen displays several important system settings. If you keep getting memory error messages in SEA, you can check this information to know the available memory in your system.

Additional memory can be created by:

- Installing additional RAM memory in your computer.
- Closing other applications that are currently loaded in memory. You can check this out with the task manager (press Ctrl-ESC).
- Add additional virtual memory via the Control Panel|Enhanced|Virtual Memory tool.

4.7 The toolbar

The toolbar is the area with icons below the pull-down menu. By clicking on the icons, you can access several of the menu commands. All icons have corresponding items in the menu. When you move the mouse over the icons, help is displayed in the Status bar at the bottom of the screen and by the pop-up hints.



This option loads the data summary screen. In this screen you can browse through the Muidsheets to display a summary of the database on the screen. This summary screen converts the class codes used in the database into full text. The corresponding item in the menu is **Data|Summary**.



The browse data screen will be loaded when this icon is clicked. This browse data screen is a worksheet-like area listing the complete soil and terrain database. The corresponding menu item is **Data|Browse**.



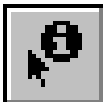
Clicking this icon will load the Muidsheet data entry forms. These forms list the most important variables as a Muidsheet form. The corresponding menu item is **Data|Muidsheet**.



This option opens the SQL query screen. SQL language syntax is found in the Help file of the programme. Corresponding menuitem is **Data|SQL query**.



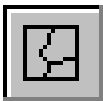
This icon provides a tool to select a number of mapping units nearby a point of interest. The complete database for the selected mapping units is displayed in worksheet format. Check for more information under **Select|Area**.



Icon used for spatial selection of mapping units with display of their summary data screen. More details are found under **Select|Summary**.



Links the map to the Muidsheets for interactive selection of mapping units and their corresponding Muidsheet. The corresponding menu item is **Select|Muidsheet**.



This icon displays the thematic map dialog box where you can select variables, colours, classes etc. for thematic mapping. The corresponding menu item is **Data|Thematic Map**.



This is an interactive zoom function to zoom in on part of the map. The corresponding menu item is **View|Zoom In**.



This is a function to zoom out from the current view of the map. Check **View|Zoom Out Linear** for more details.



With this icon, you get an interactive function to zoom out from the current map view. The corresponding menu item is **View|Zoom Out manually**.



With the pan icon, you move the centre of the map display, without changing its scale setting. The corresponding menu command is **View|Pan**.



This option resets the map view to its original size and scale, so it fits on the screen. See under **View|Reset Map** for more details.



With this icon, you simply redraw the map. The corresponding menu command is **View|Redraw Map**.



This icon loads the layer control dialog box to manage the display of the different map layers. The option is similar as the menu command **View|Layer Control**.

5. Appendix

5.1 References

Sources for the documentation are:

1. Soil map of the World. Revised Legend. World Soil Resources Report, nr. 60. FAO, Unesco, 1990.
2. Soils of Eastern and North Eastern Africa at 1:1 million scale and their irrigation suitability. A preliminary compilation of data for input in FAO's digital geographic information system. Prepared by the International Soil Reference and Information Centre (ISRIC), Wageningen, The Netherlands, on assignment of FAO, Rome, Italy. January 1988.
3. Database Application Developer's Guide. Borland Delphi for Windows. Borland International, 1995.
4. IDRISI User's Guide and Technical Reference, version 4.0, March 1992. Clark University.
5. Arc-Info on-line Help, version 7.0 , 1995. Environmental Systems Research Institute, Inc.

The programme uses the Borland Database Engine (BDE) for the database manipulation and querying facilities. This engine is installed during the installation of SEA.

5.2 The soil and terrain database

5.2.1 General Soil and Terrain data

The general variables in the SEA database are coded as follows:

IDNUMBER

The ID-number is an incremental field, used for indexing and thematic mapping. It is not possible to modify this field. When browsing the table, this field is not displayed.

MUIDSHEET

The Muidsheet variable corresponds to the original Muidsheet number.

CNTCODE

The CNTCODE or country code field contains a unique country code. Codes in SEA area as follows:

Country	Country-code	Two-letter code
Burundi	29	BY
Djibouti	72	DJ
Egypt	59	EG
Eritrea	238	ER
Ethiopia	178	ET
Kenya	114	KE
Rwanda	184	RW
Somalia	201	SO
Sudan	206	SU
Uganda	226	UG

MAPUNIT

The Mapping Unit Identifier gives summary info of dominant soil type, dominant texture and dominant slope class. The dominant soil is given to third level.

Example: ARb.or12-1ab is an Orthic Cambic Arenosol, association number 12, sand on 0-5% slopes.

For a description of all symbol used, please refer to section 5.2.2

DOM1

This are the first three letters of the Mapping Unit Identifier (**MAPUNIT** variable). A complete overview of the FAO Classification structure can be found in the on-line help.

RELIAB

Considerable differences in reliability (RELIAB) of the sources of information occur in the different parts of the area covered. Four classes of data reliability were distinguished:

<i>Code</i>	<i>Reliability</i>
H	High (based on recent 1:1 Million scale soil surveys and/or profile description)
M	Medium (based on reconnaissance soil surveys with moderately good unit descriptions)
L	Low (based on remote sensing, soil surveys with poor unit descriptions and geological information)
V	Very Low (based only on remote sensing and geological information)

LANDSCAPE

This variable provides the landscape(s) of the mapping unit. Classes and codes are:

<i>Code</i>	<i>Landscape</i>
M	Mountain, Major Scarps
H	Hills, Minor Scarps
R	Mountain Footridges
F	Footslopes
L	Plateaus
U	Uplands
Y	Piedmont Plains
P	Plains
A	Flood Plains
B	Bottom Lands
Z	Coastal Ridges
S	Swamps
N	Recent Lava Flows
W	Bad Lands
V	Valleys/Minor Valleys
T	Tidal Flats and Swamps
D	Dunes
E	Deltas
C	Valley Bottoms
X	Complex Landforms

GEOLOGY

Geology is subdivided in four major classes: **Igneous rocks**, **Metamorphic rocks**, **Sedimentary rocks** and **Unknown bedrock**. Here are the subclasses that are used in the SEA database.

<i>Code</i>	<i>Geology subclasses</i>
G	Acid rocks Examples: granite, graniodorite, aplite, rhyolite
Y	Acid rocks
I	Intermediate rocks Examples: syenite, alkalisyenite, trachyte, alkalitracyte, trachyandesite, diorite, andesite, phonolite
B	Basic and ultrabasic rocks Examples: basalt, alkalibasalt, nephelenite, gabbro, norite, dolerite, hornblendite, pyroxenite, hyperstenite, sepeintinite, peridotite
V	Undifferentiated igneous rocks
P	Pyroclastic rocks Unconsolidated pyroclastics (ashes, pumices, scoriae) Consolidated pyroclastics (tuffs, welded tuffs, ignimbrites)
L	Crystalline limestones
C	Calc-Silicate gneisses (granulites)
Q	Granitoid gneisses/quartzites
R	Quartz-feldSpar (quartzo-fespatic) gneisses
M	Quartz-muscovite/muscovite/sillimanite gneisses
N	Biotite/biotite-garnet gneisses
F	Gneisses rich in Fe-Mg (ferromagnesian) minerals Examples: hornblende/biotite-horneblende/amphybolite gneisses
Z	Conglomerites, Gravels Sandstones, grits, arkoses
S	Grains, relatively rich sandstones
K	SitStone (consolidated silts)
D	Mudstones (consolidated clays)
W	Marls (calcareous mudstones)
T	Shales (consolidated clays/silts with fine stratification)
O	Plio-Pleistocene 'bay' sediments("Marafa Beds")
J	Lagonal deposits
E	Cover sands (eolian deposits, trona, etc.)
A	Undifferentiated unconsolidated sediments
1	evaporites (e.g. gypsum, trona, etc.)
0	limestones/coral reef limestones/travertines Examples: alluvium, colluvium, dune sands
H	Cherts/flints/chalcedonites/diatomites Rocks consisting of SiO ₂
X	Unknown If the bedrock is unknown, or various parent materials are involved

VEGETATION

The vegetation of the mapping unit is coded as follows:

<i>Code</i>	<i>Vegetation</i>
F	Forest
W	Woodland
B	Bushland
G	Grassland

Soils of East Africa - User's-Guide

t	Thicket
d	Dense
M	Mangrove
S	Swamp vegetation
A	Alpine vegetation
X	Complex mixture
C	Cultivation
E	Exposed surface, bare

5.2.2 Three most important soils

This section describes the variables of the three most important unit components:
 All following variables are related to the different soils in the mapping unit. Variable names for the FAO classification class are for instance **FAOCLASS1** for the dominant soil, **FAOCLASS2** for the second soil etc. Soil numbers below are represented by **x**

SNUMx

This is the soil number, ranging from 1 to maximum 5.

FAOCLASSx

The soil according to the FAO soil classification

AREAPERCx

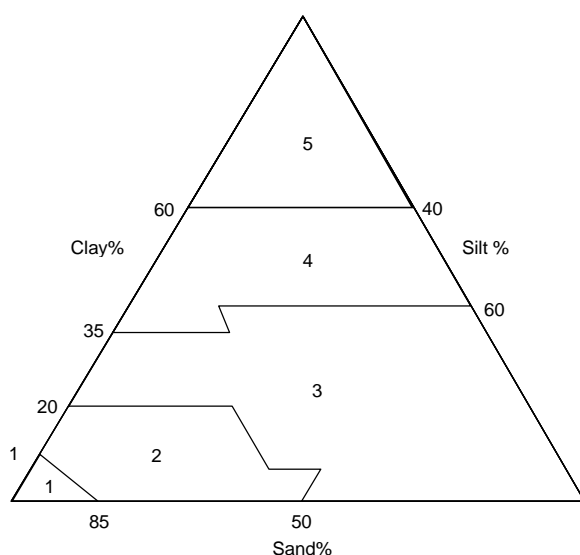
The area percentage of the respective soil in the mapping unit. The dominant soil always has the highest area.

SLOCLASSx

The slope class **SLOCLASS** is classified in six classes.

<i>Code</i>	<i>Slope class</i>
a	0-2 %
b	2-5 %
c	5-8 %
d	8-16 %
e	16-30 %
f	30+ %

TEXTCLASSx



- 5 very clayey more than 60%
- 4 clayey sandy, silty clay and clay texture classes
- 3 loamy loam, sandy clay loam clay loam, silt, silt loam and silty clay loam texture classes
- 2 sandy loamy sand and loam texture classes
- 1 extremely sandy sand texture

Texture classes are coded as follows:

<i>Code</i>	<i>Texture</i>

Soils of East Africa - User's-Guide

1	sand
2	sandy loam
3	loam
4	clay loam
5	clay

SURFAFORx

Surface form of the mapping units:

<i>Code</i>	<i>Surface form</i>
D	Dissected
B	Depression
I	Inclined
L	Level
R	Rolling
S	Steep
U	Undulating
T	Terraced
V	Small Valley

PARENTMATx

<i>Code</i>	<i>Parent material</i>
A	Alluvial
C	Colluvial
H	Ejecta Ash
L	Lacustrine
M	Marine
O	Organic
R	Solid Rock
E	Eolian sand
U	Unconsolidated/unspecified
X	Residual

EXTERDRAIx

<i>Code</i>	<i>External drainage</i>
W	well
I	imperfect
P	poor
F	flooded

STONELOWx

Surface stoniness is given in percentage.

STONEHIGHx

Surface stoniness is given in percentage.

CRUSTINGx

<i>Code</i>	<i>Surface crusting</i>
U	unslaked
W	weak
M	moderate
S	strong

EDEPTHLOWx (0-10 cm)

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Effective soil depth in cm.

EDEPTHHIGx (10-50 cm, 50-100 cm, 100-150 cm)

Effective soil depth in cm.

EDEPTHPLUx (150+ cm)

Effective soil depth in cm.

FAO Classification

(From: FAO Final revised legend of the SMW, 1988)

A complete overview of the FAO Classification structure can be found in the on-line help.

List of third level subunit names

<i>Code</i>	<i>Name</i>	<i>Description</i>
.al	albic	Albi-soils having an albic E horizon
.an	andic	Andi-soils having andic properties
.ar	arenic	Areni - intergrade to Arenosols
.ca	calcaric	Calcari-soils which are calcareous within 125 cm of the surface
.ch	chromic	Chromi - Vertisols having a moist value of more than 3 and a chroma of more than 2 dominant in the soil matrix throughout upper 30 cm.
.cm	cambic	Having a cambic horizon
.dy	dystric	Dystri-soils having a base saturation of less than 50% (by NH ₄ OAc) in some parts within 125 cm of the surface
.eu	eutric	Eutri-soils having a base saturation of 50% (by NH ₄ OAc) to a depth of 125 cm from the surface
.fe	ferric	Ferri-soils having ferric properties within 100 cm of the surface
.fl	fluvic	Fluvi - soils developed from alluvial deposits
.gl	gleyic	Gleyi - intergrade to Gleysols
.ka	calcic	Calci-soils having a calcic horizon or concentrations of soft powdery lime within 125 cm of the surface
.lu	luvic	Luvi-soils having an argic horizon
.ma	mazzic	Mazi-Vertisols having a massive structure in the upper 30 cm and becoming hard when dry
.mo	mollic	Molli-soils having a mollic horizon
.ni	nitic	particularly Acrisols having nitic properties
.or	orthic	Orthi-soils, having no specific characteristics to separate them at third level
.pe	pellic	Pelli-Vertisols having a moist value of 3 or less and a chroma of 2 or less dominant in the soil matrix throughout the upper 30 cm
.pl	plinthic	Plinthi-soils, having plinthite within 100 cm of the surface
.rh	rhodic	Rhodi-soils having a red to dusky red B horizon (rubbed soils have hues redder than 5YR with a moist value of less than 4 and a dry value not more than one unit higher than the moist value)
.ro	yermic	Yermi-soils such as Regosols and Arenosols showing yermic properties
.sm	sombic	Sombri - applies to Ferralsols showing some accumulation of dark colour organic matter in the

Soils of East Africa - User's-Guide

		ferralic B horizon
.um	umbric	Having an umbric horizon
.ve	vertic	Verti - intergrade to Vertisols

PHASE1SOx

First Phase of soil

PH1PERSOx

Percentage of the phase

PHASE2SOx

Second Phase of soil

PH2PERSOx

Percentage of the phase

For each phase a code (listed below) and the area occupied are given (example: SO 50 means that 50% of the area as a sodic phase). If two phases apply to the same part of the area, they are separated by a slash (example: SO/SA 50 means that 50% of the area has a sodic and a salic phase). Two phases without a slash (example: RU 75 SO 75) do not occupy the same part of the area. For each soil type, a maximum of two sets of combined phases can be given (example: SO/SA 25 LI/RU 50). Phases apply only to the area corresponding with the soil type they are given. NOTE: Most soil maps that were used as sources for this new Eastern Soil Map of Africa already add a phase to a soil if more than half of the area covered by this soil is occupied by the phase. In these cases, an overall assumption of 100% occupation would overestimate the areas affected by phases. Therefore, the area percentage for phases on the description sheets will not exceed 75%, unless there are specific reasons to assume that a phase covers more than 75%.

<i>Code</i>	<i>Phase</i>
AN	antraquic
DU	duripan
FR	fragipan
GE	gelundic
GI	gilgai
IN	inundic
LI	lithic
PE	petroferric
PH	phreatic
PL	placic
RU	rudic
SA	salic
SK	skeletal
SO	sodic
TA	takyric
YE	yermic

SOIL SUITABILITY FOR IRRIGATION

<i>Code</i>	<i>Description</i>
UCS1	Upland crops very suitable

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UCS2	Upland crops marginally suitable
UCNS	Upland crops not suitable
PDS1	Paddy rice very suitable
PDS2	Paddy rice marginally suitable
PRNS	Paddy rice not suitable

EDEPTHLOWx

Effective soil depth in cm.

EDEPTHHIGx

Effective soil depth in cm.

5.2.3 Soil profile data

The soil profile information in the SEA database is repeated for up to five horizons for each soil. The variable names below should be modified as follows: the **x** becomes the soil number (1 to 5) and the **y** becomes the profile number (from 0 to 4).

SOIPROxy

The soil profile number from 0 to 4, with 0 for the complete profile (corresponds to S in the Muidsheets) and 1 to 4 for the separate horizons if representative profiles were available.

HORIZONUxy

The soil profile number.

DEPTHCMxy

Depth of the bottom boundary of the horizon in cm.

DEPTHPLUxy

ORGCARBOxy

<i>Code</i>	<i>Organic Carbon in Percentage weight,</i>
A	0-0.6 %
B	0.6-2 %
C	2-3 %
D	3-8 %
E	8+ %

CECSOILxy

<i>Code</i>	<i>Cation Exchange Capacity in meq/100 g soil.</i>
A	0-2
B	2-10
C	10-30
D	30-60
E	60+

CECLAYxy

<i>Code</i>	<i>Cation Exchange Capacity in meq/100 g clay.</i>
A	0-1.5
B	1.5-6.0
C	6.0-16
D	16-36
E	36+

BASESATUxy

<i>Code</i>	<i>Base saturation, related to CECpH7 (%)</i>
A	0-10
B	10-25
C	25-50
D	50-75
E	75-100

EXCHAGENxy

<i>Code</i>	<i>Exchangeable Na in meq/100 g soil.</i>
A	0-0.1
B	0.1-0.3
C	0.3-0.7
D	0.7-2.0
E	2.0+

EXCHAALxy

<i>Code</i>	<i>Exchangeable Aluminium in % CEC.</i>
A	0-30
B	30-85
C	85+

AVAILPxy

<i>Code</i>	<i>Available Phosphorus in ppm.</i>
A	0-3
B	3-6.5
C	6.5-13
D	13-22
E	22+

CARBONATxy

<i>Code</i>	<i>Carbonates in percentage weight.</i>
A	0-5
B	5-15
C	15-25
D	25-40
E	40+

GYP SUMxy

<i>Code</i>	<i>Gypsum in percentage weight.</i>
A	0-5
B	5-25
C	25+

SODICITYxy

<i>Code</i>	<i>Sodicity (ESP) in percentage.</i>
A	0-6
B	6-15
C	15-30
D	30-60
E	60+

SALINITYxy

<i>Code</i>	<i>Salinity (ECe, mS/CM saturation extract)</i>
A	0-2
B	2-4
C	4-8
D	8-15
E	15+

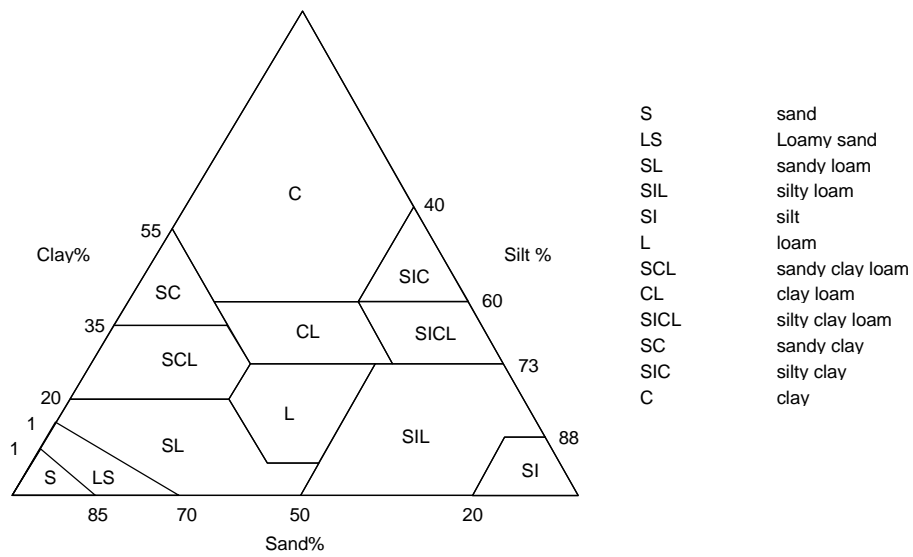
PHxy

<i>Code</i>	<i>pH in water.</i>
A	0-3.8
B	3.8-5.4
C	5.4-6.5
D	6.5-8.5
E	8.5+

TEXTURExy

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Texture of fine earth fraction, according the texture triangle in FAO, Guidelines for Soil Profile description (1977)



- S sand
- LS Loamy sand
- SL sandy loam
- SIL silty loam
- SI silt
- L loam
- SCL sandy clay loam
- CL clay loam
- SICL silty clay loam
- SC sandy clay
- SIC silty clay
- C clay

NATBUNDxy

<i>Code</i>	<i>Nature of boundaries.</i>
A	abrupt
B	clear
C	gradual
D	diffuse

STRUSIZE_{xy}

<i>Code</i>	<i>Structure size.</i>
1	very fine
2	fine
3	medium
4	coarse

STRUFOR_{xy}

<i>Code</i>	<i>Structure form (type)</i>
pl	platy
pr	prismatic
cpr	columnar
ab	angular blocky
sb	subangular blocky
gr	granular
cr	crumbly
sg	single grain
m	massive

STRUSTA_{xy}

<i>Code</i>	<i>Structure stabilities.</i>
w	weak
m	moderate
s	strong

COLWETA_{xy}

According to the Munsell Colour scale.

COLWETB_{xy}

According to the Munsell Colour scale.

COLWETC_{xy}

According to the Munsell Colour scale.

COLDRYA_{xy}

According to the Munsell Colour scale.

COLDRYB_{xy}

According to the Munsell Colour scale.

COLDRYC_{xy}

According to the Munsell Colour scale.

**BASE MAPS AND NATIONAL MAPS USED IN THE PREPARATION OF THE
SOILS OF EAST AFRICA (SEA)**

CONTENTS

	Page
1. Introduction	3
1.1 The base map	4
1.2 Data transfer	4
1.3 Sources of information used	5
1.4 Border discrepancies	11
1.5 Satellite image interpretation	12

1. INTRODUCTION

Between January 1987 and January 1988, the International Soil Reference and Information Centre (ISRIC), compiled a draft 1:1 million scale soil map for North East Africa. Countries concerned were Egypt, Sudan, Ethiopia, Djibouti, Somalia, Uganda, Kenya, Rwanda, Burundi, and Northern Tanzania. Together, these countries cover about a fifth of the African continent. The map consists of 12 sheets of 90 cm by 130 cm.

The Project, codename SMEA, was carried out by Messrs. R.T.A. Hakkeling (Msc. Graduate Amsterdam University) and D.M. Endale (Msc. Graduate Wageningen University), under supervision of Dr. W.G. Sombroek, Director of ISRIC.

The basic purpose where:

1. to test the validity at 1:1 million level of the 1988 revision of the FAO/Unesco legend for the Soil Map of the World
2. to provide an estimate of the acreage, at regional level, that may have a potential for irrigation development.

The product had to be entered, in digital form, into FAO's Geographical Information System as it was in a development for internal use at its Headquarters. For ISRIC, it was a first tryout at the effectuation of a digital soil and terrain database at 1:1 million scale (SOTER) as being promoted by an ISSS Working Group for the purpose.

A wide variety in sources of information (from recent, highly reliable maps to satellite image interpretations) resulted in considerable differences in reliability of the data. This will be elaborated in paragraph 1.1

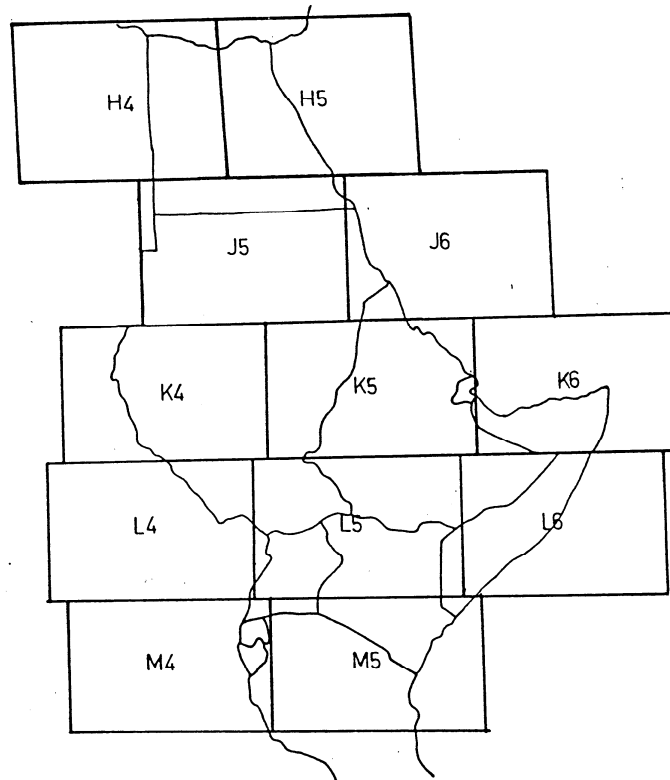
For each mapping unit of the soil map, a suitability classification for irrigated upland crops and for paddy rice was estimated. For estimation, a methodology was developed that uses site and soil properties available in the mapping unit descriptions.

THE SOIL MAP

1.1 The base map

As base map, the 1:1 Million scale Operational Navigation charts (ONC) were chosen. Figure 1 shows the distribution of the map sheets.

Figure 1
Distribution of the
Base Map Sheets



ONC maps have several advantages over regular topographic maps:

- A world wide coverage
- World wide obtainable
- Showing geomorphological information
- Good detail
- As an average highly reliable

The draft version of the soil map was drawn on full-transparent foil. In this way, nearly all geomorphological information were visible on the soil map, thus enabling easy understanding of the major soil differences, especially when related to mountains, scarps, plains and floodplains.

1.2 Data Transfer

As every source map uses a different base map, many topographic features would be out of place when copied without sufficient attention being to topography. To prevent this, main topographical features, like mountains, major rivers, major towns and lakes were copied from the base map to the transparent foil and used as points of reference when copying the source maps.

Even when satellite images proved that the ONC base map was not correct, base map location was used as reference. This was done to prevent confusion.

1.3 Sources of information used

As mentioned before, considerable differences in reliability of the sources of information occur. For all source maps listed below, reliabilities are given.

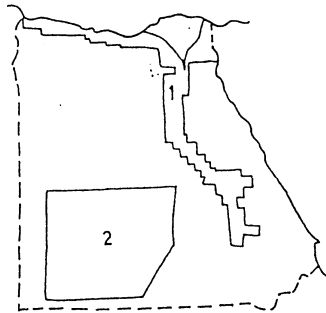
Definition

- **High:** Recent 1:1 million scale soil surveys. Unit descriptions must contain unit components with area percentages, landscape, geology, slope classes, phases and soil textures. Soils must be classified with the FAO/Unesco system or with the US Soil Taxonomy system.
- **Medium:** Reconnaissance soil surveys with moderately good unit descriptions, not meeting all demands for High reliability.
- **Low:** Soil surveys with poor unit descriptions and lacking classification of the soils.

Where necessary, main limitations of the source maps are given.

Figure 2

EGYPT
source maps location
of reliability classes:



1. - Land Master Plan. Soil, Land Capability and Land Management Category Maps. By Euroconsult-Pacer, 1987. Arnhem, The Netherlands.

Scale 1:1 Million, reliability: low

Main limitations: no slope class, no classification, no profile descriptions.

2. - Soil Associations Map of the Western Desert of Egypt. By Alai F. and Blume H.P., 1986.

Fachhochschule,
Berlin

Scale 1:1 Million, reliability: medium

Main limitations: no slope class, textures too general

Additional information

- Soil Associations Map of Egypt. By Hammad M.A., 1975. Soil Survey Institute, Wageningen, The Netherlands. Scale 1:4 Million

- High Dam Soil Survey, United Arab Republic. By FAO, 1966. Scale 1:1 Million

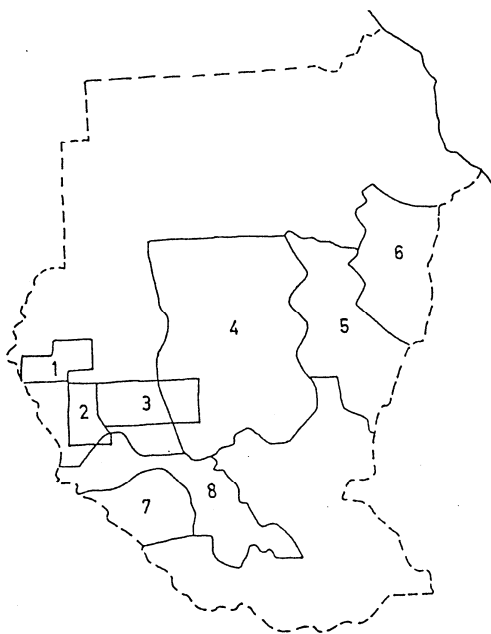
- Geological Map of Egypt. By the Egyptian Geological Survey and Mining Authority, 1981.

Scale 1:2 Million

- Soil Types and Associations of South West Egypt. by Blume H.P. et al, 1984. Berliner Geowiss. Abh. 50.

293-302

Figure 3
SUDAN
 source maps location



1. - Land and Water Resources survey in the Jebel Marra Area. By FAO, 1968. (FA9/SF:48/SUD-17)
 Scale 1:250 000, reliability: low
 Main limitations: no classification, no slope classes.
- 2.- Southern Darfur Land Use Planning Survey. By Hunting Technical Services Ltd, 1974. Herts, England.
 Scale 1:250,000, reliability: medium
 Main limitation: no slope classes
3. - Preliminary Report on ERTS-1 Imagery in the Sudan. By Eggeling M.D. and Gaddas R.R., 1973. FAO, Khartoum.
 Scale 1:250,000, reliability: low
 Main limitations: no classifications, no slope classes
4. - Exploratory Soil Survey of North and South Kordofan. By Pachego R. and Dawoud H., 1976. FAO, Soil Survey Report no.81.
 Scale 1:1 Million, reliability: medium
5. - Soil Resources Regions of the Blue Nile, White Nile, Gezira, and Khartoum Provinces of the Sudan. By Purnell M. et al, 1976. FAO, Soil Survey Report no.80.
 Scale 1:1 Million, reliability: medium
6. - Exploratory Soil Survey of Kassala Province. By Kevie W. and Burayman I. M., 1976. FAO, Soil Survey Report no.73.
 Scale 1:1 million, reliability: medium
7. - Land Resources of Part of the Ironstone Catena of Bahr El Ghazal Province. By Venema J.L. and Klinkenberg K., 1978.
 Scale 1:500,000, reliability: medium
8. - Land Systems from ERTS, Bahr el Ghazal Province. By Hunting Technical Services Ltd, 1975, Herts, England.
 Scale 1:1 Million, reliability: low
 Main limitations: no classifications, no slope classes

Additional information:

- Desertification in North Darfur. By Fouad N. Ibrahim, 1980. Universitat Hamburg.
 Scale 1:1 Million
- Carte Pedologique du Chad. By ORSTOM, 1970
 Scale 1:1 Million

- Carte Pedologique de la Republique Central Africaine. By ORSTOM, 1983. Paris, France.
Scale 1:1 Million
- Multitempora1 Landsat, Imagery Interpretation of the Flood Region Draining to the Sudd, Southern Sudan, By FAO, 1977.
Scale 1:1 Million
- Soil Resources and Potential for Agriculture Development in Bahr el Jebel Area. By Remote Sensing Centre, Academy of Scientific Research and Technology, Cairo, 1978.
Scale 1:1 Million
- Geological Map of the Sudan. By the Ministry of Energy and Mines, 1981. Khartoum, Sudan
Scale 1:2 Million
- Report on the Methods, Organization and Costs of a Soil Survey and Land Classification of Equatorial Province. By Blokhuis W.A. and Ochtmans L.M.J., 1960.
Scale 1:2 Million
- The Pedogeomorphic Map of the Central Clay Plain. By Blokhuis W.A.,
Vertisols in the Central Clay Plain of the Sudan, Ph.D. Wageningen University, 1993.
Scale 1:2 Million

ETHIOPIA

- Geomorphology and Soils, Ethiopia (8 sheets). By the Land Use Planning and Regulatory Department/ Assistance to Land Use Planning (FAO), 1984. FAO
Scale 1:1 Million, reliability: high

DJIBOUTI

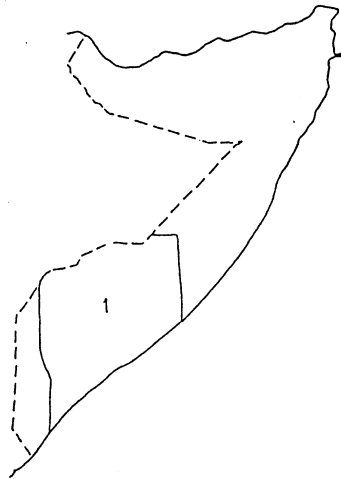
Additional information:

- Geological Map of Ethiopia and Somalia. By Consiglio Nazionale delle Ricerche, 1973. Firenze, Italy. Scale 1:2 Million

Figure 4

SOMALIA

source map location



- Agricultural and Water Surveys Somalia. By Lockwood Survey, Corporation Ltd./FRO, 1968. FAO, Rome
Scale 1:660,000 approx., reliability: medium.
Main limitations: No associated soils

Additional information:

- Geological Map of Ethiopia and Somalia. By Consiglio Nazionale delle Ricerche, 1973. Firenze, Italy
Scale 1:2 Million

Figure 5
UGANDA
 source maps locations



Uganda Protectorate, Department of Agriculture, Memoirs of the Research Division, with Maps:

1. The Soils of the Northern Province, Uganda, Excluding Karamoja. Memoir no.3. By Ollier C.D., 1959.
 - Scale 1:5 000 000, reliability: medium
 - Main limitations: no classifications, no associated soils
2. Soils of the Karamoja district, Northern Province of Uganda. Memoir no.5. By Wilson J.G., 1959.
 - Scale 1:250,000, reliability: medium
 - Main limitations: no classification, no associated soils
3. The Soils of the Western Province of Uganda. Memoir no.6. By Harrop J.F., 1960
 - Scale 1:500,000, reliability: medium
 - Main limitations: no classifications, no associated soils
4. - Soils and Land Use of Buganda. Memoir no.4. By Radwanski S.A., 1960
 - Scale 1:500,000, reliability: medium
 - Main limitations: no classification, no associated soils
5. - Soils of the Eastern Province of Uganda. Memoir no.2. By Ollier C.D. and Harrop .J.F., 1959
 - Scale 1:500,000, reliability: medium
 - Main limitations: no classification, no associated soils

Additional information:

- Introduction to the Soils of the Uganda Protectorate. Memoir no.1. By Chenery E.M., 1960
- Terrain Systems of Uganda, Atlas. By Ollier C.D.et al., 1969 Report Military Engineering Experimental Establishment, no. 959. Christchurch.
Scale 1:1 Million
- Agriculture in Uganda. By Jameson J.D., Oxford, 1970, England.
Map at scale 1:1,500,000

KENYA

- Exploratory Soil Map and Agro-Climatic Zones Map of Kenya. By Sombroek W.G. et al., 1980.
Kenya Soil Survey, Nairobi
Scale 1:1 Million, reliability: high

Additional information:

- Descriptions and analytical data of profiles sampled for the preparation of the exploratory soil map
- Consultants Final Report on the Soils, Physiography, and Agroecological Zones of Tanzania. By Pauw E.de, 1984. Crop Monitoring and Early Warning System Project (GCPS-URT-047NET), Ministry of Agriculture, Dar Es Salaam, Tanzania. FAO.
Scale 1:2,000,000, reliability: medium

RWANDA/BURUNDI

- Les Sols de Rwanda et Burundi. By Wambeke A. van, 1961. Pedologie 11-2 PP 289-353
Scale 1:1 Million, reliability: low
Main limitations: no slope classes, no indications about areas of associated soils

Additional information:

- Proceedings of the 14th International Soil Classification Workshop, Rwanda 1981. Part 2: Field and Background Soil Data. Published in 1983 by ABO-AGCD, Brussels, Belgium.

ADDITIONAL INFORMATION, NOT COUNTRY-CONNECTED

1. - FAO/Unesco Soil map of the World. Volume VI - AFRICA, 1977
Scale 1:5,000,000
2. - Soil Map of the World. By USDA/SCS, 1940-1955 approx. (only in draft). World Soil Geographic Office, Lanham, USA.
Scale 1:1 Million
3. - AFRIKA-KARTENWERK-bodensruppen (N-E Lake Victoria Region).
By German Research Society, 1983. Berlin-Stuttgart, Germany.
Scale 1:1 Million

1.4 Border discrepancies - Correlation between different surveys. As could be expected, significant differences occur when soil maps of neighboring countries are compared along their mutual border. Solutions for these problems differ from case to case and will therefore be discussed separately,

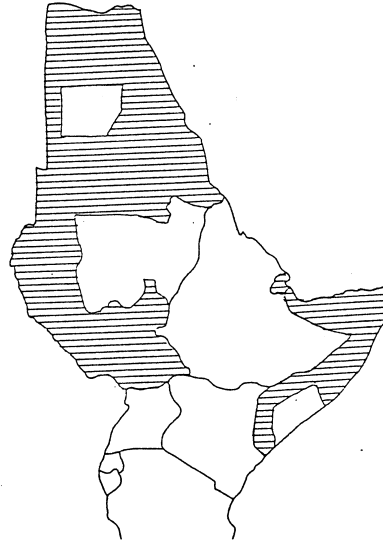
- Central Sudan / Ethiopia
The border between these countries reflects a major geomorphological boundary (Sudan clay plain versus Ethiopian Highlands). Little correlation difficulties occur.
- Ethiopia / Kenya
Although little differences occur in geomorphology, some major differences occur in the field of soil, classification. This was dealt with by interpretation of 1:500.000 working copies of satellite images kindly provided by the Kenya Soil Survey.
- Ethiopia / Southern Somalia
Soil descriptions on the Somali side of the border were very poor, so Ethiopian descriptions were used where necessary.
- Uganda / Kenya
The greater part of this border is formed by the Turkana Scarp, preventing soil boundaries to cross the border. Where difficulties arose, interpretation of a lens et mosaic map of Uganda proved helpful. Because of the higher reliability, credit was given to the descriptions in the Kenya report.
- Uganda / Rwanda; Uganda / Tanzania ; Tanzania / Rwanda ; Tanzania / Burundi
Little differences in descriptions on both sides of the border
- Tanzania / Kenya
Some differences occur. Because of higher reliability and greater detail, credit was given to the data in the Kenya report.

If soil data were only available at one side of the border, these data were used as a reference for satellite image interpretation of the area at the other side of the border.

1.5 Satellite image interpretation

For all areas not covered by soil maps of scales between 1:250,000 and 1:2,000,000 and all areas covered by soil maps with a low reliability, Landsat satellite images were obtained and interpreted (see figure 6). For Egypt, MSS band 5 images were used, for Sudan and Somalia, False Colour images were obtained from the Regional Remote Sensing Facilities, Nairobi, Kenya. Wherever possible, an overlap of images into a well surveyed area was obtained as well. In total, about 180 images were interpreted.

Figure 6
Area covered by satellite image interpretation (hatched)



All images had scales of about 1:1 million. Small differences in scale between images and the base map were dealt with by using topographic features, if visible on both the images and the base map, as a reference. Images were covered with a transparent foil on which the interpretation lines were drawn. This to protect the images and to facilitate the transfer of lines from image to base map.

Interpretation of a set of images covering an area starts with checking the "overlap images" with the soil map and the geological map of that area, thus creating a soil/landscape/geology model. Mapping units that continue from the well surveyed overlap area into the unsurveyed area, receive the same symbol, with the same descriptions and reliability as the original unit. Mapping units further away, and differing from the units in the overlap area, are described with help of the soil/landscape/geology model. Reliabilities of these newly distinguished and described units are classified as very low.

Areas covered by low reliability soil maps are also Landsat-image interpreted, with help of the model and the source map. Reliabilities of units described this way are classified as low.