Technical Paper 26

WORLD INVENTORY OF SOIL EMISSION POTENTIALS

WISE 2.1

PROFILE DATABASE USER MANUAL AND CODING PROTOCOLS

N. H. Batjes

January 1995

INTERNATIONAL SOIL REFERENCE AND INFORMATION CENTRE

Related ISRIC Publications ...

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ABSTRACT

This report documents the data handling system which has been developed for a project on World Inventory of Soil Emission Potentials (WISE) at the International Soil Reference and Information Centre (ISRIC) in the framework of the Dutch National Research Programme on Global Air Pollution and Climate Change (NRP). The central aim of the WISE project is to arrive at a geographical quantification of the soil factors that control fluxes of greenhouse gases and other processes of global environmental change by developing a global soil database. The integrated WISE database consists of two parts, a spatial component and an attribute data component. The attribute data consist of soil profiles considered to be representative for the various soil units shown on a ½° latitude by ½° longitude grid-map, which has been derived from FAO's edited, digital Soil Map of the World. Each grid is characterized by its main soil units, up to a maximum of 10 per cell. The properties of the component soil units of each grid can be characterized using appropriate data selected from the WISE profile database. The resulting, geo-referenced sets of derived soil data can be linked to a raster-GIS, for subsequent use in global environmental studies.

The user interface and coding protocols of release 2.1 of the WISE system are documented. The interface is written in the dBASE IV language and can be run on IBM compatible microcomputers operating under MS-DOS 4.0 and later versions. The system contains modules that permit storage and handling of a range of soil attributes, which have been identified as being useful for a variety of studies of global environmental change involving soils. The WISE system uses self-explanatory menus, which include options for entering and editing data as well as for making selections. The output can either be sent to the screen or to a printer. Alternatively, data sets can be off-loaded to both dBASE and ASCII files, for use in application programs as well as other data handling systems. The modular structure of the WISE system makes it possible to add new procedures; software for these will be prepared as the need arises.

Keywords: Soil Digital Database; Soil Map of the World; Soil Profiles ; Global Change

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- Contributing Investigators:

The data handling system described in this User Manual has been developed at the International Soil Reference and Information Centre (ISRIC) in the framework of a project on the Geographic Quantification of Soil Factors and Processes that Control Fluxes of Greenhouse Gases —known as World Inventory of Soil Emission Potentials (WISE)— with sponsorship from the Netherlands National Research Programme on Global Air Pollution and Climate Change (Project 851039). As with any collaborative effort, this project has been carried out with the help of many people. Members of an international workshop, organized by ISRIC in August 1992, refined the aims and objectives of the initial WISE research programme. The WISE system and user interface were developed by Niels H. Batjes. Primary testing of the WISE data handling system was done by Dr. E.M. Bridges and Ir. H. Vellema, and valuable comments on the methodology were also received from Drs V.W.P. van Engelen. The data held in the profile component of the WISE database have been derived from various sources including: (a) responses to a questionnaire sent to soil scientists from various countries of the world, whose names are documented individually in the WISE database; (b) the Natural Resources Conservation Service (USDA-NRCS, formerly SCS) Database at Lincoln, Dr. J.M. Kimble in particular; (c) FAO's Soil Database (SDB), notably Dr. F.O Nachtergaele; (d) the ISRIC Soil Information System (ISIS), particularly Ir. J.H. Kauffman; and (e) profile descriptions extracted from the ISRIC library collection (Messrs. Bridges, Batjes and Vellema). Crucial, auxiliary software for the transfer of data from the USDA-NRCS, FAO-SDB and ISRIC-ISIS databases to WISE was developed and tested by Ir. P. Tempel and the accompanying "map files" by Ir. W. Zunnenberg, both of ISRIC. All profiles transferred from the USDA-NRCS data tape have been checked and classified in the FAO system by Dr. O.C. Spaargaren. The procedures for the ½° x ½° resolution griding of the digital Soil Map of the World were developed and tested by Dr. F.O. Nachtergaele, of FAO's Land and Water Development Division (AGL), in close consultation with WISE project staff. K.M. Sinclair made a final edit of the English text. Finally, the overall support of ISRIC's staff in the WISE project activities is gratefully acknowledged.

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1. Introduction

1.1 Background

This User Manual documents the procedures for handling profile data in the global database developed at the International Soil Reference and Information Centre (ISRIC) within the framework of a project entitled World Inventory of Soil Emissions Potentials (WISE). The emphasis in this project has been on the development of a uniform soil data set for global modelling purposes (Batjes and Bridges, 1994).

Release 2.1 of WISE permits the handling of soil "attribute data" and "spatial data" using a relational database management system. The "attribute data" consist of geo-referenced soil profiles, considered to be representative for the legend units of the 1:5 million scale Soil Map of the World (FAO-Unesco, 1971-1981), which are linked to a ½° by ½° degree grid-version of the edited, digital version of this map (FAO, 1991). Consequently, the main soil units of each grid cell on the map can be characterized using appropriate data held in the profile database (Figure 1). The procedures for the ½° by ½° degree griding of the digital Soil Map of the World have been developed by FAO (Nachtergaele, *unpublished data*), in close collaboration with ISRIC staff (Batjes *et al.*, 1994a). The integrated WISE database will provide a refinement to the 1° x 1° database which Zobler (1986) derived from the original printed Soil Map of the World.

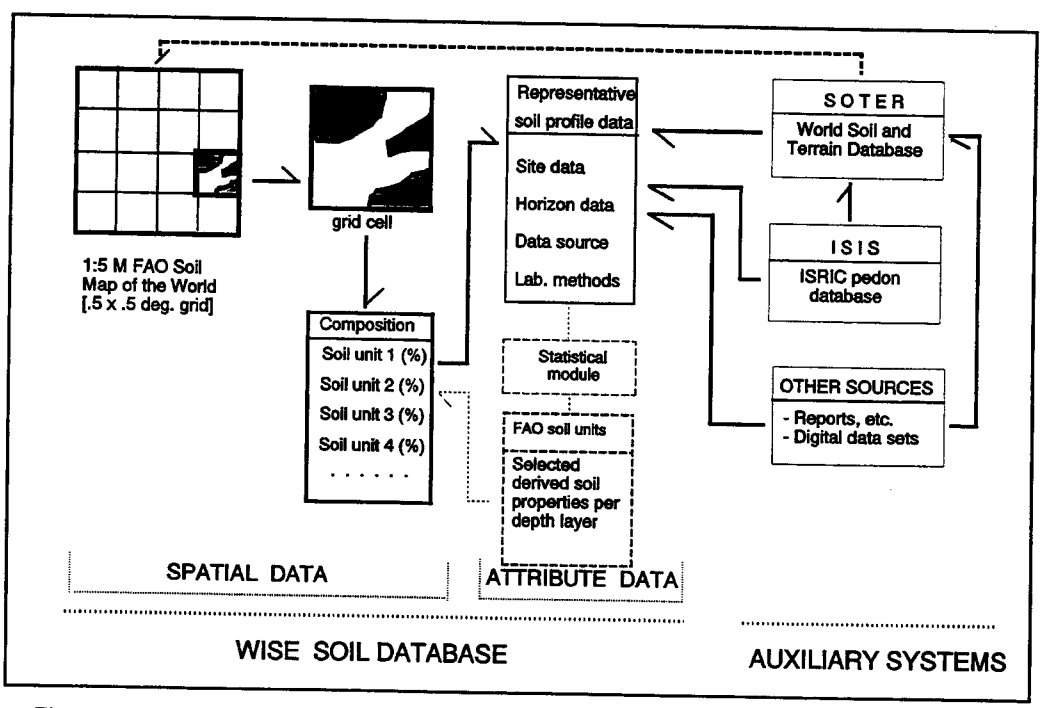


Fig. 1. Schematic representation of spatial and attribute data of the WISE database (Batjes, 1992)

WISE 2.1 is a soil data handling system developed for IBM-compatible microcomputers. This compiled release includes a collection of over 90 program modules for storing, editing, selecting and printing soil data. The individual modules are linked in a user-friendly manner by a unified menu system. The procedures are written in dBASE IV, version 1.5 (Ashton-Tate, 1988). The dBASE IV language has also been used to program ISRIC's Soil Information System (ISIS 4.0; Van de Ven and Tempel, 1994) and the World Soils and Terrain Database (SOTER 1.0; Tempel, 1994). The ISIS, SOTER and WISE databases have been developed for use at different levels of generalization, ranging from 1:250,000 to 1:5 M (Batjes *et al.*, 1994b). Of particular importance in the context of the WISE database are the SOTER activities which include a full-scale update of the information on soil unit boundaries and types, using a physiographic approach (Oldeman and Van Engelen, 1993). Ultimately, global coverage in SOTER will permit the update of the spatial component of the WISE database (see Fig. 1).

The WISE profile database aims to provide a basic set of uniform soil data for global environmental studies. As is shown in figure 2, the profile component of the WISE database includes information on:

(a) soil classification and site data;
(b) soil horizon data;
(c) source of data;
(d) the methods used for determining the analytical data; and
(e) a series of "code-definition" translation files.

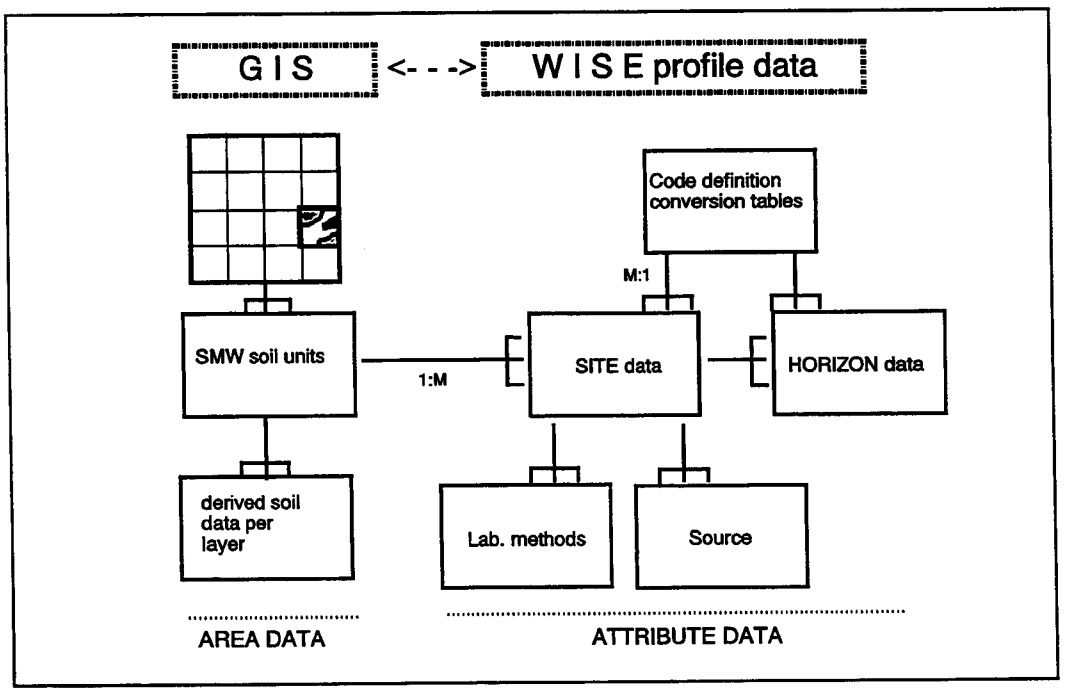


Fig. 2. Main database files of the WISE data handling system (M:1 stands for many to one relations, and 1:M for one to many relations)

The rationale and procedures for developing the first release of WISE are discussed elsewhere (Batjes 1992, 1993a, 1993b). The full complement of data selected for inclusion in the WISE profile database is listed in Appendix 5. These attributes are similar to those proposed for the European Soil Analytical Database (Madsen and Jones, 1992), and during the IGBP-DIS/GCTE workshop at Silsoe (Ingram, 1993). Recently, IGBP-DIS's Global Soils Data Taskgroup recommended that the WISE data set be used as the nucleus for developing a Global Database of Soil Properties (Scholes *et al.*, 1994). Geo-referenced soil data sets derived from the WISE database use the same format as the Global Ecosystems Database (Kineman, 1992; see Batjes, 1995).

1.2 Manual overview

This manual gives instructions for the installation and operation of the WISE 2.1 user interface. The general design of the WISE system and type of files used are described in Section 2. An overview of the system requirements and installation procedure is given in Section 3. The first part of Section 4 explains how the various core modules can be accessed from the main WISE menu. Thereafter, the operation and function of the four core modules, INPUT, EDIT, SELECTION, and TOOLS are discussed (Section 4.2 to 4.5).

Appendix 1 lists the programs and their main functions, while Appendix 2 outlines the database file structures. A blank data entry sheet is attached as Appendix 3, while Appendix 4 is an example of a data sheet produced by the computer. Guidelines and protocols for coding profile data in WISE 2.1 are presented in Appendix 5, while the routine quality checks are listed in Appendix 6. Appendix 7 is a listing of the world's country ISO-codes. The appendices are followed by a glossary and an index of selected key-terms.

2. The WISE system

2.1 System design

WISE 2.1 is not a single program but a collection of small computer programs which interface with the various database files. The programs and database files are stored in the C:\WISE directory, which is automatically created with the installation module. The advantage of this approach is that all WISE related operations are kept separate from operations of other software application systems, facilitating overall system maintenance.

Each core module of WISE is comprised of a number of programs, and each single program carries out specific data operations (see Appendix 1). The programs are incorporated into a

hierarchical structure, each program accessing a lower-level program as required. Each program is commonly called a "procedure" in dBASE, and these allow for manipulation of specific types of database files.

2.2 Types of files

File names are up to 8 characters long, with an extension of 3 characters. Under dBASE each type of file is recognized by a specific extension. For example ".NDX", refers to an index file as shown in Table 1.

Table 1. Overview of WISE system and database files

System files		Database files	
WISXXXXX.PRG	program files	WISENAME.DBF	data files
ANYNAME.FRM	format files	ANYNAME.NDX	index files
KEYNAME.DBF	code—description conversion files		

A distinction can be made between so-called "system files" and "database files". For a given release of WISE, the contents of the system files are fixed. The system files contain the dBASE commands necessary to carry out special operations with different types of data files, as well as the code-description conversion files. The contents of the database files and associated index files will change as new data are appended or deleted from the system. The structure and field-definitions for a particular database, however, are fixed (Appendix 2).

Each database file consists of a number of records which contain information related to a particular attribute (Table 2). For example, the attribute could relate to site information of a particular soil profile. Each site variable or data field is described using a mnemonic field-name, for instance WISE_ID for the profile reference number and LANDUS for the land use code. Each data field is characterized by its name, length, and the type of data it contains. The data type is either C(haracter), N(umeric), L(ogical) or D(ate). For numeric data, the total number of positions and number of positions after the decimal point are indicated (e.g., a pH(H_2O) of 10.2 is shown as: N 4 1).

2.3 Indexing files

Under dBASE, data are stored in natural order, i.e. in the order they have been added to the data files. To facilitate queries within the relational database, each data file is indexed on one or several unique field-names which in turn form an unique identifier for each record in a data set (also known as primary key). For example, the database file shown in Table 2 is indexed on two primary keys, WISE_ID+HORIZ, the unique profile reference number plus a unique number for

the horizon in question. Two data files can be linked using a (unique) common key, which has been defined as a primary key for both databases.

Table 2. Example of records and fields in a hypothetical database file

RECNO()	WISE_ID	HORIZ	DESIG	TOPDEP	BOTDEP	DCOLOR	MCOLOR	MOTTL	ORGC	TOTN
1	FJ003	1	Ah	0	19	-	10YR3/2	N	5.41	0.24
2	FJ003	2	AB	19	32	-	10YR3/4	N	1.06	0.08
3	FJ003	3	Bt1	32	58	-	7.5YR4/4	N	0.44	0.04
4	FJ003	4	Bt2	58	81	-	5YR5/6	N	0.26	0.02
5	FJ003	5	BC1	81	151	-	5Y6/3	-	0.20	-1.00
6	FJ004	1	Au	0	19	-	10YR3/3	N	1.58	0.23
7	FJ004	2	Au2	19	33	-	10YR3/3	N	0.74	0.10
8	FJ004	3	Au3	33	49	-	10YR3/2	F	0.80	0.10
9	FJ004	4	C	49	70	-	2.5Y4/4	N	0.57	0.07
10	FJ004	5	Ab1	70	91	-	10YR3/2	N	0.70	0.08
11	FJ004	6	Ab2	91	111	-	2.5Y3/2	N	0.56	0.06
12	FJ005	1	Ah	0	25	10YR5/3	10YR3/2	N	2.78	0.19
13	FJ005	2	Bt	25	43	10YR6/4	10YR4/3	N	0.88	0.08
....	.....	..	...	...	...	...	...	..	....	....

Note: Missing values are shown by a "-" in case of alphanumeric data and "-1.00" in case of numeric data; records in a database file correspond with rows in the table, and fields with columns.

Each time a database file is opened using the WISE system, its associated index-files are automatically activated (Table 3). Each index-file is updated whenever changes are made to the controlling database file. Queries in WISE search the index files and not the data files proper, speeding up the searching process (see appropriate section in dBASE manual).

Table 3. Interactive data files and associated index files and indexed key fields

Type of data	Database file	Index files	Indexed fields
- Site data	wisesite.dbf	sitecode.ndx	wise_id
		sitefao.ndx	FAO_74
		sitecoun.ndx	coun
	wiseanad.dbf	anadcode.ndx	wise_id
- Horizon data	wisehor.dbf	horid.ndx	wise_id
		horcode.ndx	wise_id+horiz
- Source data	wisesour.dbf	sourcode.ndx	source_id
- Laboratory data	wiselab.dbf	labcode.ndx	lab_id
- Laboratory method, codes	wisatrib.dbf	atribcode.ndx	lab_id
- Laboratory codes, descriptive	keymethod.dbf	keymethod.ndx	key

Data access problems will occur when the index files are not kept up-to-date. The index files can be re-created or re-indexed using option <1> of the TOOLS module (see Section 4.5). Use of this option is essential when:

(a) changes have been made to a database at the level of the dBASE prompt, for instance with the BROWSE or APPEND commands, without having activated the associated index files beforehand; and

(b) data have been corrupted, for instance by a power failure. Under these conditions, re-indexing is a crucial operation because the index files are not automatically activated under dBASE. The names of the WISE database files, related index files and indexed primary-keys are shown in Table 3.

3. System requirements and installation

3.1 Hardware requirements

Version 2.1 of WISE was developed at ISRIC for systems with the following configuration:

- IBM PC-compatible computer, 386 or 486, with MS-DOS 4.01 and later versions,
- preferably at least a 60 Mb of usable space on the hard drive,
- one high density 3½ floppy drive,
- a CGA, EGA or VGA colour monitor for screen output,
- a printer with 132 column capability for hard copy output,
- preferably at least 2 MB of RAM, to ensure a reasonable performance of dBASE with large databases,
- preferably a system running at 25 MHz or better, otherwise handling of large databases will become time consuming,
- preferably a math co-processor, particularly for auxiliary GIS applications.

The system assumes the printer is connected to the first parallel port (LPT1). If there is no printer, the output is automatically re-directed to an ASCII file residing in sub-directory C:\WISE\REPORTS. The ASCII file will have the extension ".DAT" and can be manipulated with a word processing system.

3.2 Software requirements

Operation of WISE 2.1 requires the installation of dBASE IV version, 1.5 and up, on the hard disk for which about 6 Mb of free disk space is needed. The WISE programs and database structures require about 0.5 Mb of hard disk space. The package consists of 90 programs (*.PRG, or *.DBO when compiled) and 7 format files (*.FRM). The index files (*.NDX) are automatically opened and updated by the various programs. There are 30 database files, six of

which contain the actual profile data (WISE*NAME*.DBF) and the remainder "code to description" conversion-keys (KEY*NAME*.DBF).

On average, a database with data for 1000 soil profiles will require 1.5 Mb of disk space. When used in conjunction with the ½° x ½° spatial database file of WISE, another 25 Mb of disk space is needed for storage alone. For good data operations, a free disk space of at least 30 Mb is then advised.

Since the WISE system cannot operate without the dBASE IV language, a copy of the proprietary language must reside in a separate directory on the hard drive. A path to this directory must be specified in the auto-execution file which resides on the bootable hard disk, which is usually designated as the C-drive. The computer uses path specifications to locate files within the DOS directory structure. When dBASE IV is installed for the first time on a PC, the CONFIG.DB file must be customized to suit the user PC (see dBASE Language Reference Manual). Note that WISE assumes that the dBASE IV package is installed in subdirectory C:\DB4, which must be specified as default in the computer's path.

A path can be set by modifying the AUTOEXEC.BAT file, using a suitable line or program editor. Alternatively, a word processor may be used but in this case the auto-execution file must be saved as an ASCII-file. Typically, a path command would look like:

PATH: C:\, C:\DOS, ... C:\DB4, C:\WISE

In this example, the dBASE IV software is stored in subdirectory C:\DB4, and the WISE programs and system files in subdirectory C:\WISE. In the manual, all DOS commands are shown in **bold** whereas key-board operations are highlighted using the format <statement>.

3.3 Setup and configuration

First check if the PC meets the hardware requirements defined in Section 3.1, and verify whether the necessary software (e.g., dBASE IV, PKUNZIP) is installed and running properly. Make certain you are getting the most from dBASE IV's data handling capacity and power by defining the proper BUFFERS and FILES commands in CONFIG.SYS, which is a DOS file that defines the operating system configuration commands (see dBASE User Manual).

The program parameters which dBASE will use are held in C:\DB4\CONFIG.DB, which is loaded each time dBASE IV is started. These parameters can be changed with DBSETUP.EXE from the DOS prompt. This operation may be necessary in the case of first time installation, for instance, to specify the printer driver which contains the print codes specific to a particular printer. If the "wrong" printer driver is installed, an error trapping routine will explain the steps to be undertaken for a proper installation of the current printer, and thereafter return the user to

DOS. For more information on using DBSETUP.EXE, reference is made to the dBASE User Manual.

3.4 System maintenance

A careful maintenance schedule for the data residing on the hard disk should be developed. Backups of the databases must be made at regular intervals, and several sets of backups should be kept up to date (see Section 4.5). Whenever appropriate, obsolete files should be removed from the hard disk (e.g., obsolete ASCII files residing in C:\WISE\REPORTS).

Over time, reading from and writing to the hard disk will lead to fragmentation of the database files. This fragmentation does not affect the validity of the information, but system operation will be enhanced after the files are de-fragmented. This operation can be performed with a range of commercial programs, including NORTON.

3.5 Installing WISE

WISE 2.1 is designed only for hard disk based systems. Release 2.1 of the WISE system comes on one 3½ inch double-sided and high-density floppy disk. No special preparation is required to install the software package on a suitable PC. However, it is strongly advised that a copy of the WISE 2.1 distribution disk(s) be made before installation.

Although the procedures or modules of WISE are written in dBASE IV, users do not need to have an understanding of this programming language in order to operate the system. The procedures are user friendly and can be accessed independently or in combination to meet the user application requirements from a set of simple menus (see Section 4). To make full use of the data held in WISE, however, a working knowledge of DOS and dBASE commands is useful (see appropriate manuals).

If the WISE system is already installed on your PC, please proceed to Section 3.6. Otherwise, for instance in cases where the copy on the hard disk has been inadvertently erased or damaged, proceed as described below:

(1) Reboot the system by pressing <Ctrl-Alt-Del>. This is also necessary if you have just modified your AUTOEXEC.BAT file to include a path to the C:\DB4 and C:\WISE subdirectories.

(2) Insert the "working copy" of the installation diskette, which holds a compressed version of the WISE 2.1 programs and database files (WISSETUP.ZIP), into the A-drive.

(3) Type the following commands, followed by <enter>:

C> PKUNZIP -d -o A:WISSETUP C:

Typing errors can be corrected at this stage using the <del> or <backspace> keys. Pressing <enter> tells the system to access PKUNZIP.EXE, to "unzip" the compressed file A:WISSETUP.ZIP to the hard disk, and to execute the specified commands. The installation module automatically creates the WISE directory structure on the C-drive and copies the different type of files to the appropriate (sub)directories. Insert the other distribution diskettes in the A-drive, as prompted.

(4) After installation and program execution remove the diskette from the A-drive, place it in a jacket and store it in a safe and dust-free place.

3.6 Accessing WISE

This is where the user starts once the WISE software has been installed.

(1) If appropriate, switch on the computer by turning on the main power supply. At this time there should be no floppy disks in the A-drive, so that the system automatically accesses the auto-execution file on the C-drive.

(2) Depending on the general commands in your AUTOEXEC.BAT file, which sets the configuration of the PC and paths to the WISE and dBASE files, a number of messages may echo onto the screen.

(3) In order to access the WISE system —at the level of the DOS prompt— type the following command:

C> **WISE**

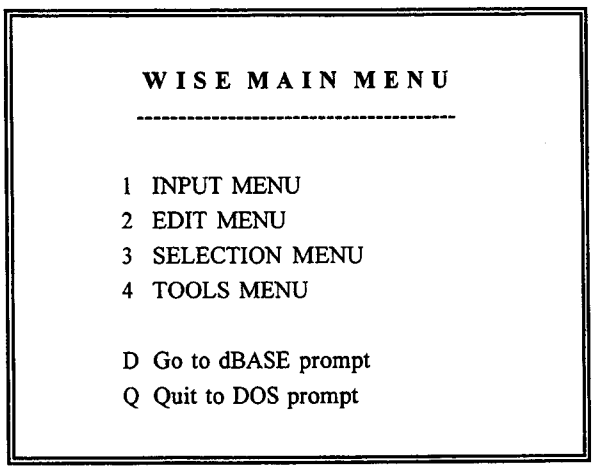
On pressing the <enter> key, the computer accesses WISE.BAT, the batch file that starts dBASE IV and initializes the system software, displaying a menu on the screen with general information on the WISE system. The user can access the second screen, which displays a disclaimer, by pressing <enter>, after which the main WISE menu appears on the screen, from which a number of operations can be performed (see Section 4). In case of a new installation, the system will automatically check whether the printer driver is correctly installed and update the index files.

4. The Core Modules

4.1 WISE main module

The main module, which is accessed from the DOS prompt by typing WISE, allows to access the INPUT, EDIT, SELECTION, and TOOLS menu. A particular option can be accessed by typing the corresponding number or letter on the key-board. For instance, choosing option <1> at the level of the main menu takes the user to the INPUT menu, which in turn allows the user to select from a new range of data input options (Section 4.2). At each level in WISE, it is possible to return to the preceding menu and ultimately to the dBASE or DOS prompt. For

convenience, a double-lined box at the head of every screen provides the user information on the module in use. Similarly, the type of data being processed is displayed on the screen. Important messages are highlighted on the screen.



Upon entering a data set with the INPUT module, it is crucial to determine whether any errors in data entry have been made. This check is done with the EDIT menu, corresponding with option <2> of the WISE menu (Section 4.3).

Operations based on a number of specific criteria can be made by choosing option <3> which accesses the SELECTION module (Section 4.4). For experienced dBASE users, it may prove more efficient to directly access (backup copies of) the relevant database files using self-developed programs which extract the required information.

Pressing option <D> at the level of the WISE menu closes the databases and returns the user to the dBASE prompt from where all dBASE operations can be performed (**Note**: the default directory remains C:\WISE, unless changed by the SET DIRECTORY TO command). It is **recommended** that option D be used only by those who are familiar with the dBASE language as inexperienced users may inadvertently damage both the structure and content of the database files! Upon completing a session at the level of the dBASE prompt, pressing the **F10** key will return to the user to the WISE system.

Option <4> of the WISE menu allows the user to access the TOOLS module, the applications of which are explained in Section 4.5. Finally, pressing <Q> at the level of the WISE menu will close all dBASE files and return the user to the DOS-prompt; it is only then that the PC can be switched off safely. Turning off the PC while it is still running dBASE may corrupt the database files and their index files.

4.2 INPUT module

Strict criteria have been defined for accepting profiles into the WISE database, viz.: (a) completeness and apparent reliability of data; (b) traceability of source of data; (c) classifiable in the FAO-Unesco (1974) legend; and (d) geo-referenced within defined limits.

Profile data can be appended to the WISE database as follows:

(1) Manually, using the INPUT module to enter data on the site and physico-chemical characteristics of geo-referenced profiles selected to be representative of a particular unit of the Soil Map of the World. The INPUT module also allows entry of the source from which the profile data were derived as well as the name/identifier of the laboratory where the corresponding analyses were performed. It also includes a procedure for specifying codes for the various analytical methods, and for entering descriptions of these methods into a "key" file.

(2) By off-loading from auxiliary digital data sets using a computerized data-transfer facility (Tempel, 1994). Procedures, called map-files, have been developed for transferring data from the USDA Natural Resources Conservation Service (NRCS, formerly SCS), FAO Soil Data Base (SDB) and ISRIC's Soil Information System (ISIS; Van de Ven and Tempel, 1994) databases to WISE 2.1 (W. Zunnenberg, *unpublished data*). Following the initial transfer to a WISE-compatible dBASE format, the integrity of the transferred data is checked by a second computer module. It is only after this second operation that the "screened" data sets are appended to the main WISE database files.

The options of the INPUT menu are:

```
                WISE INPUT MENU
                ---------------

Site data                          (Y/N)
Horizon data                       (Y/N)
Reference to source of data        (Y/N)
Laboratory name and methods        (Y/N)
Description of analytical methods  (Y/N)

Return to WISE menu                (W)

Enter your selection:
```

Unlike the other menus of WISE, the INPUT menu allows for simultaneous selections, the combination of which is chosen based on the type of data to be entered. The **recommended** procedure for a given profile is to enter both the site and horizon data in one session, which requires typing <Y> for each of these options. Generally, several profiles will be derived from the same source (e.g., monograph or database) and analyzed with the same analytical procedures. This means that this type of information does not have to be re-entered for every pit. It is further **recommended** that information on the source, laboratory name and laboratory methods be stored when the first profile from a particular data set/source is entered. Otherwise, gaps are liable to occur in the database. Although this type of gap will be flagged with the checking module (Section 4.3), it is better to avoid such errors at the data entry stage!

Once the relevant options have been selected by pressing the <Y> or <N> keys, the user will be prompted to enter a unique reference number (WISE_ID) for the profile. Each WISE_ID must have the same format: the first two letters refer to the country's ISO-code, and the last three digits to the number of the profile. For example, profile reference code "JM003" would refer to the third soil profile stored for Jamaica (ISO-code: JM, see Appendix 7). The site data input-module includes a checking routine that precludes duplicate entry of a particular profile code. In cases where duplication is about to occur, the first (highest) free number for the country is determined and automatically assigned to the new profile. In these cases, it is imperative that the user manually records this new profile number on the corresponding Data Entry Sheet in order to keep the referencing system of the manuscript files up to date. When data are appended by digital transfer from auxiliary sources, a similar procedure is used and the original profile-ID is automatically stored in the field REFPAG.

Only if a unique WISE_ID is entered, will the user be brought to the first input screen. To facilitate data entry, the cursor can be moved from one screen-field to the other using the →, ←, ↑ and ↓ keys. When the last entry is entered, or <PgDn> is used to go to the end of the current input screen, the system prompts:

==> Continue or Modify the above data (C/M)

Entering <C> closes the current input screen and proceeds to the next input-screen, while pressing <M> will allow the user to modify the displayed data using the appropriate arrow keys. This procedure is repeated for all the input screen belonging to a particular selection; for example, there are three input screens for the site data. During this process, the entered data are only temporarily saved in a buffer! Actual storage to the appropriate database file on the hard disk first happens upon entering <Y> at the following prompt:

==> Write data to disk (Y or N) or exit (E)

Upon confirmation, the site data are stored to WISESITE.DBF. If option <N> is entered, the input screen and buffers will be cleared and none of the data will be stored in a disk file. The system will proceed to the next module irrespective of whether <Y> or <N> was entered.

Pressing <E> for exit, however, allows the user to directly return to the main menu of the WISE system without saving any of the newly entered data.

Remarks on each profile can be stored as 254 character long strings in WISEANAD.DBF, using WISE_ID as the primary key. Each horizon is automatically numbered starting from the surface to the bottom, the sequence in which all horizons must be entered into the database. Horizons for any given profile are indexed on both the WISE_ID and HORIZ_ID fields, that is on the profile code and horizon number, in WISEHOR.DBF.

The source of the data sets, be it a digital database or soil survey monograph, is documented in WISESOUR.DBF. Although there is no fixed coding convention for sources, the SOURCE_ID must be less than 10 characters long and unique.

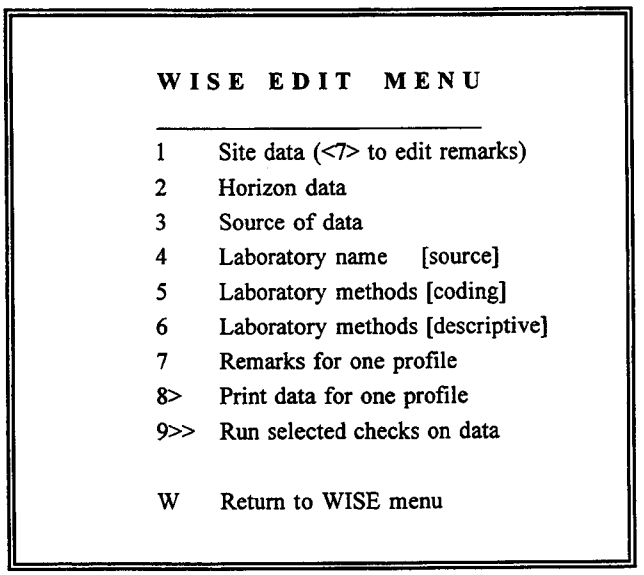
Each soil laboratory —and its set of associated analytical procedures— is also identified by a unique code, LAB_ID. This code consists of the countries's ISO-code and two numerals. For example, "FR01" would refer to the first laboratory described for France. The LAB_IDs together with a short reference to the laboratory are documented in WISELAB.DBF. Similarly, the analytical procedures used at a particular laboratory are described by a methods-code in WISEATRI.DBF. This coding system is held in KEYMETHO.DBF. This database file will be expanded as new sets of analytical procedures are encountered in the international data collection program.

The INPUT screens prompt the user for specific types of input. It is imperative that all data are coded and entered exactly according to the format described in the WISE 2.1 Database Coding Protocols (Appendix 5). Input screens will only accept the data types specified in the program, each with their own pre-defined field type and length (see Appendix 2). Numeric entries are automatically right-justified. Character fields for descriptive data are left-justified, and a character should always occupy the leftmost position.

For character strings it is crucial to distinguish between the letter O and the number 0 (zero); all searches are carried out based on exact matches in WISE! In the case of attributes defined as numeric, the dBASE language does not differentiate between "" (space) and 0 (zero). This creates a potential risk of contaminating the integrity of the database. In WISE this problem has been circumvented by defining all attributes as being "missing values" when the data entry starts. On the input screen, this is shown by a "-" in case of alphanumeric data and a "-1.00" in case of numeric data. The actual data can be entered directly over this information, provided the key-board is in the <insert> mode.

4.3 EDIT module

After entering several data sets using the INPUT module, it is crucial to identify and correct any errors in data entry. This validation is done through the EDIT menu, which can be accessed from the WISE menu by entering option <2>, which allows the following selections:



In order to facilitate the control process, the data for a selected profile can be printed for a visual check using option <8>. An additional automated check on all profiles is possible with option <9>, so that potential data entry errors are flagged. The listings can be compared with the manuscript forms, which is a safer way of checking data for possible inconsistencies than by visual inspection of the video screen.

Once the errors have been identified, they can be edited with a set of fully interactive and self-explanatory menus. The general procedure is that the unique identifier of a particular data set is entered into the system. For example, if an error was made in the location for the profile with WISE_ID of "IT012" in file WISESITE.DBF, the system will display the associated information on the video-screen. In the case where non-existing codes or wrong combinations of codes have been entered, the user will be prompted to re-enter a correct entry for the relevant ID-code. Alternatively, the module can then be "exited" by typing <E> which will return the user to the first higher-level procedure.

The (current) records stored in the selected database file are displayed on the screen, using a set of screen displays identical to those of the INPUT module, facilitating the editing process. At this stage, all corrections must be left-justified on the video screen. Do not leave any blanks, particularly for the "numeric" attributes. This is crucial, because the EDIT module uses a procedure in which all data are temporarily stored and treated as character fields.

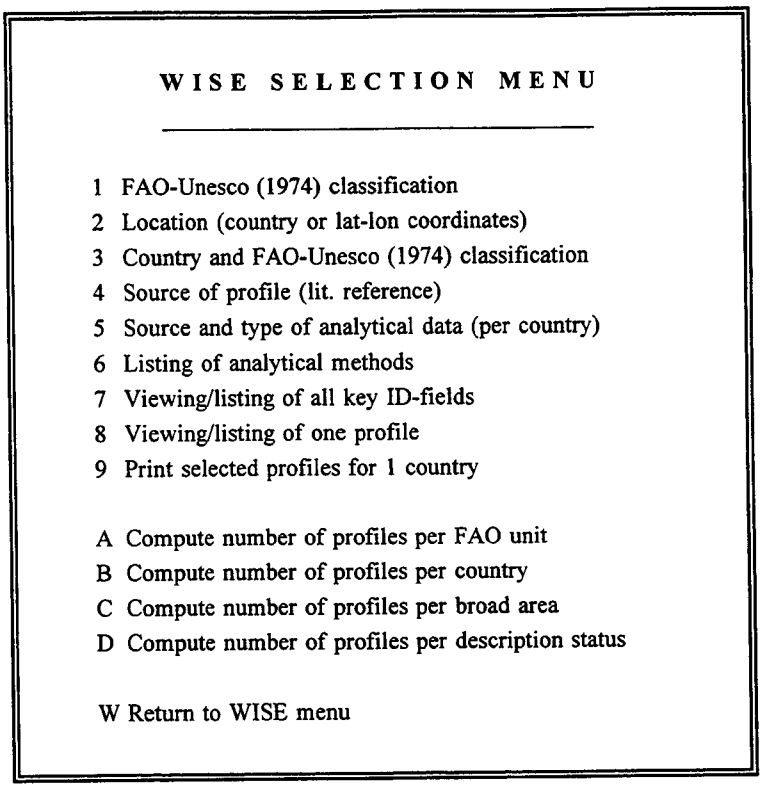
Data can be edited by overwriting the displayed information, while the keyboard is in the <insert> mode. The arrow-keys and page down <Pg Dn> key may again be used to move over the screen without changing the contents of the data fields. Note that at this stage all missing values must be entered either as '-1' for numeric values or '-' for alphanumeric data. Once the data for a whole screen have been edited, the user will be prompted to indicate whether the new information is considered correct or not. Finally, the user must indicate whether the modified data should be written to disk or not. This last operation may seem somewhat redundant, however, it was added to preclude any "unwanted" modifications from being introduced into the WISE database files. Contamination is one of the greatest threats that can damage the integrity and ultimately the applicability of the data! It is also for this reason that un-checked, auxiliary database files should never be appended directly to the global WISE database.

The operation of options <3>, <4>, <5> and <7> is similar to those described above. In the case of option <2> for the editing of horizon data, the user must first specify whether to edit: (a) data for one specific horizon only, or (b) all available horizons in sequence. Access to option <6>, which allows editing of the master keys for the analytical procedures, is limited by a PIN-code. Option <8> allows printing of a profile data entry sheet (see Appendix 3), which can be used for a rough visual check on the entered data. In the event that the printer is switched off, all output will be re-directed to an ASCII-file called C:\WISE\REPORTS\PRINDIR1.DAT.

Option <9> is very important as it complements the visual checks described above. It accesses a number of programs that screen the various database files for possible inconsistencies in all alphanumeric data and selected numeric data. Two options are available. The first permits a full scale screening, which includes the identification of possible errors in selected physical and chemical data, as shown in Appendix 6. The second option only checks for possible discrepancies in qualitative codes as well as possibly missing data records (e.g., flag profiles for which no remarks fields are available). All potentials errors must be carefully checked against the original sources, and corrected using options <1> to <7> of the EDIT menu.

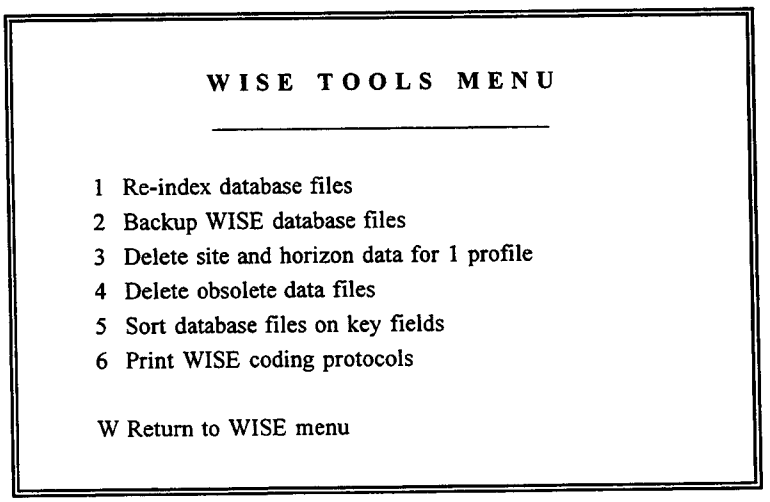
4.4 SELECTION module

The SELECTION module permits the extraction of specific data sets from the WISE database, using a simple menu. Each option accesses a number of user-friendly sub-menus which perform the specified queries of the WISE database files. The outcome of these can be printed as a hard copy or displayed on the screen. Output from option <9>, however, can also be sent to a floppy residing in the A-drive. Other application specific selections, can best be formulated directly at the level of the dBASE prompt.



4.5 TOOLS module

The TOOLS module facilitates the handling of selected files from the following menu:



Upon confirmation, option <1> re-indexes the user-interactive database files of the WISE system. This option should be used whenever dBASE has been exited in an unorthodox way, such as when the system hangs-up, and in the case where database files have been accessed from the dBASE prompt without having activated the associated index files.

Computer files can easily be lost or damaged, for instance after a power-failure or if the system hangs-up. Consequently, it is imperative to regularly make copies of the database files. This process is known as making back-ups. Backups of WISE related database files residing on the hard disk should be made each time new data have been added to the system or files have been edited. Keeping a triple set of backups up to date is considered good practice. The respective sets can then be used on alternating days, ensuring that a fairly up to date set is always available in case the computer crashes. In the worst case scenario, only the data sets for one whole day would have to be re-entered and re-checked for eventual data entry errors.

Option <2> of the TOOLS menu copies the 6 database files (WISE*NAME*.DBF) to either: (a) a series of floppies in the A-drive or (b) to the C:\WISE\WISEBAK directory on the hard disk. Although option (b) allows for a quick copy of the database files, this copy will be useless in the case of total system failure when a backup on a floppy will be needed. Therefore, option (a) must be used on a regular basis. After insertion of a diskette in the A-drive —the contents of which will be erased— all database files will be copied to it. In the case of large databases, the user will be prompted to insert a new diskette once the current diskette is full. It is **recommended** that the number of the backup set, the sequence in which the disks of each set were entered, and the date on which the backup was made on each floppy be recorded.

Option <3> allows deletion of the site, horizon and remark fields for one particular profile at a time. After the deletion process, the database files are automatically re-indexed. Option <4> permits the deletion of any type of data file, from a simple screen menu, using a dBASE application screen. Alike option <3>, option <4> should be used with great care since all deletions are irreversible. When using option <4>, the default directory is temporarily set to C:\WISE\REPORTS. However, the user-screen can also be used to access another directory, in which situation critical database files and program can easily be destroyed in case of wrong usage! It is therefore imperative to critically read and follow the commands displayed on the screen.

Option <5> creates new database files in which the current databases (WISE*NAME*.DBF) are sorted on their key field(s). This operation can be useful when new data sets have been appended to the database files. Following the sorting operation, the new database files are automatically re-indexed.

Option <6> allows printing of a listing of the contents of all the KEYNAME.DBF database files (see Appendix 2). These files contain the coding conventions for the WISE database (see Appendix 5). The contents of the system database files should **never be altered** in any way as they are directly related to the global WISE data set.

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Appendices

Appendix 1. Overview of WISE program files

Programs	Function	Calls/uses*
WISE.BAT	Access WISE 2.1 user interface	DOS; dBASE IV; wis00000.prg
WIS00000.PRG	WISE main module	wis0001.prg; wis10000.prg; wis20000.prg; wis30000.prg; wis40000.prg; wis5000.prg
WIS00001.PRG	Procedure file	Individual WISE 2.1 procedure files
WIS01000.PRG	Default WISE system settings	
WIS02000.PRG	Default printer settings	
WIS03000.PRG	Error trapping routine	Lists program, line and type of error
WIS10000.PRG	INPUT module	wis11000.prg; wis12000.prg; wis13000.prg; wis14000.prg; wis15000.prg; wis16000.prg
WIS11000.PRG	Input site data	wis11100.prg; wisesite.dbf
WIS11100.PRG	Flag missing values	None
WIS12000.PRG	Input horizon data	wis12100.prg; wisehor.dbf; wisesite.dbf
WIS12100.PRG	Flag missing values	None
WIS13000.PRG	Source input screen	wisesour.dbf
WIS14000.PRG	Lab. references	wiselab.dbf
WIS14100.PRG	Lab. method codes	wiseatrib.dbf
WIS15000.PRG	Remarks	wiseanad.dbf
WIS16000.PRG	Code + descr. of lab methods	keymetho.dbf
WIS20000.PRG	TOOLS module	wis21000.prg; wis22000.prg; wis23000.prg; wis24000.prg; wis25000.prg; wis26000.prg; wis27000.prg
WIS21000.PRG	Re-index files	wis21100.prg, wis21200.prg
WIS21100.PRG	Re-index WISE user files	wisesite.dbf --> wise_id (sitecode.ndx) --> fao_74 (sitefao.ndx) --> coun (sitecoun.ndx) wisehor.dbf --> wise_id (horid.ndx) --> wise_id+horiz (horcode.ndx) wiseanad.dbf --> wise_id (anadcode.ndx) wisesour.dbf --> source_id (sourcode.ndx) wiselab.dbf --> lab_id (labcode.ndx) wiseatrib.dbf --> lab_id (atribcode.ndx)

* Extension: frm= format files; ndx= index file; prg= program file; mem= memory variables.

Programs	Function	Calls/uses
WIS21200.PRG	Re-index WISE system files	keyarea.dbf, keycoun.dbf, keycrops.dbf, keydrain.dbf, keyfao.dbf, keykoppe.dbf, keylandf.dbf, keylus.dbf, keymethod.dbf, keymottl.dbf, keyparen.dbf, keyph74.dbf,keyph90.dbf,keyposit.dbf,keyregion.dbf, keyroots.dbf, keystatu.dbf, keystruc.dbf, keytext.dbf, keyveget.dbf --> key (key*name*.ndx)
WIS22000.PRG	Backup database files	wis22100.prg; wis22200.prg
WIS22100.PRG	Backup to A:\	wisesite.dbf; wiseanad.dbf; wisehor.dbf; wisesour.dbf; wiselab.dbf; wiseatri.dbf; wise_exte.dbf (**Requires**: PKZIP, a proprietary software)
WIS22200.PRG	Backup to C:\WISE\WISEBAK	wisesite.dbf; wiseanad.dbf; wisehor.dbf; wisesour.dbf; wiselab.dbf; wiseatri.dbf (**Requires**: PKZIP)
WIS23000.PRG	Delete data for one profile	wisesite.dbf; wisehor.dbf; wiseanad.dbf (does not remove data from: wisesour.dbf, wiselab.dbf and wiseatri.dbf)
WIS24000.PRG	Delete obsolete data files	deletes any type of file [irreversible, danger!]
WIS25000.PRG	Sort database files	wisesite.dbf; wiseanad.dbf; wisehor.dbf; wisesour.dbf; wiselab.dbf; wiseatri.dbf
WIS26000.PRG	Make listing of coding protocols	keyname.dbf; wis_abb2.txd; wis_abb2.dbf
WIS30000.PRG	SELECTION module	wis30000.prg to wis38000.prg, and wis3A000.prg to wis3D000.prg
WIS31000.PRG	Select on FAO-Unesco (1974)	wisesite.dbf; keyfao.dbf; wisesise.frm
WIS32000.PRG	Select on country or coordinates	wis32100.prg; wis32200.prg
WIS32100.PRG	Select on country ISO-code	wisesite.dbf; keycoun.dbf; wisesise.frm
WIS32200.PRG	Select on coordinates	wisesite.dbf; wisesise.frm
WIS33000.PRG	Select on country+FAO-Unesco	wisesite.dbf; keycoun.dbf; keyfao.dbf; wisesise.frm
WIS34000.PRG	Select on source of profiles	wisesour.dbf
WIS35000.PRG	Select on source of analyses	wiselab.dbf; wiseatrib.frm
WIS36000.PRG	Display analytical methods	wiseatrib.dbf; keymethod.dbf;
WIS37000.PRG	Display all key-fields	wisesite.dbf; wiselist.frm
WIS38000.PRG	Print one WISE profile data sheet	wis48000.prg
WIS39000.PRG	Print selected data sheets	wis391000.prg; wis39200.prg
WIS39100.prg	Hard copy	wis48000.prg
WIS39200.prg	Database file	wis48000.prg
WIS3A000.prg	Print no. profiles per FAO (1974) unit	keyfao.dbf; keyfao_1.dbf
WIS3B000.prg	Print no. profiles per country	keycoun.dbf
WIS3C000.prg	Print no. profile per broad region	keyarea.dbf; keyregion.dbf
WIS3D000.prg	Print no. prof. per descr. status class	keystatu.dbf
WIS40000.PRG	EDIT module	wis41000.prg to wis49000.prg
WIS41000.PRG	Edit site data	wis41100.prg; wisesite.dbf
WIS41100.PRG	Edit subroutine	None
WIS42000.PRG	Edit horizon data	wisehor.dbf; wisesite.dbf; tempstore.mem (temp.)
WIS43000.PRG	Edit source data	wiseour.dbf; tempstore.mem (temp.)

(Appendix 1, cont.)

Programs	Function	Calls/uses
WIS44000.PRG	Edit laboratory name	wiselab.dbf; tempstore.mem (temp.)
WIS45000.PRG	Edit laboratory method codes	wiseatrib.dbf; tempstore.mem (temp.)
WIS46000.PRG	Edit laboratory descriptions	keymethod.dbf; tempstore.mem (temp.)
WIS47000.PRG	Edit remarks for one profile	wiseanad.dbf; tempstore.mem (temp.)
WIS48000.PRG	Print profile data	wis48100.prg; wis48200.prg; wisesite.dbf
WIS48100.PRG	Print site data	wisesite.dbf; keystatu.dbf; keyfao.dbf; keyph74.dbf; keyph90.dbf; keycoun.dbf; keylandf.dbf; keyposit.dbf; keydrain.dbf; keyparen.dbf; keykoppe.dbf; keylus.dbf; keycrops.dbf; keyveget.dbf; keytext.dbf; keylandf.dbf
WIS48110.PRG	Data handling	None
WIS48200.PRG	Print horizon data	wis48210.prg; wisesite.dbf; wisehor.dbf; wisesour.dbf; wiselab.dbf; wiseanad.dbf; keymottl.dbf; keyroots.dbf; keystruc.dbf
WIS48210.PRG	Data handling	wiseatrib.dbf; keymetho.dbf
WIS49000.PRG	Data validation procedures	wis49100.prg upto wis49600.prg; wisesite.dbf; wiseanad.dbf; wisehor.dbf; wisesour.dbf; wiselab.dbf; wiseatri.dbf; keystatu.dbf; keyfao.dbf; keyph74.dbf; keyph90.dbf; keycoun.dbf; keylandf.dbf; keyposit.dbf; keydrain.dbf; keyparen.dbf; keykoppe.dbf; keylus.dbf; keycrops.dbf; keyveget.dbf; keymethod.dbf; keymottl.dbf; keylandf.dbf; keyroots.dbf; keystruc.dbf; keytext.dbf

Appendix 2. Structure and attributes of WISE database files

A) WISE database files

Structure for database: WISESITE.DBF

Field Name	Type	Width	Dec	Description
WISE_ID	Character	5		Unique profile reference number
LAB_ID	Character	4		Unique laboratory reference number
SOURCE_ID	Character	10		Unique reference number for source of profile data
REFPAG	Character	50		Profile/page reference in source
HORNUM	Numeric	1		Number of horizons described for pit (Y/N, control variable)
FAO_74	Character	2		FAO-Unesco (1974), classification as code
PHA_74	Character	2		As above, but code for (main) phase
TOP_74	Character	1		As above, but code for topsoil textural class
FAO_90	Character	3		FAO-Unesco (1990), classification as code
PHA_90	Character	2		As above, but code for (main) phase
USCL	Character	50		USDA Soil Taxonomy classification, descriptive
USYR	Character	2		Year (version of Soil Taxonomy, e.g., 75, 94)
LOCAL	Character	50		Local classification, descriptive
DESCR	Character	1		Profile description status, code
DATE	Character	5		Date profile was first described
COUN	Character	2		ISO code for country of origin
LOCAT	Character	50		Location of profile, descriptive
LATIT	Character	1		Latitude of profile (N/S)
LATDEG	Character	2		degrees
LATMIN	Character	2		minutes
LATSEC	Character	2		seconds
LONGI	Character	1		Longitude of profile (E/W)
LONDEG	Character	3		degrees
LONMIN	Character	2		minutes
LONSEC	Character	2		seconds
ALTIT	Numeric	4		Elevation (m)
LFORM	Character	2		Landform, code
POSIT	Character	2		Position, code
ASPECT	Character	3		Aspect, code
SLOPE	Character	3		Slope at profile site (%)
DRAIN	Character	2		Drainage condition, code
GRWHI	Numeric	4		Average, highest groundwater level (cm)
GRWLO	Numeric	4		Average, lowest groundwater level (cm)
SOLDEP	Numeric	4		Average, soil depth to a physically limiting layer (cm)
PARMAT	Character	3		Parent material, code
PARREM	Character	50		Remarks on parent material, descriptive
KOPPEN	Character	3		Köppen climate classification, code
LANDUS	Character	3		Land use, code
CROPS	Character	2		Crops, code
VEGCOD	Character	2		Vegetation, code
VEGREM	Character	100		Remarks on either land use or vegetation, descriptive
REMARKS	Character	5		Data entry source code

Structure for database: WISEHOR.DBF

Field Name	Type	Width	Dec	Description
WISE_ID	Character	5		Unique soil profile number
HORIZ	Character	1		Unique horizon number (in combination with WISE_ID)
DESIG	Character	8		Horizon designation, coded acc. to local system
TOPDEP	Numeric	3		Upper depth of horizon (cm)
BOTDEP	Numeric	3		Lower depth of horizon (cm)
DCOLOR	Character	8		Dry matrix colour, Munsell code
MCOLOR	Character	8		Moist matrix colour, Munsell code
MOTTLE	Character	1		Mottling, code
ROOTS	Character	2		Roots abundance/size, code
ORGC	Numeric	5	2	Organic carbon (%, acc. to method specified in keymethod.dbf)
TOTN	Numeric	5	2	Total Nitrogen (%)
PTOT	Numeric	5	1	Available phosphorus (mg P_2O_5 kg^{-1})
CACO3	Numeric	4	1	Calcium carbonate content (%)
GYPSUM	Numeric	4	1	Gypsum content (%)
PHH2O	Numeric	4	1	pH measured in water
PHKCL	Numeric	4	1	pH measured in KCl solution
PHCACL2	Numeric	4	1	pH measured in $CaCl_2$ solution
ECE	Numeric	5	2	Electrical conductivity (dS m^{-1} or mmho cm^{-1})
EXCA	Numeric	5	1	Exchangeable calcium (cmol(+) kg^{-1})
EXMG	Numeric	5	1	Exchangeable magnesium
EXNA	Numeric	5	1	Exchangeable sodium
EXK	Numeric	5	1	Exchangeable potassium
EXACID	Numeric	5	1	Exchangeable acidity
EXALUM	Numeric	5	1	Exchangeable aluminum
CECSOIL	Numeric	5	1	Cation exchange capacity (cmol(+) kg^{-1})
ECEC	Numeric	5	1	Effective CEC (cmol(+) kg^{-1}; 1 *M* KCl)
BSAT	Numeric	3		Base saturation, expressed as % of CEC
SAND	Numeric	2		Sand content (w/w%)
SILT	Numeric	2		Silt content (w/w%)
CLAY	Numeric	2		Clay content (w/w%)
GRAVEL	Numeric	2		Gravel content (v/v %)
STRUCT	Character	2		Soil structure, code
BULKDENS	Numeric	5	2	Bulk density (g cm^{-3})
PF	Character	1		Soil moisture content (Y/N, control variable)
PF00	Numeric	2		Soil moisture content (% v/v) held at pF 0
PF10	Numeric	2		As above, but at pF1.0
PF15	Numeric	2		As above, but at pF1.5
PF17	Numeric	2		As above, but at pF1.7
PF20	Numeric	2		As above, but at pF2.0
PF23	Numeric	2		As above, but at pF2.3
PF25	Numeric	2		As above, but at pF2.5
PF27	Numeric	2		As above, but at pF2.7
PF34	Numeric	2		As above, but at pF3.4
PF37	Numeric	2		As above, but at pF3.7
PF42	Numeric	2		As above, but at pF4.2
AWC	Numeric	2		Available water capacity
HC	Character	1		Hydraulic conductivity (control variable)
CONDSAT	Numeric	4	1	Saturated conductivity (cm hr^{-1})
CONDUNSAT	Numeric	4	1	Unsaturated conductivity (cm hr^{-1})

Structure for database: WISEANAD.DBF

Field Name	Type	Width	Dec	Description
WISE_ID	Character	5		Unique profile number
ADD	Character	254		Remarks on profile, descriptive

Structure for database: WISESOUR.DBF

Field Name	Type	Width	Dec	Description
SOURCE_ID	Character	10		Unique reference number for source of profile data
AUTHOR	Character	70		Author name and initials
AUTYR	Numeric	2		Year of publication
REFTIT	Character	100		Title of monograph/database, descriptive
REFPUB	Character	100		Series/publisher/year, descriptive

Structure for database: WISELAB.DBF

Field Name	Type	Width	Dec	Description
LAB_ID	Character	4		Unique laboratory code
LABNAM	Character	150		Reference to laboratory, descriptive

Structure for database: WISEATRIB.DBF

Field Name	Type	Width	Dec	Description
LAB_ID	Character	4		Unique laboratory code
ORGC	Character	2		Number-code of analytical method (see KEYMETHO.DBF)
TOTN	Character	2		As above, but for total nitrogen
PTOT	Character	2		As above, but for 'available' phosphorus
CACO3	Character	2		As above, but for calcium carbonate content
GYPSUM	Character	2		As above, but for gypsum content
PHH2O	Character	2		As above, but for pH-water
PHKCL	Character	2		As above, but for pH-KCl
PHCACL2	Character	2		As above, but for pH-$CaCl_2$
ELECON	Character	2		As above, but for electrical conductivity
EXBAS	Character	2		As above, but for exchangeable Ca, Mg, K and Na
EXACID	Character	2		As above, but for exchangeable acidity
CECSOIL	Character	2		As above, but for CEC
ECEC	Character	2		As above, but for ECEC
BSAT	Character	2		As above, but for base saturation
TEXTURE	Character	2		As above, but for texture (definition of esd-sizes + method)
BULKDENS	Character	2		As above, but for bulk density
MOISTCON	Character	2		As above, but for moisture content (pF measurements)
HYDROCON	Character	2		As above, but for hydraulic conductivity

B) Key-description conversion files

Structure for database: KEYAREA.DBF

Field Name	Type	Width	Dec	Description
KEY	Character	2		Unique identifier for broad geographic area (e.g., AF for Africa)
REGION	Character	150		Description of broad geographic area

Structure for database: KEYCOUN.DBF

Field Name	Type	Width	Dec	Description
ISO	Character	2		Country ISO code
COUNTRY	Character	20		Country name, descriptive
REGION	Character	2		Unique identifier for broad geographic area (e.g., AF for Africa)

Structure for database: KEYCROPS.DBF

Field Name	Type	Width	Dec	Description
KEY	Character	2		Arable crops, code
CROPS	Character	25		As above, but descriptive

Structure for database: KEYDRAIN.DBF

Field Name	Type	Width	Dec	Description
KEY	Character	2		Soil drainage class, code
DRAIN	Character	40		As above, but descriptive

Structure for database: KEYFAO.DBF

Field Name	Type	Width	Dec	Description
KEYFAO90	Character	3		FAO-Unesco (1990) Revised Legend, code
FAOUNIT90	Character	20		FAO-Unesco (1974) Legend, code
KEYFAO74	Character	2		FAO-Unesco (1990) classification, descriptive
FAOUNIT74	Character	20		FAO-Unesco (1974) classification, descriptive

Structure for databases: C:\WISE\KEYFAO_1

Field Name	Type	Width	Dec	Description
KEYFAO74	Character	2		FAO-Unesco (1974) Legend, 1st level codes only
FAOUNIT74	Character	20		FAO-Unesco (1974) Legend, descriptive

Structure for database: KEYKOPPE.DBF

Field Name	Type	Width	Dec	Description
KEY	Character	4		Unique identifier for Köppen climate code (e.g., Aw)
KOPPEN	Character	115		Summary description of Köppen climate

Structure for database: KEYLANDF.DBF

Field Name	Type	Width	Dec	Description
KEY	Character	2		Landform, code
LFORM	Character	90		As above, but descriptive

Structure for database: KEYLUS.DBF

Field Name	Type	Width	Dec	Description
KEY	Character	3		Land use, code
LANDUS	Character	45		As above, but descriptive

Structure for database: KEYMETHOD.DBF

Field Name	Type	Width	Dec	Description
KEY	Character	4		Unique identifier code (such as "OC"+"01")
LABMETHOD	Character	175		Summary description of laboratory method

Structure for database: KEYMOTTL.DBF

Field Name	Type	Width	Dec	Description
KEY	Character	1		Soil mottling, code
MOTTLE	Character	20		As above, but descriptive

Structure for database: KEYPAREN.DBF

Field Name	Type	Width	Dec	Description
KEY	Character	3		Parent material, code
PARMAT	Character	50		As above, but descriptive

Structure for database: KEYPH74.DBF

Field Name	Type	Width	Dec	Description
KEY	Character	2		Code for FAO-Unesco (1974) phase
PHA_74	Character	15		As above, but descriptive

Structure for database: KEYPH90.DBF

Field Name	Type	Width	Dec	Description
KEY	Character	2		Code for FAO-Unesco (1990) phase
PHA_90	Character	15		As above, but descriptive

Structure for database: KEYPOSIT.DBF

Field Name	Type	Width	Dec	Description
KEY	Character	2		Site position, code
POSITI	Character	25		As above, but descriptive

Structure for database: KEYREGION.DBF

Field Name	Type	Width	Dec	Description
ISO	Character	2		Country ISO code
COUN	Character	20		Country name, descriptive
REGION	Character	2		Code for broad region (see KEYAREA.DBF)

Structure for database: KEYROOTS.DBF

Field Name	Type	Width	Dec	Description
KEY	Character	2		Roots abundance and size, code
ROOTS	Character	40		As above, but descriptive

Structure for database: KEYSTATU.DBF

Field Name	Type	Width	Dec	Description
KEY	Character	1		Profile description status, code
DESCR	Character	25		As above, but descriptive

Structure for database: KEYSTRUC.DBF

Field Name	Type	Width	Dec	Description
KEY	Character	2		Soil structure, code
STRUCT	Character	30		As above, but descriptive

Structure for database: KEYTEXT.DBF

Field Name	Type	Width	Dec	Description
KEY	Character	1		FAO-Unesco (1974) topsoil texture class, code
TOP_74	Character	15		As above, but descriptive

Structure for database: KEYVEGET.DBF

Field Name	Type	Width	Dec	Description
KEY	Character	2		Vegetation classification, code
VEGCOD	Character	30		As above, but descriptive

Structure for database: WIS_EXTE.DBF

Field Name	Type	Width	Dec	Description
FIELD_NAME	Character	10		Name of field
FIELD_TYPE	Character	1		Type of field (C, N, L)
FIELD_LEN	Numeric	3		Length of field
FIELD_DEC	Numeric	3		Decimal places
FIELD_IDX	Character	1		Index

Structure for database: TMPCOORD.DBF

Field Name	Type	Width	Dec	Description
NUMBER	Numeric	4		Sequential reference number
WISE_ID	Character	5		Unique profile number
X	Numeric	9	4	Longitude (decimal; + = N, - = S)
Y	Numeric	8	4	Latitude (decimal; - = W, + = E)
LONGI	Character	1		Longitude (E/W)
LONDEG	Character	3		Longitude, degrees
LONMIN	Character	2		Longitude, minutes
LONSEC	Character	2		Longitude, seconds
LATIT	Character	1		Latitude (N/S)
LATDEG	Character	2		Latitude, degrees
LATMIN	Character	2		Latitude, minutes
LATSEC	Character	2		Latitude, seconds
REMARKS	Character	5		Data entry source code

Appendix 3. WISE soil data entry sheet (Version 2.1)

WISE_ID: ¦__¦__¦__¦__¦__¦

WISE Soil Data Entry Sheet - Form A

FAO-Unesco soil unit (1974): ¦__¦__¦ Remarks:_____
Phase (1974): ¦__¦__¦ Remarks:_____
Topsoil texture class: ¦__¦
FAO-Unesco soil unit (1990): ¦__¦__¦__¦ Remarks:_____
Phase (1990): ¦__¦__¦ Remarks:_____
USDA subgroup: *Descriptive* _____
edition (year): ¦__¦__¦
Local soil classification: *Descriptive*

SOURCE_ID: ¦__¦__¦__¦__¦__¦__¦__¦__¦__¦__¦__¦
Ref. in source (no. and page) *Descriptive* _____

LAB_ID: ¦__¦__¦__¦__¦

Soil prof. description status: ¦__¦ Remarks:_____
Date (MM¦YY): ¦__¦__¦__¦__¦

Country: ¦__¦__¦ Remarks:_____
Location: *Descriptive*
Coordinates of soil profile:
LAT.: ¦__¦ N or S ¦__¦__¦ degrees ¦__¦__¦ minutes ¦__¦__¦ seconds
LON.: ¦__¦ E or W ¦__¦__¦__¦ degrees ¦__¦__¦ minutes ¦__¦__¦ seconds
Altitude: ¦__¦__¦__¦__¦ m
Landform: ¦__¦__¦ Remarks:_____
Landscape position: ¦__¦__¦ Remarks:_____
Aspect: ¦__¦__¦__¦
Slope gradient (%): ¦__¦__¦__¦
Drainage class: ¦__¦__¦ Remarks:_____
Groundwater depth (mean high): ¦__¦__¦__¦ cm
Groundwater depth (mean low): ¦__¦__¦__¦ cm
Soil depth to rock: ¦__¦__¦__¦ cm (estimate when necessary)
Parent material/lithology: ¦__¦__¦__¦ Remarks:_____
Remarks on p.m./lithology: *Descriptive*
Köppen climate classification: ¦__¦__¦__¦ Remarks:_____
Current land use (LU): ¦__¦__¦__¦ Remarks:_____
Main crop (for arable uses): ¦__¦__¦ Remarks:_____
Vegetation (VE): ¦__¦__¦ Remarks:_____
Remarks on LU or VE: *Descriptive*

No. of horizons for this profile: ¦__¦

Remarks on profile: _____

WISE_ID: ¦__¦__¦__¦__¦__¦__¦

WISE Soil Data Entry Sheet - Form B

Horizon		top (cm)	bottom (cm)	Org. C (%)	Tot. N (%)	Av. P (mg P_2O_5 kg^{-1})	pH			EC (dS m^{-1})	$CaCO_3$ (w%)	$CaSO_4$ (w%)	Exch. base cations (cmol(+) kg^{-1})				Exch. $Al^{3+}+H^+$ (cmol(+) kg^{-1})		CEC (cmol(+) kg^{-1})	ECEC (cmol(+) kg^{-1})	BS (%)
No.	Design.						H_2O	KCl	$CaCl_2$				Ca^{2+}	Mg^{2+}	K^+	Na^+	Acid.	Al^{3+}			
1																					
2																					
3																					
4																					
5																					
6																					

Hor	Matrix colour		Mottling	roots	Struct. type	Particle size distribution			Stone and gravel content (%v/v tot. soil)	Bulk dens. (g cm^{-3})	volume per cent water (% v/v) held at: (Indicate pF for Field Capacity and Permanent Wilting Point)						AWC (% v/v)	Hydr. cond. (cm hr^{-1})	
	Dry	Moist				sand size	silt size	clay size			pF=	pF=	pF=	pF=	pF=	pF=		Sat.	Unsat.
1																			
2																			
3																			
4																			
5																			
6																			

*> The Data Entry Sheets must be used in conjunction with the *WISE 2.1 Database Coding Protocols* which specify the compulsory coding and data format (see **WISE 2.1 User Manual, Appendix 5 & 7, and p. 36-52.**).
Missing numeric values must be entered as '-1', and missing alphanumeric values as '-'.

*> Use two sheets in cases where there are more than 6 horizons per pit (maximum accepted by WISE software is 9!)

SOURCE_ID: ¦___¦___¦___¦___¦___¦___¦___¦___¦___¦___¦

Source (Authors + initials): *Descriptive* _____
year: ¦___¦___¦ _____
title: *Descriptive* _____
_____
series/publisher/year: *Descriptive* _____
_____
_____

LAB_ID: ¦___¦___¦___¦___¦
Laboratory name: *Descriptive* _____
_____
_____

Coding system for analytical methods:		Description of analytical methods:
Organic Carbon:	OC¦___¦	
Total Nitrogen	TN¦___¦	
Available Phosphorus	TP¦___¦	
pH-H_2O	PH¦___¦	
pH-KCl	PK¦___¦	
pH-$CaCl_2$	PC¦___¦	
Electrical conductivity	EL¦___¦	
Free CaCO3	CA¦___¦	
Gypsum	GY¦___¦	
Exch. Ca, Mg, K, and Na:	EX¦___¦	
Exch. acidity and Aluminum:	EA¦___¦	
CEC soil	CS¦___¦	
ECEC soil	CE¦___¦	
Base saturation:	BS¦___¦	
Particle size distribution:	TE¦___¦	
Bulk density	BD¦___¦	
Moisture content	MC¦___¦	
Hydraulic conductivity	HC¦___¦	

Appendix 4. Example of WISE listing

ID022 W I S E S O I L P R O F I L E D A T A S H E E T 02/08/94

SOIL CLASSIFICATION:
FAO-Unesco Legend (1974): Gleyic Acrisol (Ag) Phase: -- (-) Topsoil texture: medium (M)
FAO-Unesco Legend (1988): Gleyic Alisol (ALg) Phase: -- (-)
USDA Soil Taxonomy (1987): Aquic Paleudult
Local Classification System: --

SOURCES:
Source_ID: AS4/65 Ref. page: Annex 2, p 43, profile 22.
Lab_ID: ID01 Descr. status: reference pedon (1)
Desc. (MM/YY): 06/88

SITE DATA:
Location: 25 km N.W. Balikpapan, East Kalimantan (Indonesia)
Coordinates: Lat.: S 00 deg. 42 min. 15 sec. Lon.: E 116 deg. 42 min. 45 sec.
Altitude: 115 m
Landform: valley floor (slope 0-8 %; relief int. < 100 m/km) (LV)
Position: intermediate part (IN)
Aspect: NE
Slope: 5 %
Drainage class: somewhat poorly drained (I)
Groundwater: -1 to -1 (cm)
Eff. soil depth > 150 (cm)
Parent material: sandstone, greywacke, arkose (SC2) (Remarks: Sandstone)
Köppen climate: Equatorial humid with no dry season (driest month > 60 mm; Tcm > 18C) (Af)
Land use (LU): selective felling (FN1)
Main crop: -- (-)
Vegetation (VE): evergreen forest (FE)
Remarks on LU/VE: Tropical rainforest - logged.

HORIZON DATA:

Horiz. Desig.	Depth (cm)	Org. C (%)	Tot. N (%)	Av. P	pH H_2O	pH KCl	pH CaCl2	ECx	CACO3 (%)	GYPS UM (%)	Exch. bases and acidity Ca	Mg	K	Na	Ac	Al	CEC (meq/100g)	ECEC (meq/100g)	BS (%)
Ah	0- 5	4.60	0.34	26.3	5.5	4.6	-1.0	-1.00	-1.0	-1.0	2.6	1.6	0.4	0.1	0.4	0.3	14.8	5.0	32
E	5- 38	0.70	0.09	4.5	4.4	3.6	-1.0	-1.00	-1.0	-1.0	0.4	0.3	0.2	0.1	6.8	6.4	11.4	7.4	8
Btg1	38- 68	0.37	0.07	3.4	4.6	3.7	-1.0	-1.00	-1.0	-1.0	0.4	0.3	0.2	0.1	6.4	5.8	11.4	6.8	8
Btg2	68-150	0.27	0.05	3.2	4.6	3.7	-1.0	-1.00	-1.0	-1.0	0.4	0.3	0.2	0.1	6.8	6.3	12.0	7.3	8

Horiz. Desig.	Colour Dry	Colour Moist	M	R	ST	Sand (%)	Silt (%)	Clay (%)	GR (%)	Bd	% vol/vol moisture held at a pF of 0.0	1.0	1.5	1.7	2.0	2.3	2.5	2.7	3.4	3.7	4.2	AWC (%v/v)	HCs (cm/hr)	HCu (cm/hr)
Ah	-	10YR3/3	C	MX	GR	34	41	25	-1	1.03	61	-1	-1	47	-1	-1	46	-1	-1	-1	7	39	-1.0	-1.0
E	-	10YR5/4	N	CX	AB	33	35	32	-1	1.40	47	-1	-1	41	-1	-1	40	-1	-1	-1	12	28	-1.0	-1.0
Btg1	-	10YR5/6	C	FX	AB	38	27	35	-1	1.47	46	-1	-1	41	-1	-1	40	-1	-1	-1	21	19	-1.0	-1.0
Btg2	-	10YR5/8	C	FM	AB	47	23	30	-1	1.50	44	-1	-1	39	-1	-1	39	-1	-1	-1	20	19	-1.0	-1.0

* Abbr.: Available P as mg P2O5/kg soil; ECx= electrical conductivity in dS/m; Ac= exchangeable (H + Al) in meq/100g; BS= base saturation as % of CEC; M= mottles; R= roots; ST= structure; GR = % > 2mm size; Bd= bulk density (g/cm3); HC= hydr. conduct., saturated (HCs) resp. unsaturated (HCu) in cm/hr; AWC = av. moisture in % v/v; -1 stands for missing numeric values and - for missing alphanumeric values.

REMARKS:
Acid; argic; mottling in surface and below 38cm depth.

REFERENCES:

(Cont. for ID020)

a) Source of profile data [AS4/65]:
Van Bremen, H., Iriansyah, M. and Andriesse, W. 1990. Detailed Soil Survey and Site Characteristics in 12 permanent plots in East Kalimantan. Tropenbos Foundation, Ede.

b) Laboratory name and methods [ID01]:
Centre for Soil Research, Bogor, Indonesia.

Analytical method	Code and description
Organic Carbon:	OC01: Method of Walkley-Black (Org. matter = Org. C x 1.72)
Total Nitrogen:	TN01: Method of Kjeldahl
Available P:	TP02: Method of Bray I (dilute HCl/NH4F)
pH-H_2O:	PH02: pH 1:2.5 soil/water solution
pH-KCl:	PK02: pH in 1:2.5 soil/ M KCl solution
pH-CaCl2:	PC--: Not measured
Electr. conductivity:	EL--: Not measured
CaCO3 content:	CA--: Not measured
Gypsum content:	GY--: Not measured
Exch. Ca, Mg, Na and K:	EX01: Various methods with no apparent differences in results
Exch. acidity and aluminum:	EA01: Exchangeable acidity (H+Al) in 1 M KCl
CEC soil:	CS01: CEC in 1M NH4OAc buffered at pH 7
Effective CEC:	CE01: Sum of exch. Ca, Mg, K and Na, plus exchangeable aluminium (in 1M KCl)
Base saturation:	BS01: Sum of bases as percentage of CEC (method specified above)
Particle size analysis:	TE01: Pipette method, with appropriate dispersion treatment (clay< 0.002 mm <silt< 0.05 mm <sand< 2mm)
Bulk density:	BD01: Core sampling (pF rings)
Soil moisture content:	MC01: sand/silt baths and porous plates, undisturbed samples (pF rings)
Hydraulic conductivity:	HC--: Not measured

Appendix 5. WISE 2.1 database coding protocols

Data Entry Form A —— SITE ATTRIBUTES

WISE_ID:
Unique reference number for the soil profile in question, which consists of the country's ISO-3166 code (see Appendix 7) followed by 3 numbers (Example: BR022).

FAO-Unesco classification (1974):
Classification of profile according the 1 or 2 letter codes used in the Key to Soil Units (FAO-Unesco, 1974 p. 43-53), for example E for a Rendzina and Ge for an Eutric Gleysol. A thorough classification is crucial, because the code provides the main "key" for linking the profile data to the spatial database.

FAO-Unesco phase (1974, p. 5-7):
The main phase, specified using the codes presented below:

Code	Description
ST	stony
PE	petric
MK	petrocalcic
LI	lithic
MY	petrogypsic
PH	phreatic
X	fragipan
MQ	duripan
Z	saline
SO	sodic
CE	cerrado
MS	petroferric

Topsoil texture class:
Textural class of the upper 30 cm of the mineral soil (FAO-Unesco, 1974 p. 4-5), specified according to the codes below:

Code	Description	Range in % clay and sand
C	coarse	< 15% clay* and > 65% sand
M	medium	< 35% clay and < 70% sand or ≤ 85% clay if clay ≥ 15%
F	fine	> 35% clay

* Clay, silt and sand-size minerals as used in FAO-ISRIC (1990).

FAO-Unesco classification (1990):
These are to be encoded using the 3-letter codes of the Key to Major Soil Groupings and Soil Units (FAO-Unesco, 1990 p. 74-88), for example, HSf for a Fibric Histosol and ACp for a Plinthic Acrisol.

FAO-Unesco phase (1990, p. 68):
The main phase, specified using the codes presented below:

Code	Description	Code	Description
AN	anthraquic	PF	petroferric
DU	duripan	PH	phreatic
FR	fragipan	PL	placic
GE	gelundic	SO	sodic
GI	gilgai	RU	rudic
IN	inundic	SA	salic
SK	skeletic	TK	takyric
YR	yermic	LI	Lithic

USDA Soil Taxonomy:
The classification is to be specified at the subgroup level, as a text string with a maximum length of 50 characters (see Soil Survey Staff, 1994; abbreviate if necessary).

Version of USDA Soil Taxonomy:
Two characters indicating the version/year of USDA Soil Taxonomy (e.g., 75, 87, 90, 94).

Local soil classification:
The classification according to the National System, up to a maximum of 50 characters (abbreviate if necessary).

SOURCE_ID:
The unique SOURCE_ID provides an alphanumeric reference to the source from which the soil profile data were derived, for example a soil monograph or digital database. The format is free, provided the total length is less than 10 characters (e.g., AF5/34.1 for a source from the ISRIC library).

Ref. in source:
The page and number of the profile in the source represented by SOURCE_ID.

LAB_ID:
This unique code provides an alphanumeric reference to the laboratory where the measurements have been made. The LAB_ID consists of the country's ISO-code, followed by two numbers (Example: IN02). Further information on the analytical procedures that have been used to

measure a certain attribute can be described on Form C, using the coding system held in the KEYMETHO.DBF database file.

Soil profile description status:
This code refers to the completeness of the soil descriptions and analytical data for the specified profile. The description status is determined after screening of the original profile description and the analytical data for possible inconsistencies. It may be seen as an indicator of the (likely) accuracy and reliability of the data shown. The following distinctions are made (modified after FAO-ISRIC, 1990).

Code	Description
1	ISIS or other Reference Pedon Description (additional information is provided under the heading SOURCE_ID).
2	Routine profile description in which no essential data are lacking from the description, sampling or analysis. The data give a good indication of the nature of the soil in the FAO-Unesco (1974) Legend.
3	Incomplete description in which certain relevant elements are missing from the description, an insufficient number of samples collected, or the reliability of the analytical data do not permit a complete characterization of the soil. The description is however useful for specific purposes and provides a satisfactory indication of the nature of the soil in the FAO-Unesco (1974) Legend.
4	Other descriptions in which essential elements are lacking from the description, preventing a satisfactory soil characterization and classification*.

* Generally not accepted for inclusion in WISE database unless soil unit is grossly under represented in global data set.

Date of description:
The date on which the profile was described, specified as month and year (MM/YY).

Country:
The country where the profile was described, specified according to the ISO-3166 codes (Example: NE for Niger, see Appendix 7).

Location:
Description of general location of profile (e.g., town, province), as text string of maximum 50 characters.

Coordinates of soil profile:
The full coordinates of the soil profile given as degrees, minutes and seconds latitude (N or S) and longitude (E or W). The coordinates can be derived from an appropriately detailed topographical map, and must be accurate to at least 25 km in view of their application in a ½° by ½° spatial database (A ½° by ½° degree grid corresponds approximately with 55 x 55 km at the equator). [**Note**: if only deg. min. is given in the database, this indicates the profile coordinates are approximative and derived from the Times Atlas (1993)].

Altitude:

The altitude of the soil profile relative to mean sea level, specified in meters. This information can be derived from a suitably detailed topographical map. (Note: 1 foot = 0.3048 m).

Landform:

This refers to the major landforms, which are described principally by their morphology and not by their genetic origin, or processes responsible for their shape. The first differentiating criterion is the dominant slope, followed by relief intensity as used in the SOTER manual (Van Engelen and Wen, 1993 p. 24-25):

Code	Landform	Description
L	Level land	Land with characteristic slopes of 0-8 %, and a relief intensity of less than 100 m per km.
S	Sloping land	Land with characteristic slopes of 8-30 % and a relief intensity of more than 50 m per slope unit. Areas with a limited relief intensity (< 50 m per slope unit) but slopes in excess of 8% are included, as are isolated mountains (relief intensity > 600 m) with slopes of 8-30 %.
T	Steep land	Land with characteristic slopes of over 30 % and a relief intensity of mostly more than 600 m per 2 km.
C	Land with composite landforms	Land made up of steep elements together with sloping or level land, or sloping land with level land, in which at least 20 % of the area consists of land with the lesser slope.

Codes for second level major landforms are used in the WISE database. The initial breakdown of major landforms is made according to the procedures of the SOTER Manual:

First level		Second level		Gradient	Relief intensity
L	Level land	LP	plain	0-8%	< 100 m/km
		LL	plateau	0-8%	< 100 m/km
		LD	depression	0-8%	< 100 m/km
		LF	low-gradient footslope	0-8%	< 100 m/km
		LV	valley floor	0-8%	< 100 m/km
S	Sloping land	SM	medium-gradient mountain	15-30%	> 600 m/2km
		SH	medium-gradient hills	8-30%	> 50 m/s.u.
		SE	medium-gradient escarpment zone	15-30%	< 600 m/2km
		SR	ridges	8-30%	> 50 m/s.u.
		SU	mountainous highland	8-30%	> 600 m/2km
		SP	dissected plain	8-30%	> 50 m/s.u.
T	Steep land	TM	high-gradient mountain	> 30%	> 600 m/2km
		TH	high-gradient hill	> 30%	< 600 m/2km
		TE	high-gradient escarpment zone	> 30%	> 600 m/2km
		TV	high gradient valleys	> 30%	variable
C	Land with composite	CV	valley	> 8%	variable
		CL	narrow plateau	> 8%	variable
		CD	major depression	> 8%	variable

Note: s.u. stands for slope unit. Where this is not clear from the gradient or relief intensity, the distinction between the various second level major landforms follows from the description.x

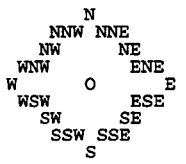
Landscape position:

The physiographic position of the site where the profile is located, specified according to the following system (FAO-ISRIC, 1990 p. 7).

Code	Description
Position in undulating to mountainous terrain	
CR	Crest/top
UP	Upper slope
MS	Middle slope
LS	Lower slope
BO	Bottom (flat)
Position in flat or almost flat terrain	
HI	Higher part
IN	Intermediate part
LO	Lower part
BO	Bottom (drainage line)

Aspect:

The aspect of the site coded using the following format: N, NNE, NE, ENE, E, ..., NNW. In case of flat or almost level land, the aspect is indicated as O (letter) .



Slope gradient:

The slope refers to the inclination of the land immediately surrounding the site. The measured or estimated slope angle is specified to the nearest per cent.

Drainage class:

The internal drainage class is coded according to the conventions of FAO-ISRIC (1990 p. 20). In WISE, intergrades of two neighbouring drainage classes may be indicated by a combination of two codes. For instance "VP", represents a soil with very poor to poor internal drainage.

Code	Description
V	very poorly drained
P	poorly drained
I	somewhat poorly (imperfectly) drained
M	moderately well drained
W	well drained
S	somewhat excessively drained
E	excessively drained

Depth of groundwater table:

The measured or estimated depth to the groundwater table, if present/known, indicating both the mean highest and mean lowest values during the year. Depths are specified in centimetres from the surface. If the water-table always occurs at a great depth, this can by entering similar values for the both the mean high and low values (e.g., 200 cm).

Soil depth to rock:

The average measured or estimated depth, in cm, from the surface to a layer that *physically* precludes the development of most roots. Limitations of a chemical nature, such as high levels of salt/alkali, are not considered under this heading as they are often of a transient nature, being prone to change with agricultural practices.

Parent material/lithology:

The main parent rock/material over which the soil has been formed is coded using the categories considered in the SOTER manual (Van Engelen and Wen, 1993 p. 29) and FAO-ISRIC (1990, p. 14). Additional codes, introduced in the context of the WISE project, are indicated by an asterisk in the following table.

Major class		Group		Type	
I	Igneous rocks	IA	acid igneous	IA1	granite
				IA2	grano-diorite
				IA3	quartz-diorite
				IA4	rhyolite
		II	intermediate igneous	II1	andesite, trachyte, phonolite
				II2	diorite-syenite
		IB	basic igneous	IB1	gabbro
				IB2	basalt
				IB3	dolerite
		IU	ultrabasic igneous	IU1	peridotite
				IU2	pyroxenite
				IU3	ilmenite, magnetite, ironstone, serpentine
M	Metamorphic rocks	MA	acid metamorphic	MA1	quartzite
				MA2	gneiss, migmatite
				MA3*	slate, phyllite
				MA4*	schists
		MB	basic metamorphic	MB1	slate, phyllite (pelitic rocks)
				MB2	schist
				MB3	gneiss rich in ferro-magnesian minerals
				MB4	metamorphic limestone (marble)
S	Sedimentary rocks	SC	clastic sediments	SC1	conglomerate, breccia
				SC2	sandstone, greywacke, arkose
				SC3	siltstone, mudstone, claystone
				SC4	shale
		SO	organic	SO1	limestone, other carbonate rocks
				SO2	marl and other mixtures
				SO3	coals, bitumen and related rocks

Major class		Group		Type	
		SE	evaporites	SE1 SE2	anhydrite, gypsum halite
U	Unconsolidated	UF	fluvial		
		UL	lacustrine		
		UM	marine		
		UC	colluvial		
		UE	eolian		
		UG	glacial		
		UP	pyroclastic		
		UO	organic		
		UX*	soft laterite and ferruginous materials		
		UY*	hardened laterite and ferruginous materials		

* Additional, tentative codes

Remarks on parent material/lithology:
When necessary, additional remarks about the parent material can be specified as text on the proforma, with a maximum length of 50 characters.

Köppen climate classification:
The climate at the site is classified according to the Köppen system which considers precipitation effectiveness for plant growth as the major classification factor, and uses the appropriate seasonal values of temperature and precipitation to determine the limits of climatic groupings.

The Köppen system figures a shorthand code of letters designating major climate groups, subgroups within these major groups, with further subdivisions to distinguish particular seasonal characteristics of temperature and precipitation (adapted from Strahler, 1969 p. 224; Times Atlas, 1993).

a) Major climate groups
The following major climate groups are considered:

Code	Classification and description
A	Tropical (rainy) climates: Average temperature of every month is above 18 °C. These climates have no winter season. Annual rainfall is large and exceeds annual evaporation.
B	Dry: Potential evaporation exceeds precipitation on the average throughout the year. No water surplus; hence no permanent streams originate in B climate zones.
C	Warm temperate (mesothermal) climates: Coldest month has an average temperature under 18 °C, but above -3 °C. The C climates thus have both a summer and a winter season.
D	Snow (microthermal) climates: Coldest month average temperature under -3 °C. Average temperature of the warmest month above 10 °C, that isotherm corresponding approximately with pole-ward limit of forest growth.
E	Ice climates: A polar climate type with average temperature in no month averaging over 10 °C. These climates have no true summer
H	Mountain/Highland climates

b) Subgroups

Subgroups within the major climate groups are designated by a second letter according to the following code:

Code	Description
S*	Steppe climate, a semiarid climate with about 380 to 760 mm of rainfall annually at low latitudes.
W	Desert climate. Arid climate. Most regions included have less than 250 mm of rainfall annually.
f	Moist. Adequate precipitation in all months. No dry season. This modifier is applied to major climate types A, C and D.
w	Dry season in winter of the respective hemisphere (low-sun season)
s	Dry season in summer of the respective hemisphere (high-sun season)
m	Rainforest climate despite a short dry season in monsoon type of precipitation cycle. Applies only to A climates.

* The letters S and W are applied only to the dry climates (i.e., BS and BW).

From combinations of the two letter groups, 12 distinct climates emerge as follows:

Code	Description
Af	Tropical rainforest (also Am a variant of Af)
Aw	Tropical savanna
BS	Steppe climate
BW	Desert climate
Cw	Temperate rainy (humid mesothermal) climate with dry winter
Cf	Temperate rainy (humid mesothermal) climate moist all seasons
Cs	Temperate rainy (humid mesothermal) climate with dry summer
Df	Cold snowy forests (humid microthermal) climate moist in all seasons
Dw	Cold snowy forest (humid microthermal) climate with dry winter
ET	Tundra climate
EF	Climates of perpetual frost (ice-caps)
H	Mountain/Highland climates (undifferentiated)

c) A third letter may be added to differentiate still more variations. Meanings are as follows:

Code	Description
a	With hot summer; warmest month over 22 °C (C and D climates)
b	With warm summer; warmest month below 22 °C (C and D climates)
c	With cool, short summer; fewer than four months over 10 °C (C and D climates)
d	With very cold winter; coldest months below - 38 °C (D climates only)
h	Dry-hot; mean annual temperature over 18 °C (B climates only)
k	Dry-cold; climates annual temperature under 18 °C (B climates only).

The unique, Köppen codes allowed in WISE are listed in file KEYKOPPE.DBF. For example BWk, which refers to a dry-cold, desert climate.

Current land use:

The current land use at the site is coded using the classes given by FAO-ISRIC (1990 p. 13), as below:

Code	Description
S	**Settlement Industry**
SR	Residential use
SI	Industrial use
ST	Transport
SC	Recreational use
SX	Excavations
A	**Crop Agriculture**
AA	Annual field cropping
AA1	Shifting cultivation
AA2	Fallow system cultivation
AA3	Ley system cultivation
AA4	Rainfed arable cultivation
AA5	Wet rice cultivation
AA6	Irrigated cultivation
AP	Perennial field cropping
AP1	Non-irrigated cultivation
AP2	Irrigated cultivation
AT	Tree and shrub cropping
AT1	Non-irrigated tree crop cultivation
AT2	Irrigated tree crop cultivation
AT3	Non-irrigated shrub crop cultivation
AT4	Irrigated shrub crop cultivation
H	**Animal Husbandry**
HE	Extensive grazing
HE1	Nomadism
HE2	Semi-nomadism
HE3	Ranching
HI	Intensive grazing
HI1	Animal Production
HI2	Dairying
F	**Forestry**
FN	Natural forest and woodland
FN1	Selective felling
FN2	Clear felling
FP	Plantation forestry
M	**Mixed farming**
MF	Agro-forestry
MP	Agro-pastoralism (cropping and livestock systems)
E	**Extraction and Collection**
EV	Exploitation of natural vegetation
EH	Hunting and fishing
P	**Nature Protection**
PN	Nature and game reserve
PN1	Reserves
PN2	Parks
PN3	Wildlife management
PD	Degradation control
PD1	Without interference
PD2	With interference
U	**Not Used and Not Managed**

Main corp (for arable uses):

The dominant crop is coded using the following list (adapted from FAO-ISRIC, 1990).

Code	Crop	Code	Crop	Code	Crop
BA	Barley	FR	Fruit trees	SO	Sorghum
BE	Beans	GR	Groundnut	SB	Soybean
CH	Cashew	MA	Maize	SC	Sugar cane
CA	Cassava	MI	Millet	SF	Sunflower
CO	Cocoa	OL	Oil/protein crops	SI	Sisal
CN	Condiments	OP	Oil palm	SP	Sweet potato
CC	Coconut	PE	Peas	SU	Sugar beet
CE	Cereals (unspecified)	PO	Potato	ST	Stimulants (unspecified)
CF	Coffee	RI	Rice	TC	Tuber crops (unspecified)
CT	Cotton	RB	Rice (flooded)	TE	Tea
CP	Cowpea	RT	Root crops (unspecified)	TB	Tobacco
FB	Fibre crops	RU	Rice (upland)	VE	Vegetables
FD	Fodder crops	RR	Rubber	WH	Wheat
				YA	Yams

Vegetation:

The natural vegetation at a site is described using the broad classes given by Unesco (1973), conforming with the coding conventions of SOTER:

Code	Description	Code	Description
F	**Closed Forest**	**D**	**Dwarf scrub**
FE	Evergreen forest	DE	Evergreen dwarf shrub
FS	Semi-deciduous forest	DS	Semi-deciduous dwarf shrub
FD	Deciduous forest	DD	Deciduous dwarf shrub
FX	Xeromorphic forest	DX	Xeromorphic dwarf shrub
		DT	Tundra
W	**Woodland**		
WE	Evergreen woodland	**H**	**Herbaceous**
WS	Semi-deciduous woodland	HT	Tall grassland
WD	Deciduous woodland	HM	Medium grassland
WX	Xeromorphic woodland	HS	Short grassland
		HF	Forb
S	**Scrub**	HE*	Hydromorphic vegetation
SE	Evergreen shrub		
SS	Semi-deciduous shrub		
SD	Deciduous shrub		
SX	Xeromorphic shrub		

* New code

Remarks on land use or vegetation:

Additional remarks, for instance about the crop rotation or felling history, can be entered as text with a maximum length of 100 characters.

Number of horizons:

This refers to the total number of horizons for which analytical data are available. The maximum number of horizons that can be accommodated per profile in the database is 9. However, physically, there is only place for 6 horizons on each data entry sheet.

Data Entry Form B —— HORIZON ATTRIBUTES

Horizon number:

This number is automatically created by the WISE input module. Data for the main horizons must be entered from the surface downwards. If more than 9 soil horizons are described in the original source, it may be necessary to 'regroup' this information to a smaller number. This should only be done for the subsoil, for example, by averaging numeric data for similar horizons such as a Btg1 and Btg2.

Horizon designation:
Whenever possible, the horizon designation should be given according to the terminology of FAO-ISRIC (1990).

Top (upper) depth:
Upper depth of horizon (cm). In case of a litter layer, use negative numbers (e.g., top depth of -20 cm to bottom depth of 0 cm). If the original depth of a horizon is given as e.g. 30/40 cm, the horizon depth is entered as (30+40)/2= 35 cm.

Bottom (lower) depth:
Lower depth of horizon (cm). If the lower depth of a profile is not indicated and analytical data are available for the last horizon, the assumption is that this horizon is 15 cm thick. For example, 75^{+} cm would imply a lower depth of 90 cm.

Organic carbon:
Organic carbon (% by weight) is specified with 2 decimal places. The code for the measurement method is to be specified separately on Form C. [**Note**: The codes for the analytical methods are held in KEYMETHO.DBF. The list of codes will grow as new analytical procedures are encountered during data collection. The most recent list can be printed with option <6> of the selection menu of WISE (see Section 4.5)].

Total Nitrogen:
Total nitrogen (% by weight) is rounded to 2 decimal places. The code for the measurement method is to be specified separately on Form C (see KEYMETHO.DBF).

Available P:
Available (extractable) P content, by weight, in mg P_2O_5 kg^{-1} soil. The code for the measurement method is to be specified separately on Form C (see KEYMETHO.DBF).

pH-H_2O:
Measured in water at a soil:water ratio which is to be specified in the 'analytical methods' key-file. One decimal is adequate.

pH-KCL:
Measured in 1 *M* KCl solution at the soil:solution ratio specified with the data. The code for the measurement method is to be specified separately on Form C (see KEYMETHO.DBF).

pH-$CaCl_2$:
Measured in 1 *M* $CaCl_2$ solution at the soil:solution ratio specified with the data. The code for the measurement method is to be specified separately on Form C (see KEYMETHO.DBF).

Electrical conductivity (EC):
Specify the EC for the horizon, indicating the soil:water ratio. The unit used is mS cm^{-1} or dS m^{-1}, originally mmho cm^{-1}, at 25 °C. The code for the measurement method is to be specified separately on Form C (see KEYMETHO.DBF).

$CaCO_3$:
Total $CaCO_3$ content (% by weight) is rounded off to the nearest integer. The code for the measurement method is to be specified separately on Form C (see KEYMETHO.DBF).

$CaSO_4$:
Total gypsum ($CaSO_4.2H_2O$) content, by weight %, is rounded off to the nearest integer. The code for the measurement method is to be specified separately on Form C (see KEYMETHO.DBF).

Exchangeable bases (Ca^{2+}, Mg^{2+}, K^+ and Na^+):
To be specified in cmol(+) kg^{-1}, using 1 decimal. The code for the measurement method is to be specified separately on Form C (see KEYMETHO.DBF).

Exchangeable acidity (Al^{3+} and H^+):
Obtained with a percolation of a soil sample with a 1 *M* KCl solution. Exchangeable acidity is measured by titration of the percolate, and exchangeable aluminum is determined separately in the percolate. Exchangeable acidity is specified in cmol(+) kg^{-1}, using 1 decimal. [**Note**: Values for exchangeable acidity, determined in 1 *M* KCl percolate, and extractable acidity, equilibrated with a $BaCl_2$-TEA buffer at pH 8.2, refer to different measurement methods!]

Exchangeable aluminum (Al^{3+}):
Exchangeable aluminum, in cmol(+) kg^{-1}, as determined separately in the percolate described above.

Cation exchange capacity (CEC):
CEC is given in cmol(+) kg^{-1}, using 1 decimal, according to the method specified on Form C.

Effective cation exchange capacity (ECEC):
ECEC is determined by summation of exchangeable bases and exchangeable acidity, and expressed in cmol(+) kg^{-1} using 1 decimal (i.e., ECEC= Exch[Ca^{2+} + Mg^{2+} + K^+ + Na^+] + Exch[H^+ + Al^{3+}]). [**Note**: The above definition is used in the WISE database to conform with the definition of the ISRIC laboratory (Van Reeuwijk, 1990, p. 11.1)].

Base saturation (BS):
Specified as nearest integer, and calculated as sum of exchangeable cation bases (Ca^{2+}, Mg^{2+}, K^+ and Na^+) divided by the CEC, measured with the specified CEC method, times 100%.

Matrix colour, dry:

The dry colour is specified using the Munsell Colour Charts. Colour codes have the general form: hue, value, chroma (e.g., 5YR5/3). All "complex" Munsell codes must be rounded off. For example, 10YR3.5/1 would become 10YR4/1.

Matrix colour, moist:

The moist colour is specified using the Munsell Colour Charts (e.g., 5YR3/2).

Mottling:

Mottling in a horizon is characterized by its abundance (after FAO-ISRIC, 1990 p. 42).

Code	Description	% of occurrence
N	none	positive statement
V	very few	0-2 %
F	few	2-5 %
C	common	5-15 %
M	many	15-40 %
A	abundant	> 40 %

Roots:

The presence of roots is described using a two character code (FAO-ISRIC, 1990 p. 63). The first letter of this code refers to the overall size of the roots, and the second letter to their abundance (e.g., MC stands for many coarse roots).

- Abundance of roots (expressed as number of roots per square decimeter):

Code	Quantity	Description
O	no roots	0
V	very few	1-20
F	few	20-50
C	common	50-200
M	Many	> 200

- Description of root sizes:

Code	Description	Diameter (mm)
V	very fine	< 0.5 mm
F	fine	0.5-2 mm
M	medium	2-5 mm
C	coarse	> 5 mm
X	all	very fine roots to coarse

Soil structure:

The type of soil structure is described according to the classes of FAO-ISRIC (1990 p. 51):

Code	Description of class	Code	Description
SG	single grain	AS	angular and subangular blocky
MA	massive	SA	subangular and angular blocky
CR	crumb	SN	nutty subangular blocky
GR	granular	AW	angular blocky wedge-shaped
PR	prismatic	AP	angular blocky parallelepiped
PS	subangular prismatic	PL	platy
CO	columnar	RS	rock structure
AB	angular blocky	SS	stratified structure
SB	subangular blocky		

Particle size distribution:

The particle size distribution refers to the fine earth fraction only (< 2 mm). The weight percentages of sand-, silt- and clay-size materials are given as integers. The analytical procedure and 'esd' or equivalent spherical diameter for the clay-, silt-, and sand-size fractions must be documented on Form C. For example: pipette method, full dispersion; esd: <2 μm, < 50 μm and < 2 mm.

Stone and gravel content:

Give a visual estimate of the percentage of large rock and mineral fragments with a diameter larger than 2 mm, rounded off to the nearest 5 per cent.

Bulk density:

Bulk density (oven dry sample) is given as g cm^{-3}, using two decimals.

Soil water retention:

The *volume* percentage of water (MC) in the soil horizon, at the considered pF-values (i.e., 0.0, 1.0, 1.5, 1.7, 2.0, 2.3, 2.5, 2.7, 4.3, 3.7 and 4.2; see WISEHOR.DBF p. 27), is to be specified as an integer. The moisture content is expressed on a percent by volume basis:

$$\text{MC (\% by volume v/v)} = \text{MC (\% by weight w/w)} \times \text{bulk density (kg m}^{-3}\text{)}$$

Selected pF-values or suctions, at which the soil water retention measurements were made, can be entered on the data entry sheet. (Indicate which pF values are considered to correspond with the Field Capacity and the Permanent Wilting Point so that the Available Water Capacity (AWC) can be calculated). [*Note*: pF is the $\log_{10}$ [head(cm of water)], i.e. a head of 100 cm of water corresponds with a pF of 2.0. (1 bar = 1017 cm of water = 100 kPa = 0.987 atmosphere)]

Hydraulic conductivity:
Hydraulic conductivity or permeability (cm hr^{-1}) varies with soil moisture conditions (pF values). Two values can be entered: (a) saturated hydraulic conductivity, and (b) non-saturated hydraulic conductivity.

Data Entry Form C —— SOURCE OF DATA

SOURCE_ID:
Unique code for source (e.g., soil monograph or digital database).

Source:
Authors and initials, as text string (For example: Van Waveren, E.J. and Bos, A.B.).

Year:
Year data during which the profile data were collected/described (For example: 1988).

Title:
Title of source in which data are published, as text string (For example: ISRIC Soil Information System).

Series/publisher/year:
Self-explanatory, as text string (For example: Technical Paper 15, International Soil Reference and Information Centre, Wageningen).

LAB_ID:
Unique reference code for laboratory where analyses for relevant profile(s) were made (e.g., FR01).

Laboratory name:
Name of laboratory where analyses were made, as text string.

Coding system for analytical methods:

- Organic Carbon (OC__)
- Total Nitrogen (TN__)
- Available Phosphorus (TP__)
- pH-water (PH__)
- pH-KCl (PK__)
- pH-$CaCl_2$ (PC__)
- Electrical conductivity (EL__)

- Free CaCO3 (CA__)
- Gypsum (GY__)
- Exch. Ca, Mg, K, and Na (EX__)
- Exch. acidity and Aluminum (EA__)
- CEC soil (CS__)
- ECEC soil (CE__)
- Base saturation (BS__)
- Particle size distribution (TE__)
- Bulk density (BD__)
- Moisture content (MC__)
- Hydraulic conductivity (HC__)

Note: All codes, plus a brief description of the corresponding analytical procedures, are documented in KEYMETHO.DBF, for example "OC01" stands for "Method of Walkley-Black". This information can be printed with option <6> of the TOOLS menu.

Appendix 6. WISE 2.1 quality controls

The current, mechanized controls for (possible) errors in the WISE database are:

(1) Flag all profiles for which the 2 leftmost characters of the WISE_ID differ from the country ISO-code.

(2) Flag all horizons whose upper depth is larger than its lower depth.

(3) Flag all horizons for which the sum of clay, sand and silt fractions differs from 100%.

(4) Flag all horizons for which the bulk density is either smaller than 0.5 or greater than 2.4 g cm^{-3}. (**Note** for items 4 to 7: all flagged values are potential errors only, and need not be wrong; for example, a low bulk density for an organic layer or a high bulk density for a compact subsoil).

(5) Flag all horizons for which the C/N ratio is either smaller than 4 or greater than 80. (**Note**: high (computed) values are prone to occur in soils with very low Total N contents, where analytical errors in determining total N contents can be large).

(6) Flag all horizons for which either the pH-H_2O, pH-KCl or pH-$CaCl_2$ is either less than 2.0 or greater than 11.0, corresponding with the normal pH-H_2O range for most soils (Soil Survey Staff, 1993 p. 192).

(7) Flag all horizons for which: (a) exchangeable aluminum exceeds 0 cmol(+)/kg, when pH-H_2O is greater than 6.0 and the organic carbon content is low (<1%); (b) the effective cation exchange capacity (ECEC) is not equal to the sum of exchangeable Ca^{2+}, Mg^{2+}, Na^{+} and K^{+} plus exchangeable acidity, keeping in mind the analytical procedures used and presence of eventual missing data (Definition of ECEC conform Van Reeuwijk, 1990 p. 11.1).

(8) Check whether all records associated to a given WISE_ID exist, and flag missing records.

(9) Check whether all alphanumeric codes in the various database files match the allowed definitions specified in the KEYNAME.DBF and KEYMETHO.DBF system database files, and flag all possible errors. (For example, a field for which AF was entered as the FAO-Unesco (1974) legend code for a Ferric Acrisol will be flagged as being incorrect because the only correct entry is: Af).

(10) Flag all laboratories for which the analytical procedures have not (yet) been entered.

Appendix 7. List of country ISO codes

AF	Afghanistan
AL	Albania
DZ	Algeria
AS	American Samoa
AD	Andorra
AO	Angola
AI	Anguilla
AQ	Antarctica
AG	Antigua and Barbuda
AR	Argentina
AM	Armenia
AW	Aruba
AU	Australia
AT	Austria
AZ	Azerbaijan
BS	Bahamas
BH	Bahrain
BD	Bangladesh
BB	Barbados
BE	Belgium
BZ	Belize
BJ	Benin
BT	Bhutan
BO	Bolivia
BW	Botswana
BV	Bouvet Island
BR	Brazil
IO	Brit. Ind. Ocean Territory
BN	Brunei Darussalam
BG	Bulgaria
BF	Burkina Faso
BU	Burma
BI	Burundi
BY	Belarus
CM	Cameroon
CA	Canada
CV	Cape Verde
KY	Cayman Islands
CF	Central African Republic
TD	Chad
CL	Chile
CN	China
CX	Christmas Island
CC	Cocos Islands
CO	Colombia
CG	Congo
CK	Cook Islands
CR	Costa Rica
HR	Croatia
CU	Cuba
CY	Cyprus
CS	Czechoslovakia
CI	Côte d'Ivoire
DK	Denmark
DJ	Djibouti
DM	Dominica
DO	Dominican Republic
TP	East Timor
EC	Ecuador
EG	Egypt
SV	El Salvador
GQ	Equatorial Guinea
EE	Estonia
ET	Ethiopia
FK	Falkland Islands
FO	Faroe (Islands)
FJ	Fiji
FI	Finland
FR	France
GF	French Guiana
PF	French Polynesia
TF	French Southern Territories
GA	Gabon
GM	Gambia
GE	Georgia
DE	Germany, Fed. Rep. of
GH	Ghana
GI	Gibraltar
GR	Greece
GL	Greenland
GD	Grenada
GP	Guadeloupe
GU	Guam
GT	Guatemala
GN	Guinea
GW	Guinea-Bissau
GY	Guyana
HT	Haiti
HM	Heard and McDonald Islands
HN	Honduras
HK	Hong Kong
HU	Hungary
IS	Iceland
IN	India
ID	Indonesia
IR	Iran, Islamic Republic of
IQ	Iraq
IE	Ireland
IL	Israel
IT	Italy
JM	Jamaica
JP	Japan
JO	Jordan
KH	Kampuchea, Democratic
KZ	Kazakhstan
KE	Kenya
KI	Kiribati
KR	Korea, Republic of
KP	Korea, Dem. Peopl. Rep.
KW	Kuwait
KG	Kyrgystan
LA	Lao, People's Democratic Rep.
LB	Lebanon
LS	Lesotho
LR	Liberia
LY	Libyan Arab Jamahiri
LI	Liechtenstein
LT	Lithuania
LU	Luxembourg
MO	Macau
MG	Madagascar
MW	Malawi
MY	Malaysia
MV	Maldives
ML	Mali
MT	Malta
MH	Marshall Islands
MQ	Martinique
MR	Mauritania
MU	Mauritius
MX	Mexico
FM	Micronesia
MD	Moldova, Republic of
MC	Monaco
MN	Mongolia
MS	Montserrat
MA	Morocco
MZ	Mozambique
NA	Namibia
NR	Nauru
NP	Nepal
NL	Netherlands
AN	Netherlands Antilles
NT	Neutral Zone
NC	New Caledonia
NZ	New Zealand
NI	Nicaragua
NE	Niger
NG	Nigeria
NU	Niue
NF	Norfolk Island
MP	Northern Mariana Islands
NO	Norway
OM	Oman
PK	Pakistan
PW	Palau
PA	Panama
PG	Papua New Guinea
PY	Paraguay
PE	Peru
PH	Philippines
PN	Pitcairn
PL	Poland
PT	Portugal
PR	Puerto Rico
QA	Qatar
RE	Reunion
RO	Romania
RU	Russian Federation
RW	Rwanda
LC	Saint Lucia
WS	Samoa
SM	San Marino
ST	Sao Tome and Principe
SA	Saudi Arabia
SN	Senegal
SC	Seychelles
SL	Sierra Leone
SG	Singapore
SB	Solomon Islands
SO	Somalia
ZA	South Africa
ES	Spain
LK	Sri Lanka
SH	St. Helena
KN	St. Kitts and Nevis
PM	St. Pierre and Miquelon
VC	St. Vincent and the Grenadines
SD	Sudan
SR	Suriname
SJ	Svalbard and Jan Mayen
SZ	Swaziland
SE	Sweden
CH	Switzerland
SY	Syrian Arab Republic
TW	Taiwan, Province China
TJ	Tajikistan
TZ	Tanzania, United Rep. of
TH	Thailand
TG	Togo
TK	Tokelau
TO	Tonga
TT	Trinidad and Tobago
TN	Tunisia
TR	Turkey
TM	Turkmenistan
TC	Turks and Caicos Islands
TV	Tuvalu
SU	USSR
UG	Uganda
UA	Ukraine
AE	United Arab Emirates
GB	United Kingdom
US	United States
UY	Uruguay
UM	US. Minor Outlying Islands
UZ	Uzbekistan
VU	Vanuatu
VA	Vatican City State
VE	Venezuela
VN	Viet Nam
VG	Virgin Islands (U.K.)
VI	Virgin Islands (U.S.)
WF	Wallis and Futuna Islands
EH	Western Sahara
YE	Yemen
YD	Yemen, Democratic
YU	Yugoslavia
ZR	Zaire
ZM	Zambia
ZW	Zimbabwe

Glossary

The glossary was compiled from the following sources:

[1] ORNL, 1990. *Glossary: Carbon Dioxide and Climate.* Environmental Sciences Division Publication No. 3532, The Carbon Dioxide Information Analysis Centre, Oak Ridge National Laboratory.

[2] SSSA, 1979. *Glossary of Soil Science Terms.* Soil Science Society of America, Madison, Wisconsin.

[3] Burrough, P. A., 1986. *Principles of Geographical Information Systems for Land Resources Assessment.* Monographs on Soil and Land Resources Survey No. 12, Clarendon Press, Oxford. p. 177-183.

[4] Reinhardt, R. D., 1992. *Geographic Information Systems (GIS) - A Global Perspective.* Global Environmental Change Report, Cutter Information Corporation, Arlington.

[5] IDRISI, 1993. *IDRISI User Guide (Version 4.0)*, Clark University, Worcester.

Attribute: Non-graphic information associated with a point, line, or area element in a GIS [3].

Attribute values file: A non-spatial file in which the attributes of numbered regions (or features) are listed. In raster-GIS, attribute values files are paired with a geographic definition file which records, as an image, the locations of each region. From these two files, a normal raster image can be constructed [5].

Classification, soil: The systematic arrangement of soils into groups or categories on the basis of their characteristics. Broad groupings are made on the basis of general characteristics and subdivisions on the basis of more detailed differences in specific properties [2].

Compiler: A computer program that can translate instructions of a high-level language, such as dBASE, into the binary format of a particular computer [5].

Database: A collection of interrelated information, usually stored on some form of mass-storage system such as magnetic tape or disk. A GIS database includes data about the position and the attributes of geographical features that have been coded as points, lines, areas, pixels or grid cells [3].

Database management system (DBMS): A set of computer programs for organizing the information in a database. Typically, a DBMS contains routines for data input, verification, storage, retrieval, and combination [3].

Data set: A collection of logically related items arranged in a prescribed manner [4].

Documentation file: An ASCII file that accompanies and supplies important information about every raster-GIS image [5].

Field: A related set of characters that supply some element of information. In a DBMS, a field is one piece of information within a record, such as land use or soil pH [5].

File: A related set of data records, stored under one name on a computer disk or tape [5].

Greenhouse effect: A popular term used to describe the roles of water vapour, carbon dioxide, and other trace gases in keeping the Earth's surface warmer than it would be otherwise. The 'radiatively-active' gases are relatively transparent to incoming shortwave radiation, but are relatively opaque to outgoing

long-wave radiation. The latter radiation, which would otherwise escape to space, is trapped by these gases within the lower levels of the atmosphere. The subsequent re-radiation of some of the energy back to the surface maintains surface temperatures higher that they would be if the gases were absent. There is concern that increasing concentrations of greenhouse gases, including carbon dioxide, methane and manmade chlorofluorocarbons, may enhance the greenhouse effect and cause global warming [1].

Grid: A cellular-based data structure composed of pixels or cells of equal size arranged in columns and rows [4].

Grid map: A map in which the information is carried in the form of grid cells [5].

Hierarchical database structure: A method of arranging computer files or other information so that the units of data storage are connected in a hierarchically defined pathway. From above to below, relations are one-to-many [3].

Map scale: An expression of a unit of measure on a map and the equivalent measure on the Earth's surface, often expressed as a representative fraction of distance [4]. For instance, 1:5,000,000, or one unit (e.g. cm) on the map equals 5,000,000 units on the Earth's surface.

Modelling: An investigative technique that uses a mathematical or physical representation of a system or theory that counts for all or some of its known properties. Models are often used to test the effects of changes in system components on the overall performance of the system [1].

Module: The term module is used to refer to each of the separate programs in the WISE 2.1 system.

Profile, soil: A vertical section of the soil through all its horizons and extending into the parent material [2].

Record: A related set of data fields. Typically a record consists of all the information pertinent to a single entity within a database file [5].

Relational database: A method of structuring data in the form of sets of records or 'tuples' so that relations between different entities can be used for data access and information [3].

Soil: (i) The unconsolidated mineral material on the immediate surface of the earth that serves as a natural medium for the growth of land plants. (ii) The unconsolidated mineral matter on the surface of the earth that has been subjected to and influenced by genetic and environmental factors of: parent material, climate (including moisture and temperature effects), macro- and microorganisms, and topography, all acting over a period of time and producing a product — soil — that differs from the material from which it is derived in many physical, chemical, biological and morphological properties, and characteristics [2].

Spatial data: Information concerning location, shape and relationships among geographic features, usually stored as coordinates within a topological function [4].

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