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A HOMOGENIZED SOIL PROFILE DATA SET FOR GLOBAL AND REGIONAL ENVIRONMENTAL RESEARCH

(WISE, version 1.1)

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INTERNATIONAL SOIL REFERENCE AND INFORMATION CENTRE

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ABSTRACT

A homogenized data set holding 4382 soil profiles is presented, corresponding with version 1.1 of the WISE Global Soil Profile Database. The geo-referenced profiles, which originate from 123 countries worldwide, are classified both in the original Legend (1974) and Revised Legend (1988) of FAO-Unesco. The data set further includes information on site data, soil chemical and physical data for 21667 horizons, the source of data, and methods used for determining analytical data. The digital data set is in Access® format.

An important objective of the WISE database is to provide scientists and modellers with a homogenized set of primary soil data relevant for a wide range of environmental studies, including agro-ecological zoning, assessments of crop production, soil vulnerability to pollution, and soil gaseous emission potentials. Results of such derived interpretations can be linked to the digital version of the FAO-Unesco Soil Map of the World as well as to more recent soil and terrain (SOTER) databases through the soil legend code.

Keywords: soil profiles; WISE database; soil chemical data; soil physical data

1 INTRODUCTION

The compilation and processing of large-scale data sets of the world's environmental resources, using well-documented procedures and standards, are crucial for many global modelling activities. Staff at ISRIC has developed a uniform methodology for a global soil profile database in the framework of WISE, a project entitled "World Inventory of Soil Emission Potentials" (Batjes and Bridges, 1994). During this project a wide selection of profiles from all regions of the world have been screened for completeness and incorporated into the WISE data handling system. The profiles were compiled from 5 main sources: (a) ISIS 4.0, the ISRIC Soil Information System (Van Waveren and Bos, 1988); (b) SDB, the FAO Soil Database System (FAO, 1989); (c) a digital soil data set compiled by the Natural Resources Conservation Service (NRCS, formerly SCS) of the United States of America; (d) profiles obtained from an international data gathering activity coordinated by WISE project staff, in which national soil survey organisations were asked to supply descriptions and analyses of profiles representative of the units of the Soil Map of the World (FAO-Unesco, 1974) present in their countries; and, (e) suitable profiles gathered from survey monographs held in the ISRIC library. Special attention was given to the systematic compilation of data and recording of the laboratory methods by which the analytical results were obtained (Batjes, 1995b).

The central aim of the WISE database is to provide a basic set of uniform soil data for a wide range of global and regional studies, including assessments of crop production, soil vulnerability to pollution, and soil gaseous emission potentials (Batjes, 1997; Batjes *et al.*, 1995). To this avail, all profiles have been classified according to both the original and revised Legend of the Soil Map of the World (FAO, 1988; FAO-Unesco, 1974). Thereby, derived interpretations can be linked either to the spatial data shown on the digital Soil Map of the World (FAO, 1995), which uses the original Legend, and more recent soil and terrain data (SOTER) bases that use the revised Legend (e.g., FAO and IIASA, 1999; FAO *et al.*, 1998).

This report describes a uniform set of 4382 soil profiles, corresponding with version 1.1 of the WISE Global Soil Profile Database. The current data set includes the selection of 1,125 profiles, commonly known as the "international" profiles of the WISE database (Batjes, 1995a), which provided the primary data for the activities of the Global Soils Data Task Group of IGBP-DIS (2000).

The report consists of 5 Sections and 6 Appendices. Section 2 describes the structure of the various data tables (2.1), criteria for accepting profiles in WISE (2.2), and the main sources of profile data used (2.3). Section 3 discusses the contents of the database, both in terms of geographic (3.1) and taxonomic coverage (3.2), and summarizes the available data (3.3). The applicability and limitations of the current data are discussed in Section 4, while concluding remarks are made in Section 5.

The structure of the various tables is described in Appendix 1 and the coding protocols in Appendix 2. The number of profiles available for each soil unit classified according to the original Legend is listed in Appendix 3, while Appendix 4 shows the classification according to the Revised Legend. Appendix 5 lists the number of profiles available for each country and their description status, which gives an indication of the inferred reliability of the data. Appendix 6 shows the percentage of records that is filled for each attribute in the site and soil horizon tables.

2 DESCRIPTION OF DATA BASE

2.1 Data structure

WISE 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 which document, for example, the source of data and laboratory where the analyses have been carried out. The structure of the individual tables is presented in Appendix 1; there are 6 tables with soil data proper (i.e., WISExxxx) and 21 tables that explain the various codes (i.e., KEYxxxx). The logical relationships between these 27 tables are documented in the Access® database that accompanies this report (i.e., *WISE1.1 – Global Soil Profile Data Set.mdb*).

2.2 Criteria for accepting soil profile data

Strict criteria have been defined for accepting profiles into WISE: (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. Upon their entry into WISE, all data have been screened using an automated facility. Further details may be found elsewhere (Batjes, 1995b).

2.3 Data sources

The data set holds profiles released by ISRIC, FAO, USDA-NRCS, and profiles collated at ISRIC from national soil survey reports and other publications (Table 1). The full complement of data selected for inclusion in the database is listed in Table 2.

Table 1. Source of profile data

Source of data	Number of profiles
ISIS 4.0 (ISRIC)	210
NRCS-USDA	665
SDB (FAO)	1379
Other sources[¶]	2128
Total	4382

[¶] Data collated at ISRIC from a wide range of national contributions and soil survey monographs.

Profiles originating from ISIS 4.0 have been compiled specifically to be representative of the map units of the Soil Map of the World, with special emphasis on the tropics. They have all been described using the *Guidelines for Soil Description* (FAO/ISRIC, 1990) and analysed in a uniform manner in the ISRIC laboratory (Van Reeuwijk, 1993). The profiles derived from the NRCS set originate from the USA and 41 other countries. Soil descriptions in this data set follow the methodology of the *Soil Survey Manual* (Soil Survey Staff, 1983), and the analyses have been made at the Lincoln laboratory (Soil Survey Staff, 1996). These analytical methods compare well with those used at ISRIC (Kimble and Van Reeuwijk, *pers. comm.*, 1994). Profiles originating from the SDB database collated by FAO (1989) have been described using the same guidelines that ISRIC used. However, chemical and physical analyses of the

Table 2. List of attribute data held in the WISE soil profile database.

Site Data	Horizon Data
WISE_ID (unique identifier of profile)	WISE_ID + horizon_NO (unique reference
Soil classification and source:	number for horizon within a profile
FAO-Unesco classification (1974 Legend)	
phase (1974)	*General attributes:*
topsoil texture class (1974)	horizon designation
FAO-Unesco classification (1988 Legend)	depth, top
phase (1988)	depth, bottom
	matrix colour (dry and moist)
USDA subgroup level classification	mottling
edition (year) of Soil Taxonomy	presence of roots
National classification	
source of data	*Chemical attributes:**
name of laboratory where analyses were made	organic carbon
	total N
soil profile description status	available P
date of description	pH-H_2O
	pH-KCl
Location:	pH-$CaCl_2$
country	electrical conductivity (EC)
location of soil profile, descriptive	free $CaCO_3$
latitude (deg/min/sec)	$CaSO_4$
longitude (deg/min/sec)	exchangeable Ca^{2+}
altitude	exchangeable Mg^{2+}
	exchangeable Na^{+}
General site data:	exchangeable K^{+}
major landform	exchangeable Al^{3+} + H^{+} (exchangeable acidity)
landscape position	
aspect	exchangeable Al^{3+} (exchangeable aluminium)
slope	
drainage class	cation exchange capacity (CEC)
groundwater depth	effective CEC (at field pH)
effective soil depth	base saturation (as percent of CEC)
parent material	
Köppen climate classification	*Physical attributes:**
land use	structure type
natural vegetation	particle size distribution:
	weight % sand
	weight % silt
	weight % clay
	stone and gravel content
	bulk density
	volume per cent water held at specified suctions
	hydraulic conductivity at specified suctions

* Analytical methods are specified in a separate key-attribute look-up table (KEYMETHO, see Appendix 2, sub C).

corresponding soil samples have taken place in different laboratories, using the methods in use in the countries from which the profiles were obtained (FAO-Unesco, 1974-1981). Therefore, it is not always possible to compare all data held in SDB directly with those analysed at NRCS and ISRIC (Vogel, 1994). The same limitation often applies to soil data that have been derived from a range of national soil survey reports, a feature that is commonly encountered during compilations of transnational soil databases (e.g., CEC, 1985; FAO and ISRIC, 2000; FAO-Unesco, 1974-1981; ISSS, 1983; Madsen and Jones, 1998). Thus serious problems are prone to arise with the comparison of analytical data originating from disparate datasets (Nettleton *et al.*, 1996; Pleijsier, 1989; Van Reeuwijk and Houba, 1998).

3 DATABASE CONTENTS

3.1 Geographic distribution

Version 1.1 of WISE holds data for 4382 profiles, which originate from 123 countries. Most profiles come from Africa (41 %), followed by South America and the Caribbean (14 %); South East Asia (13 %); South West and Northern Asia (12 %); Europe (12 %); North America (6 %); and Australia and the Pacific Islands (3%). As shown by Figure 1, there still are few profiles for some regions of the world, notably the Newly Independent States (former USSR), the Northern Territories of Canada, and Australia.

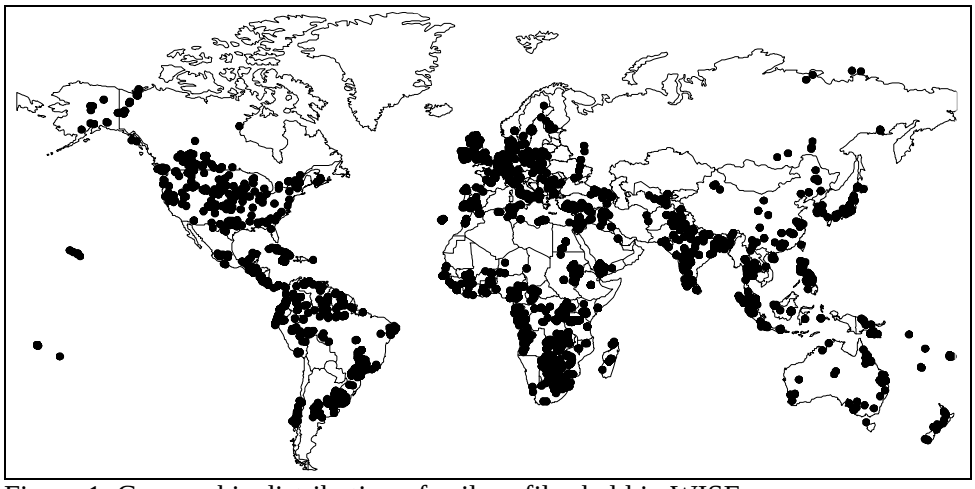

Figure 1. Geographic distribution of soil profiles held in WISE.

The profile description status by broad geographic region is shown in Table 3. It may be seen as a coarse measure for the inferred quality of the data held in WISE. Essentially, the profile description status is determined by the confidence the data compilers had in the various sources of soil profiles that are globally available and accessible (see Appendix 2, sub A under STATUS).

About 21 per cent of the profile descriptions in WISE 1.1 are for “reference pedons” that originate from ISRIC and NRCS. About 42 per cent corresponds with so-called “routine profile descriptions” in which no essential data are lacking from the description, sampling or analysis. Category 3, amounting to 35 per cent of the total, corresponds with profiles whose descriptions are useful for specific purposes and provide a satisfactory indication of the nature of the soils in the FAO-Unesco (1974)

Legend. The fourth and last category (2%) corresponds with incomplete profile descriptions: such profiles are only accepted for inclusion in case of under-represented soil units for which specific measured attributes have been found to be scarce.

Table 3. Summary of number of soil profiles by broad geographic area and their description status.

Region	Profile description status[¶]				Total
	1	2	3	4	
Africa	222	1165	394	18	1799
Australia and Pacific Islands	28	19	71	4	122
China, India, Indonesia & Philippines	260	96	196	1	553
Europe	32	112	357	20	521
North America	154	57	54	1	266
South America and Caribbean	200	84	315	0	599
SW and Northern Asia (Siberia)	44	298	151	29	522
Total	940	1831	1538	73	4382

[¶] The code under "soil profile description status" refers to the apparent completeness of the soil profile descriptions and accompanying analytical data for the specified profile in the original source. The status is highest for "1" and lowest for "4" (see Appendix 2, sub A). See Appendix 5 for underlying data presented on a country basis.

3.2 Taxonomic distribution

WISE was specially developed to characterize the soil units of the Soil Map of the World, which uses the original Legend (FAO-Unesco, 1974). This Legend comprises 26 major soil groupings, subdivided at a second level into 106 soil units. The Revised Legend, however, comprises 28 major soil groupings and 153 subdivisions at soil unit level (FAO, 1988). As a result, more units of the Revised Legend are under-represented in WISE 1.1 than for the original Legend. Arbitrarily, the latter is defined here as having less than 10 profiles per soil unit.

Under-represented soil units in the original Legend include (Appendix 3): gleyic Chernozems (Gc); dystric, eutric and gleyic Podzoluvisols (De, Dd and Dg); plinthic and gelic Gleysols (Gp and Gx); Lithosols (I); luvic Kastanozems (Kl); gleyic and orthic Greyzems (Mg and Mo); gelic Histosols (Ox); ferric Podzols (Pf); gelic Regosols (Rx); mollic Solonetz (Sm); Rankers (R); humic and gelic Planosols (Wh and Wx); gypsic Xerosols (Xy); takyric Yermosols (Yt); and takyric Solonchaks (Zt).

Appendix 4 shows there are less than 10 observations for the following soil units of the Revised Legend: stagnic and plinthic Alisols (ALj and ALp); gleyic and gelic Andosols (ANg and ANi); gleyic and glossic Chernozems (CHg and CHw); aric, fimic and urbic Anthrosols (ATa, ATf and ATu); umbric and salic Fluvisols (FLs and FLu); plinthic Ferralsols (FRp); andic and thionic Gleysols (GLa and GLt); gleyic and haplic Greyzems (GRg and GRh); haplic, luvic and petric Gypsisols (GYh, GYl and GYp); gelic, folic and thionic Histosols (HSi, HSl and HSt); haplic, luvic and gypsic Kastanozems (KSh, KSl and KSy); gelic, mollic, lithic and umbric Leptosols (LPi, LPm, LPq and LPu); albic, gleyic, stagnic and plinthic Lixisols (LXa, LXg, LXj and LXp); all Podzoluvisol units (PDd, PDe, PDg, PDi and PDj); gelic and umbric Planosols (PLi and PLu); all Plinthosol units (PTa, PTd, PTe and PTu); ferric and

gelic Podzols (PZf and PZi); gelic, umbric and gypsic Regosols (RGi, RGu, and RGy); gelic and mollic Solonchaks (SCi and SCm); stagnic, mollic and gypsic Solonetz (SNj, SNm and SNy); and, dystric and gypsic Vertisols (VRd and VRy).

3.3 Summary of available data

The percentage of records that are filled with data for each field in tables WISESITE and WISEHOR is shown in Appendix 6. Soil physical attributes, such as soil moisture retention, bulk density and hydraulic conductivity, in particular are under-represented. This is so because these data are seldom collected during routine soil surveys, which provided the bulk of the profile descriptions for WISE.

4 APPLICABILITY AND LIMITATIONS OF DATA SET

The WISE data set contains soil characterizations and profile descriptions from 123 countries, presented in a uniform and controlled format. Criteria applied for the selection of soil profiles for inclusion in WISE have been discussed elsewhere (Batjes, 1995b).

Several soil units and regions are still under-represented in WISE 1.1; inclusion of additional profiles would be useful in further releases of the database.

Complete data sets are not always available for each sample or horizon for the soil attributes selected, and some site data may be missing. Consequently, the number of samples for each of these attributes will vary between soil units and with the depth range considered. In addition, the profiles have been analysed according to a range of analytical methods, often necessitating a screening by analytical procedures (see Batjes *et al.*, 1997).

Initial printouts obtained from the NRCS, SDB and ISIS data sets after transfer into WISE contained occasionally distorted soil horizon designations and duplicate horizon depths. This was partly associated with the fact that soil horizon and sample depths were not always defined unambiguously in the source data files. In so far as possible, these "data issues" have been remedied manually with reference to the original data sets.

Profile databases such as those developed at ISRIC (ISIS), FAO (SDB), and NRCS are working databases, implying that their contents can be updated as current knowledge increases. As a result, data for some profiles held in the digital data files differed from those published elsewhere for the same profiles. This was the case for some NRCS profiles from Brazil, Korea and Zambia (Spaargaren and Batjes, 1995), some SDB profiles from Botswana (FAO, 1990), and some ISIS profiles. The various attribute values thus reflect the current state of the source materials at the time they were incorporated in WISE. In most cases, data sets were taken at "face value" in view of the fact that they have been officially submitted for inclusion in the WISE database. Nonetheless, all transferred data sets have been submitted to WISE's computerized and rigorous data-checking scheme leading to rejection of numerous profiles. Special attention was paid to the classification according the FAO legends (version 1974 and 1988).

Differences in versions of USDA Soil Taxonomy used in the NRCS source files formed a difficulty when classifying profiles according to the FAO Legend (Spaargaren and Batjes, 1995). Similarly, different horizon designations are used in various national data sets.

In case of missing latitude-longitude references, approximate coordinates have been derived from the Times Atlas, using general information on location (e.g., Machakos, Kenya).

5 CONCLUSIONS

Being a compilation of available data, WISE 1.1 inevitably includes some gaps. These can be of a taxonomic, geographic, and soil analytical nature. For example, there are relatively few soil physical data because they are seldom measured on a routine basis during most soil surveys. Further, a range of soil analytical methods has been used. Nonetheless, adroit use of the database will permit a wide range of agricultural and environmental applications.

The Global Soil Profile Data Set is particularly meant for those scientists who wish to use primary soil data, presented in a uniform and homogenized format, in studies at a global and regional scale. Examples of applications that use primary or secondary soil data derived from version 1.0 of WISE (Batjes, 1996; Batjes, 1997), include global modelling of environmental change (Alcamo *et al.*, 1998; Bouwman and Van Vuuren, 1999; Cindery *et al.*, 1998; Ganzenveld *et al.*, 1998; Hootsmans *et al.*, 2001), analyses of global ecosystems (Wood *et al.*, 2000), up-scaling and down-scaling of greenhouse gas emissions (Denier van der Gon *et al.*, 2000), and crop simulation and agro-ecological zoning (Fischer *et al.*, 2000; Fischer *et al.*, 2001; Knox *et al.*, 2000). Clearly, many other applications of the soil data set can be envisaged in the context of global environmental change.

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Data in WISE 1.1 have been obtained from various organisations and experts, including: (a) the Natural Resources Conservation Service (USDA-NRCS, formerly SCS) at Lincoln, and Dr. J.M. Kimble in particular; (b) FAO's Land and Water Development Division (AGL), notably Dr. F.O. Nachtergaele; (c) ISRIC, particularly Ir. J.H. Kauffman, concerning the ISIS 4.0 data; and, (d) many national organizations and individual experts who provided profile data from all regions of the world. The contribution of Professor E.M. Bridges in the WISE project activities (1991-1994) is particularly acknowledged.

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APPENDICES

Appendix 1. Structure and attributes of WISE 1.1 tables

A) Main data tables

Structure for table WISESITE

Field Name	Type	Width	Dec	Description
WISE_ID	Char.	5		Unique profile reference number
LAB_ID	Char.	4		Unique laboratory reference number
SOURCE_ID	Char.	10		Unique reference number for source of profile data
REFPAG	Char.	50		Profile/page reference in source
HORNUM	Num.	1	0	Number of horizons described for pit
FAO74	Char.	2		FAO-Unesco (1974), classification as code
PHA74	Char.	2		As above, but code for (main) phase
TOP74	Char.	1		As above, but code for topsoil textural class
FAO88	Char.	3		FAO-Unesco (1988), classification as code
PHA88	Char.	2		As above, but code for (main) phase
USCL	Char.	50		USDA Soil Taxonomy classification, descriptive
USYR	Char.	2		Year (version of Soil Taxonomy, e.g., 75, 94)
LOCAL	Char.	50		Local classification, descriptive
DESCR	Char.	1		Profile description status, code
DATE	Char.	5		Date profile was first described
ISO	Char.	2		ISO code for country of origin
LOCAT	Char.	50		Location of profile, descriptive
LATIT	Char.	1		Latitude of profile (N/S)
LATDEG	Char.	2		" in degrees
LATMIN	Char.	2		" in minutes
LATSEC	Char.	2		" in seconds
LONGI	Char.	1		Longitude of profile (E/W)
LONDEG	Char.	3		" in degrees
LONMIN	Char.	2		" in minutes
LONSEC	Char.	2		" in seconds
ALTIT	Num.	4		Elevation (m)
LFORM	Char.	2		Landform, code
POSIT	Char.	2		Position, code
ASPECT	Char.	3		Aspect, code
SLOPE	Char.	3		Slope at profile site (%)
DRAIN	Char.	2		Drainage condition, code
GRWHI	Num.	4	0	Average, highest groundwater level (cm)
GRWLO	Num.	4	0	Average, lowest groundwater level (cm)
SOLDEP	Num.	4	0	Av. soil depth to a physically limiting layer (cm)
PARMAT	Char.	3		Parent material, code
PARREM	Char.	50		Remarks on parent material, descriptive
KOPPEN	Char.	3		Köppen climate classification, code
LANDUS	Char.	3		Land use, code
CROPS	Char.	2		Crops, code
VEGCOD	Char.	2		Vegetation, code
VEGREM	Char.	100		Remarks on either land use or vegetation, descriptive
ORIGIN	Char.	5		Main source of data (see also SOURCE_ID)

See Appendix 2 for coding conventions.

Structure for table WISEHOR

Field Name	Type	Width	Dec	Description
WISE_ID	Char.	5		Unique soil profile number
HORIZ	Char.	1		Unique horizon number (in combination with WISE_ID)
DESIG	Char.	8		Horizon designation, coded acc. to local system
TOPDEP	Num.	3	0	Upper depth of horizon (cm)
BOTDEP	Num.	3	0	Lower depth of horizon (cm)
DCOLOR	Char.	8		Dry matrix colour, Munsell code
MCOLOR	Char.	8		Moist matrix colour, Munsell code
MOTTLE	Char.	1		Mottling, code
ROOTS	Char.	2		Roots abundance/size, code
ORGC	Num.	5	2	Org. carbon (%)
TOTN	Num.	5	2	Total Nitrogen (%)
PTOT	Num.	5	1	*Available* phosphorus (mg P_2O_5 kg^{-1})
CACO3	Num.	4	1	Calcium carbonate content (%)
GYPSUM	Num.	4	1	Gypsum content (%)
PHH2O	Num.	4	1	pH measured in water
PHKCL	Num.	4	1	pH measured in KCl solution
PHCACL2	Num.	4	1	pH measured in $CaCl_2$ solution
ECE	Num.	5	2	Electrical conductivity (dS m^{-1} or mmho cm^{-1})
EXCA	Num.	5	1	Exchangeable calcium ($cmol_c$ kg^{-1})
EXMG	Num.	5	1	Exchangeable magnesium ($cmol_c$ kg^{-1})
EXNA	Num.	5	1	Exchangeable sodium ($cmol_c$ kg^{-1})
EXK	Num.	5	1	Exchangeable potassium ($cmol_c$ kg^{-1})
EXACID	Num.	5	1	Exchangeable acidity ($cmol_c$ kg^{-1})
EXALUM	Num.	5	1	Exchangeable aluminium ($cmol_c$ kg^{-1})
CECSOIL	Num.	5	1	Cation exchange capacity ($cmol_c$ kg^{-1})
ECEC	Num.	5	1	Effective CEC ($cmol_c$ kg^{-1}; 1 *M* KCl)
BSAT	Num.	3	0	Base saturation, expressed as % of CEC
SAND	Num.	2	0	Sand content (w/w%)
SILT	Num.	2	0	Silt content (w/w%)
CLAY	Num.	2	0	Clay content (w/w%)
GRAVEL	Num.	2	0	Gravel content (v/v %)
STRUCT	Char.	2	0	Soil structure, code
BULKDENS	Num.	5	2	Bulk density (g cm^{-3})
PF	Char.	1		Soil moisture content (Y/N, control variable)
PF00	Num.	2	0	Soil moisture content (% v/v) held at pF 0
PF10	Num.	2	0	As above, but at pF1.0
PF15	Num.	2	0	As above, but at pF1.5
PF10	Num.	2	0	As above, but at pF1.0 (-3 kPa)
PF17	Num.	2	0	As above, but at pF1.7 (-5 kPa)
PF20	Num.	2	0	As above, but at pF2.0 (-10 kPa)
PF23	Num.	2	0	As above, but at pF2.3
PF25	Num.	2	0	As above, but at pF2.5 (-33 kPa)
PF27	Num.	2	0	As above, but at pF2.7
PF34	Num.	2	0	As above, but at pF3.4
PF37	Num.	2	0	As above, but at pF3.7
PF42	Num.	2	0	As above, but at pF4.2 (-1500 kPa)
AWC	Num.	2	0	Available water capacity
HC	Char.	1		Hydraulic conductivity (control variable)
CONDSAT	Num.	4	1	Saturated conductivity (cm hr^{-1})
CONDUNSAT	Num.	4	1	Unsaturated conductivity (cm hr^{-1})

See Appendix 2 for coding conventions.

Structure for table WISEANAD

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

Structure for table WISESOUR

Field Name	Type	Width	Dec	Description
SOURCE_ID	Char.	10		Unique reference number for source of Profile data
AUTHOR	Char.	70		Author name and initials
AUTYR	Num.	2	0	Year of publication
REFTIT	Char.	100		Title of monograph/database, descriptive
REFPUB	Char.	100		Series/publisher/year, descriptive

Structure for table WISELAB

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

Structure for table WISEMETH

Field Name	Type	Width	Dec	Description
LAB_ID	Char.	4		Unique laboratory code
METHCODE	Char.	4		Code for analytical method (e.g., "OC"+"01", see table KEYMETHO)

B) Conversion tables[1]

Structure for table KEYAREA

Field Name	Type	Width	Dec	Description
REGION	Char.	2		Unique identifier for broad geographic area
REGION_name	Char.	150		Description of broad geographic area

Structure for table KEYCOUN

Field Name	Type	Width	Dec	Description
ISO	Char.	2		Country ISO code
COUNTRY	Char.	20		Country name, descriptive
REGION	Char.	2		Unique identifier for broad geographic area

[1] *Contents of key-attribute tables should never be modified or deleted – as they document the unique codes used in WISE 1.1 – to preserve referential integrity of the data set.*

Structure for table KEYCROPS

Field Name	Type	Width	Dec	Description
CROPS	Char.	2		Arable crops, code
CROPS_name	Char.	25		As above, but descriptive

Structure for table KEYDRAIN

Field Name	Type	Width	Dec	Description
DRAIN	Char.	2		Soil drainage class, code
DRAIN_name	Char.	40		As above, but descriptive

Structure for table KEYFAO74

Field Name	Type	Width	Dec	Description
FAO74	Char.	2		Code for FAO-Unesco (1974) classification
FAO74_name	Char.	20		FAO-Unesco (1974) classification, descriptive

Structure for table KEYFAO88

Field Name	Type	Width	Dec	Description
FAO88	Char.	3		FAO (1988) Revised Legend, code
FAO88_name	Char.	20		FAO (1988) classification, descriptive

Structure for table KEYKOPPE

Field Name	Type	Width	Dec	Description
KOPPEN	Char.	4		Unique identifier for Köppen climate code
KOPPEN_name	Char.	115		Summary description of Köppen climate

Structure for table KEYLANDF

Field Name	Type	Width	Dec	Description
LFORM	Char.	2		Landform, code
LFORM_name	Char.	90		As above, but descriptive

Structure for table KEYLUS

Field Name	Type	Width	Dec	Description
LANDUS	Char.	3		Land use, code
LANDUS_name	Char.	45		As above, but descriptive

Structure for table KEYMETHO

Field Name	Type	Width	Dec	Description
METHCODE	Char.	4		Unique code lab. method (e.g., "OC"+"01")
METHOD_name	Char.	175		Brief description of laboratory method

Structure for table KEYMOTTL

Field Name	Type	Width	Dec	Description
MOTTLE	Char.	1		Soil mottling, code
MOTTLE_name	Char.	20		As above, but descriptive

Structure for table KEYORIGIN

Field Name	Type	Width	Dec	Description
ORIGIN	Char.	5		Code for main data (see also SOURCE_ID)
ORIGIN_name	Char.	70		As above, but descriptive

Structure for table KEYPAREN

Field Name	Type	Width	Dec	Description
PARMAT	Char.	3		Parent material, code
PARMAT_name	Char.	50		As above, but descriptive

Structure for table KEYPHASE74

Field Name	Type	Width	Dec	Description
PHA74	Char.	2		Code for FAO-Unesco (1974) phase
PHA74_name	Char.	15		As above, but descriptive

Structure for table KEYPHASE88

Field Name	Type	Width	Dec	Description
PHA88	Char.	2		Code for FAO (1988) phase
PHA88_name	Char.	15		As above, but descriptive

Structure for table KEYPOSIT

Field Name	Type	Width	Dec	Description
POSITI	Char.	2		Site position, code
POSITI_name	Char.	25		As above, but descriptive

Structure for table KEYROOTS

Field Name	Type	Width	Dec	Description
ROOTS	Char.	2		Roots abundance and size, code
ROOTS_name	Char.	40		As above, but descriptive

Structure for table KEYSTATU

Field Name	Type	Width	Dec	Description
DESCR	Char.	1		Profile description status, code
DESCR_name	Char.	25		As above, but descriptive

Structure for table KEYSTRUC

Field Name	Type	Width	Dec	Description
STRUCT	Char.	2		Soil structure, code
STRUCT_name	Char.	30		As above, but descriptive

Structure for table KEYTEXT

Field Name	Type	Width	Dec	Description
TOP_74.	Char	1		FAO-Unesco (1974) topsoil texture class, code
TOP_74_name	Char.	15		As above, but descriptive

Structure for table KEYVEGET

Field Name	Type	Width	Dec	Description
VEGCOD	Char.	2		Vegetation classification, code
VEGCOD_name	Char.	30		As above, but descriptive

Appendix 2. WISE data coding protocols

A) *Site data* (Table WISESITE)

WISE_ID
This code is a unique reference number for the soil profile in question, and consists of the country's ISO-3166 code (see table KEYCOUN) followed by 3 numbers (Example: BR022).

FAO74
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.

PHA74
The main phase, according to FAO-Unesco (1974, p. 5-7), 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

TOP74
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 per cent 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).

FAO88
FAO-Unesco classification in the Revised Legend, encoded using the 3-letter codes of the Key to Major Soil Groupings and Soil Units (FAO, 1988 p. 74-88), for example, HSf for a Fibric Histosol and ACp for a Plinthic Acrisol.

PHA88
The main phase, according to FAO (1988, p. 68), 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

USCL
Soil classification at subgroup level in USDA Soil Taxonomy, as a text string with a maximum length of 50 characters (see Soil Survey Staff, 1994; abbreviated where necessary).

USYR
Version/year of USDA Soil Taxonomy used, expressed as two characters (e.g., 75, 87, 90, 94).

LOCAL
The soil classification according to the National System, with a maximum of 50 characters (abbreviated if necessary).

SOURCE_ID
The unique SOURCE_ID provides an alphanumeric code to the source from which the soil profile data were derived, for example a soil monograph or digital database (e.g., AF5/34.1 for a survey monograph held in the ISRIC library).

REFPAG
The page and number of the profile as used in the corresponding SOURCE_ID.

HORNUM
This refers to the total number of horizons for which analytical data are available for the given profile. The maximum number of horizons that can be accommodated per profile in the database is 9.

LAB_ID
This unique code provides an alphanumeric reference to the laboratory where the measurements have been made. Each LAB_ID consists of the country's ISO-code, followed by two numbers (Example: IN02). Summary information on the analytical procedures that have been used to measure a certain attribute is presented in table KEYMETHO.

STATUS
This code, for “soil profile description status”, refers to the apparent completeness of the soil profile descriptions and accompanying analytical data for the specified profile in the original source. The description status is determined after screening of the original information 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	Reference Pedon Description (e.g., ISRIC and NRCS profiles; additional information may be found under 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, often preventing a satisfactory soil characterization and classification*.
*	Code 4 type of data is generally not accepted for inclusion in WISE database, unless the corresponding soil unit is grossly under represented in the global profile data set.

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

COUN
The country of origin of the profile, specified according using ISO-3166 codes (Example: NE for Niger, see table KEYCOUN).

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

LATIT, LATDEG, LATMIN, LATSEC and
LONGI, LONDEG, LONMIN, LONSEC
The combination of these fields gives the full coordinates of a soil profile. Coordinates are given as given as degrees, minutes and seconds latitude (LATIT; N S) and longitude (LONGI; E or W). Unless given in the source description, coordinates were derived from appropriately detailed topographical maps and accurate to at least 25 km in view of their original application in a 2 E by 2 E spatial database (Batjes, 1999). If only the fields LATIT, LATDEG, LATMIN, LONGI, LONDEG, and LONMIN are filled given in the data set, this indicates the profile coordinates are approximate and derived from the Times Atlas (1993).

ALTIT
Altitude of the soil profile relative to mean sea level, specified in meters. Unless specified on the original soil description, this information was derived from a suitably detailed topographical map. (Note: 1 foot = 0.3048 m).

LFORM
This code refers to the major landform. In accordance with SOTER criteria (Van Engelen and Wen, 1995), landforms are described principally by the 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:

Code	Landform	Description
L	Level land	Land with characteristics slopes of 0-8 %, and a relief intensity of less than 100 m per km.
S	Sloping land	Land with Characteristics 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 Characteristics slopes of over 30 % and a relief intensity of mostly more than 600 m per 2 km.
C	Land with com-	Land made up of steep elements together with sloping or level land, or sloping land landforms 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 SOTER:

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 med.-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-grad. escarpment zone	> 30%	> 600 m/2km
	TV high gradient valleys	> 30%	variable
C Land with composite landforms	CV valley	> 8%	variable
	CL narrow plateau	> 8%	variable
	CD major depression	> 8%	variable

POSIT

The physiographic position of the site of the profile, described according to FAO/ISRIC(1990, p. 7).

Position	Code	Description
a) Position in undulating to mountainous terrain		
	CR	Crest/top
	UP	Upper slope
	MS	Middle slope
	LS	Lower slope
	BO	Bottom (flat)
b) 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, ..., NNW. In case of flat or almost level land, the aspect is indicated with the letter O.

SLOPE
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.

DRAIN
The internal drainage class is coded according to the conventions of FAO/ISRIC (1990, p. 20). In WISE, intergrades of two neighbouring drainage classes are 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

GRWHI and GRWLO
The measured or estimated depth to the groundwater table (if present or known). Values are given for both the mean highest (GRWHI) and mean lowest (GRWLO) level during the year. Depths are specified in centimetres from the surface. If the water table occurs always at a great depth, this is shown by entering the same figure for both GRWHI and GRWLO (e.g., 200 cm).

SOLDEP
The average measured or estimated depth, in cm, from the soil 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.

PARMAT

The main parent material over which the soil has been formed is coded using the categories considered in the SOTER manual and FAO/ISRIC (1990, p. 14).

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-magn. min.
		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 carbonaceous rocks
		SO2	marl and other mixtures
		SO3	coals, bitumen and related rocks
	SE evaporates	**SE1**	anhydrite, gypsum
		SE2	halite
U Unconsolidated	**UF** fluvial		
	UL lacustrine		
	UM marine		
	UC colluvial		
	UE eolian		
	UG glacial		
	UP pyroclastic		
	UO organic		
	UX soft laterite and ferrugi materials		
	UY hardened laterite and ferruginous materials		

PARREM
Additional remarks about the parent material as text, with a maximum length of 50 characters.

KOPPEN
The climate at the site is classified according to the system of Köppen that 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 (Strahler, 1969; 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 ^{o}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 ^{o}C, but above -3 ^{o}C. The C climates thus have both a summer and a winter season.
D	Snow (microthermal) climates: Coldest month average temperature under -3 ^{o}C. Average temperature of the warmest month above 10 ^{o}C, that isotherm corresponding approximately with the pole-ward limit of forest growth.
E	Ice climates: A polar climate type with average temperature in no month averaging over 10 ^{o}C. These climates have no true summer.
H	Mountain/Highland climates

b) Subgroups
A second letter according to the following code designates subgroups within the major climate groups:

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

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

CROPS

Main crop, for arable uses. The dominant crop is coded using the following list (adapted from FAO/ISRIC, 1990).

Code	Crop
BA	Barley
BE	Beans
CH	Cashew
CA	Cassava
CO	Cocoa
CN	Condiments
CC	Coconut
CE	Cereals (unsp.)
CF	Coffee
CT	Cotton
CP	Cowpea
FB	Fibre crops
FD	Fodder crops
WH	Wheat
YA	Yams

Code	Crop
FR	Fruit trees
GR	Groundnut
MA	Maize
MI	Millet
OL	Oil/protein crops
OP	Oil palm
PE	Peas
PO	Potato
RI	Rice
RB	Rice (flooded)
RT	Root crops (unsp.)
RU	Rice (upland)
RR	Rubber

Code	Crop
SO	Sorghum
SB	Soybean
SC	Sugar cane
SF	Sunflower
SI	Sisal
SP	Sweet potato
SU	Sugar beet
ST	Stimulants (unsp.)
TC	Tuber crops (unsp.)
TE	Tea
TB	Tobacco
VE	Vegetables

* unsp.= unspecified

LANDUS

The current land use at the site is coded using the classes of FAO/ISRIC (1990, p. 13).

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 cultures
	AA3 -- Ley system cultures
	AA4 -- Rainfed arable cultures
	AA5 -- Wet rice cultivation
	AA6 -- Irrigated cultivation
	AP - Perennial field cropping
	AP1 -- Non-irrigated cultures
	AP2 -- Irrigated cultures
	AT - Tree and shrub cropping
	AT1 -- Non-irrigated tree crop Cultures
	AT2 -- Irrigated tree crop cultures
	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

VEGCOD

The natural vegetation at a site is described using the broad classes given by UNESCO (1973), in accordance with SOTER conventions.

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

VEGREM
Additional remarks, for instance about the crop rotation or felling history, given as text.

B) *Horizon data* (Table WISEHOR)

HORIZ
The WISE input module automatically creates this sequential number for an horizon in a profile. Data for the main horizons are numbered from the surface downwards.

DESIG
Whenever possible, the horizon designation should be given according to the terminology of FAO\ISRIC (1990).

TOPDEP
Upper depth of horizon (cm). In case of a litter layer, negative numbers are used (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 was entered as (30+40)/2= 35 cm.

BOTDEP
Lower depth of horizon (cm). If the lower depth of a profile was not given in the original materials, 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 an inferred lower depth of 90 cm.

ORGC
Organic carbon given as % by weight, specified with 2 decimal places. The code for the measurement method is documented in table KEYMETHO.

TOTN
Total nitrogen (% by weight) is rounded to 2 decimal places. The code for the measurement method is documented in table KEYMETHO.

PTOT
Available (extractable) P content expressed in mg P_2O_5 kg^{-1} soil. The code for the measurement method is documented in table KEYMETHO.

PHH2O
Soil reaction measured in water at a soil:water ratio; the analytical methods are documented in table KEYMETHO.

PHKCL
Soil reaction measured in 1 *M* KCl at the soil:solution ratio specified in table KEYMETHO.

PHCACL2
Soil reaction measured in 1 *M* $CaCl_2$ solution at the soil:solution ratio given in table KEYMETHO.

ECE
Electrical conductivity (EC_x) for the horizon, for the soil:water ratio (x) documented in table KEYMETHO. The unit of measurement used is mS cm^{-1} or dS m^{-1}, originally mmho cm^{-1}, at 25 ^oC.

CACO3
Total $CaCO_3$ content (% by weight), rounded off to the nearest integer. The code for the measurement method is specified in table KEYMETHO.

GYPSUM
The content of total gypsum ($CaSO_4.2H_2O$), by weight % (for methods see table KEYMETHO).

EXCA, EXMG, EXK and EXNA
Exchangeable bases (i.e., Ca^{2+}, Mg^{2+}, K^+ and Na^+) in $cmol_c\ kg^{-1}$. The code for the measurement method is documented in table KEYMETHO.

EXACID
Exchangeable acidity, the sum of exchangeable Al^{3+} and H^+, is 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 aluminium is determined separately in the percolate (Van Reeuwijk, 1993). Exchangeable acidity is specified in $cmol_c\ kg^{-1}$. [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].

EXALUM
Exchangeable aluminium (Al^{3+}), in $cmol_c\ kg^{-1}$, as determined separately in the percolate described above. The code for the measurement method is documented in table KEYMETHO.

CECSOIL
The cation exchange capacity (CEC), in $cmol_c\ kg^{-1}$, determined according to the method specified in table KEYMETHO.

ECEC
The effective cation exchange capacity (ECEC), in $cmol_c\ kg^{-1}$, determined by summation of exchangeable bases and exchangeable acidity (i.e., ECEC= Exch(Ca^{2+} + Mg^{2+} + K^+ + Na^+) + Exch(H^+ + Al^{3+}) (Van Reeuwijk, 1993).

BSAT
Base saturation (BS) 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%. The code for the measurement method is documented in table KEYMETHO.

DCOLOR
The dry matrix colour specified using the Munsell Colour Charts(Munsell, 1975). Colour codes have the general form: hue, value, chroma (e.g., 5YR5/3). All "complex" Munsell codes have been rounded off, for example 10YR3.5/1 would become 10YR4/1.

MCOLOR
The moist colour according to the Munsell Colour Charts (e.g., 5YR3/2).

MOTTLE
Mottling in a horizon, 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 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).

a) Abundance of roots (expressed as number of roots per square decimetre):

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

b) 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

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

Code	Description of class
SG	single grain
MA	massive
CR	crumb
GR	granular
PR	prismatic
PS	subangular prismatic
CO	columnar
AB	angular blocky

Code	Description of class
SB	subangular blocky
AS	angular and subangular blocky
SA	subangular and angular blocky
SN	nutty subangular blocky
AW	angular blocky wedge-shaped
AP	angular blocky parallelepiped
PL	platy
RS	rock structure
SS	stratified structure

SAND, SILT and CLAY
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 equivalent spherical diameter (esd) for the clay-, silt-, and sand-size fractions are documented in table KEYMETHO. For example, "TE01" corresponds with "pipette method, full dispersion; esd: <2 µ, < 50 µ and < 2 mm".

GRAVEL
This figure gives 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.

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

PFxx
Soil water retention or the *volume* percentage of water (MC) in the soil horizon, at pre-defined pF-values or suctions (see table WISEHOR). The moisture content is expressed on a percent by volume basis:

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

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.

CONDSAT and CONDUNSAT
Hydraulic conductivity or permeability (cm hr^{-1}) varies with soil moisture conditions. Two values can be entered: (a) saturated hydraulic conductivity, and (b) non-saturated hydraulic conductivity. Hydraulic conductivity is seldom determined during routine soil surveys, therefore the corresponding fields are often left blank in WISE. Specialist databases dealing with hydraulic soil parameters are available elsewhere (Wösten *et al.*, 1998). ISRIC also prepared a uniform soil data set for the development of pedotransfer functions at the request of the Global Soil Data task (GSDT) of IGBP-DIS (Tempel *et al.*, 1996).

C) *Source of data*

a) Table WISESOUR

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

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

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

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

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

b) Table WISELAB

LAB_ID
Unique reference code for laboratory where analyses for relevant profile(s) have been made. A brief description of the analytical methods in use at a particular laboratory (e.g., FR01) may be found in table KEYMETHO.

LABNAM
Name of laboratory where analyses were made, as text string.

b) Table KEYMETHO

Each code for a method (METHCODE) consists of two characters and two numbers. The characters refer to the overall type of analyses, such as the determination of total organic carbon (OC), while the sequential numbers list to the specific type of analysis used. The following codes are used:

Attribute	Code
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 & 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 table KEYMETHO. For example, "OC01" stands for "Method of Walkley-Black".

Appendix 3. Number of profiles by soil unit (1974 Legend)

```
A: Acrisols
Af= 125 Ag= 21  Ah= 71  Ao= 67  Ap= 36
B: Cambisols
Bc= 30  Bd= 91  Be= 140 Bf= 47  Bg= 49  Bh= 49  Bk= 119 Bv= 45  Bx= 17
C: Chernozems
Cg= 0   Ch= 24  Ck= 32  Cl= 14
D: Podzoluvisols
Dd= 5   De= 5   Dg= 1
E: Rendzinas
E= 35
F: Ferralsols
Fa= 24  Fh= 51  Fo= 84  Fp= 8   Fr= 44  Fx= 50
G: Gleysols
Gc= 15  Gd= 63  Ge= 90  Gh= 33  Gm= 48  Gp= 4   Gx= 7
H: Phaeozems
Hc= 26  Hg= 19  Hh= 76  Hl= 93
I: Lithosols
I= 8
J: Fluvisols
Jc= 141 Jd= 32  Je= 168 Jt= 26
K: Kastanozems
Kh= 13  Kk= 15  Kl= 1
L: Luvisols
La= 29  Lc= 110 Lf= 113 Lg= 103 Lk= 145 Lo= 153 Lp= 12  Lv= 18
M: Greyzems
Mg= 1   Mo= 7
N: Nitosols
Nd= 25  Ne= 43  Nh= 13
O: Histosols
Od= 35  Oe= 11  Ox= 4
P: Podzols
Pf= 2   Pg= 15  Ph= 20  Pl= 11  Po= 29  Pp= 12
Q: Arenosols
Qa= 12  Qc= 184 Qf= 89  Ql= 36
R: Regosols
Rc= 28  Rd= 35  Re= 54  Rx= 2
S: Solonetz
Sg= 17  Sm= 5   So= 42
T: Andosols
Th= 90  Tm= 28  To= 16  Tv= 31
U: Rankers
U= 8
V: Vertisols
Vc= 156 Vp= 149
W: Planosols
Wd= 10  We= 22  Wh= 1   Wm= 8   Ws= 21  Wx= 0
X: Xerosols
Xh= 20  Xk= 19  Xl= 88  Xy= 8
Y: Yermosols
Yh= 9   Yk= 13  Yl= 17  Yt= 1   Yy= 15
Z: Solonchaks
Zg= 21  Zm= 3   Zo= 49  Zt= 2
```

* For further details on classification see Legend (FAO-Unesco, 1974). Total number of profiles in accompanying data set is 4382.

Appendix 4. Number of profiles by soil unit (1988 Legend)

```
AC: Acrisols
ACf= 53  ACg= 14  ACh= 99  ACp= 28  ACu= 41
AL: Alisols
ALf= 10  ALg= 11  ALh= 32  ALj= 1   ALp= 3   ALu= 12
AN: Andosols
ANg= 8   ANh= 18  ANi= 0   ANm= 23  ANu= 64  ANz= 49
AR: Arenosols
ARa= 11  ARb= 25  ARc= 17  ARg= 12  ARh= 121 ARl= 67  ARo= 67
AT: Anthrosols
ATa= 2   ATc= 20  ATf= 1   ATu= 1
CH: Chernozems
CHg= 5   CHh= 14  CHk= 32  CHl= 11  CHw= 0
CL: Calcisols
CLh= 112 CLl= 35  CLp= 35
CM: Cambisols
CMc= 110 CMd= 87  CMe= 138 CMg= 48  CMi= 16  CMo= 67  CMu= 46  CMv= 45  CMx= 24
FL: Fluvisols
FLc= 141 FLd= 25  FLe= 146 FLm= 13  FLs= 5   FLt= 25  FLu= 3
FR: Ferralsols
FRg= 25  FRh= 99  FRp= 6   FRr= 48  FRu= 29  FRx= 59
GL: Gleysols
GLa= 0   GLd= 59  GLe= 91  GLi= 7   GLk= 12  GLm= 44  GLt= 2   GLu= 22
GR: Greyzems
GRg= 0   GRh= 7
GY: Gypsisols
GYh= 5   GYk= 12  GYl= 1   GYp= 4
HS: Histosols
HSf= 20  HSi= 4   HSl= 1   HSs= 21  HSt= 3
KS: Kastanozems
KSh= 9   KSk= 19  KSl= 2   KSy= 0
LP: Leptosols
LPd= 11  LPe= 22  LPi= 0   LPk= 29  LPm= 7   LPq= 6   LPu= 9
LV: Luvisols
LVa= 25  LVf= 25  LVg= 59  LVh= 155 LVj= 44  LVk= 99  LVv= 18  LVx=144
LX: Lixisols
LXa= 3   LXf= 30  LXg= 4   LXh= 67  LXj= 1   LXp= 5
NT: Nitisols
NTh= 32  NTr= 8   NTu= 15
PD: Podzoluvisols
PDd= 5   PDe= 5   PDg= 1   PDi= 0   PDj= 0
PH: Phaeozems
PHc= 25  PHg= 18  PHh= 64  PHj= 5   PHl= 96
PL: Planosols
PLd= 12  PLe= 36  PLi= 0   PLm= 12  PLu= 0
PT: Plinthosols
PTa= 5   PTd= 9   PTe= 5   PTu= 2
PZ: Podzols
PZb= 10  PZc= 14  PZf= 2   PZg= 24  PZh= 35  PZi= 3
RG: Regosols
RGc= 22  RGd= 24  RGe= 48  RGi= 2   RGu= 3   RGy= 1
SC: Solonchaks
SCg= 20  SCh= 11  SCi= 0   SCk= 11  SCm= 2   SCn= 14  SCy= 14
SN: Solonetz
SNg= 19  SNh= 26  SNj= 4   SNk= 12  SNm= 4   SNy= 3
VR: Vertisols
VRd= 2   VRe= 180 VRk= 121 VRy= 3
```

* For further details on classification see Revised Legend (FAO, 1988). Total number of profiles classifiable according to Revised legend is 4360 [99% out of 4382 profiles].

Appendix 5. Number of soil profiles by country and their description status[¶]

COUNTRY	Description status				Total
	1	2	3	4	
Afghanistan	0	0	5	0	5
Albania	29	0	0	6	35
Algeria	0	4	0	0	4
Angola	0	0	36	0	36
Argentina	0	4	41	0	45
Armenia	0	0	6	0	6
Australia	0	8	35	4	47
Azerbaijan	0	0	5	0	5
Bahrain	0	0	3	0	3
Bangladesh	0	3	16	0	19
Belgium	0	6	1	0	7
Benin	0	0	8	0	8
Botswana	19	853	11	4	887
Brazil	45	22	46	0	113
Bulgaria	0	0	3	0	3
Burkina Faso	0	1	0	0	1
Burundi	12	0	3	1	16
Cameroon	3	31	21	0	55
Canada	1	40	50	1	92
Central African Rep.	0	0	32	0	32
Chile	5	1	22	0	28
China	50	0	10	0	60
Cocos Islands	1	0	0	0	1
Colombia	27	17	27	0	71
Congo	0	0	5	1	6
Cook Islands	0	1	0	0	1
Costa Rica	25	3	0	0	28
Cote d'Ivoire	7	16	2	0	25
Cuba	21	0	0	0	21
Czechoslovakia	0	0	6	0	6
Denmark	0	4	13	0	17
Ecuador	13	3	18	0	34
Egypt	0	15	4	0	19
El Salvador	5	0	0	0	5
Ethiopia	0	1	10	0	11
Fiji	0	0	9	0	9
Finland	0	1	8	1	10
France	0	0	46	1	47
Gabon	0	2	17	0	19
Georgia	0	0	9	0	9
Germany	0	23	18	0	41
Ghana	0	10	0	0	10
Greece	0	0	1	0	1
Guatemala	11	0	0	0	11
Guinea	0	1	6	0	7
Guyana	0	3	0	0	3
Honduras	8	0	0	0	8
India	5	47	69	1	122
Indonesia	79	4	19	0	102
Iran,Islamic Rep. Of	0	0	0	2	2
Iraq	0	0	14	0	14
Ireland	0	0	28	0	28
Israel	0	0	33	0	33

Italy	0	15	51	3	69
Jamaica	0	13	44	0	57
Japan	3	7	24	0	34
Jordan	14	14	15	0	43
Kenya	32	0	0	0	32
Korea, Republic of	15	0	2	0	17
Lebanon	0	2	5	0	7
Lesotho	15	0	12	0	27
Liberia	0	18	0	0	18
Libyan Arab Jamahiri	0	12	5	0	17
Luxembourg	0	0	1	0	1
Madagascar	0	1	21	12	34
Malawi	0	0	3	0	3
Malaysia	2	4	22	0	28
Mali	14	0	0	0	14
Mexico	9	9	4	0	22
Morocco	5	0	20	0	25
Mozambique	0	9	2	0	11
Nepal	5	0	6	0	11
Netherlands	0	0	21	0	21
New Caledonia	0	1	0	0	1
New Zealand	0	3	12	0	15
Nicaragua	21	0	0	0	21
Niger	11	0	5	0	16
Nigeria	0	9	1	0	10
Norway	0	0	4	0	4
Pakistan	35	0	2	0	37
Panama	14	0	0	0	14
Papua New Guinea	13	3	15	0	31
Peru	0	0	28	0	28
Philippines	50	16	1	0	67
Poland	0	6	32	3	41
Portugal	0	24	11	0	35
Puerto Rico	0	1	0	0	1
Romania	0	1	15	0	16
Russian Federation	0	0	12	4	16
Rwanda	6	3	3	0	12
Samoa	14	0	0	0	14
Senegal	0	3	11	0	14
Sierra Leone	0	11	0	0	11
Solomon Islands	0	1	0	0	1
Somalia	0	2	8	0	10
South Africa	0	8	16	0	24
Spain	0	0	22	0	22
Sri Lanka	0	0	10	0	10
Sudan	25	39	7	0	71
Suriname	0	8	7	0	15
Sweden	0	4	11	2	17
Switzerland	0	0	14	0	14
Syrian Arab Republic	6	0	4	0	10
Taiwan	1	0	0	0	1
Tajikistan	0	0	5	0	5
Tanzania,Unit.Rep.of	0	94	1	0	95
Thailand	35	15	23	0	73
Togo	0	0	8	0	8
Tonga	0	2	0	0	2
Tunisia	15	0	0	0	15

Turkey	0	22	31	0	53
Uganda	12	0	0	0	12
Ukraine	0	0	6	0	6
United Kingdom	1	28	24	0	53
United States	144	8	0	0	152
Uruguay	0	0	72	0	72
USSR	2	0	0	0	2
Uzbekistan	0	0	8	0	8
Venezuela	5	9	10	0	24
Yemen	4	260	9	27	300
Zaire	0	0	67	0	67
Zambia	31	6	49	0	86
Zimbabwe	15	16	0	0	31
Total	940	1831	1538	73	4382

[¶] For explanation of soil profile description status see Appendix 2.

Appendix 6. Percentage of records in WISESITE and WISEHOR filled with measured data.

a) Site data (Table WISESITE; total number of records= 4382)

Attribute	Filled	Percent of total
WISE_ID	4382	100%
LAB_ID	4382	100%
SOURCE_ID	4382	100%
REFPAG	4276	98%
HORNUM	4382	100%
FAO74	4382	100%
PHA74	414	9%
TOP74	4240	97%
FAO88	4360	99%
PHA88	419	10%
USCL	2611	60%
USYR	4372	100%
LOCAL	2927	36%
DESCR	4382	100%
DATE	4382	100%
ISO	4382	100%
LOCAT	4026	92%
LATIT	4382	100%
LATDEG	4382	100%
LATMIN	4373	100%
LATSEC	4079	93%
LONGI	4382	100%
LONDEG	4382	100%
LONMIN	4374	100%
LONSEC	4042	92%
ALTIT	3516	80%
LFORM	3740	85%
POSIT	2848	65%
ASPECT	1222	28%
SLOPE	2432	55%
DRAIN	4170	95%
GRWHI	326	7%
GRWLO	308	7%
SOLDEP	2331	53%
PARMAT	3064	70%
PARREM	2149	49%
KOPPEN	3706	85%
LANDUS	3039	69%
CROPS	765	17%
VEGCOD	1956	45%
VEGREM	1936	44%
ORIGIN	4382	100%

Notes: The full complement of site data considered in WISE, version 1.1, is described in Table 2 and Appendix 1.

b) Horizon data (Table WISEHOR, total number of records= 21167)

Attribute	Filled	Percent of total
WISE_ID	21167	100%
HORIZ	21167	100%
DESIG	20417	96%
TOPDEP	21066	100%
BOTDEP	21156	100%
DCOLOR	8687	41%
MCOLOR	19234	91%
MOTTLE	10315	49%
ROOTS	15118	71%
ORGC	18306	86%
TOTN	9504	45%
PTOT	5788	27%
CACO3	6737	32%
GYPSUM	823	4%
PHH2O	19599	93%
PHKCL	6819	32%
PHCACL2	9955	47%
ECE	6827	32%
EXCA	16798	79%
EXMG	16784	79%
EXNA	14775	70%
EXK	16611	78%
EXACID	5336	25%
EXALUM	3552	17%
CECSOIL	18689	88%
ECEC	3740	18%
BSAT	16097	76%
SAND	19639	93%
SILT	19592	93%
CLAY	19554	92%
GRAVEL	4664	22%
STRUCT	17530	83%
BULKDENS	6813	32%
PF00	1196	6%
PF10	751	4%
PF15	657	3%
PF17	511	2%
PF20	1326	6%
PF23	501	2%
PF25	4962	23%
PF27	554	3%
PF34	647	3%
PF37	117	1%
PF42	6879	32%
AWC	2894	14%
CONDSAT	416	2%
CONDUNSAT	22	0%

Notes: The full complement of horizon data considered in WISE, version 1.1, is described in Table 2 and Appendix 1.

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