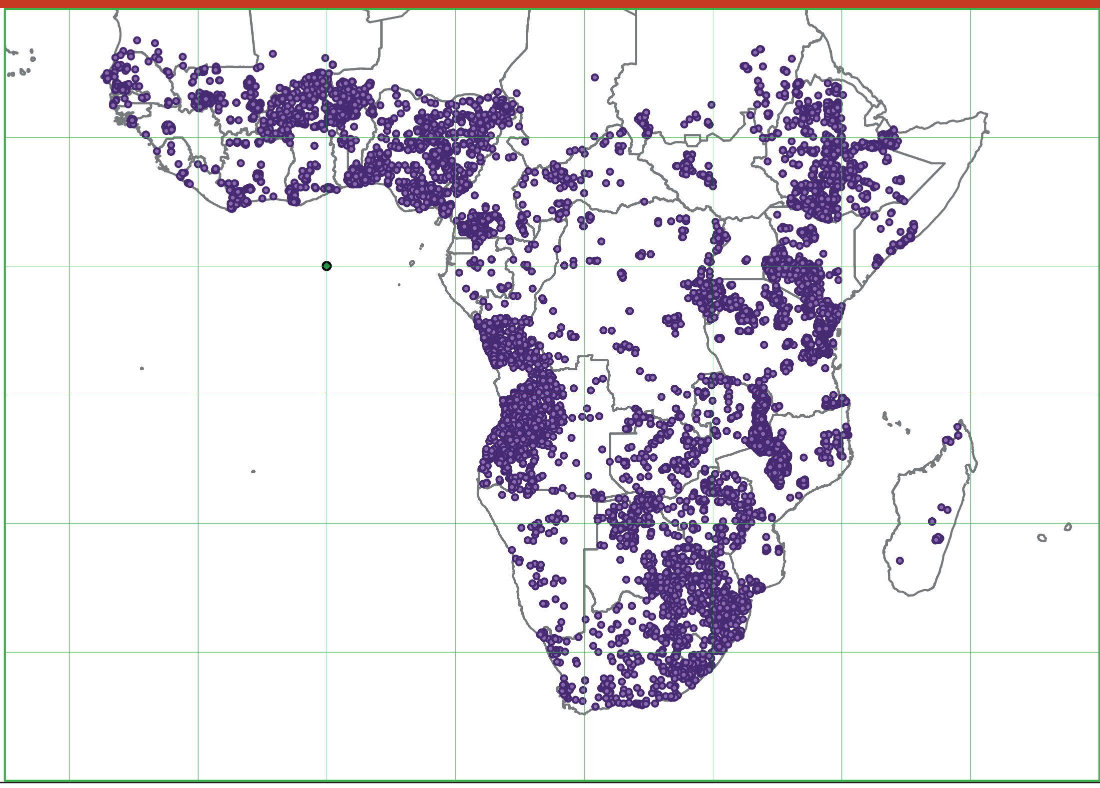
Africa Soil Profiles Database

Version 1.2

A compilation of georeferenced and standardised legacy soil profile data for Sub-Saharan Africa (with dataset)

ISRIC World Soil Information

ISRIC Report 2014/01



J.G.B. Leenaars, A.J.M. van Oostrum and M. Ruiperez Gonzalez

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ISRIC Report 2014/01

Wageningen, 2014

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Preface

The compilation and publication of the Africa Soil Profiles Database is at the heart of ISRIC's mandate, which is to serve the international community as custodian of global soil information and to increase awareness and understanding of soils in major global issues.

Soil data are at the basis of soil research needed to provide insights in the current debate about enriching soils as a key to improve food security in Africa, as expounded in Nature (Gilbert, 2012).

ISRIC is determined, also as ICSU World Data Centre for Soils, to continue contributing to alleviating these pressing issues by serving and improving access to soil data, both old and new, information and knowledge, for subsequent use.

The Africa Soil Profiles Database contributes to the production and updating of evidence-based high-resolution soil property maps of the entire Sub-Saharan African continent which permits to convey spatially explicit information to policy makers and local land users.

This research has been carried out within the framework of the Africa Soil Information Service (AfSIS) project, funded by the Alliance for the Green Revolution in Africa and the Bill and Melinda Gates Foundation, for which much gratitude is due.

Many have contributed to this report as has been mentioned in the acknowledgements, in spirit of the aim of ISRIC to advance soil information through collaborative actions worldwide.

Rik van den Bosch
Director ISRIC – World Soil Information

Summary

This version 1.2 of the Africa Soil Profiles Database is an update of version 1.1 (Leenaars, 2013) and includes additional soil profile data from in particular Burkina Faso, Mali, Ghana, Chad, Somalia, Tanzania, Mozambique and Zambia. The database is compiled from a wide variety of digital and analogue data sources reporting soil profile data in various formats and standards. The soil-attribute values are compiled and standardised according to SOTER conventions and are submitted to routine quality control. The soil profile data are georeferenced, permitting to establish and model the relationships between soil data and auxiliary spatial information prior to soil property mapping.

The Africa Soil Profiles Database version 1.2 holds attribute values for 18,532 soil profiles, of which 17,160 are georeferenced, consisting of 74,961 soil profile layers. The profile attributes are originally observed or measured by methods and standards which typically vary from one study or survey to another – these have been documented in the dataset. The Africa Soil Profiles Database inevitably includes data gaps of varying nature, and as a result not all data may be fit for modelling and analysis purposes without prior gap filling. The quality of the data is by definition use- and resolution-dependent. The present standardised and quality-controlled legacy soil profile data are considered appropriate to underpin digital soil property mapping of vast areas at moderate resolution (1-10 km^2 pixel size, depending on the attribute concerned) as well as to serve other purposes such as conventional area class mapping and exploratory studies of soil properties across Sub-Saharan Africa.

This report describes the sources and methods used to compile the database, the structure and content of the database and presents examples of use of the data. This report only serves to describe the database; a procedures manual will be prepared upon embedding of the database into the World Soil Information Service (WoSIS) and full functionality of the associated portal.

The database is accessible at:
www.isric.org/data/africa-soil-profiles-database-version-01-2

Keywords: soil profiles, legacy soil data, soil database, digital soil mapping, Africa, AfSIS, ISRIC, Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Central Africa Republic, Chad, Congo –Brazzaville, Congo -Democratic Republic, Cote d'Ivoire, Ethiopia, Gabon, Ghana, Guinea, Guinea-Bissau, Kenya, Liberia, Lesotho, Madagascar, Malawi, Mali, Mauretania, Mozambique, Namibia, Niger, Nigeria, Rwanda, South Africa, South Sudan, Sudan, Sierra Leone, Senegal, Somalia, Swaziland, Togo, Tanzania, Uganda, Zambia, Zimbabwe

1 Introduction

Soils deliver various ecosystem services of provisioning and regulating character. The capacity of soils to deliver these services largely depends on soil functions and the underlying soil properties. The latter are the result of soil formation including soil genesis and management. Soil management aims at changing soil properties for improving the soil's capacity of delivering services.

Information on soil properties and on how to manage them, where and when, is of key importance for improving the soil's services delivering capacity and has been subject to large efforts of soil research and soil mapping. Soil research in Sub-Saharan Africa started in the late 1800s. The initial focus was on commodity crops for export and most research took place on soil fertility. From the 1950s onwards, food crops received research attention. Soil mapping in Sub-Saharan Africa started in the 1920s but very few areas and countries were mapped prior to World War II. Since then, soil survey organisations were established in most African countries and a large number of reconnaissance and detailed surveys was carried out. Since the 1980s, after publication of the first soil map of the world (FAO-Unesco, 1981), soil survey and mapping capacity in Africa has diminished importantly, and soil data collection continued more sporadically in especially the context of soil fertility research. In general, these soil data are referred to as legacy soil data.

At the basis of much of the soil research and soil mapping has been the understanding of soil formation, basically as mechanistically described by Jenny (1941) as a function of climate, organisms, relief, parent material and time (CORPT). Soil management, or the only factor through which man can directly target impact on soil properties, is implicitly included in the equation through the organisms factor.

Present day and near future demands for e.g. food provisioning and water and climate regulation call for adequate soil management and supporting policies, underpinned by reliable, accurate and spatially explicit soil information (Sanchez et al., 2009). The *GlobalSoilMap.net* consortium aims to produce that soil information at an increasingly fine resolution. Legacy soil data are a rich, and cost efficient, source of information to serve this goal, subject to screening and standardisation.

Soil information relevant for local soil management decision making should be detailed, both geographically and thematically, while soil information relevant for supporting policy-making may be less detailed but should be standardised and generalised for vast areas. Combining both aspects, as is aimed for by *GlobalSoilMap.net,* is a true challenge. A large population of primary soil data is required to produce regionally or continentally standardised soil information that is detailed in resolution as well as accurate and spatially explicit. For instance, according to conventional, pre-covariate, soil mapping approaches with one soil observation per cm^2 map area, for 18 * 10^6 km^2 of Sub-Saharan Africa at a targeted resolution of 90 m (approximately 1: 90,000), a total of 22 * 10^6 soil profile observations would be required. This number would be 100 times smaller for a targeted scale of 10 times less detail (1: 900,000).

McBratney et al. (2003) proposed an adapted version of Jenny's equation with a view to use the soil forming factors as soil spatial prediction functions for soil mapping purposes, known as the scorpan formulae.
Two additional factors are introduced to predict the soil property or soil class at a given location; these are 'spatial position' and 'another soil property', with the latter accommodating for legacy soil data. According to McBratney et al. (2003) the sample size of primary soil data required to set up the model for deriving soil maps is about 10 - 100 times smaller than that required by conventional methods, with the required sample

size increasing with increasing resolution and with the number of environmental attributes or covariates included in the model.

In spite of this reduction in required sample size, due to modern Digital Soil Mapping techniques, the availability of sufficient primary soil data remains crucial input. Sustained investments and efforts are needed to develop and populate such large soil profile databases. The situation in Africa changes for the better where the compilation of digital soil databases is concerned (Paterson and Mushia, 2012) and the compilation of the current database contributes importantly to this positive development.

One major component of the Globally Integrated – Africa Soil Information Service (AfSIS) project, funded by AGRA and the Bill and Melinda Gates Foundation, aims at generating new soil data for 60 sentinel sites through sampling of topsoils of a total number of 9600 soil profiles in Sub-Saharan Africa. Another component of the project is to collect and collate legacy soil data (http://www.africasoils.net/data/legacyprofile). This report and associated database are the result of the second component.

Within the project it has been concluded that standardised legacy soil data for at least 30,000 to 40,000 geo-referenced soil profiles are required to set up and test the model for predicting soil properties for the entire Sub-Saharan Africa area. That is a tangible goal and is achievable with sufficient capacity allocated to that purpose. This report describes version 1.2 of the database, compiling and standardising georeferenced legacy soil data for 18,532 soil profiles for the region.

Chapter 2 describes the materials and methods used to compile the data. It explains the inventory of data, their entry and collation, the database structure used to store the data, the types of data that distinguish between features, attributes, methods and values, and the standardisation and quality control of entered values. Chapter 3 discusses the contents of the database by giving summary statistics and by presenting a few data use cases. Chapter 4 presents a brief discussion with conclusions.

2 Materials and methods

2.1 Data inventory

The present database is an updated compilation of legacy soil profile data for Sub-Saharan Africa that have been georeferenced and standardised. Procedures for data standardisation are described in Section 2.4.3 and 2.4.5. The basis for the present database version 1.2 is the previous version 1.1.

The basis for the first version (1.0) of the Africa Soil Profiles Database was derived from the digital soil profile dataset ISRIC-WISE3 (Batjes, 1998) which includes soil data for some 2,222 geo-referenced profiles south of the Sahara (Figure 1), and was used by AfSIS for preliminary analyses. These profiles were harmonised, and screened, according to their FAO soil classification.

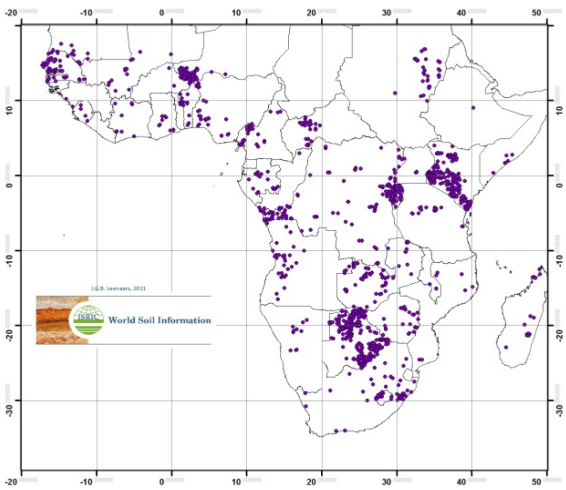

Figure 1
Spatial distribution of the initial data (ISRIC-WISE3) of the Africa Soil Profiles Database.

Additional profile data compiled in version 1.1 were derived from other digital datasets as well as from analogue reports, books and publications available in the ISRIC World Soil Library and other holdings in partner countries, international partner organisations and the internet. The identification of additional profile data required an inventory of possible data holdings (e.g. libraries A, B and C) followed by an inventory of possible data sources (e.g. reports A01, A02 and A03) and of actual, useable profile records (e.g. profiles A01-1, A01-2 and A01-3). This means that possible data sources are inventoried for content of geo-referenced, or geo-referable, soil profile data, with particular focus on soil analytical layer data and important soil field layer data such as coarse fragments content.

Profile data in version 1.2, additional to those in version 1.1, were derived from data sources, additional to those inventoried and used for version 1.1. Data holders considered in the inventory for data sources include:

– ISRIC – World Soil Information, The Netherlands
– FAO – UN Food and Agriculture Organisation, Italy
– WOSSAC - World Soil Surveys Archive and Catalogue, United Kingdom
– IRD – Institut de Recherche pour le Développement, France
– CIRAD - Centre de Coopération Internationale en Recherche Agronomique pour le Développement, France
– USDA / NRCS – Department of Agriculture, Natural Resources Conservation Service, USA
– IICT - Instituto de Investigação Científica Tropical, Portugal
– EthioSIS (/AfSIS) – Ethiopia (/Africa) Soil Information Service, Ethiopia
– WUR - Wageningen University (Department of Environmental Sciences), The Netherlands
– Ghent University (Laboratory of Soil science), Belgium
– Texas A&M (Spatial Sciences Laboratory), USA
– Hohenheim University, Germany
– IER – Institut d'Economie Rurale, Sotuba, Mali
– NSS – National Soil Service, Mlingano, Tanzania
– Ahmadu Bello university (Department of Soil Science), Zaria, Nigeria
– EARO – Ethiopian Agricultural Research Organisation (National Soil Research Center, NSRC), Ethiopia
– KARI – Kenya Agricultural Research Institute, Kenya Soil Survey, Nairobi, Kenya
– ISCW - Institute for Soil, Climate and Water, Ministry of Agriculture, Pretoria, South Africa
– MINAGRI - Ministère de l'Agriculture de l'elevage et de forets, Kigali, Rwanda
– CSIR-SRI – Council for Scientific and Industrial Research, Soil Research Institute, Ghana

2.1.1 Source datasets

Profile data in version 1.2, additional to those in version 1.1, were derived from additional data sources including additional digital source datasets.

Digital soil datasets in version 1.0 adding to the data derived from WISE3 include datasets made available by ISRIC (www.isric.org/data/data-download), knowing: SOTERSAF2004 & 2007, ZASOTER, KENSOTER2007, SOTER_UT2011, SOTERCAF, SENSOTER, WASP and ISIS5 (see Annex 1a for a full overview of source datasets, including acronyms and referencing to the dataset authors and holders). Collation of these datasets resulted in a total of 4,300 geo-referenced unique profiles. At this stage of collation, profile duplicates (some 3,000) were identified by tracing recorded lineages. It is estimated that herewith most duplicates are removed, resulting in unique profile feature IDs, with referencing to the original profile IDs used in the different source datasets (and source reports).

The attribute data of the profile duplicates were compared and, where necessary, merged to produce as completely as possible profile data attribution. Herein, profile layer data from WISE3, with a relatively 'narrow' range of profile layer attributes seen its objectives (Batjes and Bridges 1994), are replaced by profile layer data of profile duplicates from SOTER datasets in which a larger range of attributes may be characterised, when available. Subsequently, the collated profiles were compared with the profiles from WASP and the data of possible duplicates were replaced by the data derived from WASP. Upon comparison of these datasets, some ISIS profiles proved not included in any of the above datasets and those profiles, including profile data, were collated as well.

Other digital source datasets include the online National Cooperative Soil Characterization Database (NCSS), also accessible as the Laboratory Pedon Data Map, of NRCS-USDA (Natural Resources Conservation Service), from which the majority of Sub-Saharan Africa profile data were already included in the above referred to ISRIC datasets. The remaining profiles, only 6, were added to the Africa Soil Profiles Database. Further, digital data sources accessed and collated include the LREP dataset for Malawi (Land Resources Evaluation Project, UNDP/FAO), the TZSDB98 soil database for Tanzania (originally produced for SOTER purposes), the VALSOL dataset for Burkina Faso as served online by IRD, the PEDI dataset for Sanmatenga province of Burkina Faso as produced by Wageningen University, the SOTER datasets for South Benin and West Niger as produced and put online by the University of Hohenheim, the SWALIM datasets for Somalia produced by FAO, and the BORENA district Land Use project database as kindly shared by the National Soil Research Centre of Ethiopia.

Additional digital source datasets collated into version 1.1 include the CONGOSOTER dataset for the Republic of the Congo produced by the university of Leuven for FAO, the KARIDB dataset of selected profile data for Kenya, as compiled according to SOTER conventions and shared by the Kenya Soil Survey (KARI-KSS) and the DROP datasets for Ethiopia, as assembled from various studies and shared by AfSIS / EthioSIS. The ACTD (Arquivo Científico Tropical Digital) is an online registry of IICT profile identifiers for Angola, including identifiers with geo-coordinates but without profile attribute data. The profile identifiers were combined with the corresponding profile attribute data as digitised from analogue reports.

This version 1.2 collates few additional profile data from the SWALIM dataset for Somalia and from an ITC training dataset derived from a study in Cameroon. It does not collate any other profile data from additional digital source datasets. The online South Africa soil dataset (AGIS) of the ISCW provides 2595 profiles identifiers for South Africa including geo-coordinates but excluding soil attribute data. To date, soil attribute data are available only for those 615 profiles previously shared for SOTER purposes. The STIPA dataset holds soil attribute data for 1505 georeferenced profiles of the former French overseas territory, as collected by the former ORSTOM through various studies, and digitised, compiled and kindly made available by CIRAD under the condition that the data are to be released only after having agreed upon an IP protocol. Consequently, the soil attribute data have not been included in the current database, except those as already digitised directly from analogue source reports and as shared by IER, Mali. The dataset associated with the online soil map viewer for Rwanda holds soil attribute data for 1833 georeferenced profiles, as owned by the Ministry of Agriculture (MINAGRI) and developed with the assistance of the University of Ghent, and data are available only for those 47 profiles previously shared for SOTER purposes. The NAFORMA soil dataset (Mäkipää et al., 2012) contains georeferenced soil data from 845 plots recently collected within the framework of the UN-REDD initiative, with support from Finland and oversight by FAO. The dataset is owned by the Tanzanian government and is publicly available under specific restrictions. Georeferenced soil data for over 3,000 point locations are recently collected, with the support of the Netherlands, by the governments of Burundi, Rwanda and Uganda in collaboration with FAO and IFDC. The datasets (e.g. Nduwimana et al., 2013) are publicly available without copyrights but permission for further distribution and use has not yet been granted explicitly.
Annex 1a lists 39 source datasets, together with as completely as possible referencing to the dataset authors and holders. Half of this list refers to direct source datasets and the other half to datasets that were the original source for the WISE3 and SOTER datasets. Note that profile data derived from digital datasets were in some cases complemented with additional data, for the same profiles, from the original source reports.

For each profile feature compiled in the database, the source dataset, if any, is specified.

Source reports
Source reports used for data entry, adding to the soil profile data assembled in Section 2.1.1, are uniquely identified by an ISN number, linking to the ISRIC library item identifiers as accessible through the ISRIC World Soil Information database (http://library.isric.org/). This database provides the report's metadata and a link to the scanned full text original (pdf), when available, which enhances traceability of the data. ISN identifiers also have been assigned to source reports acquired from external holdings, for subsequent data entry, and added to the ISRIC World Soil Information database. Actually, hundreds of African soil maps and soil reports have been added to the ISRIC library during the current inventory and compilation of Africa legacy soil data.

The ISRIC library holds over 34,000 ISN numbered items, also including reports that were source of the soil data compiled in various ISRIC datasets. Those source reports had received different identifiers in the different source datasets, which posed a challenge to the inventory for additional source reports. The source report identifiers in the various datasets have been harmonised during this study by conversion to ISN. This process also facilitated the identification of duplicate profiles, and the unique numbering also enhances future avoidance of duplicated efforts.

For each profile feature compiled in the database, the source report, if any, is specified. The report ID connects to a dictionary table (Annex 1b) which lists the 503 source reports together with as complete as possible referencing to authors and publishers.

Lineage of the profile data can be quite complicated in some cases, where source datasets have derived selections of soil data from each other and/or where source datasets have different, overlapping, selections of soil data from similar source reports or from different source reports with overlapping selections of profile data. In some cases, unique profile identification proved to be more time-consuming than profile data entry.

No lineage could be established yet to the source reports of the dataset compiled and shared by IER, Mali, and by AfSIS (for EthioSIS, Ethiopia).

2.1.2 Source overview

The Africa Soil Profiles Database version 1.2 is derived from 54 data sources. About 25% thereof was extracted from ISRIC datasets, 30% from other digital datasets and 45% from analogue reports (Table 1).

In total, 24,333 unique profiles have been identified and compiled so far of which 22,962 are geo-referenced, including 17,160 geo-referenced profiles with layer attribute data. This adds 1,562 profiles from the latter category to the 15,499 profiles compiled in version 1.1 of the Africa Soil Profiles Database. In total, version 1.2 holds soil attribute data for 18,532 profiles of which 1,370 are nót geo-referenced.

The current database includes an inventory of unique profile IDs, together with full lineage to source datasets and source reports, including the original profile IDs in those data sources, and with lineage to maps and corresponding mapping units.

Note that the various data sources originally produced for various, specific purposes provide soil data of various degrees of validation and associated inherent quality and reliability. Reference soil profile data (ISIS, NRCS) as well as soil profile data representative for FAO soil units or WRB reference groups, harmonised using consistent procedures (SOTER, WISE, WASP), are thus compiled here together with soil profile data of lesser inherent representativeness and lesser degree of previous validation. The inferred quality and reliability of the soil profile data have been rated subjectively per profile record.

Table 1
Overview of data sources (acronyms in Annex 1a).

Data source	Data holder	Number of profiles
Analogue reports	Diverse (mainly ISRIC library)	8,126
BJSOTER	Hohenheim University, Germany	849
BORENA	EARO-NSRC, Ethiopia	213
VALSOL	IRD, France	310
ISIS5	ISRIC, Netherlands	13
SOTER	ISRIC, Netherlands	1,985
WASP	ISRIC - JRC, Netherlands – Italy	540
WISE3	ISRIC, Netherlands	2,222
LREP	MoA, Malawi	3,135
NCSS	USDA, United States of America	15
PEDI	Wageningen University, Netherlands	227
CONGOSOTER	FAO, Italy	28
DROP	EthioSIS (/AfSIS), Ethiopia	546
KARIDB	KARI-NSS, Kenya	77
TCP_ITCR	ITC, Netherlands	147
FAOCSIC	SWALIM-FAO, Somalia	98
NAFORMA	MoNR, Tanzania	0
CATALYST	IFDC, Kenya	0
MINAGRI	Ministry of Agriculture, Rwanda	0
ZA001	ARC-ISCW, South Africa	0
STIPA	CIRAD, France	0
Total		18,532

2.2 Data digitisation and collation

Prior to the setup of the database, a preliminary study of soil data models with soil definitions and standards was carried out, including ISRIC- ISIS, WISE, WASP, SOTER, SoterML, FAO-SDBm, EU-SPADE, INRA-DONESOL, CSIRO-ASRIS, USDA-NCSS, CANSIS and ISO (TC 190 – Soil Quality, TC 345 – Characterisation of Soils). These models and standards are very diverse in configuration and content and pose a challenge to standardisation and interoperability. For this purpose, a soil data modelling workshop was held in Wageningen (2009) and it was concluded to initiate the SoilML initiative to come forward to long term purposes while setting up a pragmatic data entry vehicle to meet immediate AfSIS purposes. In 2010 the IUSS accorded the initiation of such soil data modelling workgroup and important progress has been made since then on developing SoilML in close alignment with ISO initiatives on this subject.

Data entry and collation took place by means of excel tables assuring pragmacy and speed. The tables are organised in a way that reflects basic steps of the workflow and that aligns with basic principles underlying the above mentioned data models. A simplified version of the data entry template is visualised in Figure 2.

NR	DATASET	DATASETACCESS	DATASETHOLDER
1	WISE3	http://www.isric.org/isric/CheckRegistration.aspx?dataset=8	ISRIC
2	SOTERSAF2004	http://www.isric.org/isric/CheckRegistration.aspx?dataset=18	ISRIC

NR	REPORTID	REPORTACCESS
1	13514	http://library.wur.nl/WebQuery/isric/13514
2	13578	http://library.wur.nl/WebQuery/isric/13578
3	27974	http://library.wur.nl/WebQuery/isric/26974

PRID	SRC_DSET	SRC_DSET_PRID	SRC_DSET2	SRC_DSET2_PRID	SRCREPORT	SRCREPORT_PRID	X	Y	Z	T	KEYMETHOD
1	WISE3	TZ120	-	-	13514	101	35.039	-4.298	1635	1979	TZ WISE3/13514/WISE3.TZ02
2	-	-	-	-	13514	104	35.190	-4.507	1690	1979	TZ NA/13514/WISE3.TZ02
3	SOTERSAF2004	TZ1MBP38	WISE3	TZ0014	13578	1MBP38	35.290	-3.700	1335	1995	TZ SOTERSAF2004/13578/SOTERSAF.T
4	-	-	-	-	13578	MP38	35.519	-3.836	1760	1988	TZ NA/13578/SOTERSAF.TZ01
5	-	-	-	-	26974	KP1	32.586	-3.496	1170	1996	TZ NA/26974/AFSP.TZ05

PROFILEID	LAYERID	TOPDEPTH	BOTDEPTH	FLDHORIZON	FLDCOLOR	FLDTEXTURE	GRAVEL	LABCLAY	LABPH	LABOC
2	2_2	15	50	Bcg	-	SCL	3	22	6.5	0.3
2	2_3	50	60	R	-	-	80	-	-	-
3	3_1	0	20	A1	2.5YR3/4	-	-	44	5.7	16.30
3	3_2	20	40	B21t	2.5YR3/4	-	-	55	5.4	10.20
3	3_3	40	90	B22t	2.5YR3/4	-	-	54	5.6	8.20
3	3_4	90	140	B31	2.5YR3/4	-	-	15	6.8	2.10
4	4_1	0	36	-	7.5YR2.5/0	C	0	74	7.6	25.20
4	4_2	36	85	-	7.5YR2.5/0	C	0	77	7.9	18.60
4	4_3	85	125	-	7.5YR2.5/0	C	0	79	7.5	18.20
5	5_1	0	10	-	-	S	0	4	5.5	2.1
5	5_2	10	30	-	-	S	0	8	4.3	0.2

KETMETHOD	LABMANUAL	FIELDMANUAL	GEOREF	SOILCLASS	GRAVEL	LABCLAY	LABPH	LABOC
TZ WISE3/13514/WISE3.TZ02	WISE3.TZ02	TZCA	WGS84, DMS	FAO1974	CF02	TE01	PC04	OC01
TZ NA/13514/WISE3.TZ02	WISE3.TZ02	TZCA	WGS84, DMS	FAO1974	CF02	TE01	PC04	OC01
TZ SOTERSAF2004/13578/SOTERSAF.TZ01	SOTERSAF.TZ01	FAO1977	UTM37S, M, CLARKE1880	FAO1988	CF04	TE01	PH02	OC01
TZ NA/13578/SOTERSAF.TZ01	SOTERSAF.TZ01	FAO1977	UTM37S, M, CLARKE1880	FAO1988	CF04	TE01	PH02	OC01
TZ NA/26974/AFSP.TZ05	AFSP.TZ05	FAO-ISRIC1990	UTM36S, M, CLARKE1880	FAO1988	CF02	TE01	PH02	OC01

Figure 2

Data entry tables, with five illustrative profiles.

The central entry table (in the black rectangle) represents the inventory of soil profile records. For each profile record, the profile ID is included together with profile attribute values such as X-Y coordinates (WGS84), soil type and site data. The profile ID also serves as a key to connect to a separate table for the profile layers with profile layer attribute-values. The profile record includes keys that specify lineage to source datasets and reports (the upper two tables) and a key that specifies the collection of methods applied to assess the reported attribute values (the lower table).

A number of data models explicitly defines the attribute as a separate entry, thus not as a column heading. Figure 3 illustrates an additional data entry table, wherein the attribute names are defined explicitly by separate entries. These attribute names correspond to the column headings of the two central tables of Figure 2 that hold the actual soil data.

aAttr	aLyrObj	aCfPc	aCfLabPc	aSand	aSilt	aClay	aSumTxtr	aBlkDens	aPHH2O	aPHKCl	aPHCaCl2	aEC
Attr	LyrObj	CfPc	CfLabPc	Sand	Silt	Clay	SumTxtr	BlkDens	PHH2O	PHKCl	PHCaCl2	EC

Figure 3

Data entry table, for explicit definition of attributes.

Prioritisation of data entry is much dependent on the labour intensity of the workflow. Priority is given to digital datasets, which are relatively easy and quickly processed and imported into the entry tables. Data from scanned reports, which are made machine readable by OCR'ing, are simply copy-pasted into tables for being checked/corrected and converted when necessary prior to collation into the definitive entry tables. Manual data entry is slowest, but necessary for areas that still lack digital data.

Subsequently, the data entry tables have been imported into a spatial database environment (see next section) to enhance robustness and ensure data integrity, to permit for data querying and to verify geo-locations.

2.3 Database structure

The database structure of version 1.2 of the Africa Soil Profiles Database is similar to that of versions 1.0 and 1.1.

The Africa Soil Profiles Database is a relational spatial database. It is compiled in an ArcGIS environment (mxd) and consists of a number of interlinked dbf tables and a shapefile with spatial point features. The data are readily converted to other formats, such as Access, Excel, SQL, Filemaker, Fusion, XML, KML or ASCII text. The database itself will be embedded into the federated database of the World Soil Information Service or WoSIS (Tempel and Kraalingen, 2011) and the data are (partly) visualised through the WorldSoilProfile.org portal.

Included with the Africa Soil Profiles Database is a query, exported as a flat table into KMZ format (AfSP012Qry_ISRIC.kmz), to facilitate viewing of a selection of the data in Google Earth.

2.3.1 Considerations

The database structure is set up such that querying of the different tables permits that the feature, attribute, method and value, as well as lineage, can be reconstructed and made explicit for each entry in the database. Herewith, the soil profile data are expressed as results of observations and measurements (O&M), in line with GeoSciML and WoSIS conventions. This also implies that each entry is considered to be composed of a feature, attribute (plus unit), method and value.

Rigid application of the O&M concept, compiling the data as individual observations or measurements, entry by entry, would yield a single basic table with only five basic columns (feature, attribute, method, value and lineage). However, this would make data entry time inefficient and would create much redundancy, particularly because of the considerable number of different attributes that are associated with each feature combined with comparable numbers of corresponding methods and values. The resulting table would be hundreds of thousands of records (rows) long.

Therefore, the data are compiled as 'collections of observations and measurements', with the profile record corresponding to such a collection. Such record is basically composed of the above mentioned five basic columns, with 1) the profile ID (serving as record ID and feature ID), 2) the lineage ID and 3) the associated collection of attribute-values, with two additional keys to relate to separate tables for 4) the associated collection of attribute-methods and 5) the associated collection of attribute-names.

The nature of legacy soil profile data dictates a slightly more elaborated setup. The features (profiles) include subfeatures (profile layers), with profile-attribute values distinguished from layer-attribute values. The values, standardised and quality controlled, are distinguished from the original values. A query or join of the various separate tables would result in a single flat table comparable to that illustrated in Table 2, showing how the lineage, feature (and subfeature), value (and original value), method and attribute are reconstructed and made explicit for each entry in the database.

Table 2
Simplified outline of a flat table resulting from a query or join of related tables.

Lineage	Feature & subfeature		Value		OriginalValue		Method		Attribute	
Source	ProfileID	LayerID	Sand	Clay	oSand	oClay	mSand	mClay	aSand	aClay
A	A01	A01_1	24	48	42	-	TE02	TE02	Sand	Clay
A	A01	A01_2	10	40	-	-	TE02	TE02	Sand	Clay
A	A01	A01_3	-	-	-	-	-	-	Sand	Clay
A	A02	A02_1	65	5	-	50	TE01	TE01	Sand	Clay
B	B01	B01_1	98	1	-	-	-	-	Sand	Clay

2.3.2 Tables

The full schema of the current database holds seventeen tables, including seven dictionaries, as specified in Table 3. *Profiles* is the central table of the database, through which all other tables relate. It holds the profile inventory and the IDs and keys to relate to the other tables, as well as the profile soil and profile site data.

Table 3
Overview of the names of tables included in the database.

Data tables	*Dictionaries*
Profiles, with profile soil attribute-values	*DictioSrcDBases*
Profiles *(central table)*	*DictioSrcReports*
OriProfiles	
GeoPoints (shapefile)	
Layers, with layer soil attribute-values	
Layers	
OriLayers	
Methods	*DictioLabs*
AttrMethods	*DictioLabMethods*
Attributes	*DictioAttributes*
Attrs_1Profiles	*DictioRefs*
Attrs_2LayerFld	*DictioClassValues*
Attrs_3Layerlab	
AttrUnits	

Note: The *Attrs* tables (*Attrs_1Profiles, Attrs_2LayerFld* and *Attrs_3LayerLab)* have no specific added value for the database or for the soil data, except for making the attributes, associated with the reported attribute-values, explicit by entry, and for relating the attribute-values to the attribute dictionary.

Added to this version 1.2 are the tables *OriAttrMethods* and *OriAttrUnits*, indicating the original description of the method and the original unit of expression, before standardisation. The details of these tables are not further described nor included in the annexes. For full consistency, the database should also include *OriAttrs* tables *(OriAttrs_1Profiles, OriAttrs_2LayerFld, OriAttrs_3LayerLab)*, giving the attribute or soil property as originally reported, before standardisation. Such fully consistent database structure, or data model, would permit full data exchange between different databases with different data models, but it is beyond the scope of this work to have this mechanism worked out ánd have the database populated accordingly.

Also added to this version 1.2 and not further described is the database table *MapUnits*. This table permits to relate the data of a single profile to the lat-lon coordinates of, possibly multiple, polygon centroids.

2.3.3 Table column headings

An overview of the table column headings, except for those of the dictionary tables, is given in Annex 2. Each column in this annex represents a table, and each row a column heading in that table. All these 'parallel' column headings are near-similar and are all associated with the same attribute code as given by the annex' most left column.

The meaning of the column headings is explained, indirectly, by the attribute codes of the annex' most left column. Annex 3a gives the same list of attribute codes with their explanation. The explanation includes the data type, the unit of expression, a boolean indicating whether the attribute reflects a soil property or not (1/0), and a short and long description of the attribute plus a reference to the standard definition of the attribute, if available.
Annex 3b describes the column headings of the dictionary tables. Annexes 2 and 3 are extracted from the attribute dictionary table, *DictioAttributes.*

The tables *Profiles, Layers* and *GeoPoints* compile the actual soil features and soil attribute values. The column headings of these tables are identical to the attribute codes listed in annexes 2 and 3a.

The column headings of the other tables are almost similar, with an additional letter added as prefix. The prefix is o, m, u and a in tables *OriProfiles & OriLayers, AttrsMethods, AttrUnits* and *Attrs,* respectively, and indicates that the column heading refers to original values, to method codes, to units and to attribute codes, respectively.

The length of the list of attribute codes in annexes 2 and 3a is a five-fold reduction of the length of the list that would be necessary to explain all column headings in a direct manner. Note that the attribute codes of annexes 2 and 3a are those as made explicit by entry in the *Attrs* tables *(Attrs_1Profiles, Attrs_2LayerFld, Attrs_3LayerLab)*.

As an example, OrgC is the heading of the column in table *Layers* that gives the standardised values for OrgC. aOrgC is the heading of the column in the *Attrs* table (*Attrs_3LayerLab)* that explicits the attribute code concerned (which is OrgC and thus described in the attribute dictionary (Annex 3a) as Organic Carbon). uOrgC is the heading of the column in table *AttrUnits* that specifies the unit of expression for OrgC, which is g/kg, and mOrgC heads the column in table *AttrMethods* that specifies (a code for) the method applied to measure OrgC. This method code is described in the method dictionary table, *DictioMethods* (Annex 4). oOrgC heads the column in table *OriLayers* that gives the original values for OrgC.

2.3.4 Relations between tables

Figure 4 shows the full schema of the relational database, visualising how the various tables relate to one another. Each block represents a database table, with the texts representing the table column headings. The lines between tables represent relations between tables with a column with equal relational keys in both tables. The relational structure permits to select records in one table based on the querying of records in another table.

Table *Profiles* is the central database table through which all other tables connect. It compiles the profile records inventory, with for each record a specification of the relational keys to relate to the other tables.

The column headings for the relational keys in the *Profiles* table are given by Table 4 together with the column headings for the corresponding keys in the related tables (as extracted from Annex 2).

SrcDBase1ID (and 2ID) and SrcRep1ID (and 2ID) are keys that relate to the lineage dictionary tables, *DictioSrcDBases* and *DictioSrcReports*, respectively, giving the full references for the source datasets and reports.

LabMnl_ID is a key to relate to the dictionary table, *DictioLabs,* wherein the laboratory is described with a reference to a laboratory manual, when available.

The ProfileID key relates to the *GeoPoint* table with shapefile. Besides Profile IDs, this table also includes columns with layer IDs to facilitate the creation of flat tables with the layer values of subsequent layers compiled in a single row (rather than in subsequent rows as is the case in the *Layers* table).

The ProfileID is also the key to relate to the *Layers* table. This table compiles the profile layer subfeatures combined with the associated collections of standardised layer-attribute-values.

The ProfileID and the LayerID are keys that relate to the *OriProfiles* and *OriLayers* tables, respectively, wherein the original values, prior to standardisation or possible correction, are compiled.

The MethdKey, UnitKey and AttrKey are keys relate to the *AttrMethods*, *AttrUnits* and *Attrs* tables, respectively. These tables compile the collections of attribute-methods (codes), attribute-units and attribute names (codes) as associated with the compiled collections of soil feature attribute values.

(The *Attrs* table is for technical reasons split into tables *Attrs_1Profiles, Attrs_2LayersFld* and *Attr_3LayerLab.* The reason is that the table, with only a single row, would be too wide containing too many columns to fit into an Excel spreadsheet).

To relate the *AttrMethods* table and *Attrs* tables to their respective dictionaries is a bit more elaborate. The configuration is copied from the WISE3 database, wherein the method codes given in different columns relate to the method codes as given in a single column (different rows) in the dictionary. This implies that each column in the *AttrMethods* table and *Attrs* tables serves as a key to relate to its dictionary. Table 5 illustrates this for four columns in the *AttrMethods* table and four columns in the *Attrs* table.

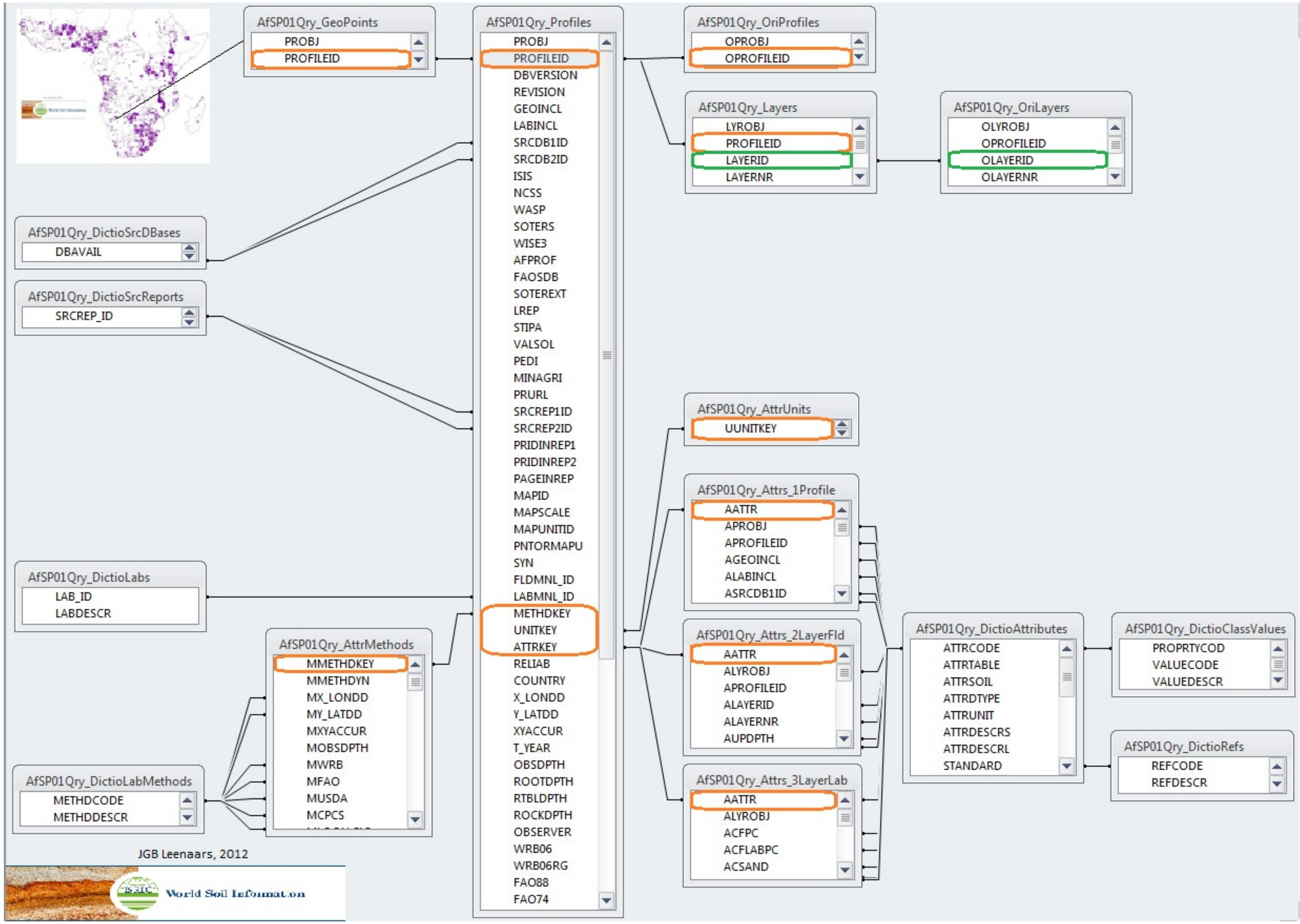

Figure 4

Database schema visualised, including 17 tables and 1 shapefile.

Table 4
Table column headings with relational keys, to relate the central table Profiles to the directly associated tables.

Profiles	Layers	OriProfiles	OriLayers	GeoPoints	AttrMethods	AttrUnits	Attrs	DictioSrcDbases	DictioSrcReports	DictioLabs
PrObj	-	oPrObj	-	PrObj	-	-	-	-	-	-
ProfileID	ProfileID	oProfileID	oProfileID	ProfileID	-	-	-	-	-	-
SrcDb1ID	-	-	-	-	-	-	-	SrcDb_ID	-	-
SrcDb2ID	-	-	-	-	-	-	-	SrcDb_ID	-	-
SrcRep1ID	-	-	-	-	-	-	-	-	SrcRep_ID	-
SrcRep2ID	-	-	-	-	-	-	-	-	SrcRep_ID	-
MapID	-	-	-	-	-	-	-	-	-	-
FldMnl_ID	-	-	-	-	-	-	-	-	-	-
LabMnl_ID	-	-	-	-	-	-	-	-	-	Lab_ID
MethdKey	-	-	-	-	mMethdKey	-	-	-	-	-
UnitKey	-	-	-	-	-	uUnitKey	-	-	-	-
AttrKey	-	-	-	-	-	-	aAttrKey	-	-	-
-	LayerID	-	oLayerID	LayerID00	-	-	-	-	-	-
-	LayerID	-	oLayerID	LayerID99	-	-	-	-	-	-

Table 5
Table column headings with relational keys, to relate the tables AttrMethods and Attrs to the associated dictionary tables.

AttrMethods	*Attrs*	*DictioMethds*	*DictioAttribs*	*DictioClassVal*	*DictioRefs*
mMethdKey	-	-	-	-	-
-	**aAttrKey**	-	-	-	-
mX_LonDD	-	MethdCode	-	-	-
mSand	-	MethdCode	-	-	-
mClay	-	MethdCode	-	-	-
mOrgC	-	MethdCode	-	-	-
-	aX_LonDD	-	AttrCode	ProprtCod	-
-	aSand	-	AttrCode	ProprtCod	-
-	aClay	-	AttrCode	ProprtCod	-
-	aOrgC	-	AttrCode	ProprtCod	-
-	-	-	Standard	-	RefCode
-	-	-	Standard2	-	RefCode

The table column AttrCode in the *DictioAttributes* table is the key that relates 1 : n to table column heading ProprtCod in the *DictioClassValues* table which explains the meaning of the class values compiled by attribute (see Annex 5a). Standard and Standard2 are column headings that are keys that relate to RefCode in the *DictioRefs* table which lists and gives reference to a number of soil standards.

Note that empty numeric fields (no value) are represented with -9999 and empty text fields by NA.

2.4 Observations and measurements

2.4.1 Profile records inventory

The profile record is considered a collection of observations and measurements, implying that the feature, attribute, method and value can be reconstructed and made explicit for each entry associated with the profile record.

The profile records inventory is compiled in database table *Profiles*. As described in the previous section, the profile record is composed of keys to relate to the other database tables, with IDs for the profile record itself (ProfileID; corresponding with the profile feature), for the data sources, and for the collections of attributes, units, methods and values (with the values for the profile feature attributes compiled into the same table).

The uniqueness of the profile record is defined by its lineage. Details on lineage include IDs for source databases and source reports, as described in Section 2.1 and given in annex 1a and 1b, and the original profile IDs as originally noted in the data source. This explicit administration of original profile IDs facilitates the identification of duplicate records and enhances the traceability of the data compiled. Lineage to the original mapping unit, if any, is also given.

Also included with the record inventory are booleans to facilitate querying according to data completeness. Information is given on whether the reported soil data represent primary data as observed or measured from a true profile or represent secondary data as derived from a mapping unit, or whether the data are synthesised. In fact, all compiled data represent true profile point observations, except for 0.5% of the records derived from (generalised) mapping units. The perceived reliability and overall quality of the recorded soil data is rated on a scale from 1 to 4 (high to low reliability). See Section 2.4.3 for more details about the data compiled for the profile record.

2.4.2 Profile features

The feature represents an actual physical piece of soil, upon which an observation or measurement is carried out. Whereas the uniqueness of the profile record is defined by its lineage, the observed profile feature is defined by its position in spatio-temporal 4D space (geographic location, depth interval and date of observation).

The profile features are compiled together with the profile records inventory in database table *Profiles,* with ProfileID as the profile feature ID. The profile is defined by its attribute values, compiled in the same table, including values for geographic coordinates (x, y), depth of observation (z) and year of observation (t), as well as the name of the observer(s).

Other data given for the profile feature are depth of rooting, rootability and bedrock, as specified by the data source, and the type of soil according to different classification systems, also as specified by the data source. Compiled with the data on the profile are data on the profile site, including values for topography, parent material, land cover, drainage, etc. See Section 2.4.3 for details about the profile feature and site attributes that are compiled in the database.

2.4.2.1 Spatial profile features

The geographic location of the soil profile feature can be defined as a point (derived from a pair of x-y coordinates), a polygon (derived from a mapping unit) and/or a raster grid cell (derived from a point or a polygon).

The current version of the database includes the shapefile *GeoPoints.* The *GeoPoints* shapefile projects x-y coordinate pairs, or points, upon a geographic surface and is thus a map or visualisation of the profile-feature point locations. Figure 1 is such a map, as are Figures 5 and 7, both produced with the same shapefile *GeoPoints*.

The shapefile is purposely separated from the *Profiles* table in anticipation of the possible digitisation of legacy soil maps with the mapping units compiled into a single shapefile. Such a shapefile permits to project the profile features as geographic polygons instead of geographic points. It can be argued that the profile location is represented more reliably by a (inaccurate) mapping unit or polygon, serving as a spatial domain of likeliness of occurrence of the profile, compared to being represented by an (inaccurate) point, especially when considering to relate the soil profile data to environmental (scorpan) covariate data of high resolution. The lineage of the profile record to mapping units is therefore included with the record inventory. Version 1.2 of the database includes the *MapUnits* table which contains point locations (polygon centroids) derived from mapping units, permitting a single profile to be geolocated by numerous point locations as previously surveyed and mapped. Actually, the table contains thousands of spatial reoccurences of 8 profiles.

The original geographic coordinate system may differ from one batch of profile records to another. If specified in the data source, the coordinates (and system used) are simply copied into the database. When necessary, these are converted from the original projected coordinate system (e.g. UTM 37-S, meters) to the standard system (WGS84, decimal degrees). Profile locations are plotted using the standard WGS84 coordinates to verify their location; i.e. whether they correspond with the site description, the study area or at least the country outline. It is not uncommon that the data source provides coordinates where lat-lon have been inverted (for example, E/N instead of W/S). In such case, the original coordinates recorded in the *OriProfiles* table are maintained and the standard coordinates in the *Profiles* table are corrected.

A large portion of the data sources, from the pre-GPS era, does not provide any explicit coordinates. In such situations, a profile's point location is plotted on a paper map or is only given as a descriptive location (e.g., 5 km from village X in the direction of village Y, in county Z). Sometimes, only the location of the study area is provided. This inferred level of accuracy in X-Y coordinates has been documented in the database.

When available, the point location map is scanned, geo-referenced and projected upon WGS84, and the coordinates for the points are assessed. See Figure 5 for examples from Nigeria (also described by Odeh et al., 2012).

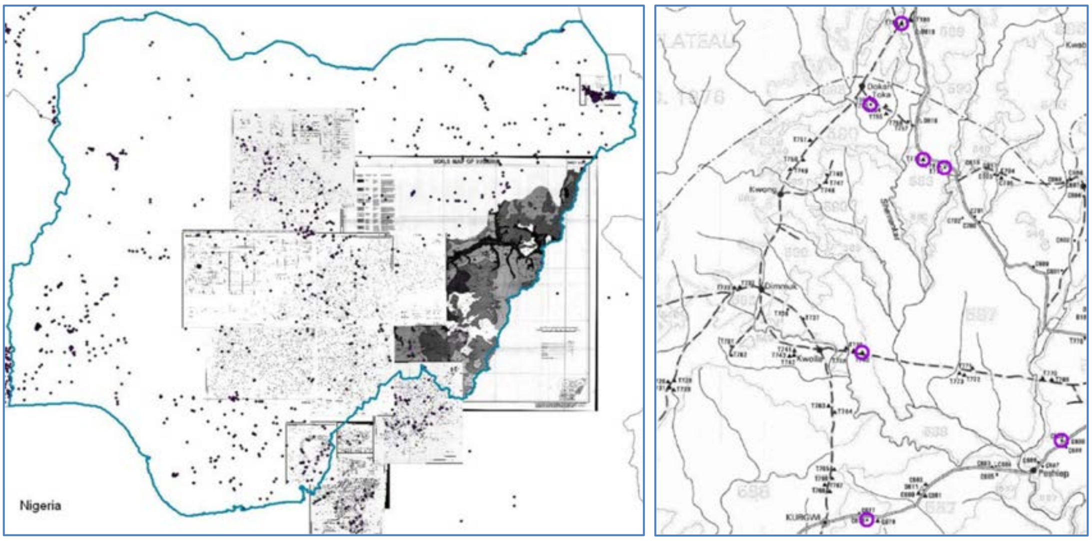

Figure 5
Assessment of WGS84 coordinates by means of point location maps projected upon a WGS84 defined geographic surface.

Less accurate are descriptive locations of which the actual point location, with coordinates, is interpreted and arbitrarily assessed with the help of functionalities of GeoNames or Google Earth. This laborious approach (referred to by method code GE under column mX_LonDD in table *AttrMethods*) is illustrated by Figure 6, where the descriptive location is combined with the reference made to the soil mapping-unit in an effort to estimate the location as accurately as possible.

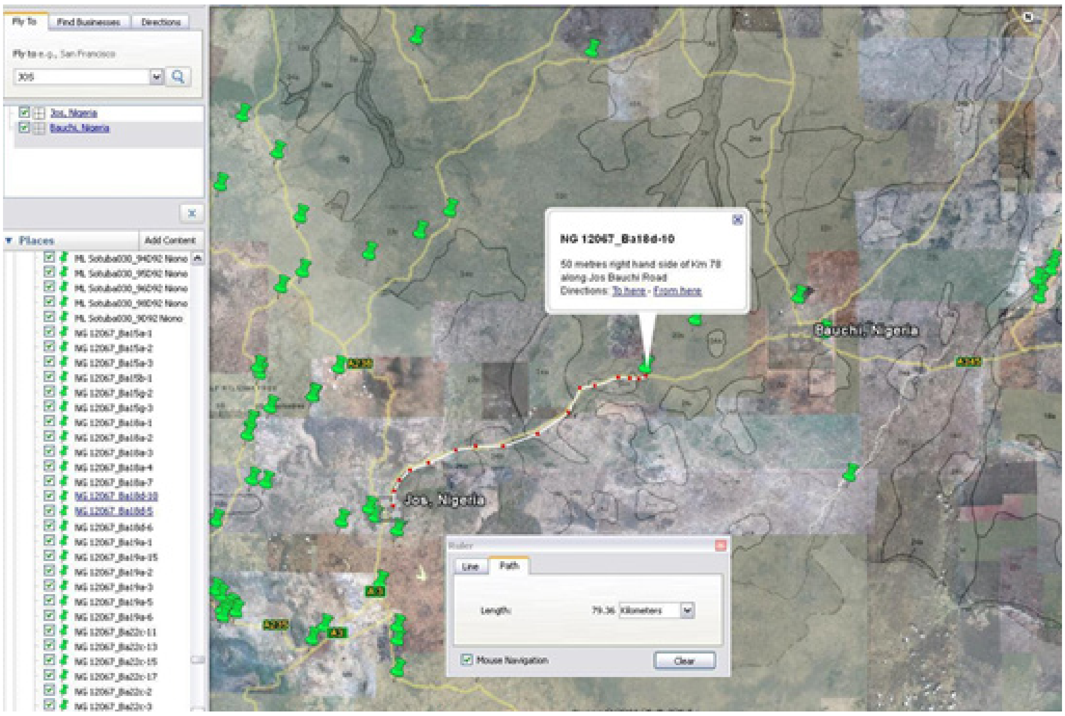

Figure 6

Assessment of WGS84 coordinates by interpretation of descriptive locations, combined with reference to the reported mapping unit, by projection of the soil map upon the WGS84 defined geographic surface of Google Earth.

For batches of profile records that lack geographic information but are located in data scarce regions, a next level of lesser accuracy is accepted out of necessity. The profiles from such batches are all georeferenced by the coordinates from the centre of the (relatively small) study area concerned.

The *Profiles* table gives the estimated precision (in WGS84, decimal degrees) of the lon-lat coordinates per feature; this uncertainty may be considered explicitly in geo-statistical analyses. The recorded values represent the diameter, not the radius, of the circle of uncertainty around the recorded point location. On average, the positional precision is 0.0235 decimal degrees (some 2.35 km near the equator) based on all 14,744 profiles for which the estimated precision is recorded. However, exceptionally imprecisely positioned (0.1 - 1 decimal degrees) profiles not considered (470), the average positional precision would be 0.007 decimal degrees (some 700 m). More relevant is the median precision which is 0.0025 decimal degrees (or 0.002 excluding the exceptionally imprecise values) which corresponds to about 250 m. A cumulative frequency distribution shows that 90% of the profiles is geo-referenced with a precision between 1 and 700 m (Leenaars et al., 2014). Relationships with spatial covariate data should be established preferably at a medium resolution only.

2.4.2.2 Spatial profile subfeatures

The profile subfeature or profile layer is defined by its position in 4D space. The difference with the profile feature is the narrower depth interval observed.

The profile subfeatures are compiled in database table *Layers* and are identified by LayerID. On average, four layers are reported per profile. The layers are sequentially numbered, with positive numbers increasing with increasing depth below ground. The depth interval is defined by the upper and lower limits in cm, with positive limits increasing with increasing depth belowground. One single aboveground layer (e.g. litter) can be added to the sequence of profile layers, with layer number = 0, and a negative upper depth limit. (Note that the latter is not in accordance with current FAO standards).

The profile subfeatures can represent in-field distinguished and described morphologic horizons as well as in-field sampled depth intervals, with the sample submitted to a laboratory for chemical and physical analyses. Sampled depth intervals may coincide with or fall within morphologic depth intervals, with the samples being considered representative for the horizons, but also may not coincide with morphologic depth intervals. In the latter case, the sequential layers with sequential depth limits are defined based on the soil analytical sample layering, but with adaptation to morphology if possible or if necessary according to expert insight. Where relevant, a distinction has been made between depth of layers, depth of samples and depth of horizons, in the table *OriLayers* (see Section 2.4.6).

Profile features for which only one subfeature (top layer) is reported are generally excluded from the compilation, except when the profile is actually very shallow over bedrock (e.g. lithic Leptosols) or hardpan, and when the profile is located in a data scarce area.

The layer data include attribute values observed in the field and attribute values measured in the laboratory. See Section 2.4.3 for details about the list of layer attribute data that are accommodated in the database.

Besides ProfileIDs, the attribute table for shapefile *GeoPoints* gives separate columns with LayerIDs (00-14). This facilitates the creation of a single flat table, with all soil data per profile compiled into a single row, including the layer data of subsequent layers. (Note that such particular data model is not efficient for the compilation and manipulation of legacy soil data, but is efficient for certain applications such as currently applied in GSIF).

The *GeoPoint* shapefile with flat table can be exported into KML format for simple data exchange and visualisation in Google Earth, as illustrated in Figure 7. Included with the Africa Soil Profiles Database is such file (AfSP012Qry_ISRIC.kmz) holding data for a selection of attributes for the first five layers. (Note that the data headings for the different layers, as illustrated for the 2nd and 3rd layers in Figure 7, cannot correspond to the column headings of the *Layers* table because the flat table requires the layer numbering to be included in the data headings, which is not the case in the *Layers* table).

2.4.3 Attributes

The attribute is the feature property that is intended to be observed or measured by applying a given method to a feature to generate a value. By definition, the reported value is the outcome of the method applied to the feature. The grouping of outcomes of different methods under a single soil attribute is basically the simplest form of soil data harmonisation. (Harmonised values are defined as values that meet a standard attribute definition; see Section 2.4.5.3).

The attribute-values are compiled by tables *Profiles, OriProfiles, GeoPoints, Layers* and *OriLayers*. The corresponding attributes are made explicit by entry of attribute codes, into the *Attrs_123* tables. These attribute codes are described in detail by the *DictioAttributes* table and Annex 3a.

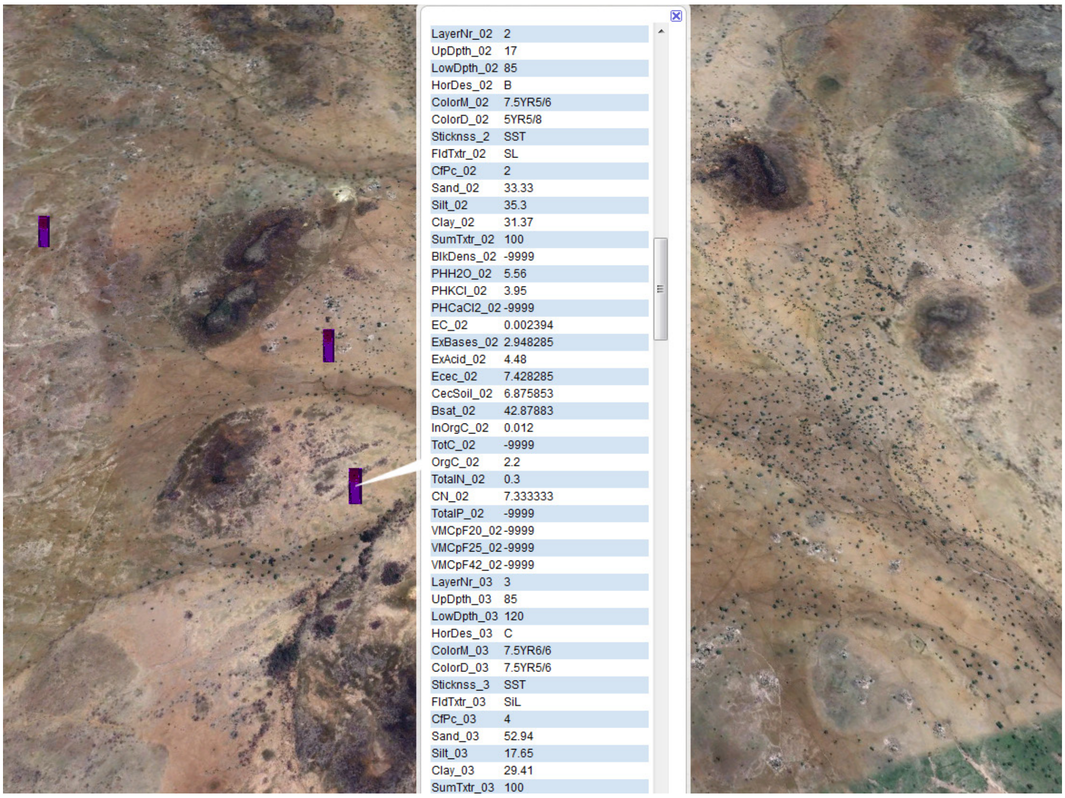

Figure 7

Visualisation in Google Earth of a query of soil profile and layer data exported as a flat table to KMZ format, with the data of subsequent layers aggregated into a single profile record (a single row).

These attributes are, as explained in Section 2.3.3, not necessarily soil attributes, but also include auxiliary attributes that describe the observation itself (e.g. name of the observer, source report title) or that facilitate database functioning (e.g. object identifier, key to dictionary).

The soil attributes are as much as possible defined according to SOTER conventions (Van Engelen and Dijkshoorn, 2013). This is the case for attributes with reference to eSOTER2012, as specified in the column 'Standard' of Annex 3a**.** The actual definitions, however, are less specific though, because the soil attribute definitions in the Africa Soil Profiles Database are exclusive of standard-method. Other referred to standards to define attributes are also given in Annex 3a.

For numerical attributes, the standard unit of measurement is specified, in accordance with eSOTER2012 standards, where applicable. Descriptive values are standardised by codification (see Annex 5a), where applicable according to eSOTER2012 coding conventions.

Exceptions to eSOTER2012 conventions for standardisation include:
- Abundance of (surface) salt or alkali is expressed as presence (Y/N) of salt or alkali.
- Abundance and thickness of roots is expressed as presence (Y/N) of roots.
- Abundance, distinctness and colour of mottles are expressed as presence (Y/N) of mottles.
- Abundance of mineral concretions, nodules, rock fragments etc. is aggregated and expressed as coarse fragments content.
- P2O5 is expressed as P
- Fe2O3 is expressed as Fe
- Al2O5 is expressed as Al
- Parent material is expressed as class values according to -an intermediate version developed for-eSOTER2012, as given in Annex 5b.
- Horizon designation is expressed as provided by the data source (i.e., not converted to FAO1990/FAO2006 standards).
- Layer numbering starts with number 1 for the first belowground (mineral) layer, and not necessarily for the first layer of observation which, in eSOTER2012 and according to international standards, may also include aboveground layers (e.g. litter). The aboveground layer, if reported, is given number 0, with negative values for depth.
- The standard method to assess the attribute is not included in the attribute definition.

An overview of the attributes, for which values are standardised and compiled in the *Profiles* and *Layers* tables, is given in Tables 6 and 7, respectively. The definitions are given in Annex 3a. The attributes highlighted in purple are the key soil attributes for GlobalSoilMap. The attribute definitions according to GlobalSoilMap specifications are given in Annex 7. Data for these attributes are compiled with priority, together with those in red, defining the features, and those in blue, defining the associated methods, attributes and units.

Available water holding capacity is routinely assessed by subtracting water content at wilting point from that at so-called field capacity. According to GlobalSoilMap specifications (see Annex 7) the water holding capacity is to be assessed by a (continuous) pedotransfer function. Wösten et al. (2013) validated such pedotransfer function (PTF), for assessing Van Genuchten parameters derived by Hodnett and Tomasella (2002) for tropical soils, with soil data from the Africa Soil Profile Database, version 1.0, including volumetric water content assessed at various tensions. The PTF has also been applied to the entire dataset of the current version 1.2 but the results are not reported here.

To serve purposes other than geostatistical digital soil mapping, such as soil and terrain area class mapping requiring profile data to be classifiable, other soil attributes, also requiring descriptive values, are included as much as possible.

The consistency of the actual entry of descriptive values was not optimal in all cases, depending on the relative importance given to the attribute and on the associated effort required. Soil type, classified according to WRB (2006), FAO1988, FAO1974, USDA, CPCS and/or the local classification system, is included if provided by the data source. However, no attempt has been made here to correlate all profiles to the FAO Legends or WRB system, unlike for eSOTER2012 and similar, seen the objectives and means given for this AfSIS project activity. Site attribute data such as landform or land use, observed in the field, are included in near all cases if provided by the data source, while morphologic horizon attribute data, also observed in the field, are excluded in most cases except when digitally available. Effort is given to at least include descriptive values for field observed volume of coarse fragment content as this attribute is, together with depth, determinant for soil volume. Soil analytical layer attributes, measured by laboratory methods (quantitative data), are included in all cases, except for very rare attributes.

The following colours are used in Tables 6 and 7 to indicate different types of attributes:

Feature identifier
Attribute that defines feature
Attribute that keys to other tables
Attribute that is mapped by GlobalSoilMap.net
Attribute

Table 6
*Profile attributes * in database table Profiles.*

Database administration	**Position of feature**
Profile record number	Country
Profile ID (Feature key**)**	Longitude WGS84 DD
Database version	Latitude WGS84 DD
Database revision	Lat-lon accuracy WGS84 DD
Geo data included Y/N	Year of observation
Analytical data included Y/N	Observation depth
Lineage	Rooted depth
1st source dataset	Rootable depth
2nd source dataset	Depth to bedrock
Original profile ID in source dataset ISIS	Observer
Original profile ID in source dataset NCSS	**Soil classification**
Original profile ID in source dataset WASP	WRB 2006 reference soil group, incl. qualifiers
Original profile ID in source dataset SOTER(S)	WRB reference soil group
Original profile ID in source dataset WISE3	FAO 1988 soil unit
Original profile ID in source dataset FAOSDB	FAO-Unesco 1974 soil unit
Original profile ID in source dataset SOTER-EXT	USDA soil class
Original profile ID in source dataset LREP	CPCS soil class
Original profile ID in source dataset STIPA	Local soil class
Original profile ID in source dataset VALSOL	**Site**
Original profile ID in source dataset PEDI	Descriptive location
Original profile ID in source dataset MINAGRI	Altitude
Source url	Slope gradient
1st source report	Topography
2nd source report	Major landform, conform to SOTER
Original profile ID in 1st source report	Slope form at site
Original profile ID in 2nd source report	Position on slope
Page in report	Flooding frequency
Map identifier	Parent material at site
Map scale	Lithology of surroundings
Mapping unit	Regolith
Profile or mapping unit	Land cover
Synthetic profile Y/N	Land use
Keys to Method and Attribute codes	Drainage
Field manual identifier	Surface drainage
Laboratory (manual) identifier	Surface stoniness
Key to methods	Surface salt or alkali
Key to units of expression	
Key to attributes	
Inferred profile data quality	

* Profile attribute definitions, exclusive of specific method, are given in Annex 3a.

Table 7
*Profile layer attributes * in database table Layers.*

Database administration	Exchangeable H
Layer object number	Exchangeable Al
Profile ID (Feature key)	Exchangeable acidity
Layer ID (Subfeature key)	Effective CEC
Layer number in profile	CEC soil
(Sub)feature definition	CEC soil, 2nd measurement
Layer upper depth	Base saturation
Layer lower depth	Base saturation, 2nd measurement
Sample composition	CaSO4
Sample identifier	CaCO3
Sample availability	Inorganic carbon
Layer field observations	Total carbon
Horizon designation	Organic carbon
Colour - moist soil	Total nitrogen
Colour - dry soil	CN ratio
Mottles - presence	Total P
Structure grade	Volumetric moisture content at pF 0.0
Structure size	Volumetric moisture content at pF 0.5
Structure type	Volumetric moisture content at pF 1.0
Stickiness when wet	Volumetric moisture content at pF 1.5
Salt or alkali - presence	Volumetric moisture content at pF 1.7
Roots - presence	Volumetric moisture content at pF 1.8
Particle size class - field	Volumetric moisture content at pF 2.0
Coarse fragments class - field	Volumetric moisture content at pF 2.2
Coarse fragment content	Volumetric moisture content at pF 2.3
Layer lab measurements	Volumetric moisture content at pF 2.4
Coarse fragment content -lab	Volumetric moisture content at pF 2.5
Sand	Volumetric moisture content at pF 2.7
Silt	Volumetric moisture content at pF 2.8
Clay	Volumetric moisture content at pF 2.9
Sum of fine earth fractions	Volumetric moisture content at pF 3.0
Bulk density	Volumetric moisture content at pF 3.3
pH H2O	Volumetric moisture content at pF 3.4
pH KCl	Volumetric moisture content at pF 3.5
pH CaCl2	Volumetric moisture content at pF 3.6
Electrical conductivity	Volumetric moisture content at pF 3.7
Electrical conductivity, 2nd measurement	Volumetric moisture content at pF 4.0
Soluble cations	Volumetric moisture content at pF 4.2
Soluble anions	Volumetric moisture content at pF 5.0
Exchangeable Ca	Volumetric moisture content at pF 5.8
Exchangeable Mg	Volumetric available water content
Exchangeable Na	Lab derived texture class
Exchangeable K	Clay mineralogy
Exchangeable bases	

* Profile layer attribute definitions, exclusive of specific method, are given in Annex 3a.

2.4.4 Methods of observation or measurement

The method refers to how a feature-attribute-value is observed or measured.

The wide variety of data sources (540) reflects a wide variety of methods applied to observe, measure and record soil property values. This variety is further accentuated by the large number of laboratories (>100) associated with the various data sources with inter-laboratory variability in cases exceeding inter-method variability (also see Labex programme, http://www.isric.org/projects/laboratory-methods-and-data-exchange-labex, and WEPAL). This has impact on the comparability of values reported for similar attributes. Different analytical methods and class-limits, applied to assess a similar feature-attribute, may result in different outcomes or values. The key question then is to what extent this inter-method and inter-laboratory variation compromises the value of the data itself and the explanatory value of (scorpan) covariate data at specific resolutions. The finer the spatial resolution, the more important the issue of comparability of soil analytical methods is.

For each profile, reference is made to the laboratory (see Table 6), and if possible to the laboratory manual, where the soil analytical attributes are measured and to the field manual. The method key refers to the collection of attribute-methods in database table *AttrMethods*. The attribute-methods are specified as method code, though only for geo-location, classification (versions) and analytical attributes, if reported by the data source. The laboratory method codes are explained, with the methods briefly described, by the dictionary table *DictioLabMethods*. This dictionary, including the codes, is copied from the eSOTER2012 procedures manual (Van Engelen and Dijkshoorn, 2013), as adopted from WISE3, and given in Annex 4.

Note that the analytical methods distinguished in the methods dictionary (Annex 4) require reclassification for obtaining consistently defined method groupings. The reclassification implies aggregation or disaggregation, depending on the soil attribute under consideration and is currently in progress.

The methods used to observe profile site attributes and morphologic profile layer attributes are not specified, in the *AttrMethods* table, by method codes per attribute but are given implicitly by specification of the field manual used. Method codes are given for the methods used to assess X-Y coordinates, and for the versions of the soil classification systems (e.g. USDA1975, USDA1998).

One method key (MethKey) represents a collection of methods that applies to all -or a large proportion of-profiles from a given data source. In total, 595 method collections are distinguished and listed in the *AttrMethods* table based on the data sources compiled so far. Note that many data sources do not report about the methods applied. Consequently, methods are specified for part of the collections only.

2.4.5 Values

The value is the outcome from a method applied to a feature to observe or measure a feature-attribute.

The feature-attribute values, or soil data, are compiled under a common standard. The standardisation of the data, including numeric and descriptive values, is as was described in Section 2.4.3. The standardisation of data thus applies to the values, not to the naming of attributes or column headings.

The standardised values, compiled in tables *Profiles and Layers*, have been routine quality controlled. Original values, as compiled in tables *OriProfiles and OriLayers*, are not routine quality controlled and are provided as is.

2.4.5.1 Original values

The original values for profile attributes are given in database table *OriProfiles* and for profile layer attributes by table *OriLayers*. These original values have been maintained only if different from the standardised and routine quality controlled values.

Original descriptive values need interpretation, prior to being coded according to the standard conventions (which may involve a loss of detail). See Figure 8 for examples, including e.g. ‘Shire plain’ (in black rectangle) as a value for topography or ‘colluvions dérivées d’altération de Schistes’ as a value for parent material (interpreted and standardised in Figure 9). The original descriptive values are maintained for two reasons. First, the standard coding is prone to errors due to misinterpretations. Second, the coding conventions are developed to serve standardisation at global scale, which implies that detailed information is lost. The current standard coding conventions may well be replaced by other conventions, and then it is better to re-standardise based on original descriptions rather than on coded values.

(Note that descriptive values have been standardised already upon entry in many cases at especially the beginning of the compilation process. In those cases, original values are to be traced back in the data source.)

Original numeric values are standardised upon entry and are transferred to the separate tables for standardised values (see next Section). The standardised value is maintained as original value in case the standardised value is changed, by correction or exclusion, upon routine quality control. In those cases, the standardised value before correction is stored as the original value.

Adding to these numeric values are original numeric values, for other attributes (as listed in Table 8), that are standardised but that are not transferred to the separate tables for standardised values and that are not routine quality controlled. For those attributes, the values are given as original values only.

Table 8

Attributes for which the, not routine quality controlled, values are compiled in tables OriProfiles and OriLayers (not transferred to the tables Profiles and Layers with standardised and routine quality controlled values).*

OriProfiles	**OriLayers**	pH H_2O, 2nd measurement	Extractable Fe - free
Profile object number	Layer object number	PH X	Extractable Fe - active
Profile ID	**Profile ID**	Soluble Ca	Extractable Fe - organic bound
Easting	**Profile layer ID**	Soluble Mg	Extractable Fe - total
Northing	Horizon upper depth	Soluble Na	Extractable Al - free
East or West	Horizon lower depth	Soluble K	Extractable Al - active
Longitude degrees	Sample upper depth	Soluble CO_3	Extractable Al - organic bound
Longitude minutes	Sample lower depth	Soluble HCO_3	Available K
Longitude seconds	Diagnostic horizon	Soluble Cl	Total K
North or South	Diagnostic property	Soluble SO_4	Iron micro nutrient
Latitude degrees	Diagnostic material	Soluble NO_3	Manganese micro nutrient
Latitude minutes	Transition	Soluble F	Zinc micro nutrient
Latitude seconds	Nature of coarse fragments	Exchangeable Ca & Mg	Cupper micro nutrient
Projected coordinate system	Coarse sand	CecMin	Borium micro nutrient
Terrain map unit	Medium sand	CecMax	Sulfur micro nutrient
Terrain map unit component	Fine sand	Available P	Organic matter
Soil map unit component	Coarse silt	Available P, 2nd measurement	Total humic C
Land element	Fine silt	P retention	Humic acid C
Parent material on site, 2nd observation	Humidity	Porosity	Fulvic acid C
Land cover, 2nd observation	Hydraulic conductivity	Weight-based water holding capacity	Full horizon description
Remark, incl. full profile description			

* Profile attribute definitions, exclusive of specific method, are given in Annex 3a.

Figure 8 gives examples of original numeric values, including e.g. 8299300 for UTM northing in meters (converted and standardised in Figure 9).

ProfileID	Y_North	YNS	Y_Deg	Y_Min	Y_Sec	OriTopography	OriParentMaterial	OriLandCover
CD 4143_79	-	-1	4	5	-	ondulée, légère pente	argile d'altération de schites	forêt abattue
CD 4143_8	-	-1	10	10	-	plateau horizontale	sable Kalahari reposant sur carapace latérique.	Savana steppique zambézienne
CD 4143_80	-	-1	4	5	-	bordure de plateau	argile d'altération de schistes	jeune forêt secondaire
CD 4143_81	-	-1	4	5	-	plateau horizontal	argile d'altération de schistes	jeune forêt secondaire
CD 4143_82	-	-1	4	24	-	plateau	produit d'altération de phyllades	savane en bordure de la forêt
CD 4143_83	-	-1	4	5	-	plateau	produit d'altération des schistes del'Urundi	savane à Imperata
CD 4143_87	-	-1	11	38	-	pénéplaine fin tertaire	argile dáltération de schistes	forêt claire dégradée en jachère
CD 4143_89	-	-1	11	30	-	dépression	colluvions dérivées d'altération de schistes	savane
CD 4143_92	-	-1	5	30	-	ondulée	produit d'altération de grès sublittoraux	savane paturée
CD 4143_93	-	-1	5	30	-	très ondulée	argile sableuse dérivant des quartzite micacés	savane très arbustive
CD 4143_94	-	1	0	55	-	pénéplaine fin-tertiaire	produit d'altération ultime de psammites de Lindi.	forêt équatoriale
CD 4143_95	-	1	0	55	-	pénéplaine fin-tertiare	produit d'altération ultime de psammites de Lindi.	forêt équatoriale
CD 4143_98	-	1	3	6	-	dôme peu élevés	sable argileux dérivés de grès	forêt secondarisée
CG 28638_1	-	-1	4	25	30	NA	Bateke sands	Savanna
CG 28639_1	-	-1	3	57	10	NA	NA	NA
CM 1868_1	8299300		-	-	-	almost flat	alluvium	Cultivation Fallow
CM 1868_108	8298250		-	-	-	rolling	tertiary basalt	grass
CM 1868_116	8299900		-	-	-	undulating	basement complex	savanna, with sparse grass
CM 1868_127	8300200		-	-	-	rolling	basalt	grass
CM 1868_13	8302500		-	-	-	gently sloping colluvium	lava colluvium	fallow
CM 1868_130	8310450		-	-	-	rugged (scarp foot hills)	Basement complex	savanna, grasses
CM 1868_138	8302400		-	-	-	rolling	basalt	tufts of sporobolus
CM 1868_161	8304800		-	-	-	undulating	lava	grassland with forrested valleys
CM 1868_177	8292750		-	-	-	rolling	lava	sporobolus
CM 1868_212	8297900		-	-	-	rolling to mountainous	Basement complex	sporobolus
MW lrep_G16	8354500		-	-	-	Shire plain	alluvium	dense tall grassland
MW lrep_G17	8353700		-	-	-	between plain & hilly	NA	NA
MW lrep_G18	8353400		-	-	-	hilly	residual	fallow grass
MW lrep_G19	8350600		-	-	-	convex slope of a crest	banded biotite gneiss	sward

Figure 8

Examples of original values, both descriptive and numeric, as collated into the data entry table OriProfiles (with old column headings).

2.4.5.2 Standardised values

Standardised values for profile feature and site attributes are given by database table *Profiles* and for profile layer subfeature-attributes by table *Layers*. These standardised values have been routine quality controlled, as is explained in Section 2.5.

Values are standardised to conform to the standard definition of the attributes given in Section 2.4.3. The standard attribute definitions are given in table *DictioAttributes* and in Annex 3a.

Standardisation of descriptive values implies interpretation to meet the standard attribute definition, followed by classification and codification of the value. For instance, the original value for parent material of 'colluvions dérivées d'altération de Schistes', as given in Figure 8, is in Figure 9 interpreted and standardised as value class 'MB', for basic metamorphic rocks. The coding is according to the conventions in database table *DictioClassValues* and Annex 5a. The coding conventions are those of eSOTER2012, unless specified otherwise. For a few attributes (e.g. MapUnit, WRB06, USDA, CPCS, Observer, Location), descriptive values are considered standardised without being coded.

Standardisation of numeric values is required to meet the standard attribute definition as well as the standard unit of expression, as specified per attribute in Annex 3a. A value conversion is needed to match the attribute, e.g. from easting to longitude, from P_2O_5 to P or from $CaCO_3$ to inorganic C, as well as to match the unit, e.g. from degrees to decimal degrees or from % to ‰. Further, for analytical data there may be a need for harmonisation to, agreed upon, standard methods (see 2.4.5.3).

Figure 9 shows how the original value for UTM northing, in meters, of 8299300, as given in Figure 8, is converted to 5,969, meeting the standard attribute definition (WGS84 latitude) and the standard unit of expression (decimal degrees).

ProfileID	Y_LATDD	Topography	Landform_1M	Position	ParentMaterial	LandCover	LandUse	Drainage	ObservedDepthCm
CD 4143_79	-4.083	U0	NA	M	MB	IA	NA	W	150
CD 4143_8	-10.167	F0	LL	A	SI1	VB5	NA	M	75
CD 4143_80	-4.083	G0	LL	A	MB	IA	NA	NA	180
CD 4143_81	-4.083	NA	LL	A	MB	IA	NA	W	200
CD 4143_82	-4.400	F	LL	A	MB	VB	NA	W	180
CD 4143_83	-4.083	NA	LL	A	MB	VB5	NA	W	180
CD 4143_87	-11.633	U0	LP	M	MB	VB	AA2	W	150
CD 4143_89	-11.500	W0	LD	D	MB	VB	NA	P	120
CD 4143_92	-5.500	U0	NA	A	SA1	VB2	HE	W	150
CD 4143_93	-5.500	U0	NA	A	MA1	II	NA	W	200
CD 4143_94	0.917	F0	LP	A	MA1	IA1	NA	W	150
CD 4143_95	0.917	F0	LP	A	MA1	IA1	NA	W	177
CD 4143_98	3.100	U0	LP	M	SA1	IA	NA	W	200
CG 28638_1	-4.380	U0	L	L	USOF	VA1	AA2	W	260
CG 28639_1	-3.970	U0	LL	NA	SA1	NA	AT1	S	600
CM 1868_1	5.969	F0	LV	D	U00F	NA	MP	I	224
CM 1868_108	6.086	R0	S	M	VB1	VA1	HE	W	130
CM 1868_116	6.019	U0	L	M	MA	VA1	HE	W	127
CM 1868_127	6.164	R0	SH	M	VB1	VA2	AA2	W	135
CM 1868_13	6.062	G0	LF	M	UY0C	NA	AA2	W	170
CM 1868_130	6.021	R0	S	H	MA	VA1	MP	W	203
CM 1868_138	6.226	R0	SH	M	VB1	VA4	HE	W	114
CM 1868_161	6.066	U0	L	H	VB	NA	HE	W	84
CM 1868_177	5.846	R0	S	L	VB	NA	HE	W	107
CM 1868_212	6.050	T0	T	H	MA	NA	MP	W	132
MW lrep_G16	-14.870000	F0	L	L	U00F	NA	AA4	W	105
MW lrep_G17	-14.880000	U0	L	H	NA	NA	AA4	I	120
MW lrep_G18	-14.880000	R0	S	L	UR	NA	AA4	P	120
MW lrep_G19	-14.910000	U0	L	H	MA2	NA	AA4	W	60

Figure 9
Examples of standardised values, both descriptive and numeric, as collated into the data entry table Profiles (with old column headings).

2.4.5.3 Harmonised values

The harmonisation of a value implies the conversion of the value, observed or measured by a recorded non-standard method, to a target value as if observed or measured by a specific standard method. Formulated differently, standardised values meet the standard attribute definition that is exclusive of the method used to assess the attribute value. Harmonised values are standardised values that meet a standard attribute definition that is inclusive of a pre-defined standard method.

ISO TC190, SOTER or GlobalSoilMap define standard soil attributes, inclusive of associated standard method. These definitions could serve as the harmonisation target, for which pedotransfer functions or conversion rules need to be developed.

Annex 7 gives the standard soil attributes, inclusive of the associated standard method, as defined in the latest *GlobalSoilMap* specifications (version 1, release 2.1, July 2011). The careful reader of Annex 7 may discover few inconsistencies in the attribute definitions, which may inhibit future data harmonisation (and even harmonised global soil mapping) if not corrected. Version 2.2 of the specifications is underway.

To convert standardised values (X) to the harmonisation target (Y), conversion rules (from X to Y) are needed. Such rules are not yet compiled or established and applicable within the domains or scales desired. Consequently, values have not been harmonised (if not according to its simplest format which is that values, assessed by various methods, have been allocated to the corresponding attribute).

Adding to the unavailability of conversion rules, are the current inconsistencies in the inventory and definitions of methods in *DictioLabMethods* often inhibiting a proper definition of X (values assessed with methods of group X). It is recommended to define coherent method groupings and to reclassify the current list of methods accordingly, prior to possible future definition of conversion rules from X to Y. Such effort to coherently define method groupings is on-going at ISRIC.

Harmonisation is required to enable full quality control of values, including control of internal consistencies of values of two or more related soil attributes. This is elaborated upon in Section 2.5.3.

It should be noted that, though harmonisation is necessary for full quality control, harmonisation itself imposes a possible source of error or added uncertainty, as conversion rules, based on regression analysis, have a given goodness of fit only (R^2).

2.5 Data quality control

Quantitative feature attribute values have been quality controlled. Three levels of quality control are distinguished, corresponding with the three levels of value standardisation. These are:
– Basic quality control upon entry of original values;
– Routine quality control of collated and standardised values;
– Full quality control of harmonised values.

Note that the values in the database have been basic and routine quality controlled. The values have not been fully controlled, as full control requires the values to be harmonised.

Note that the identification of possibly erroneous values is well doable. The follow-up, to verify and maintain, correct or exclude the value, is far less evident.

Note that (data) quality is by definition use dependent (Finke, 2006).

2.5.1 Basic quality control of original values

Upon entry, original values are subjected to basic quality control. This implies checks on one-dimensional attribute-values, irrespective of values for other attributes (e.g. total nitrogen content, irrespective of the organic carbon content or C/N ratio).

Most important basic controls include:
– The unit of expression, e.g. % or ‰, w% or v%, meq/kg or cmol/kg
– The domain or value ranges, e.g. 0-100%
– The attribute definition, e.g. organic carbon, total organic carbon or total carbon, or sand fraction >0.05 mm or sand fraction >0.064 mm.
– Obvious mistakes, e.g. switch of latitude and longtitude
– Extreme outliers, e.g. CEC = 300 cmol/kg, or extreme exceptions in the depth profile, e.g. pH = 6 – 7 for all layers except for one with pH = 3.

Where obvious and necessary, values are corrected or excluded.

The upon-entry inferred overall quality and reliability of the values is subjectively rated on a scale from 1 to 4, as specified per profile feature.

2.5.2 Routine quality control of standardised values

Values that are collated and standardised are subjected to routine quality control. Scripts are run to verify one-dimensional attribute values and check on simple two-dimensional inconsistencies between attribute values (e.g. C/N ratio, sum of fine earth fractions, base saturation).

The criteria applied for routine quality control are given in Annex 6. Much is adopted from the WISE3 quality controls and from criteria defined in Driessen (1992), in combination with simple outlier analyses, relying on references set by ISRIC and NRCS datasets.

The rules lead to three possible outcomes:
- Value does not meet the criteria for being included: revisit data source and correct value, if possible, or exclude value.
- Value meets the criteria for being included, but is 'flagged' as 'odd': revisit data source and correct value, if possible, or maintain value.
- Value meets the criteria for being included.

Table 9 summarises the absolute numbers of corrected or excluded layer-attribute values. For the majority of attributes, the percentage of entries actually excluded is only small.

Table 9
Overview of numbers of corrected or excluded layer-attribute values.

Layer upper depth	502	Exch. Ca	1328	Moisture at pF 0.0	27
Layer lower depth	1856	Exch. Mg	1334	Moisture at pF 1.0	14
Horizon Designation	227	Exch. Na	1325	Moisture at pF 1.7	35
Colour	199	Exch. K	1360	Moisture at pF 1.8	4
Mottles - presence	7370	Exch. Bases	539	Moisture at pF 2.0	429
Structure	6334	Exch. H	17	Moisture at pF 2.2	10
Stickiness when wet	0	Exch. Al	33	Moisture at pF 2.3	4
Salt or alkali - presence	1078	Exch. Acidity	227	Moisture at pF 2.4	45
Roots - presence	6534	Effective CEC	225	Moisture at pF 2.5	16
Particle size class - field	4623	CEC soil	1771	Moisture at pF 2.7	11
Coarse fragments class	10842	CEC soil 2nd	34	Moisture at pF 2.8	9
Coarse fragments	25	Base saturation	1863	Moisture at pF 2.9	420
Coarse fragments -lab	23	Base saturation 2nd	444	Moisture at pF 3.0	567
Sand	1621	CaSO4	7	Moisture at pF 3.3	685
Silt	1617	CaCO3	40	Moisture at pF 3.4	1669
Clay	1460	Inorganic carbon	0	Moisture at pF 3.5	1576
Sum of fractions	1663	Total carbon	212	Moisture at pF 3.6	384
Bulk Density	17	Organic carbon	2425	Moisture at pF 3.7	386
pH H2O	170	Total N	2159	Moisture at pF 4.0	452
pH KCl	165	C/N ratio	2687	Moisture at pF 4.2	168
pH CaCl2	74	Total P	4469	Moisture at pF 5.0	155
Electrical conductivity	225	Available P	18524	Moisture at pF 5.8	158
Soluble cations & anions	0	Available P2	1083	Lab texture class	1150

One may ask what to do with values that are evaluated and flagged as 'odd'. It is simpler to distinguish between correct and incorrect values only and to restrict the dataset to 'correct' data by excluding flagged data. Relevant in this context are three quotes of Batjes (2008):

- all flagged values are potential errors only, and need not to be wrong;
- defining too stringent rules for data collection and data comparison would exclude many legacy data;
- many possibly imprecise measurements may be considered more efficient (and accurate) than a few expensive ones carried out in a few reference laboratories, particularly for broad scale applications of the data.

The approach applied is in line with that applied for WISE3. The criteria defined for exclusion are not very stringent. The criteria to control, and flag, for possible inconsistencies and 'odd' values are more stringent. Flagged values are to be verified visually against the source data and if possible the classification. Verification generally shows that possible inconsistencies and 'odd' values are in most instances correctly copied from the original data source, including ISRIC data sources with previously thoroughly screened data.

The criteria are subjective and arbitrary by definition. The follow-up of the criteria, after revisiting of the data source, risks being subjective and arbitrary as well.

It is difficult to decide what to do with inconsistencies in the case of criteria that include more than a single attribute. For example, it is not uncommon that particle size classes do not add up to 100% or that C/N ratio's are out of the normal range. For individual, within profile, cases, the problem can be solved by comparison with above and below layers followed by an informed correction. For batches though, of e.g. too high C/N ratios, the problem is less evidently solved as it is unknown whether the value for C is too high or that for N too low (or whether the reported unit of expression (% vs. ‰) is erroneous for one or both). A, highly arbitrary, correction of one or both is a possible source of large error while the exclusion of both values has repercussions on the size of the dataset. Moreover, it might bias the dataset since awkward values are removed while (part of) these may be real values.

It is therefore justified to include rather than to exclude 'odd' values. Data quality is use-specific and therefore the user is advised to adopt fit-for-use criteria. For instance, accurate soil property mapping is well possible, at medium resolution, based on primary data that are somewhat inaccurate. A continental-wide evidence-based soil property map is likely more accurate when informed by many values of varying accuracy, well covering covariate space, compared to when informed by only a few values of constant and high accuracy, not completely covering the covariate space.

2.5.3 Full quality control of harmonised values

Full quality control implies two- or multidimensional checks on in-pedon consistencies. It requires harmonised data that are complete and stratified. None of these criteria are met in the Africa Soil Profiles Database Version 1.2. Consequently, the data are not fully quality controlled. Nevertheless, the routine control described in the previous section includes some checks on within-pedon consistencies. The criteria applied reflect some oversimplified assumptions about the verifiability of within-pedon consistency.

An example of controlling relations between two or more properties is e.g. the relationship between base saturation and say pH-water or pH-KCl. Note that base saturation is an important criterium in soil classification. It is a composite value of four exchangeable bases and of CEC, with CEC depending on the content and the type of organic carbon and of clay. With a variety of methods used to assess the values for each of these properties, including that for pH, the variance of the property values is very likely to be large, with the expected relations between the property values very likely to be weak. In-house tests show that preliminary data harmonisation reduces variance and strengthens relationships indeed, enhancing the applicability of criteria, but only to a limited extent.

It can be concluded that the complex nature of soils, with its heterogeneity of possible attribute values, combined with the nature of legacy soil data, with its range in methods used to assess attribute values (with sometimes specific analytical methods required for specific soil types, e.g. to assess available P), combined with the lack of conversion rules to harmonise these values, inhibit the establishment of sensible criteria for full proper control of within-pedon soil data consistency and quality.

3 Results - database contents

Soil profile observations and measurements are compiled from over 540 data sources, and include values for approximately 140 soil attributes, with the soil analytical attribute values measured in over 100 laboratories with over 350 methods specified, for 74,961 layers of 18,532 profiles, of which 17,160 are georeferenced. Soil analytical data are available for 15,564 profiles, of which 14,197 are georeferenced. The values are standardised for 25 profile and site attributes and for 75 profile layer attributes. The values for some 60 analytical layer attributes are also routine quality controlled.

Figure 10 illustrates the spatial distribution of the georeferenced soil profile data included in version 1.2 of the Africa Soil Profiles Database. In total, relative to a Sub-Saharan Africa area of 18,000,000 km², the density is approximately two geo-referenced profiles per 2,100 km² or nearly one per 1,000 km². As yet, no data are compiled for Djibouti, Equatorial Guinea, Eritrea and Gambia nor for the island-countries off the main land (Cape Verde, Comores, Mauritius, Mayotte (France), Reunion, Saint Helena, Sao Tome and Principe and the Seychelles).

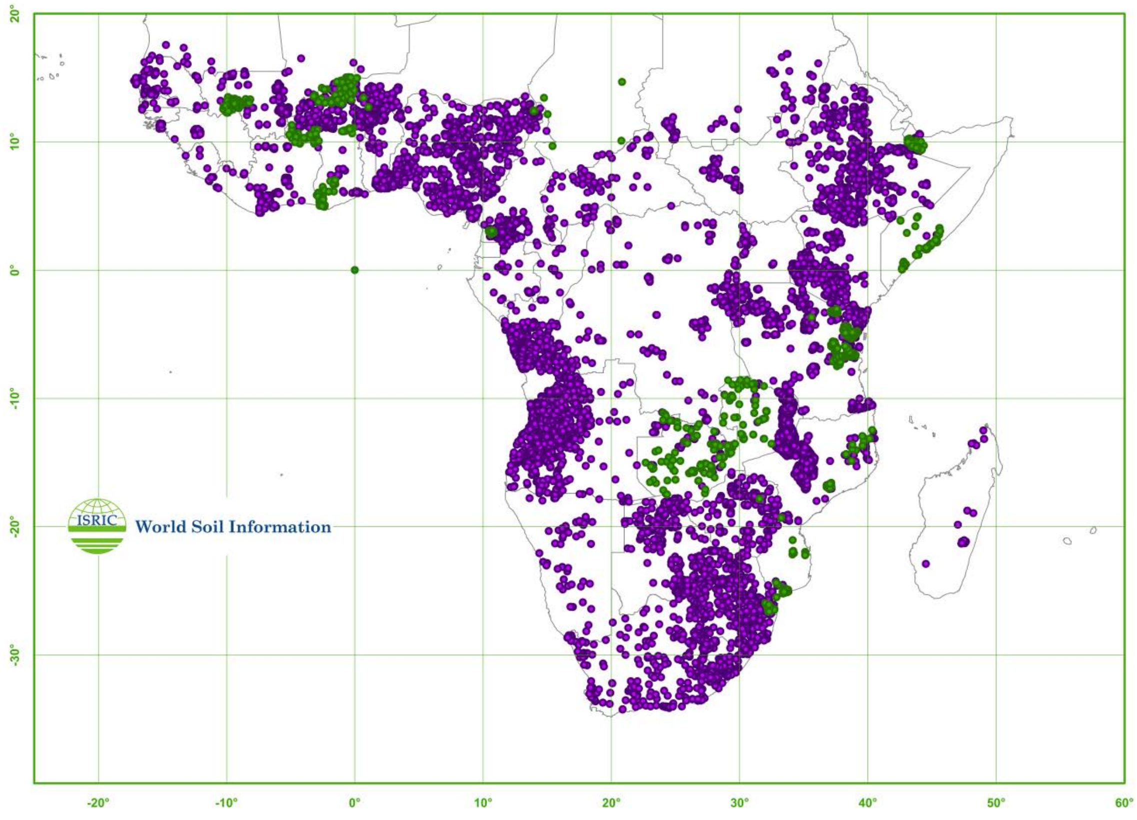

Figure 10
Spatial distribution of the soil profile data included in the Africa Soil Profiles Database version 1.2. The profiles represented in purple were included in version 1.1 and those in green are added in version 1.2.

Figure 11 shows the temporal distribution of the profile records, more or less reflecting the intensity of soil surveys carried out in Africa, peaking in the 1980s and 1990s. The high peak between 1986 and 1990 reflects the inclusion of a few large datasets with especially LREP Malawi (1989) bringing in relatively much weight. It should be noted that the temporal distribution does in no way imply that the data are necessarily outdated, as is argued by some without scientific basis, as most soil properties are in fact quite stable over time, and hardly significantly measureable over a time span of 20-30 years if not impacted by severe land degradation.

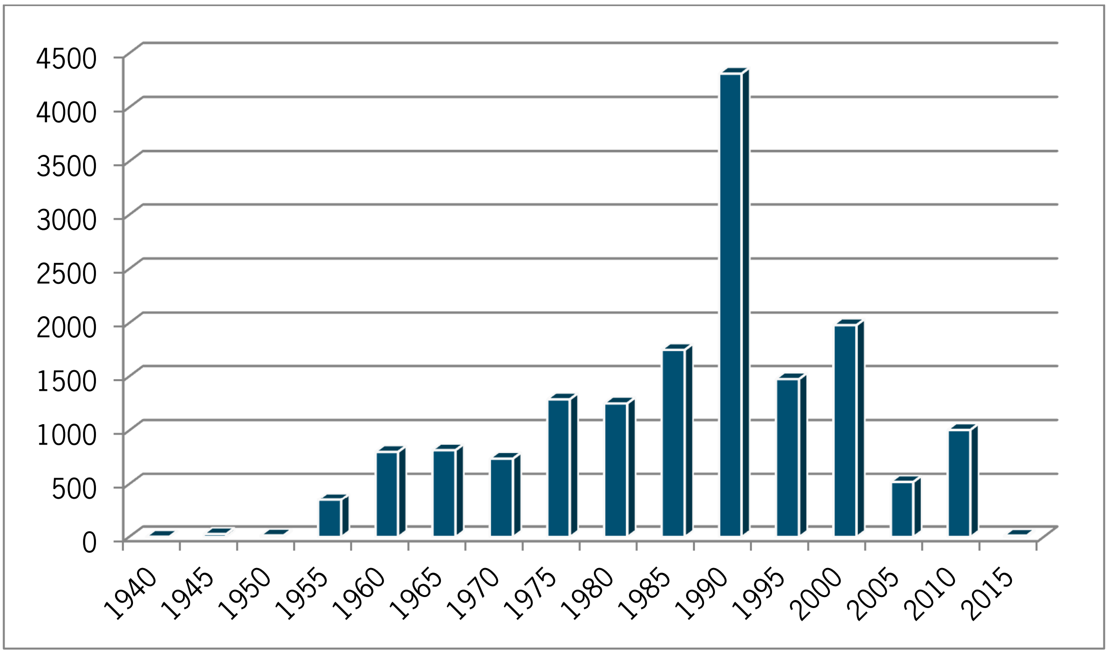

Figure 11
Temporal distribution of the profile records, aggregated per 5 year period prior to the indicated year (2015 = 2011-2015).

3.1 Summary statistics

Annex 8 gives a full overview of summary statistics about the data compiled and standardised in database tables *Profiles* and *Layers*. The overview specifies, for the whole of Sub-Saharan Africa as well as by country, the number of profiles and layers and the number of value entries per attribute, together with the associated minimum and maximum value, average value and standard deviation. Table 10 gives an extract from this annex.

Note that the statistics in Annex 8 refer to the data of all profiles compiled, including those that are not geo-referenced.

The summary statistics reveal over two-thirds (71%) of the soil profiles are classified according to one or more of the various systems. Of the 14,197 georeferenced soil profiles with soil analytical data is 81% classified. The percentage of those profiles classified according to WRB, WRB reference group, FAO88, FAO74, USDA, CPCS or a local classification (incl. series, CEPT and INEAC) is 27, 55, 73, 44, 21, 10, 39%, respectively (i.e., for some profiles, different classifications systems have been used).

The data completeness or data density varies from country to country and from attribute to attribute. This is illustrated in Figure 12 for selected attributes as the number of value entries per country area (n / 10,000 km²). Note that the numbers were calculated as integers, implying that densities of less than 0.5 / 10,000 km² are represented as if lacking (0).

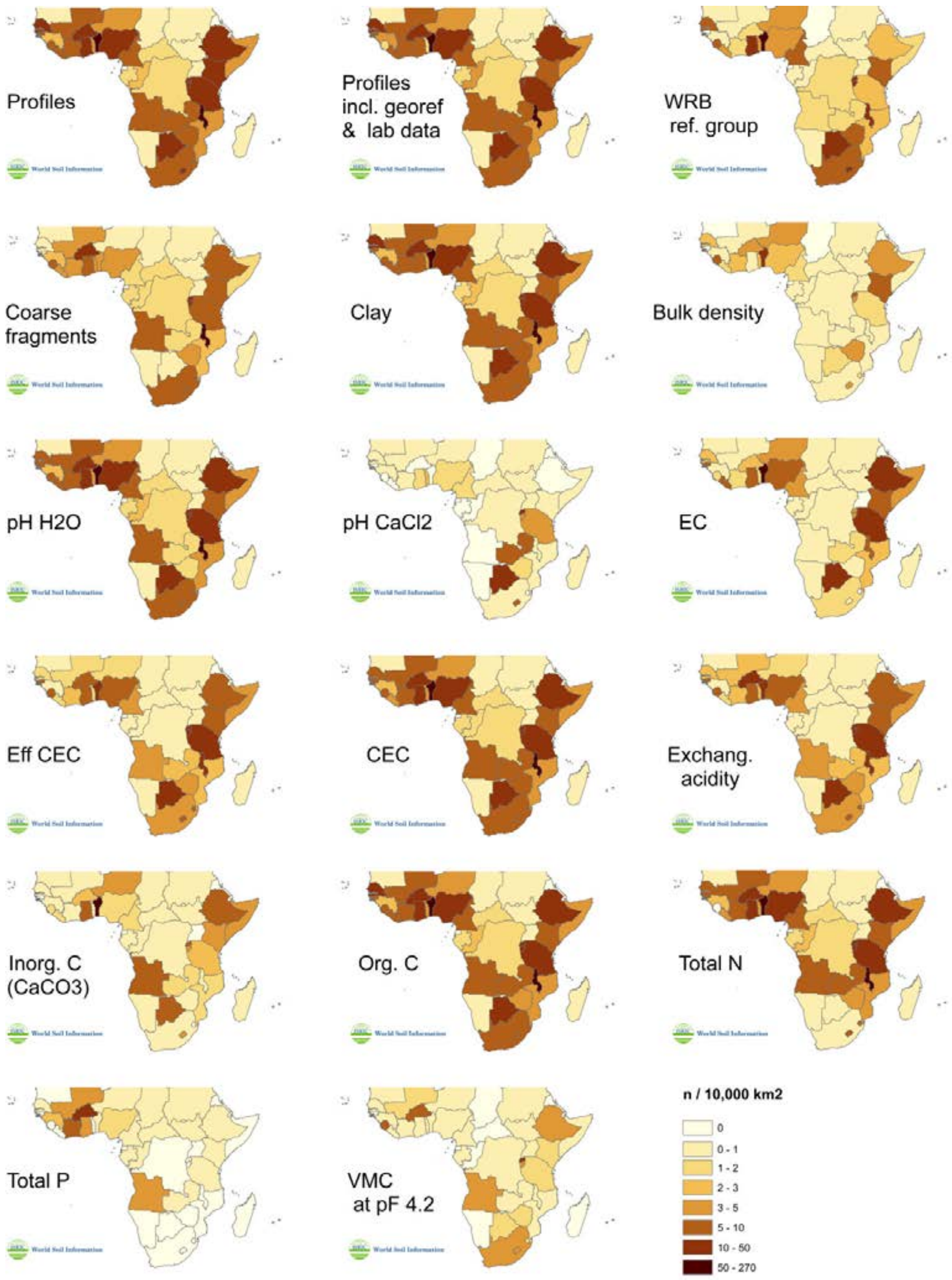

Figure 12

Density per country (n/10,000 km²) of soil profiles, with values for georeferencing, WRB reference group, coarse fragments, clay content, bulk density, pH H2O, pH CaCl2, EC, effective CEC, CEC, inorganic carbon, organic carbon, total N, total P, and volumetric moisture content at pF 4.2.

The data density per country is on average 10 profiles per 10,000 km² and varies from 0 to nearly 80 profiles per 10,000 km², with a relatively high density of over 250 per 10,000 km² for Malawi. The data completeness, relative to profile density, is very low over the entire area for especially bulk density, pH CaCl2, inorganic carbon, total P and volumetric moisture content.

Table 10
Descriptive statistics for soil layer key-attributes, according to GlobalSoilMap specifications, for Africa and per AfSIS-I pilot country and AfSIS-II focus country.

	Africa	Kenya	Mali	Malawi	Nigeria	Tanzania	Ethiopia	Ghana
Lower depth layer, cm (LowDpth)								
Profiles, n	18532	591	771	3153	1251	1711	1842	395
Layers, n	74961	2614	2570	10859	5894	6564	6365	2410
Min.	0	1	1	2	0	2	1	3
Max.	2000	750	700	1220	1120	405	500	940
Average	73	73	63	65	84	71	87	82
Std. Deviation	60	58	54	48	65	53	63	83
Coarse fragments, v% (CfPc)								
Profiles, n	10280	384	541	2983	437	644	599	155
Layers, n	40177	1485	1853	10290	2075	2801	1838	846
Min.	0	0	0	0	0	0	0	0
Max.	100	95	98	95	95	95	95	95
Average	9	7	11	7	15	8	11	19
Std. Deviation	20	19	24	17	23	20	22	26
Sand fraction, w% (Sand)								
Profiles, n	15151	580	747	937	1184	1540	1468	235
Layers, n	58322	2422	2314	2740	5320	5414	5096	1403
Min.	0	1	2	18	0	0	0	1
Max.	100	98	99	98	100	98	94	94
Average	54	40	46	65	58	50	33	48
Std. Deviation	25	23	21	16	24	24	19	22
Clay fraction, w% (Clay)								
Profiles, n	15151	580	747	937	1184	1540	1468	235
Layers, n	58321	2421	2314	2740	5320	5414	5096	1402
Min.	0	0	1	0	0	0	1	0
Max.	97	96	80	75	88	97	94	86
Average	30	42	27	27	25	34	40	29
Std. Deviation	20	21	16	15	19	20	20	17
Bulk density, kg/dm³ (BlkDens)								
Profiles, n	2589	361	18	10	266	123	349	20
Layers, n	9597	1405	70	69	1096	433	1030	85
Min.	0.2	0.2	0.5	1.3	0.7	0.4	0.5	0.6
Max.	2.7	2.1	2.0	1.9	2.1	1.8	1.9	2.1
Average	1.4	1.3	1.6	1.5	1.3	1.3	1.2	1.5
Std. Deviation	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.4
pH water (PHH2O)								
Profiles, n	14092	582	703	1014	1075	1577	1469	388
Layers, n	54867	2436	2070	2995	5024	5447	5131	2273
Min.	2.1	3.0	4.1	4.0	3.6	2.5	4.0	3.0
Max.	11.3	11.0	10.5	10.5	10.5	10.8	11.3	9.1
Average	6.2	6.4	6.0	5.9	6.2	6.4	7.3	5.6
Std. Deviation	1.2	1.3	1.0	0.8	1.1	1.2	1.2	1.0

	Africa	Kenya	Mali	Malawi	Nigeria	Tanzania	Ethiopia	Ghana
Electrical conductivity, dS/m (EC)								
Profiles, n	7776	491	68	91	495	1514	1325	234
Layers, n	28105	1995	286	234	2129	5172	4534	1330
Min.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Max.	776.0	105.0	4.6	185.0	10.0	95.0	117.3	27.7
Average	1.0	0.8	0.1	7.5	0.2	0.6	0.8	0.1
Std. Deviation	12.0	5.2	0.3	28.4	0.6	3.0	3.5	1.2
Effective cation exchange capacity, cmol+/kg (Ecec)								
Profiles, n	8056	352	245	198	627	1060	1052	152
Layers, n	24962	1257	517	458	2124	2899	3345	506
Min.	0.0	0.5	0.4	1.4	0.3	0.4	3.2	0.5
Max.	206.1	206.1	72.1	27.1	60.1	173.1	161.6	103.2
Average	20.0	25.3	12.2	7.0	13.6	22.2	43.0	12.3
Std. Deviation	21.1	22.8	10.6	4.6	13.9	20.5	20.2	12.9
Organic carbon, g/kg (OrgC)								
Profiles, n	14753	565	680	1006	1145	1649	1391	367
Layers, n	50040	2048	1979	2533	3924	5306	4761	2079
Min.	0.0	0.2	0.0	0.3	0.0	0.0	0.1	0.1
Max.	570.0	363.0	48.5	48.8	111.0	136.0	350.0	101.5
Average	8.9	11.6	4.7	8.4	6.2	10.1	10.8	7.5
Std. Deviation	15.3	18.8	4.8	7.1	7.4	10.9	11.0	10.0
Volumetric moisture content at pF 2.5 or field capacity, v% (VMCpF25)								
Profiles, n	2640	62	179	10	55	49	332	14
Layers, n	9909	237	466	68	187	149	942	56
Min.	1.0	4.0	1.1	7.9	4.5	4.8	11.4	6.5
Max.	98.0	52.1	59.8	44.0	98.0	61.7	98.0	40.3
Average	21.1	31.6	21.6	20.7	33.8	30.6	41.5	20.4
Std. Deviation	14.0	10.3	9.5	5.8	20.6	13.0	13.5	9.3
Volumetric moisture content at pF 4.2 or permanent wilting point, v% (VMCpF42)								
Profiles, n	2562	85	194	10	66	104	360	13
Layers, n	8913	300	517	75	218	363	1054	73
Min.	0.0	0.3	0.5	2.7	1.1	0.5	5.3	0.7
Max.	83.3	46.5	32.0	21.7	66.4	58.0	68.3	27.4
Average	14.6	19.2	9.5	13.5	20.5	20.8	29.1	12.4
Std. Deviation	10.7	9.1	6.0	4.6	13.5	10.5	10.8	6.5

3.2 Data use cases

AfSIS production mapping has been underway at ISRIC and Columbia University since 2012 to produce the first generation of digital soil maps according to GlobalSoilMap specifications at 1 km² spatial resolution, based on the version 1.0 of the Africa Soil Profiles Database projected onto spatial covariate layers. In 2013 AfSIS released the first version of the digital soil property maps for Sub-Saharan Africa (ISRIC, 2103). Subsequent versions incorporate the data from subsequent versions of the Africa Soil Profiles Database, as this version 1.2.

Intermediate milestone versions (0.x) of the Africa Soil Profiles Database have been shared with the AfSIS project and have been used as input to studies and research about soils and soil mapping in Africa. Hengl (in prep.) used version 0.1 of the Africa Soil Profiles Database to test soil property mapping procedures to prepare for production mapping at a later stage, and used version 1.0 to produce a full set of soil property maps for Malawi, according to GlobalSoilMap specifications (ISRIC, 2013). Odeh and Reuter (in prep.)

produced soil property maps of the whole of Nigeria, according to GlobalSoilMap specifications, using version 0.2 of the Africa Soil Profiles database. Figure 13a illustrates predicted values for pH H2O in a 1: 5 solution for a here (purposely) unspecified depth interval of a here unspecified part of Nigeria, as an example of how national soil property maps can be generated in collaboration with national soil institutes. Ugbaje and Reuter (2013) used version 1.0 for functional digital soil mapping in Nigeria. Dijkshoorn et al. (in prep.) used version 1.1 of the Africa Soil Profiles Database in building and informing a Soil and Terrain database (SOTER) for Malawi (see Figure 13b); selected profiles, classified according to WRB2006, were identified as being representative for the distinguished soil components.

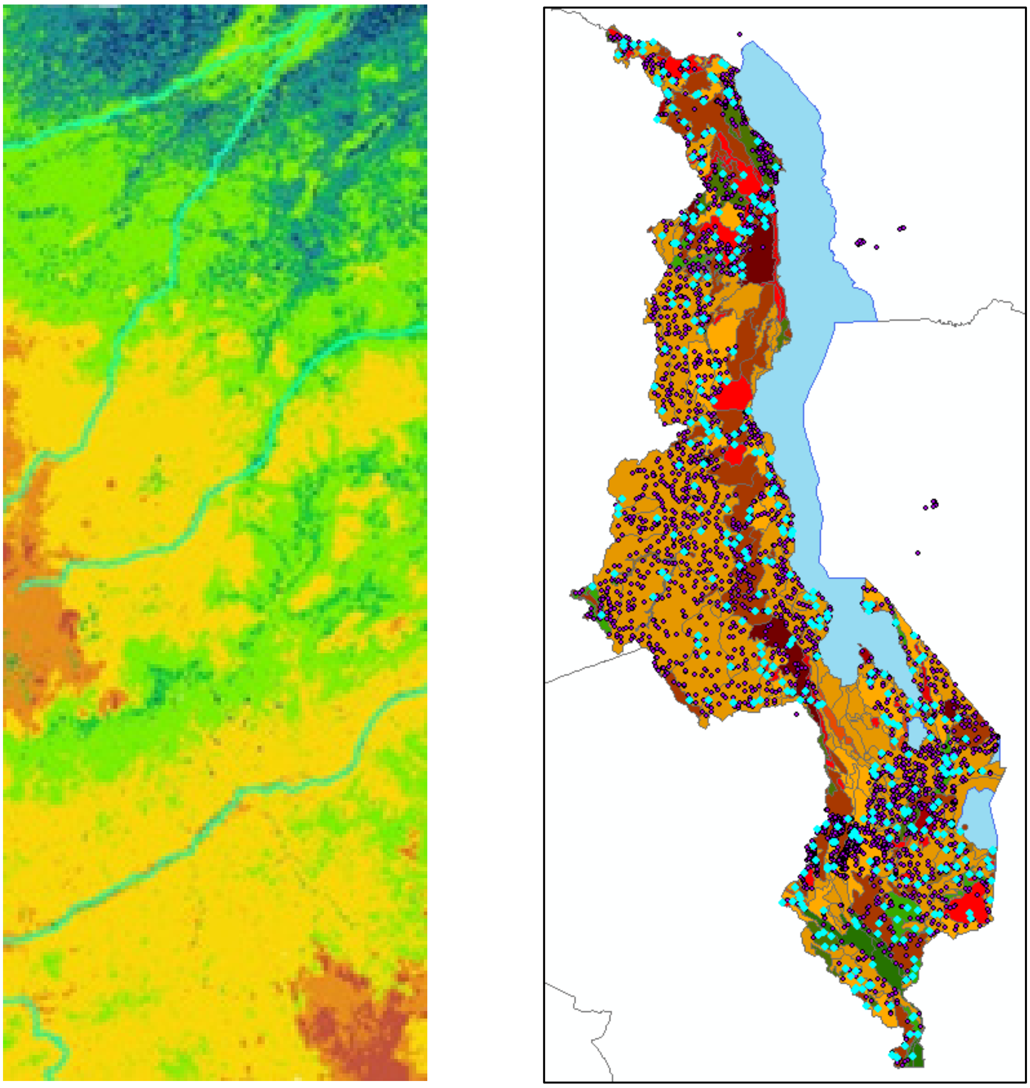

Figure 13

Two soil maps produced with soil data from the Africa Soil Profiles database. 13a (left). Extract from a soil pH map of Nigeria. 13b (right). Soil and terrain (SOTER) database of Malawi, with representative soil profiles as blue dots.

In line with Wösten et al. (1998) who used existing soil data to derive soil hydraulic properties for European soils, Wösten et al. (2013) validated a selected pedotransfer function Hodnett and Tomasella, 2002), which parameterises the continuous Van Genuchten equations for predicting soil moisture retention, using version 1.0 of the Africa Soil Profiles Database. Figure 14 illustrates the predicted versus observed values for volumetric soil moisture content at varying tensions. The results were used as input to underpin the hydrological modelling of a river basin in an African environment.

Similarly, the pedotransfer function has been applied to this version 1.2 of the Africa Soil Profiles Database and the available water holding capacity is assessed. The results are used for production mapping to serve as input to crop growth simulation modelling.

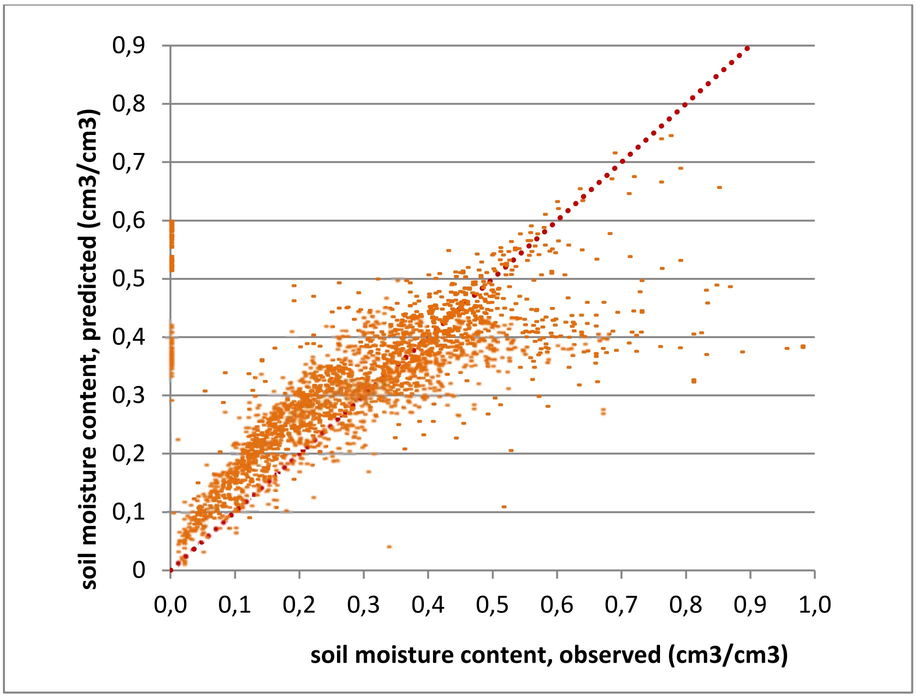

Figure 14

Validation of continuous pedotransfer functions of Hodnett & Tomasella (2002) using soil data from the Africa Soil Profiles Database (Wösten et al., 2013).

The average organic carbon value, per layer, is 8.9 g/kg. Taking the relative weight of the layer depth intervals into account, relative to the average layer depth interval of 30 cm, the average organic carbon value is 3.5 g/kg. Combined with an average bulk density of 1.39 kg/dm^3, an average coarse fragments content of 9.2 volume %, and an average (observed) soil depth of 125 cm, the average soil organic carbon profile represents approximately 55,000 kg/ha. Herewith is the total organic carbon content stored in the Sub-Saharan African soil (of 18 * 10 ^{6} km^2) indicatively estimated as 1 *10 ^{11} ton or 100 Pg. This indicative estimate is without consideration of the relative weight, or representativeness, of the different soil profiles and is likely an overestimate because of the bias in sampling, by profile, towards topsoil layers and, by country, towards relatively productive areas. On the other hand though, forested areas are relatively very undersampled. More precise estimations require the soil profile data to be linked to the mapping units of an existing continent-wide soil area-class map or require the soil profile data to be input to continent-wide soil property mapping. The total of 100 Pg is of the same order of magnitude as, for the whole of Africa, 133-184 Pg as reported by Henry (2010) and of 170-180 Pg as reported by Batjes (2008b, 2003).

To produce profile data that are continuous over depth, as a means of gap filling and of making the data applicable to produce soil property maps according to GlobalSoilMap specifications, layer attribute values of the Africa Soil Profiles Database were submitted to spline fitting functionality (Jacquier and Seaton, 2010), visualised in Figure 15, and the associated profile locations are related to covariate grids for building prediction models for digital soil mapping.

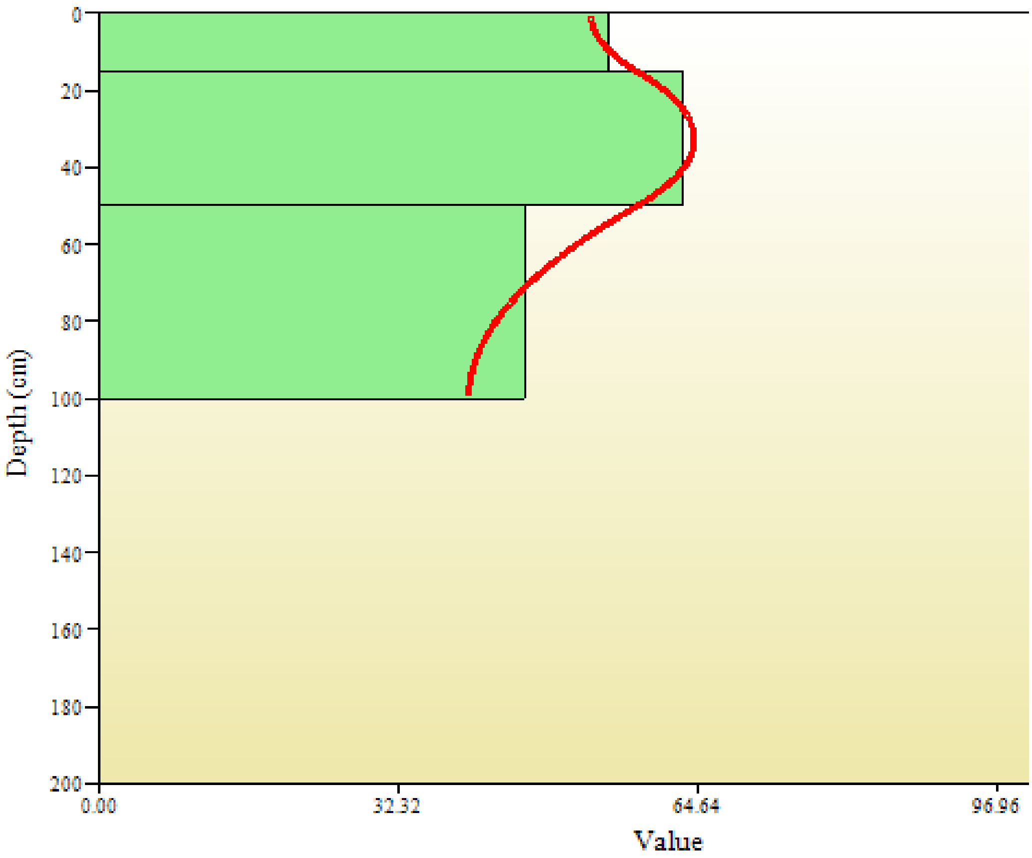

Figure 15
Visualisation of spline fitted over depth (red line) to original clay values (green bars) of a 1 m deep soil profile.

The results of AfSIS production mapping of the whole of Sub-Saharan Africa, according to GlobalSoilMap specifications at 1 km² spatial resolution and based on soil data derived from the Africa Soil Profiles Database, version 1.0, are given in Figure 16 for soil organic carbon content (g/kg) at six depth intervals (ISRIC, 2013).

The first generation of digital soil property maps with global coverage was released by ISRIC in 2013 and is available through www.isric.org/content/soilgrids and described by Hengl et al. (2014). The modelling and the resulting maps (soilgrids) are informed by numerous public soil profiles datasets including the Africa Soil Profiles Database and meet the *GlobalSoilMap* specifications at 1 km spatial resolution. With SoilGrids, one of the original goals of AfSIS aiming at developing into a Globally integrated – Africa Soil Information Service is de-facto being met.

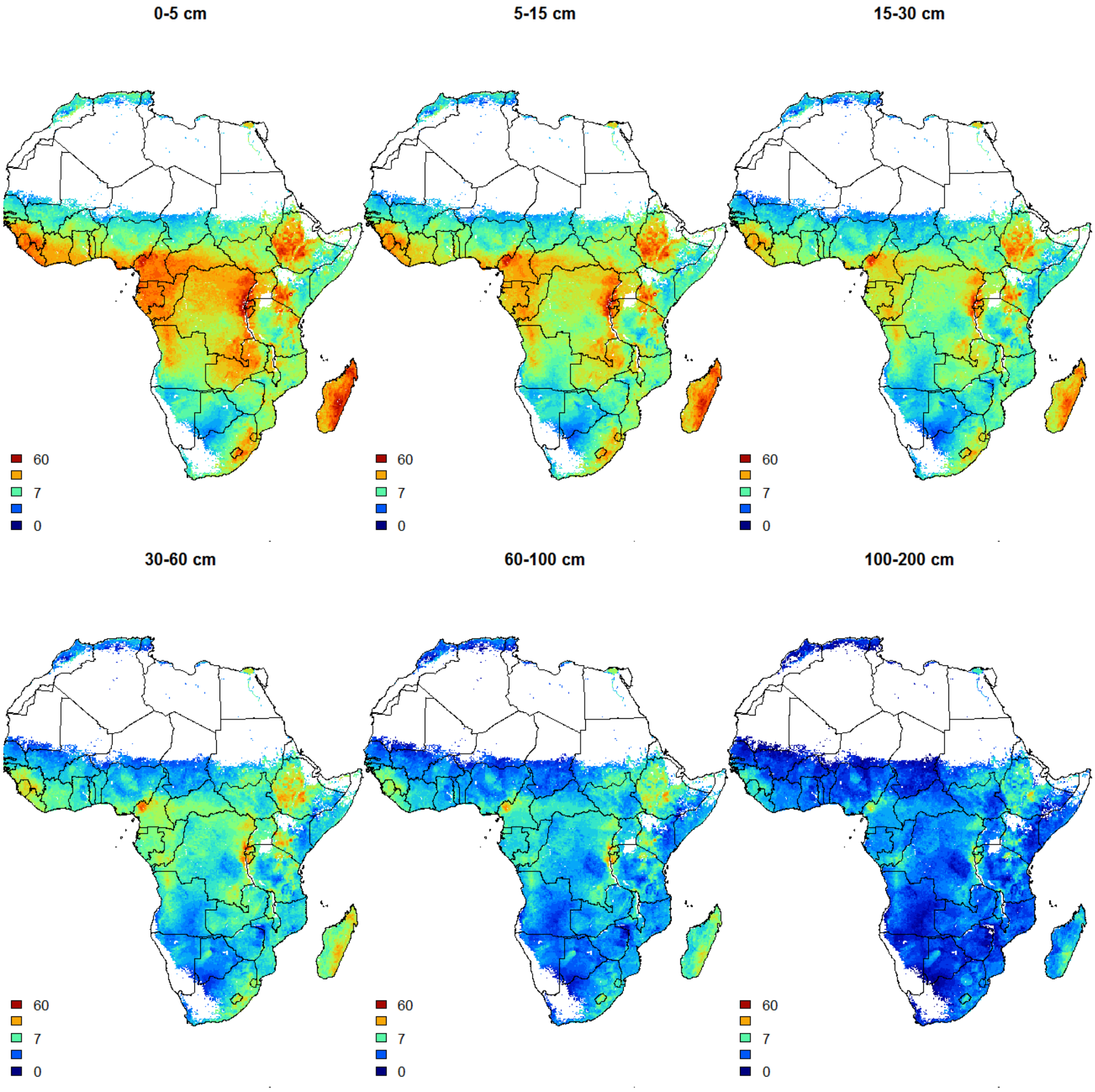

Figure 16.
Soil organic carbon content (g/kg) at six depth intervals predicted for Africa at 1 km² spatial resolution (ISRIC, 2013).

4 Discussion and conclusions

Version 1.2 of the Africa Soil Profiles Database contains standardised soil profile data for 18,532 soil profiles, of which 17,160 are georeferenced, for 40 Sub-Saharan African countries. The data were collected from 540 data sources, both analogue and digital, and were converted to a common standard, and parsed through routine quality control rules and cleaning. Previously, the unstandardised data would only be accessible through a myriad of sources, and would therefore not be shareable and usable.

The compilation of legacy soil profile data is a labour- and knowledge-intensive process. There is no obvious way to automate the process of legacy soil data collation. Substantial manual effort remains necessary to overcome the endless variety of format layouts and to combine the data with metadata and coordinates. Scripting of rules for automated, and even semi-automated, processing of the various data sources, step by step, proves far less efficient and effective compared to manual efforts, which is confirmed by the conclusions of a dedicated feasibility study (Coy et al., 2012). It is argued that crowd sourcing, also based on manual efforts, could be a way to collect large numbers of legacy soil data of defined quality, but consistent procedures are yet to be developed and tested and it remains to be seen whether 'the crowd' has access to soil data and the preparedness to contribute.

Additional manual capacity is reflected directly in additional data collated. At present, the probably most effective and cost-efficient way to increase capacity might be to actively involve the data holders as these may also have access to the auxiliary information necessary to generate complete profile records, including geographic coordinates and the specification of laboratory methods. It is proposed to facilitate close collaboration with the project partners of the focus countries to compile and use the national legacy soil data.

Despite the costliness of manual capacity required, the compilation of legacy soil profile data is seen as a relatively cost-efficient approach to generate sufficient data, or evidence, to underpin continental or national soil property mapping, compared to the collection of new soil data.

The nature of soils, with its heterogeneity of possible attribute values, combined with the nature of legacy soil data, with its incompletenesses and heterogeneity in methods used to assess attribute values combined with the lack of conversion rules to harmonise these values, inhibit the establishment of sensible criteria for proper full control of within-pedon soil data consistency and quality. Routine quality control of one-dimensional and simple multi-dimensional attribute values is well possible, though criteria for inclusion and exclusion are subjective by definition.

Despite repeated rigorous screening of the data, by means of visual checks and computer aided quality and integrity checks, the inclusion of data that are possibly inconsistent or erroneous cannot be avoided. Data gaps, of various natures, inevitably occur as well. Users should keep in mind the possible limitations of the data and reflect upon the appropriate level of scale, resolution or generalisation when analysing or applying the present dataset.

The accuracy of georeferencing of legacy soil profile point data is limited relative to that of new soil profile point data, as they are largely from the pre-GPS era. However, in principle, the accuracy of georeferencing of legacy soil profile data can be enhanced by using the associated mapping units, or polygons, as spatial domains of likeliness of profile location and such approaches should be tested and evaluated.

It is argued by some that the quality of legacy soil data is low by definition. This quality though is use dependent, and therewith resolution/scale dependent. The possible inaccuracy of some legacy soil data may well be very small relative to the on-ground variability within a covariate grid cell, making the legacy soil data fit for use.

The accuracy and reliability of legacy soil attribute-values is for certain, to be identified, attributes (as clay content, coarse fragments content, and others) as accurate and reliable as that of new soil data. The more time-stable the soil-attribute is, the more comparable the accuracy of the values, of legacy data and new data, likely is. Also, the impact of the variety of methods, associated with legacy soil data, on the variance of values is only small for certain, to be identified, attributes. It should be evaluated for which soil attributes the inherent accuracy of legacy data and new data is comparable.

Still, an accurate evidence-based final product at high resolution (Africa soil property maps) is most cost-efficiently and rapidly produced based on a combination of legacy soil data with new soil data. Accurate evidence-based soil property maps, at reduced resolution, are also attainable based on large quantities of spatially well distributed legacy soil data, of varied and possibly limited inherent accuracy, while such is not attainable based on small quantities of spatially clustered new soil data, of possibly high or consistent inherent accuracy. Where legacy soil data are cost-efficient input for accurate mapping at reduced resolution, are accurately georeferenced new soil data expensive but necessary additional input for achieving high resolution. This conclusion is confirmed and illustrated by the current updating of the SoilGrids product from 1km to 250m resolution for Sub-Saharan Africa, wherein legacy soil data and new soil data add value to each other.

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Unknown, DROP, SrcID = Herero. Count = 6

Unknown, DROP, SrcID = J-green. Count = 9

Unknown, DROP, SrcID = Jimma (Tepei & Haru). Count = 13

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Unknown, DROP, SrcID = Raya Valley. Count = 7

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Annex 2 Attribute codes (left column) with associated 'parallel' table column headings

Attribute	Associated table column headings							
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ProfileID	aProfileID	-	-	ProfileID	oProfileID	ProfileID	oProfileID	ProfileID
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Revision	aRevision	-	-	Revision	-	-	-	-
GeoIncl	aGeoIncl	-	-	GeoIncl	-	-	-	-
LabIncl	aLabIncl	-	-	LabIncl	-	-	-	-
SrcDb1ID	aSrcDb1ID	-	-	SrcDb1ID	-	-	-	-
SrcDb2ID	aSrcDb2ID	-	-	SrcDb2ID	-	-	-	-
Isis	aIsis	-	-	Isis	-	-	-	-
Ncss	aNcss	-	-	Ncss	-	-	-	-
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Afprof	aAfprof	-	-	Afprof	-	-	-	-
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SoterExt	aSoterExt	-	-	SoterExt	-	-	-	-
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Syn	aSyn	-	-	Syn	-	-	-	-
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LabMnl_ID	aLabMnl_ID	-	-	LabMnl_ID	-	-	-	-
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UnitKey	aUnitKey	uUnitKey	-	UnitKey	-	-	-	-
AttrKey	aAttrKey	-	-	AttrKey	-	-	-	-
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Northing	aNorthing	-	-	-	oNorthing	-	-	-
EW	aEW	-	-	-	oEW	-	-	-
LonD	aLonD	uLonD	-	-	oLonD	-	-	-
LonM	aLonM	uLonM	-	-	oLonM	-	-	-
LonS	aLonS	uLonS	-	-	oLonS	-	-	-
NS	aNS	-	-	-	oNS	-	-	-
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LatM	aLatM	uLatM	-	-	oLatM	-	-	-
LatS	aLatS	uLatS	-	-	oLatS	-	-	-
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ObsDpth	aObsDpth	uObsDpth	mObsDpth	ObsDpth	-	-	-	-
RootDpth	aRootDpth	uRootDpth	mRootDpth	RootDpth	-	-	-	-
RtblDpth	aRtblDpth	-	mRtblDpth	RtblDpth	-	-	-	-
RockDpth	aRockDpth	-	mRockDpth	RockDpth	-	-	-	-
Observer	aObserver	-	-	Observer	-	-	-	-
WRB06	aWRB06	-	mWRB	WRB06	oWRB06	-	-	-
WRB06rg	aWRB06rg	-	-	WRB06rg	oWRB06rg	-	-	-
FAO88	aFAO88	-	mFAO	FAO88	oFAO88	-	-	-
FAO74	aFAO74	-	-	FAO74	oFAO74	-	-	-
USDA	aUSDA	-	mUSDA	USDA	oUSDA	-	-	-
CPCS	aCPCS	-	mCPCS	CPCS	oCPCS	-	-	-
LocalCls	aLocalCls	-	mLocalCls	LocalCls	oLocalCls	-	-	-
Location	aLocation	-	-	Location	-	-	-	-
Z_Alti	aZ_Alti	uZ_Alti	mZ_Alti	Z_Alti	-	-	-	-
Slope	aSlope	uSlope	-	Slope	oSlope	-	-	-
Topogrphy	aTopogrphy	-	-	Topogrphy	oTopogrphy	-	-	-
LndForm	aLndForm	-	-	LndForm	oLndForm	-	-	-
LndElem	aLndElem	-	-	LndElem	oLndElem	-	-	-
SlpForm	aSlpForm	-	-	SlpForm	oSlpForm	-	-	-
SlpPosit	aSlpPosit	-	-	SlpPosit	oSlpPosit	-	-	-
FrqFlood	aFrqFlood	uFrqFlood	-	FrqFlood	oFrqFlood	-	-	-
ParMat	aParMat	-	-	ParMat	oParMat	-	-	-
ParMat2	aParMat2	-	-	-	oParMat2	-	-	-
Litholo	aLitholo	-	-	Litholo	-	-	-	-
Regolith	aRegolith	-	-	Regolith	-	-	-	-
LndCov	aLndCov	-	-	LndCov	oLndCov	-	-	-
LndCov2	aLndCov2	-	-	-	oLndCov2	-	-	-
LndUse	aLndUse	-	-	LndUse	oLndUse	-	-	-
Drain	aDrain	-	-	Drain	oDrain	-	-	-

Attribute	Associated table column headings							
AttrCode	Attrs_123	AttrUnits	AttrMethds	Profiles	OriProfiles	Layers	OriLayers	GeoPoints
SrfDrain	aSrfDrain	-	-	SrfDrain	oSrfDrain	-	-	-
SrfStone	aSrfStone	uSrfStone	-	SrfStone	oSrfStone	-	-	-
SrfSalt	aSrfSalt	-	-	SrfSalt	oSrfSalt	-	-	-
Remarks	aRemarks	-	-	-	oRemarks	-	-	-
LyrObj	aLyrObj	-	-	-	-	LyrObj	oLyrObj	-
LayerID	aLayerID	-	-	-	-	LayerID	oLayerID	-
LayerNr	aLayerNr	-	-	-	-	LayerNr	oLayerNr	-
UpDpth	aUpDpth	uUpDpth	mUpDpth	-	-	UpDpth	oUpDpth	-
LowDpth	aLowDpth	uLowDpth	mLowDpth	-	-	LowDpth	oLowDpth	-
UpHor	aUpHor	uUpHor	-	-	-	-	oUpHor	-
LowHor	aLowHor	uLowHor	-	-	-	-	oLowHor	-
UpSampl	aUpSampl	uUpSampl	-	-	-	-	oUpSampl	-
LowSampl	aLowSampl	uLowSampl	-	-	-	-	oLowSampl	-
Sampls	aSampls	-	-	-	-	Sampls	-	-
Sampl_ID	aSampl_ID	-	-	-	-	Sampl_ID	-	-
SamplAvai	aSamplAvai	-	-	-	-	SamplAvai	-	-
HorDes	aHorDes	-	mHorDes	-	-	HorDes	oHorDes	-
DiagnHor	aDiagnHor	-	mDiagn	-	-	-	oDiagnHor	-
DiagnPrp	aDiagnPrp	-	-	-	-	-	oDiagnPrp	-
DiagnMat	aDiagnMat	-	-	-	-	-	oDiagnMat	-
Transitn	aTransitn	-	-	-	-	-	oTransitn	-
ColorM	aColorM	-	-	-	-	ColorM	oColorM	-
ColorD	aColorD	-	-	-	-	ColorD	oColorD	-
Mottling	aMottling	-	-	-	-	Mottling	oMottling	-
StrGrade	aStrGrade	-	-	-	-	StrGrade	oStrGrade	-
StrSize	aStrSize	-	-	-	-	StrSize	oStrSize	-
StrType	aStrType	-	-	-	-	StrType	oStrType	-
Sticknss	aSticknss	-	-	-	-	Sticknss	oSticknss	-
SaltAlkl	aSaltAlkl	-	-	-	-	SaltAlkl	oSaltAlkl	-
Roots	aRoots	-	-	-	-	Roots	oRoots	-
FldTxtr	aFldTxtr	-	-	-	-	FldTxtr	oFldTxtr	-
CfNature	aCfNature	-	-	-	-	-	oCfNature	-

Attribute	Associated table column headings							
AttrCode	Attrs_123	AttrUnits	AttrMethds	Profiles	OriProfiles	Layers	OriLayers	GeoPoints
CfFldCls	aCfFldCls	-	mCfFldCls	-	-	CfFldCls	oCfFldCls	-
CfFldPc	aCfFldPc	uCfFldPc	mCfFldPc	-	-	CfFldPc	oCfFldPc	-
CfPc	aCfPc	uCfPc	mCfPc	-	-	CfPc	oCfPc	-
CfLabPc	aCfLabPc	uCfLabPc	mCfLabPc	-	-	CfLabPc	oCfLabPc	-
Csand	aCsand	uCsand	mCsand	-	-	-	oCsand	-
Msand	aMsand	uMsand	-	-	-	-	oMsand	-
Fsand	aFsand	uFsand	mFsand	-	-	-	oFsand	-
Csilt	aCsilt	uCsilt	mCsilt	-	-	-	oCsilt	-
Fsilt	aFsilt	uFsilt	mFsilt	-	-	-	oFsilt	-
Humidity	aHumidity	uHumidity	-	-	-	-	oHumidity	-
Sand	aSand	uSand	mSand	-	-	Sand	oSand	-
Silt	aSilt	uSilt	mSilt	-	-	Silt	oSilt	-
Clay	aClay	uClay	mClay	-	-	Clay	oClay	-
SumTxtr	aSumTxtr	uSumTxtr	mSumTxtr	-	-	SumTxtr	oSumTxtr	-
BlkDens	aBlkDens	uBlkDens	mBlkDens	-	-	BlkDens	oBlkDens	-
BlkDens2	aBlkDens2	uBlkDens2	mBlkDens2	-	-	BlkDens2	-	-
Ksat	aKsat	uKsat	mKsat	-	-	Ksat	oKsat	-
InfiltrR	aInfiltrR	uInfiltrR	mInfiltrR	-	-	-	oInfiltrR	-
PHH2O	aPHH2O	-	mPHH2O	-	-	PHH2O	oPHH2O	-
PH2H2O	aPH2H2O	-	mPH2H2O	-	-	-	oPH2H2O	-
PHKCl	aPHKCl	-	mPHKCl	-	-	PHKCl	oPHKCl	-
PHCaCl2	aPHCaCl2	-	mPHCaCl2	-	-	PHCaCl2	oPHCaCl2	-
PHX	aPHX	-	mPHx	-	-	-	oPHX	-
EC	aEC	uEC	mEC	-	-	EC	oEC	-
EC2	aEC2	uEC2	mEC2	-	-	EC2	oEC2	-
SlblCat	aSlblCat	uSlblCat	mSlblCat	-	-	SlblCat	oSlblCat	-
SlblAn	aSlblAn	uSlblAn	mSlblAn	-	-	SlblAn	oSlblAn	-
SlblCa	aSlblCa	-	-	-	-	-	oSlblCa	-
SlblMg	aSlblMg	-	-	-	-	-	oSlblMg	-
SlblNa	aSlblNa	-	-	-	-	-	oSlblNa	-
SlblK	aSlblK	-	-	-	-	-	oSlblK	-
SlblCO3	aSlblCO3	-	-	-	-	-	oSlblCO3	-

Attribute	Associated table column headings							
AttrCode	Attrs_123	AttrUnits	AttrMethds	Profiles	OriProfiles	Layers	OriLayers	GeoPoints
SlblHCO3	aSlblHCO3	-	-	-	-	-	oSlblHCO3	-
SlblCl	aSlblCl	-	-	-	-	-	oSlblCl	-
SlblSO4	aSlblSO4	-	-	-	-	-	oSlblSO4	-
SlblNO3	aSlblNO3	-	-	-	-	-	oSlblNO3	-
SlblF	aSlblF	-	-	-	-	-	oSlblF	-
ExCaMg	aExCaMg	uExCaMg	mExCaMg	-	-	-	oExCaMg	-
ExCa	aExCa	uExCa	mExCa	-	-	ExCa	oExCa	-
ExMg	aExMg	uExMg	mExMg	-	-	ExMg	oExMg	-
ExNa	aExNa	uExNa	mExNa	-	-	ExNa	oExNa	-
ExK	aExK	uExK	mExK	-	-	ExK	oExK	-
ExBases	aExBases	uExBases	mExBases	-	-	ExBases	oExBases	-
ExH	aExH	uExH	mExH	-	-	ExH	oExH	-
ExAl	aExAl	uExAl	mExAl	-	-	ExAl	oExAl	-
ExAcid	aExAcid	uExAcid	mExAcid	-	-	ExAcid	oExAcid	-
Ecec	aEcec	uEcec	mEcec	-	-	Ecec	oEcec	-
CecSoil	aCecSoil	uCecSoil	mCecSoil	-	-	CecSoil	oCecSoil	-
CecSoil2	aCecSoil2	uCecSoil2	mCecSoil2	-	-	CecSoil2	oCecSoil2	-
CecMin	aCecMin	uCecMin	-	-	-	-	oCecMin	-
CecMax	aCecMax	uCecMax	-	-	-	-	oCecMax	-
Bsat	aBsat	uBsat	mBSat	-	-	Bsat	oBSat	-
Bsat2	aBsat2	uBsat2	mBSat2	-	-	Bsat2	oBSat2	-
CaSO4	aCaSO4	uCaSO4	mCaSO4	-	-	CaSO4	oCaSO4	-
CaCO3	aCaCO3	uCaCO3	mCaCO3	-	-	CaCO3	oCaCO3	-
InOrgC	aInOrgC	uInOrgC	mInOrgC	-	-	InOrgC	oInOrgC	-
TotC	aTotC	uTotC	mTotC	-	-	TotC	oTotC	-
OrgC	aOrgC	uOrgC	mOrgC	-	-	OrgC	oOrgC	-
TotalN	aTotalN	uTotalN	mTotalN	-	-	TotalN	oTotalN	-
CN	aCN	-	mCN	-	-	CN	oCN	-
TotalP	aTotalP	uTotalP	mTotalP	-	-	TotalP	oTotalP	-
AvailP	aAvailP	uAvailP	mAvailP	-	-	-	oAvailP	-
AvailP2	aAvailP2	uAvailP2	mAvailP2	-	-	-	oAvailP2	-
RetentP	aRetentP	uRetentP	mRetentP	-	-	-	oRetentP	-

Attribute	Associated table column headings							
AttrCode	Attrs_123	AttrUnits	AttrMethds	Profiles	OriProfiles	Layers	OriLayers	GeoPoints
Poros	aPoros	uPoros	mPoros	-	-	-	oPoros	-
VMCpF00	aVMCpF00	uVMCpF00	mVMCpF00	-	-	VMCpF00	oVMCpF00	-
VMCpF05	aVMCpF05	uVMCpF05	mVMCpF05	-	-	VMCpF05	oVMCpF05	-
VMCpF10	aVMCpF10	uVMCpF10	mVMCpF10	-	-	VMCpF10	oVMCpF10	-
VMCpF15	aVMCpF15	uVMCpF15	mVMCpF15	-	-	VMCpF15	oVMCpF15	-
VMCpF17	aVMCpF17	uVMCpF17	mVMCpF17	-	-	VMCpF17	oVMCpF17	-
VMCpF18	aVMCpF18	uVMCpF18	mVMCpF18	-	-	VMCpF18	oVMCpF18	-
VMCpF20	aVMCpF20	uVMCpF20	mVMCpF20	-	-	VMCpF20	oVMCpF20	-
VMCpF22	aVMCpF22	uVMCpF22	mVMCpF22	-	-	VMCpF22	oVMCpF22	-
VMCpF23	aVMCpF23	uVMCpF23	mVMCpF23	-	-	VMCpF23	oVMCpF23	-
VMCpF24	aVMCpF24	uVMCpF24	mVMCpF24	-	-	VMCpF24	oVMCpF24	-
VMCpF25	aVMCpF25	uVMCpF25	mVMCpF25	-	-	VMCpF25	oVMCpF25	-
VMCpF27	aVMCpF27	uVMCpF27	mVMCpF27	-	-	VMCpF27	oVMCpF27	-
VMCpF28	aVMCpF28	uVMCpF28	mVMCpF28	-	-	VMCpF28	oVMCpF28	-
VMCpF29	aVMCpF29	uVMCpF29	mVMCpF29	-	-	VMCpF29	oVMCpF29	-
VMCpF30	aVMCpF30	uVMCpF30	mVMCpF30	-	-	VMCpF30	oVMCpF30	-
VMCpF33	aVMCpF33	uVMCpF33	mVMCpF33	-	-	VMCpF33	oVMCpF33	-
VMCpF34	aVMCpF34	uVMCpF34	mVMCpF34	-	-	VMCpF34	oVMCpF34	-
VMCpF35	aVMCpF35	uVMCpF35	mVMCpF35	-	-	VMCpF35	oVMCpF35	-
VMCpF36	aVMCpF36	uVMCpF36	mVMCpF36	-	-	VMCpF36	oVMCpF36	-
VMCpF37	aVMCpF37	uVMCpF37	mVMCpF37	-	-	VMCpF37	oVMCpF37	-
VMCpF40	aVMCpF40	uVMCpF40	mVMCpF40	-	-	VMCpF40	oVMCpF40	-
VMCpF42	aVMCpF42	uVMCpF42	mVMCpF42	-	-	VMCpF42	oVMCpF42	-
VMCpF50	aVMCpF50	uVMCpF50	mVMCpF50	-	-	VMCpF50	oVMCpF50	-
VMCpF58	aVMCpF58	uVMCpF58	mVMCpF58	-	-	VMCpF58	oVMCpF58	-
VolAWC	aVolAWC	uVolAWC	mVolAWC	-	-	VolAWC	oVolAWC	-
WghtAWC	aWghtAWC	uWghtAWC	-	-	-	-	oWghtAWC	-
Extr1Fe	aExtr1Fe	uExtr1Fe	mExtr1Fe	-	-	-	oExtr1Fe	-
Extr2Fe	aExtr2Fe	uExtr2Fe	mExtr2Fe	-	-	-	oExtr2Fe	-
Extr3Fe	aExtr3Fe	uExtr3Fe	mExtr3Fe	-	-	-	oExtr3Fe	-
ExtrTFe	aExtrTFe	uExtrTFe	mExtrTFe	-	-	-	oExtrTFe	-
Extr1Al	aExtr1Al	uExtr1Al	mExtr1Al	-	-	-	oExtr1Al	-

Attribute	Associated table column headings							
AttrCode	Attrs_123	AttrUnits	AttrMethds	Profiles	OriProfiles	Layers	OriLayers	GeoPoints
Extr2Al	aExtr2Al	uExtr2Al	mExtr2Al	-	-	-	oExtr2Al	-
Extr3Al	aExtr3Al	uExtr3Al	mExtr3Al	-	-	-	oExtr3Al	-
AvailK	aAvailK	uAvailK	mAvailK	-	-	-	oAvailK	-
TotalK	aTotalK	uTotalK	mTotalK	-	-	-	oTotalK	-
Fe	aFe	uFe	mMicroNutr	-	-	-	oFe	-
Mn	aMn	uMn	-	-	-	-	oMn	-
Zn	aZn	uZn	-	-	-	-	oZn	-
Cu	aCu	uCu	-	-	-	-	oCu	-
B	aB	uB	-	-	-	-	oB	-
S	aS	uS	-	-	-	-	oS	-
OrgMat	aOrgMat	uOrgMat	mOrgMat	-	-	-	oOrgMat	-
TotHumC	aTotHumC	uTotHumC	mTotHumC	-	-	-	oTotHumC	-
HumAcidC	aHumAcidC	uHumAcidC	mHumAcidC	-	-	-	oHumAcidC	-
FulAcidC	aFulAcidC	uFulAcidC	mFulAcidC	-	-	-	oFulAcidC	-
LabTxtr	aLabTxtr	-	mLabTxtr	-	-	LabTxtr	oLabTxtr	-
ClyMinera	aClyMinera	-	-	-	-	ClyMinera	-	-
FullDescr	aFullDescr	-	-		-	-	oFullDescr	-
FID	aFID	-	-	FID	-	-	-	-
Shape	aShape	-	-	Shape	-	-	-	-
LayerID00	aLayerID00	-	-	LayerID00	-	-	-	-
LayerID99	aLayerID99	-	-	LayerID99	-	-	-	-
oProfileID	-	-	-	-	-	-	-	-
oLayerID	-	-	-	-	-	-	-	-
mMethdKey	-	-	-	-	-	-	-	-
mMethdYN	-	-	-	-	-	-	-	-
uUnitKey	-	-	-	-	-	-	-	-
aAttr	-	-	-	-	-	-	-	-

Annex 3a Dictionary of attributes codes

Attr Code	Attr Table	Attr Soil	Attr DType	Attr Unit	AttrDescrS (description short)	AttrDescrL (description long)	Standard
OID	Profiles	0	Num integer	-	In-table object ID	Identifier of the in-table object (row)	NA
PrObj	Profiles	0	Num integer	-	AFSP profile object ID	Identifier of the profile record or object	NA
ProfileID	Profiles	0	Text	-	AFSP profile ID	Identifier of the soil profile feature, composed of country code<>source code_original profile code	eSOTER2012
DbVersion	Profiles	0	Num integer	-	AFSP database version	Version number of the AFSP database wherein the profile identifier and data are added	NA
Revision	Profiles	0	Num double	-	AFSP database revision number	Version number of the AFSP database wherein profile data values were revised	NA
GeoIncl	Profiles	0	Num integer	-	AFSP boolean of inclusion of georeferencing data	Indicator (boolean) of whether profile is georeferenced in AFSP (1=yes,0=no)	NA
LabIncl	Profiles	0	Num integer	-	AFSP boolean of inclusion of laboratory layer data	Indicator (boolean) of whether profile has soil analytical layer data in AFSP (1=yes,0=no)	NA
SrcDb1ID	Profiles	0	Text	-	AFSP-ID of 1st source dataset	Identifier of the 1st digital source dataset	NA
SrcDb2ID	Profiles	0	Text	-	AFSP-ID of 2nd source dataset	Identifier of the 2nd digital source dataset	NA
Isis	Profiles	0	Text	-	Profile ID originally in ISIS	Profile ID originally in source dataset ISIS	NA
Ncss	Profiles	0	Text	-	Profile ID originally in NCSS	Profile ID originally in source dataset NCSS	NA
Wasp	Profiles	0	Text	-	Profile ID originally in WASP	Profile ID originally in source dataset WASP	NA
Soters	Profiles	0	Text	-	Profile ID originally in SOTER(S)	Profile ID originally in source datasets ISRIC SOTERs	NA
Wise3	Profiles	0	Text	-	Profile ID originally in WISE3	Profile ID originally in source dataset WISE3	NA
Afprof	Profiles	0	Text	-	Profile ID originally in AFPROF	Profile ID originally in source dataset AFPROF	NA
FaoSdb	Profiles	0	Text	-	Profile ID originally in FAOSDB	Profile ID originally in source dataset FAOSDB	NA
SoterExt	Profiles	0	Text	-	Profile ID originally in SOTEREXT	Profile ID originally in source datasets External SOTERs	NA
Lrep	Profiles	0	Text	-	Profile ID originally in LREP	Profile ID originally in source dataset LREP	NA
Stipa	Profiles	0	Text	-	Profile ID originally in STIPA	Profile ID originally in source dataset STIPA	NA
Valsol	Profiles	0	Text	-	Profile ID originally in VALSOL	Profile ID originally in source dataset VALSOL	NA
Pedi	Profiles	0	Text	-	Profile ID originally in PEDI	Profile ID originally in source dataset PEDI	NA
Minagri	Profiles	0	Text	-	Profile ID originally in MINAGRI	Profile ID originally in source dataset MINAGRI	NA

Attr Code	Attr Table	Attr Soil	Attr DType	Attr Unit	AttrDescrS (description short)	AttrDescrL (description long)	Standard
PrUrl	Profiles	0	Text	-	URL source to profile data	URL source link to online profile data	NA
SrcRep1ID	Profiles	0	Text	-	AFSP-ID of 1st source report	Identifier of the 1st report, book or publication that is source of the profile data. Where possible, the identifier is harmonised by using the unique ISRIC library identifier (ISN).	eSOTER2012
SrcRep2ID	Profiles	0	Text	-	AFSP-ID of 2nd source report	Identifier of the 2nd report, book or publication that is source of the profile data. Where possible, the identifier is harmonised by using the unique ISRIC library identifier (ISN).	NA
PridInRep1	Profiles	0	Text	-	Original Profile ID in 1st source report	Profile ID originally in 1st source report	NA
PridInRep2	Profiles	0	Text	-	Original Profile ID in 2nd source report	Profile ID originally in 2nd source report	NA
PageInRep	Profiles	0	Text	-	Page in report	Page in the document where the profile data can be found	eSOTER2012
MapID	Profiles	0	Text	-	Map identifier	Identifier of the map associated with the profile data.	eSOTER2012
MapScale	Profiles	0	Num integer	cm/cm	Map scale	Scale of the map (1: xxxx cm/cm)	eSOTER2012
MapUnitID	Profiles	0	Text	-	Mapping unit	Legend entry of the mapping unit	NA
TerrainMU	OriProfiles	0	Text	-	Terrain mapping unit	Terrain mapping unit	NA
TerrCmpMU	OriProfiles	0	Text	-	Terrain mapping unit component	Terrain component within the given (terrain) mapping unit	NA
SoilCmpMU	OriProfiles	0	Text	-	Soil mapping unit component	Soil component within the given terrain component of the given (terrain) mapping unit	NA
PntOrMapU	Profiles	0	Text	-	Indicator for point or polygon	Indicator for whether the profile data are derived from soil point observations (P) or from soil mapping units (M)	NA
Syn	Profiles	0	Num integer	-	Indicator for synthetic profile	Indicator for whether the profile is synthetic (1) or true (0)	NA
FldMnl_ID	Profiles	0	Text	-	AFSP-ID of field manual	Identifier of the field manual or guidelines used for observing and describing the soil in the field.	NA
LabMnl_ID	Profiles	0	Text	-	AFSP-ID of laboratory manual	Identifier of the soil laboratory where the soil samples were analyzed, with -if available- the laboratory manual	eSOTER2012
MethdKey	Profiles	0	Text	-	AFSP-key to methods	Key from Inventory to AttrMethods (mMethKey) with collection of methods applied to assess feature-attribute-values	NA
UnitKey	Profiles	0	Text	-	AFSP-key to units of expression	Key from Inventory to AttrUnits (uUnitKey) with collection of units to express feature-attribute-values	NA
AttrKey	Profiles	0	Text	-	AFSP-key to attributes	Key from Inventory to Attrs (aAttr) with collection of attributes, including soil properties, observed or measured	NA
Reliab	Profiles	0	Text	-	Profile description status	Soil profile description status, refering to the inferred quality (incl. completeness) of the soil descriptive and analytical data, indicative for the reliability of the data. Classes are adapted from (FAO 2006).	eSOTER2012

Attr Code	Attr Table	Attr Soil	Attr DType	Attr Unit	AttrDescrS (description short)	AttrDescrL (description long)	Standard
Country	Profiles	0	Text	-	Country	Country where the profile is located.	eSOTER2012
Easting	OriProfiles	0	Text	-	Easting	(Projected) easting (e.g. in degrees or UTM meters)	NA
Northing	OriProfiles	0	Text	-	Northing	(Projected) northing (e.g. in degrees or UTM meters)	NA
EW	OriProfiles	0	Num integer	-	East or West	East or West (1 or -1)	NA
LonD	OriProfiles	0	Num double	deg	Longitude degrees	Longitude degrees	NA
LonM	OriProfiles	0	Num double	min	Longitude minutes	Longitude minutes	NA
LonS	OriProfiles	0	Num double	sec	Longitude seconds	Longitude seconds	NA
NS	OriProfiles	0	Num integer	-	North or South	North or South (1 or -1)	NA
LatD	OriProfiles	0	Num double	deg	Latitude degrees	Latitude degrees	NA
LatM	OriProfiles	0	Num double	min	Latitude minutes	Latitude minutes	NA
LatS	OriProfiles	0	Num double	sec	Latitude seconds	Latitude seconds	NA
ProjCS	OriProfiles	0	Text	-	Projected coordinate system	Geographic projection and coordinate system, datum	NA
X_LonDD	Profiles	0	Num double	DD	Longitude	Longitude in decimal degrees. Longitudes in the Eastern hemisphere are positive/ in the Western hemisphere negative.	NA
Y_LatDD	Profiles	0	Num double	DD	Latitude	Latitude in decimal degreesLatitudes in the Northern hemisphere are positive/ in the Southern hemisphere negative.	NA
XYAccur	Profiles	0	Num double	DD	Profile location status, accuracy	Indicative accuracy of the profile location, expressed in decimal degrees	eSOTER2012
T_Year	Profiles	0	Num integer	yr	Year of observation or measurement	The year when the profile was described and sampled. If these activities were carried out on different dates, the date of sampling should be given/ format is YYYY	eSOTER2012
ObsDpth	Profiles	0	Num integer	cm	Observation depth	Depth of observation, which can be shallower or deeper than profile depth, expressed in cm	NA
RootDpth	Profiles	1	Num integer	cm	Rooted depth	Depth of presence of roots, more than very few and thicker than very fine, expressed in cm	NA
RtblDpth	Profiles	1	Text	-	Rootable depth	Estimated depth to which root growth is not restricted by any physical or chemical impediment, such as impenetrable or toxic layers, to be determined as effective soil depth using land evaluation. Strongly fractured rocks, such as shale, may be considere	eSOTER2012
RockDpth	Profiles	1	Text	-	Depth to bedrock	Depth to consolidated bedrock or iron pan in meters. For depths less than 2 m the depth is rounded to nearest 0.1 meter. When depth exceeds observation depth, deeper as e.g. 1.2 (>1.2) is applied. Expressed as text.	eSOTER2012
Observer	Profiles	0	Text	-	Observer	Name(s) of observer(s) of the profile, or author of the profile description	NA
WRB06	Profiles	0	Text	-	WRB soil reference group incl.	Soil feature classified according to the World Reference Base for Soil	eSOTER2012

Attr Code	Attr Table	Attr Soil	Attr DType	Attr Unit	AttrDescrS (description short)	AttrDescrL (description long)	Standard
					qualifiers	Resources (IUSS 2007), preferably up to the lowest level (prefix and suffix) of the Reference Soil Group (RSG), as provided in the data source. The sequential order of the lower level	
WRB06rg	Profiles	0	Text	-	WRB soil reference group code	Soil feature classified according to the World Reference Base for Soil Resources (IUSS 2007), at the highest level (reference group) and expressed as class code	NA
FAO88	Profiles	0	Text	-	Soil class according to FAO 1988	Soil classified according to Revised Legend of the FAO-Unesco Soil Map of the World (FAO 1988, 1990), as provided in the data source, expressed as class code (major soil groupings and soil units)	eSOTER2012
FAO74	Profiles	0	Text	-	Soil class according to FAO 1974	Soil classified according to the legend of the FAO-Unesco Soil Map of the World (FAO, 1974), as provided in the data source, expressed as class code (major soil groupings and soil units)	NA
USDA	Profiles	0	Text	-	Soil class according to USDA	Soil classified according to USDA Soil Taxonomy, as provided in the data source, expressed in full (not standardised)	eSOTER2012
CPCS	Profiles	0	Text	-	Soil class according to CPCS	Soil classified according to CPCS, as provided in the data source, expressed in full (not standardised)	NA
LocalCls	Profiles	0	Text	-	Soil class according to local classification	Soil classified or named according to the local or national system, as provided in the data source, including series and ethnic namings, expressed in full	eSOTER2012
Location	Profiles	0	Text	-	Descriptive profile location	Description of the profile location, expressed in free text	NA
Z_Alti	Profiles	1	Num integer	m	Altitude	Altitude of the profile above mean sea level. Assumes locations are accurate.	eSOTER2012
Slope	Profiles	1	Num integer	%	Slope gradient	Slope gradient (%) at the site	NA
Topogrphy	Profiles	1	Text	-	Topography	Topography, interpreted from the dominant slope gradient (%) of the surroundings, expressed as class code	eSOTER2012
LndForm	Profiles	1	Text	-	Major landform	Landform class as defined by SOTER, described foremost by their morphology and not by their genetic origin, or processes responsible for their shape. The dominant slope is the most important differentiating criterion, followed by the relief intensity. At	eSOTER2012
LndElem	OriProfiles	1	Text	-	Land element	Land element as part of major landform, comparable to terrain component of the SOTER unit, expressed in full -not standardised	NA
SlpForm	Profiles	1	Text	-	Slope form at site	Form of the slope at site, expressed as class code	NA
SlpPosit	Profiles	1	Text	-	Position on slope	Relative position of the feature on the slope, at the scale of the land element or terrain component, expressed as class code	eSOTER2012
FrqFlood	Profiles	1	Text	yr^{-1}	Flooding frequency	Frequency of flooding, expressed as class code (yr^{-1})	NA

Attr Code	Attr Table	Attr Soil	Attr DType	Attr Unit	AttrDescrS (description short)	AttrDescrL (description long)	Standard
ParMat	Profiles	1	Text	-	Parent material on site	Lithologic parent material on site, expressed as class codes	eSOTER2012
ParMat2	OriProfiles	1	Text	-	Parent material on site, 2nd observation	Lithologic parent material on site, 2nd observation (from WASP)	NA
Litholo	Profiles	1	Text	-	Lithology in surroundings	Lithology associated to parent material (also known as General/Surface Lithology of TerrainComponent or dominant parent material of SoTerUnit in SOTER2002), expressed as class code	eSOTER2012
Regolith	Profiles	1	Text	-	Regolith	Regolith	NA
LndCov	Profiles	1	Text	-	Land cover	Land cover or (largely undisturbed) vegetation at the profile site at time of observation/sampling, expressed as class code	eSOTER2012
LndCov2	OriProfiles	1	Text	-	Land cover, 2nd observation	Land cover or (largely undisturbed) vegetation at the profile site, 2nd observation (from WASP)	NA
LndUse	Profiles	1	Text	-	Land use	Land use at the profile site at time of observation/sampling, expressed as class code	eSOTER2012
Drain	Profiles	1	Text	-	Drainage	Drainage of the profile, expressed as class codes	eSOTER2012
SrfDrain	Profiles	1	Text	-	Surface drainage	Surface drainage at the profile site, expressed as class codes	NA
SrfStone	Profiles	1	Text	%	Surface stoniness	Percentage cover of coarse fragments (>2 mm) incl. gravel, stones and boulders, that are completely or partly at the surface, expressed in class codes	eSOTER2012
SrfSalt	Profiles	1	Text	-	Surface salt or alkali	Notable presence of salt or alkali at the surface, expressed as text boolean (Y/N)	NA
Remarks	OriProfiles	0	Text	-	Remarks	Original remarks with the profile or profile site, including full profile descriptions	NA
LyrObj	Layers	0	Num integer	-	AFSP profile layer object ID	Identifier of the profile layer record or object	NA
LayerID	Layers	0	Text	-	AFSP profile layer ID	Identifier of the soil profile layer subfeature, composed of ProfileID_LayerNr	NA
LayerNr	Layers	0	Num integer	-	Layer number in profile	Consecutive, in profile, layer number is allocated to each distinguished profile layer, starting with 1 for the uppermost surface layer. A litter layer on top of the soil surface can be included with layer nr 0 (not according to FAO, 2006). Note that the	NA
UpDpth	Layers	0	Num integer	cm	Layer upper depth	Depth in cm of the upper (top) boundary of each distinguished layer. Note that all layers have positive depths measured from the top of the surface of the soil (upper depth = 0 cm), excluding a litter layer on top of the surface with negative upper depth	NA
LowDpth	Layers	0	Num integer	cm	Layer lower depth	Depth in cm of the lower (bottom) boundary of each distinguished layer. Note that all layers have positive depths measured from the top of the surface of the soil, excluding a litter layer on top of the surface with lower depth = 0 cm. Note	NA

Attr Code	Attr Table	Attr Soil	Attr DType	Attr Unit	AttrDescrS (description short)	AttrDescrL (description long)	Standard
						that the posi	
UpHor	OriLayers	1	Num integer	cm	Horizon upper depth	Depth in cm of the upper (top) boundary of each horizon	eSOTER2012
LowHor	OriLayers	1	Num integer	cm	Horizon lower depth	Depth in cm of the lower (bottom) boundary of each horizon	eSOTER2012
UpSampl	OriLayers	0	Num integer	cm	Sample upper depth	Depth in cm of the upper (top) boundary of the sample	NA
LowSampl	OriLayers	0	Num integer	cm	Sample lower depth	Depth in cm of the lower (bottom) boundary of the sample	NA
Sampls	Layers	0	Num integer	-	Sample composition	Sample composition, specifying the amount of separate samples taken and mixed to create the considered (composite) sample	NA
Sampl_ID	Layers	0	Text	-	Sample identifier	Identifier of the sample (in the field or laboratory) as provided in the data source	NA
SamplAvai	Layers	0	Text	-	Sample availability	Availability in storage of the original physical sample, expressed as text boolean (Y/N)	NA
HorDes	Layers	1	Text	-	Horizon designation	Horizon designation codings, unstandardised as provided by the data source. Ideally, horizons are distinguished according to FAO, 2006, with master horizon and layers incl. subordinate characteristics being coded according to (FAO, 2006/ FAO-ISRIC, 1990)	eSOTER2012
DiagnHor	OriLayers	1	Text	-	Diagnostic horizon	Diagnostic horizon, according to the World Reference Base for Soil Resources 2nd edition (IUSS 2006, 2007). (Note: SOTER databases completed before 2006 use criteria of the Revised Legend.)	eSOTER2012
DiagnPrp	OriLayers	1	Text	-	Diagnostic property	Diagnostic property, according to the World Reference Base for Soil Resources (IUSS 2007). (Note: SOTER databases completed before 2006 use criteria of the Revised Legend). The full definition of all the diagnostic properties is given in ANNEX 3.	eSOTER2012
DiagnMat	OriLayers	1	Text	-	Diagnostic material	Diagnostic material, according to the World Reference Base for Soil Resources (IUSS 2007). Diagnostic soil materials are intended to reflect (partly) the properties of the original parent materials, in which pedogenetic processes have not yet been very a	eSOTER2012
Transitn	OriLayers	1	Text	-	Transition	Abruptness or distinctness of horizon boundary to underlying horizon (FAO 2006/ FAO and ISRIC 1990).	eSOTER2012
ColorM	Layers	1	Text	-	Colour - moist soil	Colour of the moist soil matrix, expressed as hue, value and chroma according to munsell codes	eSOTER2012
ColorD	Layers	1	Text	-	Colour - dry soil	Colour of the dry soil matrix, expressed as hue, value and chroma according to Munsell codes	eSOTER2012
Mottling	Layers	1	Text	-	Mottles - presence	Indicates the presence of mottles (after FAO-ISRIC, 1990/ FAO, 2006), expressed as text boolean (Y/N)	eSOTER2012

Attr Code	Attr Table	Attr Soil	Attr DType	Attr Unit	AttrDescrS (description short)	AttrDescrL (description long)	Standard
StrGrade	Layers	1	Text	-	Structure grade	Grade of the primary structure elements, defined according to guidelines for soil description (FAO 2006/ FAO and ISRIC 1990), expressed as class code	eSOTER2012
StrSize	Layers	1	Text	-	Structure size	Size of the primary structure elements, defined according to guidelines for soil description (FAO-ISRIC, 1990/ FAO, 2006/ SSS 1951), expressed as class code	eSOTER2012
StrType	Layers	1	Text	-	Structure type	Type of the primary structure elements, defined according to guidelines for soil description (FAO 2006/ FAO and ISRIC 1990), expressed as class code	eSOTER2012
Sticknss	Layers	1	Text	-	Stickiness when wet	Stickiness for consistency of soil when wet. Indicative for major land qualities	NA
SaltAlkl	Layers	1	Text	-	Salt or alkali	Presence of salt or alkali, according to (FAO-ISRIC, 1990/ FAO, 2006), expressed as text boolean (Y/N)	NA
Roots	Layers	1	Text	-	Roots	Presence of roots, according to (FAO-ISRIC, 1990/ FAO, 2006), more than very few and thicker than very fine, expressed as text boolean (Y/N)	NA
FldTxtr	Layers	1	Text	-	Particle size class	Particle size class of the fine earth (<2 mm) observed in the field, derived from USDA texture classes which assumes particle size fractions (esd) defined according to (Soil Survey Division Staff 1993b): sand (2 û 0.05 mm)/ silt (0.050 û 0.002 mm) and c	eSOTER2012
CfNature	OriLayers	1	Text	-	Nature of coarse fragments	Nature of coarse fragments	NA
CfFldCls	Layers	1	Text	-	Coarse fragments field class	Abundance of coarse fragments (incl. mineral concretions, nodules and any rock fragments >2 mm) observed in the field, according to FAO-ISRIC1990, FAO2006, expressed as class code	eSOTER2012
CfFldPc	Layers	1	Num double	v %	Coarse fragments field	Abundance of coarse fragments (incl. mineral concretions, nodules and any rock fragments >2 mm) observed in the field, according to FAO-ISRIC1990, FAO2006, and possibly concerted from class code, expressed as volume percentage	NA
CfPc	Layers	1	Num double	v %	Coarse fragments	Abundance of coarse fragments (incl. mineral concretions, nodules and any rock fragments >2 mm) observed in the field and/or measured in the laboratory, expressed as volume percentage	NA
CfLabPc	Layers	1	Num double	v %	Coarse fragments lab	Abundance of coarse fragments (incl. mineral concretions, nodules and any rock fragments >2 mm) measured in the laboratory, expressed as volume percentage	NA
Csand	OriLayers	1	Num double	g/100g	Coarse sand	Weight% of particles 1.0-0.5 mm (coarse sand, SDCO) and 2.0-1.0 mm (very coarse sand, SDVC) in fine earth fraction	eSOTER2012
Msand	OriLayers	1	Num double	g/100g	Medium sand	Weight% of medium sand particles in fine earth fraction	eSOTER2012

Attr Code	Attr Table	Attr Soil	Attr DType	Attr Unit	AttrDescrS (description short)	AttrDescrL (description long)	Standard
Fsand	OriLayers	1	Num double	g/100g	Fine sand	Weight% of particles 0.25-0.1 mm (fine sand, SDFI) and 0.1-0.05 mm (very fine sand, SDVF) in fine earth fraction	eSOTER2012
Csilt	OriLayers	1	Num double	g/100g	Coarse silt	Weight% of coarse silt particles in fine earth fraction	NA
Fsilt	OriLayers	1	Num double	g/100g	Fine silt	Weight% of fine silt particles in fine earth fraction	NA
Humidity	OriLayers	1	Num double	g/100g	Humidity	Weight% of humidity in fine earth fraction	NA
Sand	Layers	1	Num double	g/100g	Sand	Weight% of particles 2.0-0.05 mm (sand) in fine earth fraction. The total sand fraction, either as an absolute value, or as the sum of the subfractions.	eSOTER2012
Silt	Layers	1	Num double	g/100g	Silt	Weight% of particles 0.05-0.002 mm (silt) in fine earth fraction	eSOTER2012
Clay	Layers	1	Num double	g/100g	Clay	Weight% of particles less than 0.002 mm (clay) in fine earth fraction	eSOTER2012
SumTxtr	Layers	1	Num double	g/100g	Sum of fine earth fractions	Sum of weight% of fine earth fractions, theoretically equal to 100%	NA
BlkDens	Layers	1	Num double	kg/dm3	Bulk density	Oven-dry bulk density, in kg dm-3	eSOTER2012
BlkDens2	Layers	1	Num double	kg/dm3	Bulk density, 2nd measurement	Oven-dry bulk density, in kg dm-3, 2nd measurement	eSOTER2012
Ksat	OriLayers	1	Num double	cm/h	Hydraulic conductivity	Saturated hydraulic conductivity, in cm/hour	SOTER1995
InfiltrR	OriLayers	1	Num double	cm/h	Infiltration rate	Infiltration rate, in cm/hour	NA
PHH2O	Layers	1	Num double	-	pH H2O	pH determined in a 1:x mixture of soil : water	eSOTER2012
PH2H2O	OriLayers	1	Num double	-	pH H2O, 2nd measurement	pH determined in a 1:x mixture of soil : water, 2nd measurement	eSOTER2012
PHKCl	Layers	1	Num double	-	pH KCl	pH determined in the supernatant suspension of a 1:x mixture of soil : KCl	eSOTER2012
PHCaCl2	Layers	1	Num double	-	pH CaCl2	pH determined in the supernatant suspension of a 1:x mixture of soil : CaCl2	eSOTER2012
PHX	OriLayers	1	Num double	-	PH NaF or PH Co	pH determined in the supernatant suspension of a 1:x mixture of soil : NaF, or soil : HexamineCobalt TriChloride	NA
EC	Layers	1	Num double	dS/m	Electrical conductivity	Electrical conductivity determined in a 1:x soil water mixture, in dS m-1, often measured in the same run as pH-H2O	eSOTER2012
EC2	Layers	1	Num double	dS/m	Electrical conductivity, 2nd measurement	Electrical conductivity determined in a 1:x soil water mixture, 2nd measurement (other method), in dS m^{-1}	eSOTER2012
SlblCat	Layers	1	Num double	cmol/l	Soluble cations	Sum of soluble cations, in cmol l^{-1}	NA
SlblAn	Layers	1	Num double	cmol/l	Soluble anions	Sum of soluble anions, in cmol l^{-1}	NA
SlblCa	OriLayers	1	Num double	cmol/l	Soluble Ca	Content of soluble Ca++, in cmol l^{-1}	NA
SlblMg	OriLayers	1	Num double	cmol/l	Soluble Mg	Content of soluble Mg++, in cmol l^{-1}	NA
SlblNa	OriLayers	1	Num double	cmol/l	Soluble Na	Content of soluble Na+, in cmol l^{-1}	NA
SlblK	OriLayers	1	Num double	cmol/l	Soluble K	Content of soluble K+, in cmol l^{-1}	NA
SlblCO3	OriLayers	1	Num double	cmol/l	Soluble CO3	Content of soluble CO3–, in cmol l^{-1}	NA
SlblHCO3	OriLayers	1	Num double	cmol/l	Soluble HCO3	Content of soluble HCO3-, in cmol l^{-1}	NA
SlblCl	OriLayers	1	Num double	cmol/l	Soluble Cl	Content of soluble Cl-, in cmol l^{-1}	NA

Attr Code	Attr Table	Attr Soil	Attr DType	Attr Unit	AttrDescrS (description short)	AttrDescrL (description long)	Standard
SlblSO4	OriLayers	1	Num double	cmol/l	Soluble SO4	Content of soluble SO4--, in cmol l^{-1}	NA
SlblNO3	OriLayers	1	Num double	cmol/l	Soluble NO3	Content of soluble NO3-, in cmol l^{-1}	NA
SlblF	OriLayers	1	Num double	cmol/l	Soluble F	Content of soluble F-, in cmol l^{-1}	NA
ExCaMg	OriLayers	1	Num double	cmol/kg	Exchangeable Ca & Mg	Sum of exchangeable Ca and Mg, in cmolc kg-1 (= meq/100 g)	NA
ExCa	Layers	1	Num double	cmol/kg	Exchangeable Ca	Exchangeable Ca, in cmolc kg-1 (= meq/100 g)	eSOTER2012
ExMg	Layers	1	Num double	cmol/kg	Exchangeable Mg	Exchangeable Mg, in cmolc kg-1 (= meq/100 g)	eSOTER2012
ExNa	Layers	1	Num double	cmol/kg	Exchangeable Na	Exchangeable Na, in cmolc kg-1 (= meq/100 g)	eSOTER2012
ExK	Layers	1	Num double	cmol/kg	Exchangeable K	Exchangeable K, in cmolc kg-1 (= meq/100 g)	eSOTER2012
ExBases	Layers	1	Num double	cmol/kg	Exchangeable bases	Sum of exchangeable bases, in cmolc kg-1 (= meq/100 g)	NA
ExH	Layers	1	Num double	cmol/kg	Exchangeable H	Exchangeable H, in cmolc kg-1	NA
ExAl	Layers	1	Num double	cmol/kg	Exchangeable Al	Exchangeable Al, in cmolc kg-1	eSOTER2012
ExAcid	Layers	1	Num double	cmol/kg	Exchangeable acidity	Exchangeable acidity (H + Al), in cmolc kg-1	eSOTER2012
Ecec	Layers	1	Num double	cmol/kg	Effective CEC	Effective cation exchange capacity of the soil (is sum of exbases and exacidity), in cmolc kg-1	NA
CecSoil	Layers	1	Num double	cmol/kg	CEC soil	Cation exchange capacity of the soil, in cmolc kg-1	eSOTER2012
CecSoil2	Layers	1	Num double	cmol/kg	CEC soil, 2nd measurement	Cation exchange capacity of the soil, 2nd measurement (other method), in cmolc kg-1	NA
CecMin	OriLayers	0	Num double	cmol/kg	CecMin	Calculated minimum value for CEC, assuming that CEC is function of CEC-clay and CEC-organic carbon, with CEC-clay = 1.5 cmolc kg-1 and CEC-organic carbon = 100 cmolc kg-1	NA
CecMax	OriLayers	0	Num double	cmol/kg	CecMax	Calculated maximum value for CEC, assuming that CEC is function of CEC-clay and CEC-organic carbon, with CEC-clay = 150 cmolc kg-1 and CEC-organic carbon = 600 cmolc kg-1	NA
Bsat	Layers	1	Num double	%	Base saturation	Base saturation or sum of exchangeable bases relative to CEC, expressed as %	NA
Bsat2	Layers	1	Num double	%	Base saturation, 2nd measurement	Base saturation or sum of exchangeable bases relative to CEC, 2nd measurement (other method), expressed as %	NA
CaSO4	Layers	1	Num double	g/kg	Gypsum	Gypsum content, in g kg-1. or promille (‰)	eSOTER2012
CaCO3	Layers	1	Num double	g/kg	Carbonate equivalent	Content of carbonate equivalents, in g kg-1 or promille (‰).	eSOTER2012
InOrgC	Layers	1	Num double	g/kg	Inorganic carbon	Content of inorganic carbon (C), in g kg-1 or promille (‰).	NA
TotC	Layers	1	Num double	g/kg	Total carbon	Content of total carbon (C, including both inorganic and organic carbon), in g kg-1 or promille (‰). Note that the measured content of total carbon doesn't necessarily exceed the measured contents of inorganic and/or organic carbon,	eSOTER2012

Attr Code	Attr Table	Attr Soil	Attr DType	Attr Unit	AttrDescrS (description short)	AttrDescrL (description long)	Standard
						as measuring methods	
OrgC	Layers	1	Num double	g/kg	Organic carbon	Content of organic carbon (C), in g kg-1 or promille (‰)	eSOTER2012
TotalN	Layers	1	Num double	g/kg	Total nitrogen	Content of total nitrogen (N), in g kg-1 or promille (‰)	eSOTER2012
CN	Layers	1	Num double	-	CN ratio	Ratio of organic carbon over total nitrogen (C/N)	NA
TotalP	Layers	1	Num double	mg/kg	Total P	Content of total phosphorus (P), in mg kg-1 or ppm	eSOTER2012
AvailP	OriLayers	1	Num double	mg/kg	Available P	Content of -assumed- available phosphorus (P), in mg kg-1, (is not P2O5 content).	eSOTER2012
AvailP2	OriLayers	1	Num double	mg/kg	Available P, 2nd measurement	Content of -assumed- available phosphorus (P), 2nd measurement, in mg kg-1, (is not P2O5 content).	eSOTER2012
RetentP	OriLayers	1	Num double	g/100g	P retention	Phosphorus (P) retention, in weight %	NA
Poros	OriLayers	1	Num double	v %	Porosity	Total porosity, in volume %	NA
VMCpF00	Layers	1	Num double	v %	Volumetric moisture content at pF 0.0	Volumetric soil moisture content at a matric suction of pF 0.0 (or -0.1 kPa), expressed in volume %	eSOTER2012
VMCpF05	Layers	1	Num double	v %	Volumetric moisture content at pF 0.5	Volumetric soil moisture content at a matric suction of pF 0.5 (or -0.33 kPa), expressed in volume %	NA
VMCpF10	Layers	1	Num double	v %	Volumetric moisture content at pF 1.0	Volumetric soil moisture content at a matric suction of pF 1.0 (or -1 kPa), expressed in volume %	NA
VMCpF15	Layers	1	Num double	v %	Volumetric moisture content at pF 1.5	Volumetric soil moisture content at a matric suction of pF 1.5 (or -3.3 kPa), expressed in volume %	NA
VMCpF17	Layers	1	Num double	v %	Volumetric moisture content at pF 1.7	Volumetric soil moisture content at a matric suction of pF 1.7 (or -5 kPa), expressed in volume %	NA
VMCpF18	Layers	1	Num double	v %	Volumetric moisture content at pF 1.8	Volumetric soil moisture content at a matric suction of pF 1.8 (or -6.6 kPa), expressed in volume %	NA
VMCpF20	Layers	1	Num double	v %	Volumetric moisture content at pF 2.0	Volumetric soil moisture content at a matric suction of pF 2.0 (or -10 kPa), expressed in volume % (field capacity)	eSOTER2012
VMCpF22	Layers	1	Num double	v %	Volumetric moisture content at pF 2.2	Volumetric soil moisture content at a matric suction of pF 2.2 (or -16 kPa), expressed in volume %	NA
VMCpF23	Layers	1	Num double	v %	Volumetric moisture content at pF 2.3	Volumetric soil moisture content at a matric suction of pF 2.3 (or -20 kPa), expressed in volume %	eSOTER2012
VMCpF24	Layers	1	Num double	v %	Volumetric moisture content at pF 2.4	Volumetric soil moisture content at a matric suction of pF 2.4 (or -25 kPa), expressed in volume %	NA
VMCpF25	Layers	1	Num double	v %	Volumetric moisture content at pF 2.5	Volumetric soil moisture content at a matric suction of pF 2.5 (or -33 kPa), expressed in volume % (field capacity)	eSOTER2012

Attr Code	Attr Table	Attr Soil	Attr DType	Attr Unit	AttrDescrS (description short)	AttrDescrL (description long)	Standard
VMCpF27	Layers	1	Num double	v %	Volumetric moisture content at pF 2.7	Volumetric soil moisture content at a matric suction of pF 2.7 (or -50 kPa), expressed in volume %	eSOTER2012
VMCpF28	Layers	1	Num double	v %	Volumetric moisture content at pF 2.8	Volumetric soil moisture content at a matric suction of pF 2.8 (or -66 kPa), expressed in volume %	NA
VMCpF29	Layers	1	Num double	v %	Volumetric moisture content at pF 2.9	Volumetric soil moisture content at a matric suction of pF 2.9 (or -80 kPa), expressed in volume %	NA
VMCpF30	Layers	1	Num double	v %	Volumetric moisture content at pF 3.0	Volumetric soil moisture content at a matric suction of pF 3.0 (or -100 kPa), expressed in volume %	eSOTER2012
VMCpF33	Layers	1	Num double	v %	Volumetric moisture content at pF 3.3	Volumetric soil moisture content at a matric suction of pF 3.3 (or -200 kPa), expressed in volume %	NA
VMCpF34	Layers	1	Num double	v %	Volumetric moisture content at pF 3.4	Volumetric soil moisture content at a matric suction of pF 3.4 (or -250 kPa), expressed in volume %	NA
VMCpF35	Layers	1	Num double	v %	Volumetric moisture content at pF 3.5	Volumetric soil moisture content at a matric suction of pF 3.5 (or -330 kPa), expressed in volume %	eSOTER2012
VMCpF36	Layers	1	Num double	v %	Volumetric moisture content at pF 3.6	Volumetric soil moisture content at a matric suction of pF 3.6 (or -400 kPa), expressed in volume %	NA
VMCpF37	Layers	1	Num double	v %	Volumetric moisture content at pF 3.7	Volumetric soil moisture content at a matric suction of pF 3.7 (or -500 kPa), expressed in volume %	NA
VMCpF40	Layers	1	Num double	v %	Volumetric moisture content at pF 4.0	Volumetric soil moisture content at a matric suction of pF 4.0 (or -1000 kPa), expressed in volume %	NA
VMCpF42	Layers	1	Num double	v %	Volumetric moisture content at pF 4.2	Volumetric soil moisture content at a matric suction of pF 4.2 (or -1500 kPa), expressed in volume % (permanent wilting point)	eSOTER2012
VMCpF50	Layers	1	Num double	v %	Volumetric moisture content at pF 5.0	Volumetric soil moisture content at a matric suction of pF 5.0 (or -10000 kPa), expressed in volume %	NA
VMCpF58	Layers	1	Num double	v %	Volumetric moisture content at pF 5.8	Volumetric soil moisture content at a matric suction of pF 5.8 (or -66000 kPa), expressed in volume %	NA
VolAWC	Layers	1	Num double	v %	Available volumetric water content	Volumetric content of water or soil moisture assumed available for uptake by reference plant, defined as the difference in soil moisture content at field capacity and at permanent wilting point. Expressed in volume % (m3 / 100 m3)	NA
WghtAWC	OriLayers	1	Num double	g/100g	Available weight-based water content	Weight-based water or soil moisture content, assumed available for uptake by reference plant, defined as the difference in soil moisture content at field capacity and at permanent wilting point. Expressed in weight % (g/100 g)	NA
Extr1Fe	OriLayers	1	Num double	g/100g	Extractable Fe - free	Fe fraction, in weight %, extractable in dithionite citrate (is not Fe2O3 fraction)	eSOTER2012

Attr Code	Attr Table	Attr Soil	Attr DType	Attr Unit	AttrDescrS (description short)	AttrDescrL (description long)	Standard
Extr2Fe	OriLayers	1	Num double	g/100g	Extractable Fe - active	Fe fraction, in weight %, extractable in oxalate acid (is not Fe2O3 fraction)	eSOTER2012
Extr3Fe	OriLayers	1	Num double	g/100g	Extractable Fe - organic bound	Fe fraction, in weight %, extractable in pyrophosphate (is not Fe2O3 fraction)	NA
ExtrTFe	OriLayers	1	Num double	g/100g	Extractable Fe - total	Total Fe, in weight %, extractable (is not Fe2O3 fraction)	NA
Extr1Al	OriLayers	1	Num double	g/100g	Extractable Al - free	Al fraction, in weight %, extractable in dithionite citrate (is not Al2O3 fraction)	NA
Extr2Al	OriLayers	1	Num double	g/100g	Extractable Al - active	Al fraction, in weight %, extractable in oxalate acid (is not Al2O3 fraction)	eSOTER2012
Extr3Al	OriLayers	1	Num double	g/100g	Extractable Al - organic bound	Al fraction, in weight %, extractable in pyrophosphate (is not Al2O3 fraction)	NA
AvailK	OriLayers	1	Num double	mg/kg	Available K	-Assumed- available potassium, in mg kg-1 or ppm	NA
TotalK	OriLayers	1	Num double	mg/kg	Total K	Total potassium, in mg kg-1 or ppm	NA
Fe	OriLayers	1	Num double	mg/kg	Fe micro nutrient	Micro nutrient Iron, expressed in mg/kg or ppm	NA
Mn	OriLayers	1	Num double	mg/kg	Mn micro nutrient	Micro nutrient Manganese, expressed in mg/kg or ppm	NA
Zn	OriLayers	1	Num double	mg/kg	Zn micro nutrient	Micro nutrient Zinc, expressed in mg/kg or ppm	NA
Cu	OriLayers	1	Num double	mg/kg	Cu micro nutrient	Micro nutrient Cupper, expressed in mg/kg or ppm	NA
B	OriLayers	1	Num double	mg/kg	B micro nutrient	Micro nutrient Borium, expressed in mg/kg or ppm	NA
S	OriLayers	1	Num double	mg/kg	S micro nutrient	Micro nutrient Sulfur, expressed in mg/kg or ppm	NA
OrgMat	OriLayers	1	Num double	g/kg	Organic matter	Organic matter, expressed in g kg-1 or promille (ë).	NA
TotHumC	OriLayers	1	Num double	g/kg	Total humic C	Total humic carbon (a fraction or organic carbon), expressed in g kg-1 or promille (ë).	NA
HumAcidC	OriLayers	1	Num double	g/kg	Humic acid C	Humic acid carbon (a fraction of total humic carbon), expressed in g kg-1 or promille (ë).	NA
FulAcidC	OriLayers	1	Num double	g/kg	Fulvic acid C	Fulvic acid carbon (a fraction of total humic carbon), expressed in g kg-1 or promille (ë).	NA
LabTxtr	Layers	1	Text	-	Lab derived texture	Particle size class of the fine earth (texture class), derived from particle size fractions as measured at the laboratory	eSOTER2012
ClyMinera	Layers	1	Text	-	Clay mineralogy	Dominant type of mineral in the clay size fraction, expressed as class code	eSOTER2012
FullDescr	OriLayers	0	Text	-	Full horizon description	Full horizon description	NA
FID	GeoPoints	0	Num integer	-	In-shapefile geofeature ID	Identifier of the in-shapefile spatial feature	NA
Shape	GeoPoints	0	Text	-	Geofeature type	Type of the spatial feature (point)	NA
LayerID00	GeoPoints	0	Text	-	AFSP 00th layer point subfeature ID	Identifier of the soil profile's 00th layer point subfeature (is similar to LayerID for LayerNr = 0)	NA
LayerID99	GeoPoints	0	Text	-	AFSP 99th layer point subfeature ID	Identifier of the soil profile's 99th layer point subfeature (is similar to LayerID for LayerNr = 99)	NA
oProfileID	OriProfiles	0	Text	-	AFSP profile ID	Identifier of the soil profile feature (is similar to ProfileID)	NA
oLayerID	OriLayers	0	Text	-	AFSP profile layer ID	Identifier of the soil profile layer subfeature (is similar to LayerID)	NA

Attr Code	Attr Table	Attr Soil	Attr DType	Attr Unit	AttrDescrS (description short)	AttrDescrL (description long)	Standard
mMethdKey	AttrMethods	0	Text	-	AFSP-key to methods	Key (is similar to MethdKey) to collection of methods (codes) applied to assess feature-attribute-values	NA
mMethdYN	AttrMethods	0	Text	-	Boolean for inclusion of methods	Indicates whether Method codes have been specified (Y) or not (N)	NA
uUnitKey	AttrUnits	0	Text	-	AFSP-key to units of expression	Key (is similar to UnitKey) to collection of units to express feature-attribute-values	NA
aAttr	Attrs	0	Text	-	AFSP-key to attributes	Key (is similar to AttrKey) to collection of attributes (codes), including soil properties, observed or measured	NA

Annex 3b Dictionary of attribute codes, corresponding to the column headings applied in the db dictionary tables

Attr Code	Attr Table	Attr Soil	Attr DType	Attr Unit	Attr DescrS (short)	Attr DescrL (long)	Standard
DbAvail	DictioSrcDBases	0	Num integer	-	Dataset availability	Indicator (boolean) of the availability with the compiler of the digital dataset (1=yes,0=no)	NA
SrcDb_ID	DictioSrcDBases	0	Text	-	AFSP-ID of source dataset	Identifier of the digital source dataset	NA
DbDescr	DictioSrcDBases	0	Text	-	Dataset description	Description or title of the database or digital dataset	eSOTER2012
DbHolder	DictioSrcDBases	0	Text	-	Dataset holder and owner	Name of the holder and owner, institute or organisation, of the dataset	eSOTER2012
DbPublYr	DictioSrcDBases	0	Num integer	-	Dataset publication year	Year of publication of the dataset	eSOTER2012
DbAuthor	DictioSrcDBases	0	Text	-	Dataset author	Name of the author(s) of the dataset. Where applicable, this can be an institute or organisation	eSOTER2012
DbUrl	DictioSrcDBases	0	Hyper link	-	Dataset online access	URL link to online dataset or online metadata with the dataset	NA
DbIP	DictioSrcDBases	0	Text	-	IP on source dataset	Indicator of IP rights and/or copy rights on the source dataset	NA
SrcRep_ID	DictioSrcReports	0	Text	-	AFSP-ID source report	Identifier of the report, book or publication. Where possible, the identifier is harmonised by using the unique ISRIC library identifier (ISN).	NA
PrsInAFSP	DictioSrcReports	0	Num integer	-	Quantity of soil profiles captured from report	Number of soil profiles actually captured from report into AFSP database	NA
RepAuthor	DictioSrcReports	0	Text	-	Report author	Name of the author(s) of the report, book or publication. Where applicable, this can be an institute or organisation	eSOTER2012
RepPubYr	DictioSrcReports	0	Num integer	-	Report publication year	Year of publication of the report, book or publication	eSOTER2012
RepTitle	DictioSrcReports	0	Text	-	Report title	Title of the report, book or publication	eSOTER2012
RepSerie	DictioSrcReports	0	Text	-	Report serie	Serie (plus serie number) of which the report, book or publication is part	NA
RepPublshr	DictioSrcReports	0	Text	-	Report publisher	Publisher of the report, book or publication	eSOTER2012
RepUrl	DictioSrcReports	0	Text	-	URL to report	URL to report metadata and, if available, report pdf	NA
RepIP	DictioSrcReports	0	Text	-	IP on source report	Indicator of IP rights and/or copy rights on the source report	NA
Lab_ID	DictioLabs	0	Text	-	AFSP laboratory ID	Identifier of the soil laboratory where the soil samples were analysed, with -if	eSOTER2012

Attr Code	Attr Table	Attr Soil	Attr DType	Attr Unit	Attr DescrS (short)	Attr DescrL (long)	Standard
						available- the laboratory manual	
LabDescr	DictioLabs	0	Text	-	Laboratory description	Description or name of the laboratory, with -if available, the laboratory manual	eSOTER2012
MethdDB	DictioLabMethods	0	Text	-	Database code	Code for the source database wherein the method code, applied to assess the value for feature properties, is originally used	NA
MethdCode	DictioLabMethods	0	Text	-	Method code	Code for the method applied to assess the value for feature properties	eSOTER2012
MethdDescr	DictioLabMethods	0	Text	-	Method description	Short description of the method, including references if possible. To be standardised	eSOTER2012
MethdGrp	DictioLabMethods	0	Text	-	Method group	Group of methods, expressed as targeted soil property	NA
ProprtyCod	DictioClassValues	0	Text	-	Soil property code	Coding for soil property	eSOTER2012
ValueCode	DictioClassValues	0	Text	-	Value class code	Class code for categorical soil property value	NA
ValueDescr	DictioClassValues	0	Text	-	Value class description	Description of the significance of the class code for categorical soil property value	NA
RefCode	DictioRefs	0	Text	-	Reference code	Coding for reference to standard definitions of attributes as associated value domains (= Standard)	NA
RefDescr	DictioRefs	0	Text	-	Reference description	Reference to standard definitions of attributes and associated value domains (= Standard)	NA
AttrCode	DictioAttributes	0	Text	-	Attribute code or DB column heading	Coding for database attribute or column heading (maximally 10 characters)	NA
AttrTable	DictioAttributes	0	Text	-	DB table	Table in the DB wherein the attribute or column is	NA
AttrSoil	DictioAttributes	0	Text	-	Attribute indicator	Attribute indicator, expressed as boolean (0= DB attribute, 1=soil property)	NA
AttrDType	DictioAttributes	0	Text	-	Data type	Format type of the data with the attribute (text, real, integer)	NA
AttrUnit	DictioAttributes	0	Text	-	Unit of expression	Unit to express the value of the attribute	NA
AttrDescrS	DictioAttributes	0	Text	-	Short description (this field)	Short description of the attribute, including references if possible.	NA
AttrDescrL	DictioAttributes	0	Text	-	Long description	Long description or definition of the attribute, including references if possible (this field)	NA
Standard	DictioAttributes	0	Text	-	Reference to standard	Coding for reference to the standard definition of the attribute concerned, and -in most cases- to the associated standard value domain	NA
Standard2	DictioAttributes	0	Text	-	2nd reference to standard	Coding for 2nd reference to the standard definition of the attribute concerned, and -in most cases- to the associated standard value domain	NA
GeoPoints	DictioAttributes	0	Text	-	Headings GeoPoints table	Column headings GeoPoints table, associated with the attribute concerned	NA
Profiles	DictioAttributes	0	Text	-	Headings Profiles table	Column headings Profiles table, associated with the attribute concerned	NA
Layers	DictioAttributes	0	Text	-	Headings Layers table	Column headings Layers table, associated with the attribute concerned	NA

Attr Code	Attr Table	Attr Soil	Attr DType	Attr Unit	Attr DescrS (short)	Attr DescrL (long)	Standard
OriProfile	DictioAttributes	0	Text	-	Headings OriProfiles table	Column headings OriProfiles table, associated with the attribute concerned	NA
OriLayers	DictioAttributes	0	Text	-	Headings OriLayers table	Column headings OriLayers table, associated with the attribute concerned	NA
AttrMethds	DictioAttributes	0	Text	-	Headings AttrMethods table	Column headings AttrMethods table, associated with the attribute concerned	NA
AttrUnits	DictioAttributes	0	Text	-	Headings AttrUnits table	Column headings AttrUnits table, associated with the attribute concerned	NA
Attrs_123	DictioAttributes	0	Text	-	Headings Attrs table(s)	Column headings Attrs tables (Attrs_1Profiles, Attrs_2LayerFld, Attrs_3LayerLab), associated with the attribute concerned	NA
AbbrAfSP2	DictioAttributes	0	Text	-	AFSP2 atribute code	Coding for database attribute or column heading as applied in earlier version (2) of the AFSP database	NA
AbbrSoter	DictioAttributes	0	Text	-	SOTER attribute code	Coding for database attribute or column heading as applied in the SOTER databases	NA
AbbrWise3	DictioAttributes	0	Text	-	WISE3 attribute code	Coding for database attribute or column heading as applied in the WISE3 database	NA

Annex 4 Dictionary of (analytical) method codes

Method group	Method code	Method description
MethdGrp	MethdCode	MethdDescr
AlExtractable	AL–	Not measured
AlExtractable	AL01	Al, dithionite-citrate extraction ('free aluminium')
AlExtractable	AL02	Al, acid oxalate extraction ('active')
AlExtractable	AL03	Al, pyrophosphate extraction (organic bound Al)
AlExtractable	AL99	Unspecified methods
bulkDensity	BD–	Not measured (Bulk density)
bulkDensity	BD01	Core sampling (pF rings)
bulkDensity	BD02	Clod samples
bulkDensity	BD02.1	Clod samples, at air dry
bulkDensity	BD02.2	Clod samples, at 0.33 bar / pF2.5
bulkDensity	BD02.3	Clod samples, at air dry, excl. gravel
bulkDensity	BD03	Replacement method (with spherical plastic balls; Avery & Bascomb, 1974)
bulkDensity	BD04	Auger-hole method (Zwarich & Shaykewich, 1969)
bulkDensity	BD05	Clod samples, oven-dry (USDA method 4A1h)
bulkDensity	BD05.1	Clod samples, oven-dry, undisturbed (Brasher et al., 1966)
bulkDensity	BD06	db: drying and weighting of 100-ml sample (Schlichting et al. 1995)
bulkDensity	BD07	Unspecified, air dry
bulkDensity	BD08	Grossman and Reinsch, 2002 (In: Dane JH and Topp Gc (eds.) Soil Sci. Soc. Am. book series 5, part 4, pp 201-228.)
bulkDensity	BD99	Unspecified methods
Base saturation	BS–	Not measured
Base saturation	BS01	Sum of bases as percentage of CEC (method specified with CEC)
Base saturation	BS99	Unspecified methods
CarbonateEquivalent	CA–	Not measured (CaCO3)
CarbonateEquivalent	CA01	Method of Scheibler (volumetric)
CarbonateEquivalent	CA02	Method of Wesemael
CarbonateEquivalent	CA03	Method of Piper (HCl)
CarbonateEquivalent	CA04	Calcimeter method (volumetric after adition of dilute acid)
CarbonateEquivalent	CA04.1	CO2 measurement by calcimeter Scheibler-Finkener
CarbonateEquivalent	CA05	Gravimetric (USDA Agr. Hdbk 60; method Richards et al., 1954)
CarbonateEquivalent	CA06	H3PO4 acid at 80C, conductometric in NaOH (Schlichting & Blume, 1966)
CarbonateEquivalent	CA07	Pressure calcimeter (Nelson, 1982)
CarbonateEquivalent	CA08	Bernard calcimeter (Total CaCO3)
CarbonateEquivalent	CA09	Carbonates: H3PO4 treatment at 80 deg. C and CO2 measurement like TOC (OC13), transformation into CaCO3 (Schlichting et al. 1995)
CarbonateEquivalent	CA10	CaCO3 Equivalent, CO2 evolution after HCl treatment. Gravimetric
CarbonateEquivalent	CA11	Black, 1965-HCl
CarbonateEquivalent	CA12	Treatment with H2SO4 N/2 acid followed by titration with NaOH N/2 in presence of an indicator
CarbonateEquivalent	CA99	Unspecified methods
effectiveCec	CE–	Not measured (CEC, sum of bases)
effectiveCec	CE01	Sum of exch. Ca, Mg, K and Na, plus exchangeable aluminium (in 1M KCl) *
effectiveCec	CE02	Sum of exch. Ca, Mg, K and Na, plus exchangeable Al (according to method EA02)

Method group	Method code	Method description
MethdGrp	MethdCode	MethdDescr
effectiveCec	CE03	Sum of exch. Ca, Mg, K and Na, plus exchangeable H+Al (in 1M KCl)
effectiveCec	CE04	Sum of exch. Ca, Mg, K and Na (in NH4Cl at pH 7/0), plus exchangeable H+Al (in 1M KCl)
effectiveCec	CE05	CEC and exchangeable cations with BACl2 (after extracting water soluble cations, measurement by AAS); Schlichting et al. 1995
effectiveCec	CE06	Sum of exch. Ca, Mg, K and Na, plus exchangeable H
effectiveCec	CE07	Sum of exch bases plus exch acidity
effectiveCec	CE08	Sum of exch bases (Ca, Mg, K and Na) in BaCl2 at pH 8.2, plus exch. Acidity (H+Al) in BaCl2 at pH 8.2 (method EA06)
effectiveCec	CE99	Unspecified methods
Coarse Fragments	CF–	Coarse Fragments
Coarse Fragments	CF01	Particles with 2 to 75 mm diameter are reported as a volume percent on a whole soil at 1/3 bar water tension base.
Coarse Fragments	CF02	Coarse Fragments derived from laboratory and from field (class values), with priority given to laboratory values
Coarse Fragments	CF03	Particles >2 mm measured in laboratory (sieved after light pounding). May include concretions and very hard aggregates
Coarse Fragments	CF03.1	Particles >2 mm measured in laboratory (sieved after light pounding). May include concretions and very hard aggregates. Expressed in w%
Coarse Fragments	CF04	Coarse Fragments observed in the field (class values or v%)
Coarse Fragments	CF99	Unspecified methods
cecSoil	CS–	Not measured (CEC soil)
cecSoil	CS01	CEC in 1M NH4OAc buffered at pH 7
cecSoil	CS01.1	CEC in 1M NH4OAc buffered at pH 7, with ExCa=ExMg= 0.5* ExCa&Mg if ExCa=-9999 and ExMg = -9999
cecSoil	CS02	CEC in 1M BaCl2 buffered at pH 8.1
cecSoil	CS02.1	CEC in BaCl2-TEA buffered at pH 8.1
cecSoil	CS03	CEC in 1M NH4OAc buffered at pH 8.2 (Bascomb)
cecSoil	CS04	CEC in 1M NaOAc buffered at pH 8.2
cecSoil	CS05	CEC in Silver Thiourea (AgTU)
cecSoil	CS06	CEC as sum of bases (NH4OAc at pH 7) + extr. acidity in BaCl2-TEA at pH 8.2
cecSoil	CS07	CEC determined in 0.5 M LiCl buffered at pH 8 with TEA (after Peech, 1965)
cecSoil	CS08	CEC in 1 M KCl at pH of soil
cecSoil	CS09	Sum of exch. cations (Brasil)
cecSoil	CS10	CEC in Li-EDTA at pH7; treat. with K-EDTA solution at pH 10
cecSoil	CS11	CEC in 1M BaCl2 at pH 8.4
cecSoil	CS12	CEC by saturation with NH4OAc and percolation with 10% NaCl + 4 cc conc. HCl/L
cecSoil	CS13	CEC determined in 0.2 M NH4Cl at approximately field pH (Rusell, 1973)
cecSoil	CS14	CEC determined in 0.5N BaOAc at pH 8.2-8.4 after washing
cecSoil	CS15	CEC determined according to Oosterbeek (NL) method (NH4 acetate?)
cecSoil	CS16	CEC Mehlich; Ba2+ retained from BaCL2, TEA at pH 8.2
cecSoil	CS17	CEC with 0.1 M Li-EDTA, buffered at pH 8.0
cecSoil	CS18	CEC acc. Schollenberger/Shmuck/Pfeffer dep. on initial pH and salt content
cecSoil	CS19	CEC in NH4OAc at pH7 and NaOAc at pH 8.2 dep. on initial pH and salt content
cecSoil	CS20	CEC in 1M Na-acetate (after Hermann 2005)
cecSoil	CS21	NH4OAc, pH?
cecSoil	CS22	NH4OAc. BaCl2 unbuffered percolation
cecSoil	CS23	NH4OAC (Stahlberg et. al., 1978)
cecSoil	CS24	Ca++ used to saturate complex, followed by 'washing', and replacement of Ca by NH4 (NH4Cl). CEC = Tca
cecSoil	CS25	CECmaxWithCECclayIsMax150andInclOCwith_1gramOCis600)
cecSoil	CS26	CECminWithCECclayIsMin1andInclOCwith_1gramOCis100)
cecSoil	CS27	CEC through percolation with KCl (bases through percolation with NH4OAc)

Method group	Method code	Method description
MethdGrp	MethdCode	MethdDescr
cecSoil	CS28	CEC through percolation with CaCl2 and displacement by normal KNO3
cecSoil	CS88	Estimated (synthetic)
cecSoil	CS98	Other methods (buffered at pH of about 8)
cecSoil	CS99	Other methods (buffered at pH of about 7)
exchAcidity	EA–	Not measured (Exchangeable acidity)
exchAcidity	EA01	Exchangeable acidity (H+Al) in 1 M KCl
exchAcidity	EA02	Exch. acidity in 1 M KCl estimated from soluble Al in 2:1 v/v 0.02 M CaCl2
exchAcidity	EA03	Extractable acidity in NH4OAc, formaldehyde and BaCl2; acid. by titration at pH 11 (Mados, 1943)
exchAcidity	EA03.1	Exchangeable H, in 0.2 M NH4OH, followed by formaldehyde and BaCl2. Method of Mados, modified.
exchAcidity	EA04	Ca-acetate 1 M at pH 7 (Brasil)
exchAcidity	EA05	Exch. acidity in 0.1 N NH4Cl extract
exchAcidity	EA06	Extractable acidity in 1 M BaCl2 and TEA (at pH 8.2)
exchAcidity	EA07	Exch. acidity in NaCl extract
exchAcidity	EA08	Exchangeable H and Al (pH measurement in in Ca-acetate pH 7.2); Schlichting et al. 1995
exchAcidity	EA09	McLean, 1965
exchAcidity	EA10	Exchangeable acidity (H+Al)
exchAcidity	EA11	Not measured and arbitrarily set at 0 cmol/kg
exchAcidity	EA12	Not measured and calculated from CEC (=eCEC) minus Sum of Bases
exchAcidity	EA13	Exchangeable acidity (H+Al) in 0.05 M KCl
exchAcidity	EA99	Unspecified methods
electroConductivity	EL–	Not measured (Electo-conductivity)
electroConductivity	EL01	Elec. conductivity at 1:1 soil/water ratio
electroConductivity	EL02	Elec. conductivity at 1:2.5 soil/water ratio
electroConductivity	EL03	Elec. conductivity at 1:5 soil/water ratio
electroConductivity	EL04	Elec. conductivity in saturated paste (ECe)
electroConductivity	EL05	Elec. conductivity at 1:2 soil/water ratio
electroConductivity	EL06	Elec. conductivity at 1:10 soil/water ratio
electroConductivity	EL07	Elec. conductivity at soil/water ratio varying from 1:1 to 1:2
electroConductivity	EL99	Unspecified methods
exchangeableBases	EX–	Not measured (Exchangeable bases)
exchangeableBases	EX01	Various methods with no apparent differences in results
exchangeableBases	EX01.1	AAS (Atomic Absorption Spectrometry)
exchangeableBases	EX01.2	FP (Flame Photometry)
exchangeableBases	EX01.3	EDTA titration
exchangeableBases	EX01.4	Methode test HCl N/20 (Gedroiz-Schofield)
exchangeableBases	EX88	Estimated (synthetic)
exchangeableBases	EX99	Unspecified methods
FeExtractable	FE–	Not measured
FeExtractable	FE01	Fe, dithionite-citrate extraction, 'free iron' (or 'total iron')
FeExtractable	FE01.1	Fe2O3, 'total iron'
FeExtractable	FE02	Fe, acid oxalate extraction ('active')
FeExtractable	FE03	Fe, pyrophosphate extraction (organic bound Fe)
gypsum	GY–	Not measured (Gypsum)
gypsum	GY01	Dissolved in water and precipitated by acetone
gypsum	GY02	Differ. between Ca-conc. in sat. extr. and Ca-conc. in 1/50 s/w solution
gypsum	GY03	Calculated from conductivity of successive dilutions
gypsum	GY04	In 0.1 M Na3-EDTA; turbidimetric (Begheijn, 1993)
gypsum	GY05	Gravimetric after dissolution in 0.2 N HCl (USSR-method)
gypsum	GY06	Total-S, using LECO furnace, minus easily soluble MgSO4 and Na2SO4
gypsum	GY07	Schleiff method, electrometric

Method group	Method code	Method description
MethdGrp	MethdCode	MethdDescr
gypsum	GY99	Unspecified methods
HydrConductivity	HC–	Not measured (Hydraulic conductivity)
HydrConductivity	HC01	Double ring method
HydrConductivity	HC02	Bore hole method
HydrConductivity	HC03	Inverse bore hole method
HydrConductivity	HC04	Permeability in cm/hr determined in column filled with fine earth fraction
HydrConductivity	HC99	Unspecified methods
Available potassium	KA–	Not measured (available K)
Available potassium	KA01	Available K
Available potassium	KA99	Unspecified methods
Moisture content	MC–	Not measured (Moisture content)
Moisture content	MC01	sand/silt baths and porous plates, undisturbed samples (pF rings)
Moisture content	MC02	ceramic plate extractors, dist. samples in 10x50mm rings; after L.A. Richards 1965
Moisture content	MC03	Pressure-plate extraction, disturbed -clod- samples (wt%) * density (USDA-NRCS method 4B1 * 4A1d)
Moisture content	MC03	Separate measurements in the field of humidity (by neutron meter) and of tension (by tensiometer)
Moisture content	MC04	Pressure-plate extraction, disturbed -clod- samples (wt%) * density (USDA-NRCS method 4B2 * 4A1h * 4B5)
Moisture content	MC05	pressure plate extractor & compressor
Moisture content	MC06	Pressure membrane press & compressor
Moisture content	MC07	membrane
Moisture content	MC08	pressure membrane and pressure plate extractor. Klute, 1986. pF4.2-pF2
Moisture content	MC09	Richard's apparatus
Moisture content	MC10	Pressure plate, undisturbed core samples,
Moisture content	MC11	Moisture equivalent (Lyman Briggs and McLane, 1910) to assess MC at field capacity (gravimetric)
Moisture content	MC12	Unspecified method, unclear whether expressed in v% or in w%
Moisture content	MC99	Unspecified methods
MicroNutrients	MN–	Not measured (Micro nutrients)
MicroNutrients	MN01	DiEthyneleTriAminePentaAcetic acid (DTPA) method for Fe, Mn, Zn, Cu
MicroNutrients	MN02	Nitric/perchloric acid mixture, leached by hydrochoric acid
MicroNutrients	MN03	Soluble (<> total) Mn, Zn, Cu
MicroNutrients	MN99	Unspecified methods
Organic carbon	OC–	Not measured (Total Organic Carbon)
Organic carbon	OC01	Method of Walkley-Black (Total OC = OC * 1.3 (rec.fr. = 77% has been applied\) and Org. matter = T Org. C x 1.72)
Organic carbon	OC01.1	OC01; with fr.=1
Organic carbon	OC01.2	OC01; with rec.fr.= 77% included (TOC = OC*1.3)
Organic carbon	OC01.3	OC01; Walkley & Black modified, wet combustion, with rec.fr. = 80% included (TOC= OC*1.25)
Organic carbon	OC01.4	Chromate wet oxidation of Jackson, 1958. Chromic acid digestion
Organic carbon	OC01.5	OC01; with rec.fr.= 85% included (TOC = OC * 1.18), and Org. matter = TOC x 1.72)
Organic carbon	OC01.6	OC01-/- with TOC = OM /1.72 applied to part of the data wherein OM is reported
Organic carbon	OC02	Loss on ignition (NL) is Total OC
Organic carbon	OC03	Method of Allison
Organic carbon	OC04	Method of Kurmies (=OC16, Wet oxidation, K2Cr2O7+H2SO4)
Organic carbon	OC05	Method of furnace combustion (e.g., LECO analyzer)
Organic carbon	OC06	Method of Kalembra and Jenkinson (1973); acid dichromate; Org. matter = Org. C x 1.72
Organic carbon	OC07	Wet oxidation according to Tinsley (1950)
Organic carbon	OC08	Wet oxidation according to Anne (Org. matter = Org. C x 1.7)
Organic carbon	OC09	Method of Tiurin (oxid. with K-dichr.)

Method group	Method code	Method description
MethdGrp	MethdCode	MethdDescr
Organic carbon	OC10	Wet oxidation by Chromic acid and gravimetric determination of CO2 (Knopp)
Organic carbon	OC11	Total carbon (no-carbonates present) using VarioEL CNS-analyzer
Organic carbon	OC12	Dry combustion using a CN-corder and cobalt oxide or copper oxide as an oxidation accelerator (Tanabe and Araragi, 1970)
Organic carbon	OC13	Dry combustion at 1200 deg. C and coulometric CO2 measurement (Schlichting et al. 1995)
Organic carbon	OC14	Organic Carbon, acid dichromate digestion, FeSO4 titration, automatic titrator (USDA-NRCS method 6A1c)
Organic carbon	OC15	calorimetric, oxidation by acidified dichromate
Organic carbon	OC16	Wet oxidation, K2Cr2O7+H2SO4 (=OC4, Method of Kurmies)
Organic carbon	OC17	Org Carbon by Combustion at 840 C
Organic carbon	OC18	Wet oxidation/digestion according to Nelson and Sommers, 1996. (In: Sparks DL (ed.). Soil Sci. Soc. Am. book series 5, part 3, pp 961-1010)
Organic carbon	OC18.1	Modified Walkley and Black procedure (Nelson and Sommers, 1982)
Organic carbon	OC19	Dry combustion at 500 C (total C?)
Organic carbon	OC20	Dry combustion (Strohlein disposif)
Organic carbon	OC99	Unspecified methods
Org. matter fraction	OM–	Not measured (Organic Matter fractioning)
Org. matter fraction	OM01	Organic Matter, Total Humic Matter, Humic Acid fraction, Fulvic Acid fraction
Org. matter fraction	OM02	Organic carbon * 1,724
Org. matter fraction	OM03	Method of Walkley-Black
Org. matter fraction	OM99	Unspecified methods
AvailablePhosphorus	PA–	Not measured (P-available)
AvailablePhosphorus	PA02	Method of Bray I (dilute HCl/NH4F)
AvailablePhosphorus	PA02.01	Murphy and Riley, 1962. Method of Bray I (dilute HCl/NH4F)
AvailablePhosphorus	PA03	Method of Olsen (0.5 M Sodium bicarbonate extraction at pH 8.5)
AvailablePhosphorus	PA03.1	Olsen (NaHCO3-pH8.2)
AvailablePhosphorus	PA03.2	Olsen (NaHCO3-pH8.2) if pH > 7, Mehlich if pH < 7
AvailablePhosphorus	PA04	Method of Truog (dilute H2SO4)
AvailablePhosphorus	PA05	Method of Morgan (Na-acetate/acetic acid)
AvailablePhosphorus	PA06	Method of Saunders and Metelerkamp (anion-exch. resin)
AvailablePhosphorus	PA07	Method of Bray II (dilute HCl/NH4F)
AvailablePhosphorus	PA08	Modified after ISFEI method, A.H. Hunter (1975)
AvailablePhosphorus	PA09	Method of Nelson (dilute HCl/H2SO4)
AvailablePhosphorus	PA10	ADAS method (NH4 acetate/acetic acid)
AvailablePhosphorus	PA11	Spectrometer (Brasil)
AvailablePhosphorus	PA12	North Carolina (0.05 M HCl, 0.025 N H2SO4)
AvailablePhosphorus	PA13	0.02 colorimetric in N H2SO4 extract, molybd. blue method
AvailablePhosphorus	PA14	Method of Olsen, modified by Dabin (ORSTOM)
AvailablePhosphorus	PA15	Method of Kurtz-Bray I (0.025 M HCl + 0.03 M NH4F)
AvailablePhosphorus	PA15.1	Bray&Kurtz I, if pHH2O<= 7
AvailablePhosphorus	PA15.2	Method of Kurtz-Bray II
AvailablePhosphorus	PA16	Complexation with citric acid (van Reeuwijk)
AvailablePhosphorus	PA17	NH4-lactate extraction method (KU-Leuven)
AvailablePhosphorus	PA18	Bray-I (acid soils) resp. Olsen (other soils)
AvailablePhosphorus	PA18.1	Olsen, if pHH20 >7
AvailablePhosphorus	PA19	Ambic1 method (ammonium bicarbonate) (South Africa)
AvailablePhosphorus	PA20	soluble in water (mg/kg filtrate)
AvailablePhosphorus	PA21	CaPO4
AvailablePhosphorus	PA99	Unspecified methods
pH - CaCl2	PC–	Not measured (pH_CaCl2)
pH - CaCl2	PC01	pH in 1:1 soil/1 M CaCl2 solution

Method group	Method code	Method description
MethdGrp	MethdCode	MethdDescr
pH - CaCl2	PC02	pH in 1:2.5 soil/1 M CaCl2 solution
pH - CaCl2	PC03	pH in 1:5 soil/1 M CaCl2 solution
pH - CaCl2	PC04	pH in 1:2 soil/0.01 M CaCl2 solution
pH - CaCl2	PC05	pH in 1:2.5 soil/0.01 M CaCl2 solution
pH - CaCl2	PC06	pH in 1:2.5 soil/0.1 M CaCl2 solution
pH - CaCl2	PC07	pH in 1:5 (w/v) soil/0.01 M CaCl2 solution for mineral soilsl; 1/10 for organic soils
pH - CaCl2	PC08	pH in 1:5 soil/ 0.02 M CaCl2 solution
pH - CaCl2	PC09	pH in 0.01 M CaCl2 solution on a saturated sample
pH - CaCl2	PC99	Unspecified methods
pH - H2O	PH–	Not measured (pH-water)
pH - H2O	PH01	pH in 1:1 soil/water solution
pH - H2O	PH02	pH 1:2.5 soil/water solution
pH - H2O	PH03	pH 1:5 soil/water solution
pH - H2O	PH04	pH in 1:2 soil/water solution
pH - H2O	PH05	pH in water saturated extract
pH - H2O	PH88	Estimated (synthetic)
pH - H2O	PH98	Unspecified methods – in the field
pH - H2O	PH99	Unspecified methods
pH - KCl	PK–	Not measured (pH-KCl)
pH - KCl	PK01	pH in 1:1 soil/ 1 M KCl solution
pH - KCl	PK02	pH in 1:2.5 soil/ 1 M KCl solution
pH - KCl	PK03	pH in 1:5 soil/ M KCl solution
pH - KCl	PK04	pH in 1:2 soil/0.01 M KCl solution
pH - KCl	PK99	Unspecified methods
pH - X	PX01	pH in NaF solution
pH - X	PX01.1	pH in 1M NaF solution
pH - X	PX02	pH in HexamineCobalt TriChloride
pH - X	PX03	pH in 1 : x soil : 0.005 M BaCl2 solution
Soluble salts	SS–	Not measured (soluble salts)
Soluble salts	SS01	Na, flame photometry
Soluble salts	SS02	Ca , precipitation Ca oxalate (Hdb 60)
Soluble salts	SS03	Ca , EDTA titration
Soluble salts	SS04	Ca , Atomic absorption spectrophotometry (AAS)
Soluble salts	SS05	Mg, precipitation Mg ammonium phosphate
Soluble salts	SS06	Mg, Atomic absorption spectrophotometry (AAS)
Soluble salts	SS07	K, flame photometry
Soluble salts	SS08	Cl, titration with AgNO3 (Hdb60)
Soluble salts	SS09	Cl, colorimetric by Clor-O-counter Cl titrator
Soluble salts	SS10	Cl, ion chromatography
Soluble salts	SS11	SO4, precipitation Ca sulphate (Hdb60)
Soluble salts	SS12	SO4, precipitation Ba sulphate with turbidimetry
Soluble salts	SS13	SO4, ion chromatography
Soluble salts	SS14	SO4, other
Soluble salts	SS15	HCO2 and CO3, titration with acid (Hdb60)
Soluble salts	SS16	HCO2 and CO3, potentiometric titration with HCl (=SS15?)
Soluble salts	SS17	As described by Van Beek and Kamphorst, 1973
Soluble salts	SS99	Unspecified methods
Soluble salts	SS99.1	Unspecified, mmol/kg
Soluble salts	SS99.2	Unspecified, cmol/kg
Total carbon	TC–	Not measured (Total Carbon)
Total carbon	TC01	Total Carbon (USDA-NRCS method 6A2d)
Total carbon	TC02	Total Carbon (USDA-NRCS method 6A), LECO analyzer at 1140 C

Method group	Method code	Method description
MethdGrp	MethdCode	MethdDescr
Total carbon	TC03	Total carbon by measuring CO2 evolved from soil ignition (like LECO furnace)
Total carbon	TC99	Unspecified methods
Texture	TE–	Not measured (texture)
Texture	TE01	Pipette method, with appropriate dispersion treatment (c<0.002<si<0.05<sa<2mm)
Texture	TE01.1	pipette, McKeague 1976
Texture	TE01.2	method of Robinson, dispersion with NH4. Fine sand<0.2 mm<Coarse sand
Texture	TE01.3	TE01; method of Robinson, dispersion with NH4
Texture	TE01.4	Pipette method, with appropriate dispersion treatment (c<0.002<si<0.05<sa<2mm, WITH C = C+SI, si=0)
Texture	TE01.5	Pipette method, with appropriate dispersion treatment (c<0.002<si<0.05<sa<2mm) AND SILT FRACTION ADAPTED TO SUM UP TO 100%
Texture	TE01.6	Pipette method, with appropriate dispersion treatment (c<0.002<si<0.05<sa<2mm), with fractions rounded to 5%
Texture	TE01.7	Pipette method, with appropriate dispersion treatment (c<0.002<si<0.05<sa<2mm), with humidity fraction added to clay fraction
Texture	TE01.8	Pipette method, with appropriate dispersion treatment (c<0.002<si<0.05<sa<1.7mm), with fraction 16-50 um estimated.
Texture	TE01.9	Pipette method, with appropriate dispersion treatment (c<0.002<si<0.05<sa<2mm), with 0.02-0.05 originally in sand fraction, transfered to silt fraction
Texture	TE01.10	Pipette method, with appropriate dispersion treatment (c<0.002<si<0.05<sa<2mm), with sand fraction = 100% - (silt + clay fractions)
Texture	TE02	Pipette method, without dispersion treatment (c<0.002<si<0.05<sa<2mm)
Texture	TE03	Hydrometer method, with dispersion treatment (c<0.002<si<0.05<sa<2mm)
Texture	TE03.1	Bouyoucos, 1951. Hydrometer method, with dispersion treatment (c<0.002<si<0.05<sa<2mm)
Texture	TE03.2	Hydrometer method, with dispersion treatment (c<0.002<si<0.05<sa<2mm), with fsa<0.2mm<csa AND SILT FRACTION ADAPTED TO SUM UP TO 100%
Texture	TE03.3	Hydrometer method, with dispersion treatment (c<0.002<si<0.05<sa<2mm), with fraction 0.02-0.05 originally in sand, moved to silt
Texture	TE03.4	Hydrometer method, with dispersion treatment (c<0.002<si<0.05<sa<2mm), with sand, silt and clay fractions adapted to sum up to 100%
Texture	TE04	Hydrometer, without dispersion treatment (c<0.002<si<0.05<sa<2mm)
Texture	TE05	Pipette method, with appropriate dispersion treatment (c<0.002<si<0.02<sa<2mm)
Texture	TE06	Pipette method, without dispersion treatment (c<0.002<si<0.02<sa<2mm)
Texture	TE07	Hydrometer method, with dispersion treatment (c<0.002<si<0.02<sa<2mm)
Texture	TE07.0	Hydrometer method, with dispersion treatment (c<0.002<si<0.02<sa<2mm, WITH SPLIT FRACTIONS)
Texture	TE07.1	TE07; Fine sand= 50% of 0.02-0.2mm
Texture	TE07.2	TE07; Sand= 0.2-2mm plus 50% of 0.02-0.2mm
Texture	TE07.3	TE07; Silt = 0.002-0.02mm plus 50% of 0.02-0.2mm
Texture	TE07.4	TE07; Bouyoucos. Fine sand= 50% of 0.02-0.2mm
Texture	TE07.5	TE07; Bouyoucos. Sand= 0.2-2mm plus 50% of 0.02-0.2mm
Texture	TE07.6	TE07; Bouyoucos. Silt = 0.002-0.02mm plus 50% of 0.02-0.2mm
Texture	TE07.7	Bouyoucos
Texture	TE08	Hydrometer, without dispersion treatment (c<0.002<si<0.02<sa<2mm)
Texture	TE09	Pipette method, with appropriate dispersion treatment (c<0.002<si<0.06<sa<2mm)
Texture	TE09.1	sieving, 0.6-2 mm
Texture	TE09.2	sieving, 0.06-0.6 mm
Texture	TE09.3	sieving, 0.06-2 mm
Texture	TE10	Pipette method, without dispersion treatment (c<0.002<si<0.06<sa<2mm)
Texture	TE11	Hydrometer method, with dispersion treatment (c<0.002<si<0.06<sa<2mm)
Texture	TE12	Hydrometer, without dispersion treatment (c<0.002<si<0.06<sa<2mm)

Method group	Method code	Method description
MethdGrp	MethdCode	MethdDescr
Texture	TE13	Hydrometer method, with dipsersion treatment (c<0.005<si<0.05<sa<1mm)
Texture	TE14	Beaker method of sedimentation, with dispersion treatment (c<0.002<si<0.06<sa<2mm)
Texture	TE14.2	Beaker method of sedimentation, with dispersion treatment (c<0.002<si<0.02<sa<2mm, with c=c&si, si=0, sa=fsa&csa, with fsa=0.02-0.2 mm and csa=0.2-2 mm)
Texture	TE15	Pipette method, full dispersion (c<.001<si<0.05<sa<1mm; USSR method)
Texture	TE16	Sieve and pipette method after H2O2 extraction, and dispersion (Schlichting et al. 1995)
Texture	TE17	Sieving and sedimentation method, with appropriate dispersion treatment (c<0.002<si<0.05<sa<2 mm)
Texture	TE95	Hydrometer method, with dispersion treatment (c<0.002<si<0.05<sa<2mm OR c<0.002<si<0.02<sa<2mm), with fsa<0.2<csa
Texture	TE96	Other methods (c<0.002<si<0.02<sa<2mm, with fsa 0.02-0.2 and csa 0.2-2 mm)
Texture	TE96.1	Other methods (c&si<0.02<sa<2mm, with fsa 0.02-0.2 and csa 0.2-2 mm)
Texture	TE96.2	Other methods (c< 0.002 <si< 0.02 <sa< 2mm, with fsa/msa 0.02-0.2 and csa 0.2-2 mm, with 50% of the original fsa/msa fraction allocated to sand and 50% to silt, and with the sa-si-cl fractions adapted to add up to 100%)
Texture	TE97	Other methods (c<0.002<si<0.06<sa<2mm)
Texture	TE98	Other methods (c<0.002<si<0.05<sa<2mm)
Texture	TE98.1	fine sand<0.3 mm
Texture	TE98.2	Derived from field estimated particle size class
Texture	TE99	Unspecified methods
Total nitrogen	TN–	Not measured (Total N)
Total nitrogen	TN01	Method of Kjeldahl
Total nitrogen	TN01.1	Kjeldahl, and ammonia distillation
Total nitrogen	TN02	Element analyzer (LECO analyzer), DRY COMBUSTION
Total nitrogen	TN03	Total N (Bremner, 1965, p. 1162-1164)
Total nitrogen	TN04	Dry combustion using a CN-corder and cobalt oxide or copper oxide as an oxidation accelerator (Tanabe and Araragi, 1970)
Total nitrogen	TN05	H2SO4
Total nitrogen	TN06	Continuous flow analyser after digestion with H2SO4/salicyclic acid/H2O2/Se
Total nitrogen	TN07	Nelson and Sommers, 1980
Total nitrogen	TN08	Sample digested by sulphuric acid, distillation of released ammonia, back titration against sulphuric acid
Total nitrogen	TN98	OC * 1.72 / 20 (gives C/N=11.6009)
Total nitrogen	TN99	Unspecified methods
Total phosphorus	TP–	Not measured (Total-P)
Total phosphorus	TP01	Total P; colorimetric in H2SO4-Se-Salicylic acid digest
Total phosphorus	TP02	COLORIMETRIC VANADATE MOLYBDATE
Total phosphorus	TP03	Reagent of Baeyens. Precipitation in form of Phosphomolybdate
Total phosphorus	TP04	acid fleischman
Total phosphorus	TP05	HCl extraction
Total phosphorus	TP05.1	8 M HCl extraction
Total phosphorus	TP05.2	Perchloric acid percolation
Total phosphorus	TP06	Molybdenum blue method, using ascorbic acid as reductant after heating of soil to 550 C and extraction with 6M sulphuric acid
Total phosphorus	TP07	1:1 H2SO4 : HNO3
Total phosphorus	TP07.1	Nitric acid attack
Total phosphorus	TP08	After Nitric acid attack (boiling with HNO3), colometric determination (method of Duval).
Total phosphorus	TP99	Unspecified methods
Total phosphorus	TP99.01	P2O5

Annex 5a Dictionary of class value codes

Attribute code	Value code	Value description
ProprtyCod	ValueCode	ValueDescr
CfFldCls	N	None (0%)
CfFldCls	V	Very few (0-2%)
CfFldCls	F	Few (2-5%)
CfFldCls	C	Common (5-15%)
CfFldCls	M	Many (15-40%)
CfFldCls	A	Abundant (40-80%)
CfFldCls	D	Dominant (≥ 80%)
CfFldCls	S	Stone line (any content, but concentrated at a distinct depth)
CfNature	N	not known
CfNature	M	manganese (manganiferous)
CfNature	U	sulphur (sulphurous)
CfNature	S	salt (saline)
CfNature	R	residual rock fragments
CfNature	F	iron (ferruginous)
CfNature	K	carbonates (calcareous)
CfNature	I	Iron-manganese (sesquioxides)
CfNature	G	gypsum (gypsiferous)
CfNature	Q	silica (siliceous)
ClyMinera	AL	Allophane
ClyMinera	CH	Chloritic
ClyMinera	IL	Illitic
ClyMinera	IN	Interstratified or mixed
ClyMinera	KA	Kaolinitic
ClyMinera	MO	Montmorilonitic
ClyMinera	SE	Sesquioxidic
ClyMinera	VE	Vermiculitic
Drain	E	Excessively well drained
Drain	S	Somewhat excessively well drained
Drain	W	Well drained
Drain	M	Moderately well drained
Drain	I	Imperfectly drained
Drain	P	Poorly drained
Drain	V	Very poorly drained
FAO74	A	Acrisols
FAO74	Af	Ferric Acrisols
FAO74	Ag	Gleyic Acrisols
FAO74	Ah	Humic Acrisols
FAO74	Ao	Orthic Acrisols
FAO74	Ap	Plinthic Acrisols
FAO74	B	Cambisols
FAO74	Bc	Chromic Cambisols
FAO74	Bd	Dystric Cambisols
FAO74	Be	Eutric Cambisols
FAO74	Bf	Ferralic Cambisols
FAO74	Bg	Gleyic Cambisols

Attribute code	Value code	Value description
ProprtyCod	ValueCode	ValueDescr
FAO74	Bh	Humic Cambisols
FAO74	Bk	Calcic Cambisols
FAO74	Bv	Vertic Cambisols
FAO74	Bx	Gelic Cambisols
FAO74	C	Chernozems
FAO74	Cg	Glosic Chernozems
FAO74	Ch	Haplic Chernozems
FAO74	Ck	Calcic Chernozems
FAO74	Cl	Luvic Chernozems
FAO74	D	Podzoluvisols
FAO74	Dd	Dystric Podzoluvisols
FAO74	De	Eutric Podzoluvisols
FAO74	Dg	Gleyic Podzoluvisols
FAO74	E	Rendzinas
FAO74	F	Ferralsols
FAO74	Fa	Acric Ferralsols
FAO74	Fh	Humic Ferralsols
FAO74	Fo	Orthic Ferralsols
FAO74	Fp	Plinthic Ferralsols
FAO74	Fr	Rhodic Ferralsols
FAO74	Fx	Xanthic Ferralsols
FAO74	G	Gleysols
FAO74	Gc	Calcaric Gleysols
FAO74	Gd	Dystric Gleysols
FAO74	Ge	Eutric Gleysols
FAO74	Gh	Humic Gleysols
FAO74	Gm	Mollic Gleysols
FAO74	Gp	Plinthic Gleysols
FAO74	Gx	Gelic Gleysols
FAO74	H	Phaeozems
FAO74	Hc	Calcaric Phaeozems
FAO74	Hg	Gleyic Phaeozems
FAO74	Hh	Haplic Phaeozems
FAO74	Hl	Luvic Phaeozems
FAO74	I	Lithosols
FAO74	J	Fluvisols
FAO74	Jc	Calcaric Fluvisols
FAO74	Jd	Dystric Fluvisols
FAO74	Je	Eutric Fluvisols
FAO74	Jt	Thionic Fluvisols
FAO74	K	Kastanozems
FAO74	Kh	Haplic Kastanozems
FAO74	Kk	Calcic Kastanozems
FAO74	Kl	Luvic Kastanozems
FAO74	L	Luvisols
FAO74	La	Albic Luvisols
FAO74	Lc	Chromic Luvisols
FAO74	Lf	Ferric Luvisols
FAO74	Lg	Gleyic Luvisols
FAO74	Lk	Calcic Luvisols
FAO74	Lo	Orthic Luvisols
FAO74	Lp	Plinthic Luvisols

Attribute code	Value code	Value description
ProprtyCod	ValueCode	ValueDescr
FAO74	Lv	Vertic Luvisols
FAO74	M	Greyzems
FAO74	Mg	Gleyic Greyzem
FAO74	Mo	Orthic Greyzem
FAO74	N	Nitosols
FAO74	Nd	Dystric Nitosols
FAO74	Ne	Eutric Nitosols
FAO74	Nh	Humic Nitosols
FAO74	O	Histosols
FAO74	Od	Dystric Histosols
FAO74	Oe	Eutric Histosols
FAO74	Ox	Gelic Histosols
FAO74	P	Podzols
FAO74	Pf	Ferric Podzols
FAO74	Pg	Gleyic Podzols
FAO74	Ph	Humic Podzols
FAO74	Pl	Leptic Podzols
FAO74	Po	Orthic Podzols
FAO74	Pp	Placic Podzols
FAO74	Q	Arenosols
FAO74	Qa	Albic Arenosols
FAO74	Qc	Cambic Arenosols
FAO74	Qf	Ferralic Arenosols
FAO74	Ql	Luvic Arenosols
FAO74	R	Regosols
FAO74	Rc	Calcaric Regosols
FAO74	Rd	Dystric Regosols
FAO74	Re	Eutric Regosols
FAO74	Rx	Gelic Regosols
FAO74	S	Solonetz
FAO74	Sg	Gleyic Solonetz
FAO74	Sm	Mollic Solonetz
FAO74	So	Orthic Solonetz
FAO74	T	Andosols
FAO74	Th	Humic Andosols
FAO74	Tm	Mollic Andosols
FAO74	To	Ochric Andosols
FAO74	Tv	Vitric Andosols
FAO74	U	Rankers
FAO74	V	Vertisols
FAO74	Vc	Chromic Vertisols
FAO74	Vp	Pellic Vertisols
FAO74	W	Planosols
FAO74	Wd	Dystric Planosols
FAO74	We	Eutric Planosols
FAO74	Wh	Humic Planosols
FAO74	Wm	Mollic Planosols
FAO74	Ws	Sodic Planosols
FAO74	Wx	Gelic Planosols
FAO74	X	Xerosols
FAO74	Xh	Haplic Xerosols
FAO74	Xk	Calcic Xerosols

Attribute code	Value code	Value description
ProprtyCod	ValueCode	ValueDescr
FAO74	Xl	Luvic Xerosols
FAO74	Xy	Gypsic Xerosols
FAO74	Y	Yermosols
FAO74	Yh	Haplic Yermosols
FAO74	Yk	Calcic Yermosols
FAO74	Yl	Luvic Yermosols
FAO74	Yt	Takyric Yermosols
FAO74	Yy	Gypsic Yermosols
FAO74	Z	Solonchaks
FAO74	Zg	Gleyic Solonchaks
FAO74	Zm	Mollic Solonchaks
FAO74	Zo	Orthic Solonchaks
FAO74	Zt	Takyric Solonchaks
FAO88	AC	Acrisols
FAO88	ACf	Ferric Acrisols
FAO88	ACg	Gleyic Acrisols
FAO88	ACh	Haplic Acrisols
FAO88	ACp	Plinthic Acrisols
FAO88	ACu	Humic Acrisols
FAO88	AL	Alisols
FAO88	ALf	Ferric Alisols
FAO88	ALg	Gleyic Alisols
FAO88	ALh	Haplic Alisols
FAO88	ALj	Stagnic Alisols
FAO88	ALp	Plinthic Alisols
FAO88	ALu	Humic Alisols
FAO88	AN	Andosols
FAO88	ANg	Gleyic Andosols
FAO88	ANh	Haplic Andosols
FAO88	ANi	Gelic Andosols
FAO88	ANm	Mollic Andosols
FAO88	ANu	Umbric Andosols
FAO88	ANz	Vitric Andosols
FAO88	AR	Arenosols
FAO88	ARa	Albic Arenosols
FAO88	ARb	Cambic Arenosols
FAO88	ARc	Calcaric Arenosols
FAO88	ARg	Gleyic Arenosols
FAO88	ARh	Haplic Arenosols
FAO88	ARl	Luvic Arenosols
FAO88	ARo	Ferralic Arenosols
FAO88	AT	Anthrosols
FAO88	Ata	Aric Anthrosols
FAO88	ATc	Cumulic Anthrosols
FAO88	ATf	Fimic Anthrosols
FAO88	ATu	Urbic Anthrosols
FAO88	CH	Chernozems
FAO88	CHg	Gleyic Chernozems
FAO88	CHh	Haplic Chernozems
FAO88	CHk	Calcic Chernozems
FAO88	CHl	Luvic Chernozems
FAO88	CHw	Glosic Chernozems

Attribute code	Value code	Value description
ProprtyCod	ValueCode	ValueDescr
FAO88	CL	Calcisols
FAO88	CLh	Haplic Calcisols
FAO88	CLl	Luvic Calcisols
FAO88	CLp	Petric Calcisols
FAO88	CM	Cambisols
FAO88	CMc	Calcaric Cambisols
FAO88	CMd	Dystric Cambisols
FAO88	CMe	Eutric Cambisols
FAO88	CMg	Gleyic Cambisols
FAO88	CMi	Gelic Cambisols
FAO88	CMo	Ferralic Cambisols
FAO88	CMu	Humic Cambisols
FAO88	CMv	Vertic Cambisols
FAO88	CMx	Chromic Cambisols
FAO88	FL	Fluvisols
FAO88	FLc	Calcaric Fluvisols
FAO88	FLd	Dystric Fluvisols
FAO88	FLe	Eutric Fluvisols
FAO88	FLm	Mollic Fluvisols
FAO88	FLs	Salic Fluvisols
FAO88	FLt	Thionic Fluvisols
FAO88	FLu	Umbric Fluvisols
FAO88	FR	Ferralsols
FAO88	FRg	Geric Ferralsols
FAO88	FRh	Haplic Ferralsols
FAO88	FRp	Plinthic Ferralsols
FAO88	FRr	Rhodic Ferralsols
FAO88	FRu	Humic Ferralsols
FAO88	FRx	Xanthic Ferralsols
FAO88	GL	Gleysols
FAO88	GLa	Andic Gleysols
FAO88	GLd	Dystric Gleysols
FAO88	GLe	Eutric Gleysols
FAO88	GLi	Gelic Gleysols
FAO88	GLk	Calcic Gleysols
FAO88	GLm	Mollic Gleysols
FAO88	GLt	Thionic Gleysols
FAO88	GLu	Umbric Gleysols
FAO88	GR	Greyzems
FAO88	GRg	Gleyic Greyzems
FAO88	GRh	Haplic Greyzems
FAO88	GY	Gypsisols
FAO88	GYh	Haplic Gypsisols
FAO88	GYk	Calcic Gypsisols
FAO88	GYl	Luvic Gypsisols
FAO88	GYp	Petric Gypsisols
FAO88	HS	Histosols
FAO88	HSf	Fibric Histosols
FAO88	HSi	Gelic Histosols
FAO88	HSl	Folic Histosols
FAO88	HS	Terric Histosols
FAO88	HSt	Thionic Histosols

Attribute code	Value code	Value description
ProprtyCod	ValueCode	ValueDescr
FAO88	KS	Kastanozems
FAO88	KSh	Haplic Kastanozems
FAO88	KSk	Calcic Kastanozems
FAO88	KSl	Luvic Kastanozems
FAO88	KSy	Gypsic Kastanozems
FAO88	LP	Leptosols
FAO88	LPd	Dystric Leptosols
FAO88	LPe	Eutric Leptosols
FAO88	LPi	Gelic Leptosols
FAO88	LPk	Rendzic Leptosols
FAO88	LPm	Mollic Leptosols
FAO88	LPq	Lithic Leptosols
FAO88	LPu	Umbric Leptosols
FAO88	LV	Luvisols
FAO88	LVa	Albic Luvisols
FAO88	LVf	Ferric Luvisols
FAO88	LVg	Gleyic Luvisols
FAO88	LVh	Haplic Luvisols
FAO88	LVj	Stagnic Luvisols
FAO88	LVk	Calcic Luvisols
FAO88	LVv	Vertic Luvisols
FAO88	LVx	Chromic Luvisols
FAO88	LX	Lixisols
FAO88	LXa	Albic Lixisols
FAO88	LXf	Ferric Lixisols
FAO88	LXg	Gleyic Lixisols
FAO88	LXh	Haplic Lixisols
FAO88	LXj	Stagnic Lixisols
FAO88	LXp	Plinthic Lixisols
FAO88	NT	Nitisols
FAO88	NTh	Haplic Nitisols
FAO88	NTr	Rhodic Nitisols
FAO88	NTu	Humic Nitisols
FAO88	PD	Podzoluvisols
FAO88	PDd	Dystric Podzoluvisols
FAO88	PDe	Eutric Podzoluvisols
FAO88	PDg	Gleyic Podzoluvisols
FAO88	PDi	Gelic Podzoluvisols
FAO88	PDj	Stagnic Podzoluvisols
FAO88	PH	Phaeozems
FAO88	PHc	Calcaric Phaeozems
FAO88	PHg	Gleyic Phaeozems
FAO88	PHh	Haplic Phaeozems
FAO88	PHj	Stagnic Phaeozems
FAO88	PHl	Luvic Phaeozems
FAO88	PL	Planosols
FAO88	PLd	Dystric Planosols
FAO88	PLe	Eutric Planosols
FAO88	PLi	Gelic Planosols
FAO88	PLm	Mollic Planosols
FAO88	PLu	Umbric Planosols
FAO88	PT	Plinthosols

Attribute code	Value code	Value description
ProprtyCod	ValueCode	ValueDescr
FAO88	PTa	Albic Plinthosols
FAO88	PTd	Dystric Plinthosols
FAO88	PTe	Eutric Plinthosols
FAO88	PTu	Humic Plinthosols
FAO88	PZ	Podzols
FAO88	PZb	Cambic Podzols
FAO88	PZc	Carbic Podzols
FAO88	PZf	Ferric Podzols
FAO88	PZg	Gleyic Podzols
FAO88	PZh	Haplic Podzols
FAO88	PZi	Gelic Podzols
FAO88	RG	Regosols
FAO88	RGc	Calcaric Regosols
FAO88	RGd	Dystric Regosols
FAO88	RGe	Eutric Regosols
FAO88	RGi	Gelic Regosols
FAO88	RGu	Umbric Regosols
FAO88	RGy	Gypsic Regosols
FAO88	SC	Solonchaks
FAO88	SCg	Gleyic Solonchaks
FAO88	SCh	Haplic Solonchaks
FAO88	SCi	Gelic Solonchaks
FAO88	SCk	Calcic Solonchaks
FAO88	SCm	Mollic Solonchaks
FAO88	SCn	Sodic Solonchaks
FAO88	SCy	Gypsic Solonchaks
FAO88	SN	Solonetz
FAO88	SNg	Gleyic Solonetz
FAO88	SNh	Haplic Solonetz
FAO88	SNj	Stagnic Solonetz
FAO88	SNk	Calcic Solonetz
FAO88	SNm	Mollic Solonetz
FAO88	SNy	Gypsic Solonetz
FAO88	VR	Vertisols
FAO88	VRd	Dystric Vertisols
FAO88	VRe	Eutric Vertisols
FAO88	VRk	Calcic Vertisols
FAO88	VRy	Gypsic Vertisols
FldTxtr	S	Sand
FldTxtr	LS	Loamy sand
FldTxtr	SL	Sandy loam
FldTxtr	SIL	Silty loam
FldTxtr	SI	Silt
FldTxtr	L	Loam
FldTxtr	SCL	Sandy clay loam
FldTxtr	CL	Clay loam
FldTxtr	SICL	Silty clay loam
FldTxtr	SC	Sandy clay
FldTxtr	SIC	Silty clay
FldTxtr	C	Clay
FldTxtr	HC	Heavy clay

Attribute code	Value code	Value description
ProprtyCod	ValueCode	ValueDescr
FrqFlood	N	None
FrqFlood	D	Daily
FrqFlood	W	Weekly
FrqFlood	M	Monthly
FrqFlood	A	Annually
FrqFlood	B	Biennually
FrqFlood	F	Once every 2-5 years
FrqFlood	T	Once every 5-10 years
FrqFlood	R	Rare (less than once in every 10 years)
FrqFlood	U	Unknown
HorDes	H	H horizon/layer
HorDes	O	O horizon/layer
HorDes	A	A horizon
HorDes	E	E horizon
HorDes	B	B horizon
HorDes	C	C horizon/layer
HorDes	R	R layer
HorDes	I	I Layer
HorDes	L	L Layer
HorDes	W	Water Layer
LndCov	I	Closed forest
LndCov	IA	Mainly evergreen forest
LndCov	IA1	Tropical ombrophilous forest (tropical rain forest)
LndCov	IA2	Tropical and subtropical evergreen seasonal forest
LndCov	IA3	Tropical and subtropical semi-deciduous forest
LndCov	IA4	Subtropical ombrophilous forest
LndCov	IA5	Mangrove forest
LndCov	IA6	Temperate and subpolar evergreen ombrophilous forest
LndCov	IA7	Temperate evergreen seasonal broad-leaved forest
LndCov	IA8	Winter-rain evergreen broad-leaved sclerophyllous forest
LndCov	IA9	Tropical and subtropical evergreen needle-leaved forest
LndCov	IA10	Temperate and subpolar evergreen needle-leaved forest
LndCov	IB	Mainly deciduous forest
LndCov	IB1	Tropical and subtropical drought-deciduous forest
LndCov	IB2	Cold-deciduous forest with evergreen trees (or shrubs)
LndCov	IB3	Cold-deciduous forest without evergreen trees
LndCov	IC	Extremely Xeromorphic forest
LndCov	IC1	Sclerophyllous-dominated extremely xeromorphic forest
LndCov	IC2	Thorn forest
LndCov	IC3	Mainly succulent forest
LndCov	II	Woodland
LndCov	IIA	Mainly evergreen woodland
LndCov	IIA1	Evergreen broad-leaved woodland
LndCov	IIA2	Evergreen needle-leaved forest (woodland)
LndCov	IIB	Mainly deciduous woodland
LndCov	IIB1	Drought-deciduous woodland
LndCov	IIB2	Cold-deciduous woodland with evergreen trees
LndCov	IIB3	Cold-deciduous woodland without evergreen trees
LndCov	IIC	Extremely xeromorphic woodland
LndCov	IIC1	Sclerophillous-dominated extremely xeromorphic woodland
LndCov	IIC2	Thorn woodland
LndCov	IIC3	Mainly succulent woodland

Attribute code	Value code	Value description
ProprtyCod	ValueCode	ValueDescr
LndCov	III	Scrub (shrubland or thicket)
LndCov	IIIA	Mainly evergreen shrub
LndCov	IIIA1	Evergreen broad-leaved shrubland (or thicket)
LndCov	IIIA2	Evergreen needle-leaved and microphyllous shrubland
LndCov	IIIB	Mainly deciduous scrub
LndCov	IIIB1	Drought-deciduous scrub with evergreen woody plants admixed
LndCov	IIIB2	Drought-decid. scrub without evergreen woody plants admixed
LndCov	IIIB3	Cold-deciduous scrub
LndCov	IIIC	Extremely xeromorphic (subdesert) shrubland
LndCov	IIIC1	Mainly evergreen subdesert shrubland
LndCov	IIIC2	Deciduous subdesert shrubland
LndCov	IV	Dwarf-scrub and related communities
LndCov	IVA	Mainly evergreen dwarf-scrub
LndCov	IVA1	Evergreen dwarf-scrub thicket
LndCov	IVA2	Evergreen dwarf-shrubland
LndCov	IVA3	Mixed evergreen dwarf-shrub and herbaceous formation
LndCov	IVB	Mainly deciduous dwarf-scrub
LndCov	IVB1	Facultatively drought-deciduous dwarf-thicket
LndCov	IVB2	Obligatory, drought-deciduous dwarf-thicket
LndCov	IVB3	Cold-deciduous dwarf-thicket (or dwarf-shrubland)
LndCov	IVC	Extremely xeromorphic dwarf-shrubland
LndCov	IVC1	Mainly evergreen subdesert dwarf-shrubland
LndCov	IVC2	Deciduous subdesert dwarf-shrubland
LndCov	IVD	Tundra
LndCov	IVD1	Mainly bryophyte tundra
LndCov	IVD2	Mainly lichen tundra
LndCov	IVE	Mossy bog formations with dwarf-shrub
LndCov	IVE1	Raised bog
LndCov	IVE2	Non-raised bog
LndCov	V	Herbaceous vegetation
LndCov	VA	Tall graminoid vegetation
LndCov	VA1	Tall grassland with a tree synusia covering 10-40%
LndCov	VA2	Tall grassland with a tree synusia covering less than 10%
LndCov	VA3	Tall grassland with a synusia of shrubs
LndCov	VA4	Tall grassland with a woody synusia of mainly tuft plants
LndCov	VA5	Tall grassland practically without woody synusia
LndCov	VB	Medium tall grassland
LndCov	VB1	Medium tall grassland with a tree synusia covering 10-40%
LndCov	VB2	Medium tall grassland with tree synusia cover less than 10%
LndCov	VB3	Medium tall grassland with a synusia of shrubs
LndCov	VB4	Medium tall grassland with an open synusia of tuft plants
LndCov	VB5	Medium tall grassland practically without woody synusia
LndCov	VC	Short grassland
LndCov	VC1	Short grassland with a tree synusia covering 10-40%
LndCov	VC2	Short grassland with a tree synusia covering less than 10%
LndCov	VC3	Short grassland with a synusia of shrubs
LndCov	VC4	Short grassland with an open synusia of tuft plants
LndCov	VC5	Short grassland practically without woody synusia
LndCov	VC6	Short to medium tall mesophytic grassland
LndCov	VC7	Graminoid tundra
LndCov	VD	Forb vegetation
LndCov	VD1	Tall forb communities

Attribute code	Value code	Value description
ProprtyCod	ValueCode	ValueDescr
LndCov	VD2	Low forb communities
LndCov	VE	Hydromorphic fresh-water vegetation
LndCov	VE1	Rooted fresh-water communities
LndCov	VE2	Free floating fresh-water communities
LndCov	VI	Barren
LndCov	VIB	Non-vegetated or very sparse vegetation less than 5%
LndForm	L	level land (<10%)
LndForm	LP	plain
LndForm	LL	plateau
LndForm	LD	depression
LndForm	LF	low gradient footslope
LndForm	LV	valley floor
LndForm	S	sloping land (10-30%)
LndForm	SE	medium-gradient escarpment zone
LndForm	SH	medium-gradient hill
LndForm	SM	medium-gradient mountain
LndForm	SP	dissected plain
LndForm	SV	medium-gradient valley
LndForm	T	steep land (>30%)
LndForm	TE	high-gradient escarpment zone
LndForm	TH	high-gradient hill
LndForm	TM	high-gradient mountain
LndForm	TV	high-gradient valleys
LndUse	S	Residential, industrial use
LndUse	SR	Residential use, cities
LndUse	SI	Industrial use
LndUse	ST	Transport (roads, railways etc.)
LndUse	SC	Recreation
LndUse	SX	Excavations, quarries
LndUse	A	Land used for cultivation of crops
LndUse	AA	Annual field cropping
LndUse	AA1	Shifting cultivation
LndUse	AA2	Fallow system cultivation
LndUse	AA3	Ley system cultivation
LndUse	AA4	Rainfed arable cultivation
LndUse	AA5	Wet rice cultivation
LndUse	AA6	Irrigated cultivation
LndUse	AP	Perennial field cropping
LndUse	AP1	Non-irrigated perennial field cropping
LndUse	AP2	Irrigated perennial field cropping
LndUse	AT	Tree and shrub cropping
LndUse	AT1	Non-irrigated tree crop cultivation
LndUse	AT2	Irrigated tree crop cultivation
LndUse	AT3	Non-irrigated shrub crop cultivation
LndUse	AT4	Irrigated shrub crop cultivation
LndUse	H	Animal husbandry
LndUse	HE	Extensive grazing
LndUse	HE1	Nomadism
LndUse	HE2	Semi-nomadism
LndUse	HE3	Ranching
LndUse	HI	Intensive grazing
LndUse	HI1	Intensive grazing - animal production

Attribute code	Value code	Value description
ProprtyCod	ValueCode	ValueDescr
LndUse	HI2	Intensive grazing - dairying
LndUse	F	Forestry
LndUse	FN	Exploitation of natural forest and woodland
LndUse	FN1	Selective felling
LndUse	FN2	Clear felling
LndUse	FP	Plantation forestry
LndUse	M	Mixed farming
LndUse	MF	Agro-forestry
LndUse	MP	Agro-pastoralism
LndUse	E	Extraction of products from the environment
LndUse	EV	Exploitation of natural vegetation
LndUse	EH	Hunting and fishing
LndUse	P	Nature protection
LndUse	PN	Nature and game preservation
LndUse	PN1	Reserves
LndUse	PN2	Parks
LndUse	PN3	Wildlife management
LndUse	PD	Degradation control
LndUse	PD1	Degradation control - non-interference
LndUse	PD2	Degradation control - interference
LndUse	U	Not used and not managed
Mottling	Y	Presence of mottles
Mottling	N	No presence of mottles
ParMat	M	M metamorphic rocks
ParMat	MA	MA acid metamorphic rocks
ParMat	MA1	MA1 quartzite
ParMat	MA2	MA2 gneiss
ParMat	MA3	MA3 phyllite, slate
ParMat	MA4	MA4 granulite
ParMat	MA5	MA5 migmatite
ParMat	MB	MB basic metamorphic rocks
ParMat	MB1	MB1 slate, phyllite
ParMat	MB2	MB2 (mica-) schist
ParMat	MB3	MB3 (green-) schist
ParMat	MB4	MB4 gneiss rich in ferro-magnesian minerals
ParMat	MB5	MB5 amphibolite
ParMat	MB6	MB6 eclogite
ParMat	MB7	MB7 skarn
ParMat	MC	MC calcareous metamorphic rocks
ParMat	MC1	MC1 metamorphic limestone(marble)
ParMat	MU	MU metasomatic and hydrothermal rocks
ParMat	MU1	MU1 serpentine
ParMat	MU2	MU2 iron ore
ParMat	P	P plutonic rocks
ParMat	PA	PA acid
ParMat	PA1	PA1 granite
ParMat	PA2	PA2 tonalite (quartz-diorite)
ParMat	PA3	PA3 granodiorite
ParMat	PA4	PA4 aplite
ParMat	PA5	PA5 quartz-rich granitoids, quartzolite
ParMat	PB	PB basic plutonic rocks
ParMat	PB1	PB1 gabbro

Attribute code	Value code	Value description
ProprtyCod	ValueCode	ValueDescr
ParMat	PI	PI intermediate
ParMat	PI1	PI1 diorite
ParMat	PQ	PQ acid to intermediate
ParMat	PQ1	PQ1 foid-bearing syenite
ParMat	PU	PU ultrabasic plutonic rocks
ParMat	PU1	PU1 peridotite
ParMat	PU2	PU2 pyroxenite
ParMat	PU3	PU3 horblendite
ParMat	PW	PW intermediate to basic
ParMat	PW1	PW1 syenite
ParMat	PW2	PW2 monzonite
ParMat	S	S sedimentary rocks (consolidated)
ParMat	SA	SA psammite or arenite
ParMat	SA1	SA1 sandstone
ParMat	SE	SE evaporites
ParMat	SE1	SE1 anhydrite, gypsum
ParMat	SE2	SE2 halite, sylvite
ParMat	SI	SI ironstone
ParMat	SI1	SI1 ironstone
ParMat	SL	SL pelite or lutite
ParMat	SL1	SL1 siltstone
ParMat	SL2	SL2 claystone
ParMat	SL3	SL3 shale
ParMat	SL4	SL4 mudstone
ParMat	SL5	SL5 diamictite
ParMat	SO	SO calcareous rocks
ParMat	SO1	SO1 limestone, chalk, dolomite and other carbonate rocks
ParMat	SO2	SO2 marl, marlstone, and other mixtures
ParMat	SP	SP psephite or rudite
ParMat	SP1	SP1 conglomerate
ParMat	SP2	SP2 breccia
ParMat	SQ	SQ organic-rich rocks
ParMat	SQ1	SQ1 coal, bitumen & related rocks
ParMat	SS	SS siliceous rock
ParMat	SS1	SS1 chert, hornstone, flint, diatomite, radiolarite
ParMat	SX	SX phosphorites
ParMat	SX1	SX1 guano
ParMat	U	U unconsolidated deposits
ParMat	U0	U0 group unknown
ParMat	U000	U000 subgroup and type unknown
ParMat	U00CF	U00CF subgroup unknown collo-fluvial
ParMat	U00F	U00F subgroup unknown fluvial
ParMat	UA	UA anthropogenic/ technogenic
ParMat	UAI	UAI industrial/artisanal deposits
ParMat	UAN	UAN redeposited natural materials
ParMat	UI	UI iron-sediment
ParMat	UL	UL lime-sediment
ParMat	UO	UO peat & organic rich sediments
ParMat	UO1	UO1 rainwater fed peat
ParMat	UO2	UO2 groundwater fed peat
ParMat	UO3	UO3 sapropel
ParMat	UP	UP phosphate-sediment

Attribute code	Value code	Value description
ProprtyCod	ValueCode	ValueDescr
ParMat	UQ	UQ gravelly
ParMat	UQ0C	UQ0C colluvial, unspecified
ParMat	UQ0F	UQ0F fluvial, unspecified
ParMat	UQ0G	UQ0G glaciofluvial, unspecified
ParMat	UQ0M	UQ0M marine and estuarine, unspecified
ParMat	UQ0T	UQ0T glacial till, unspecified
ParMat	UQ1C	UQ1C colluvial, not calcareous
ParMat	UQ1F	UQ1F fluvial, not calcareous
ParMat	UQ1G	UQ1G glaciofluvial, not calcareous
ParMat	UQ1M	UQ1M marine and estuarine, not calcareous
ParMat	UQ1T	UQ1T glacial till, not calcareous
ParMat	UQ2C	UQ2C colluvial, calcareous
ParMat	UQ2F	UQ2F fluvial, calcareous
ParMat	UQ2G	UQ2G glaciofluvial, calcareous
ParMat	UQ2M	UQ2M marine and estuarine, calcareous
ParMat	UQ2T	UQ2T glacial till, calcareous
ParMat	UR	UR weathering residuum
ParMat	UR1	UR1 bauxite
ParMat	US	US sandy
ParMat	US0C	US0C colluvial, unspecified
ParMat	US0E	US0E eolian, unspecified
ParMat	US0F	US0F fluvial, unspecified
ParMat	US0G	US0G glaciofluvial, unspecified
ParMat	US0L	US0L lacustrine, unspecified
ParMat	US0M	US0M marine and estuarine, unspecified
ParMat	US0T	US0T glacial till, unspecified
ParMat	US1C	US1C colluvial, not calcareous
ParMat	US1E	US1E eolian, not calcareous
ParMat	US1F	US1F fluvial, not calcareous
ParMat	US1G	US1G glaciofluvial, not calcareous
ParMat	US1L	US1L lacustrine, not calcareous
ParMat	US1M	US1M marine and estuarine, not calcareous
ParMat	US1T	US1T glacial till, not calcareous
ParMat	US2C	US2C colluvial, calcareous
ParMat	US2E	US2E eolian, calcareous
ParMat	US2F	US2F fluvial, calcareous
ParMat	US2G	US2G glaciofluvial, calcareous
ParMat	US2L	US2L lacustrine, calcareous
ParMat	US2M	US2M marine and estuarine, calcareous
ParMat	US2T	US2T glacial till, calcareous
ParMat	UT	UT silty, loamy
ParMat	UT0C	UT0C colluvial, unspecified
ParMat	UT0E	UT0E eolian, unspecified
ParMat	UT0F	UT0F fluvial, unspecified
ParMat	UT0L	UT0L lacustrine, unspecified
ParMat	UT0M	UT0M marine and estuarine, unspecified
ParMat	UT0T	UT0T glacial till, unspecified
ParMat	UT1C	UT1C colluvial, not calcareous
ParMat	UT1E	UT1E eolian, not calcareous
ParMat	UT1F	UT1F fluvial, not calcareous
ParMat	UT1L	UT1L lacustrine, not calcareous
ParMat	UT1M	UT1M marine and estuarine, not calcareous

Attribute code	Value code	Value description
ProprtyCod	ValueCode	ValueDescr
ParMat	UT1T	UT1T glacial till, not calcareous
ParMat	UT2C	UT2C colluvial, calcareous
ParMat	UT2E	UT2E eolian, calcareous
ParMat	UT2F	UT2F fluvial, calcareous
ParMat	UT2L	UT2L lacustrine, calcareous
ParMat	UT2M	UT2M marine and estuarine, calcareous
ParMat	UT2T	UT2T glacial till, calcareous
ParMat	UU	UU diamicton (unsorted)
ParMat	UU0C	UU0C colluvial, unspecified
ParMat	UU0F	UU0F fluvial, unspecified
ParMat	UU0G	UU0G glaciofluvial, unspecified
ParMat	UU0L	UU0L lacustrine, unspecified
ParMat	UU0M	UU0M marine and estuarine, unspecified
ParMat	UU0T	UU0T glacial till, unspecified
ParMat	UU1C	UU1C colluvial, not calcareous
ParMat	UU1F	UU1F fluvial, not calcareous
ParMat	UU1G	UU1G glaciofluvial, not calcareous
ParMat	UU1L	UU1L lacustrine, not calcareous
ParMat	UU1M	UU1M marine and estuarine, not calcareous
ParMat	UU1T	UU1T glacial till, not calcareous
ParMat	UU2C	UU2C colluvial, calcareous
ParMat	UU2F	UU2F fluvial, calcareous
ParMat	UU2G	UU2G glaciofluvial, calcareous
ParMat	UU2L	UU2L lacustrine, calcareous
ParMat	UU2M	UU2M marine and estuarine, calcareous
ParMat	UU2T	UU2T glacial till, calcareous
ParMat	UX	UX siliceous-ooze
ParMat	UY	UY clayey
ParMat	UY0C	UY0C colluvial, unspecified
ParMat	UY0E	UY0E eolian, unspecified
ParMat	UY0F	UY0F fluvial, unspecified
ParMat	UY0L	UY0L lacustrine, unspecified
ParMat	UY0M	UY0M marine and estuarine, unspecified
ParMat	UY0T	UY0T glacial till, unspecified
ParMat	UY1C	UY1C colluvial, not calcareous
ParMat	UY1E	UY1E eolian, not calcareous
ParMat	UY1F	UY1F fluvial, not calcareous
ParMat	UY1L	UY1L lacustrine, not calcareous
ParMat	UY1M	UY1M marine and estuarine, not calcareous
ParMat	UY1T	UY1T glacial till, not calcareous
ParMat	UY2C	UY2C colluvial, calcareous
ParMat	UY2E	UY2E eolian, calcareous
ParMat	UY2F	UY2F fluvial, calcareous
ParMat	UY2L	UY2L lacustrine, calcareous
ParMat	UY2M	UY2M marine and estuarine, calcareous
ParMat	UY2T	UY2T glacial till, calcareous
ParMat	V	V volcanic rocks
ParMat	VA	VA acid
ParMat	VA1	VA1 rhyolite
ParMat	VA2	VA2 dacite
ParMat	VB	VB basic volcanic rocks
ParMat	VB1	VB1 basalt

Attribute code	Value code	Value description
ProprtyCod	ValueCode	ValueDescr
ParMat	VI	VI intermediate
ParMat	VI1	VI1 andesite, trachyandesite
ParMat	VJ	VJ acid to basic
ParMat	VJ1	VJ1 phonolite
ParMat	VP	VP pyroclastic rocks (tephra)
ParMat	VP1	VP1 tuff, tuffstone, tuffite, pumice
ParMat	VP2	VP2 scoria
ParMat	VP3	VP3 pyroclastic-breccia
ParMat	VP4	VP4 volcanic ash
ParMat	VP5	VP5 ignimbrite
ParMat	VP6	VP6 lappilistone
ParMat	VQ	VQ acid to intermediate
ParMat	VQ1	VQ1 trachyte, trachydacite
ParMat	VU	VU ultrabasic volcanic rocks
ParMat	VU1	VU1 picrobasalt
ParMat	VU2	VU2 basanite
ParMat	VW	VW intermediate to basic
ParMat	VW1	VW1 basaltic-trachyandesit,
ParMat	VW2	VW2 phono-thephrite, tephri-phonolite
Regolith	R	Residuum
Regolith	U	Unknown
Regolith	M	Mixed origin
Regolith	T	Transported
Reliab	1	Reference profile description, high reliability
Reliab	2	Routine profile description, moderately high reliability
Reliab	3	Incomplete description, moderately low reliability
Reliab	4	Other descriptions, low reliability
Roots	Y	Presence of roots
Roots	N	No presence of roots (at most very few)
RtblDpth	V	Very shallow (<30 cm)
RtblDpth	S	Shallow (30-50 cm)
RtblDpth	M	Moderately deep (50-100 cm)
RtblDpth	D	Deep (100-150 cm)
RtblDpth	X	Very deep (≥ 150 cm)
SaltAlkl	Y	Notable presence of Salt or Alkali
SaltAlkl	N	No notable presence of Salt or Alkali
SlpForm	U	Uniform slope
SlpForm	C	Concave, lower slope with decreasing gradient downslope
SlpForm	V	Convex, upper slope with decreasing gradient upslope
SlpForm	T	Terraced
SlpForm	I	Irregular (complex) slope
SlpPosit	H	High
SlpPosit	M	Middle
SlpPosit	L	Low
SlpPosit	D	Lowest
SlpPosit	A	All
SrfCrck	Y	Presence of Surface Cracks
SrfCrck	N	No presence of Surface Cracks
SrfDrain	V	Very rapid
SrfDrain	R	Rapid
SrfDrain	W	Well

Attribute code	Value code	Value description
ProprtyCod	ValueCode	ValueDescr
SrfDrain	M	Moderately well
SrfDrain	S	Slow
SrfDrain	E	Extremely slow
SrfSeal	Y	Notable presence of Surface Sealing / Crust
SrfSeal	N	No notable presence of Surface Sealing / Crust
SrfStone	N	None (0%)
SrfStone	V	Very few (0-2%)
SrfStone	F	Few (2-5%)
SrfStone	C	Common (5-15%)
SrfStone	M	Many (15-40%)
SrfStone	A	Abundant (40-80%)
SrfStone	D	Dominant (≥ 80%)
Sticknss	NST	Non-sticky
Sticknss	SST	Slightly sticky
Sticknss	ST	Sticky
Sticknss	VST	Very sticky
StrGrade	N	Structureless
StrGrade	W	Weak
StrGrade	M	Moderate
StrGrade	S	Strong
StrSize	V	Very fine
StrSize	F	Fine
StrSize	M	Medium
StrSize	C	Coarse
StrSize	X	Very coarse
StrSize	E	Extremely coarse
StrType	P	Platy
StrType	R	Prismatic
StrType	C	Columnar
StrType	A	Angular blocky
StrType	S	Subangular blocky
StrType	G	Granular
StrType	B	Crumb
StrType	M	Massive
StrType	N	Single grain
StrType	W	Wedge shaped
StrType	K	Rock structure
StrType	BL	Blocky
Topogrph	W0	0-0.5% flat, wet
Topogrph	F0	0.5-2% flat
Topogrph	G0	2-5% gently undulating
Topogrph	U0	5-10% undulating
Topogrph	R0	10-15% rolling
Topogrph	S0	15-30% moderately steep
Topogrph	T0	30-45% steep
Topogrph	V0	45-60% very steep
Topogrph	E0	>60% extremely steep
Transitn	A	Abrupt (0-2 cm)
Transitn	C	Clear (2-5 cm)
Transitn	G	Gradual (5-15 cm)
Transitn	D	Diffuse (≥ 15 cm)

Annex 5b Classification of soil parent material (after eSOTER2012, intermediate version)

Major class	Group	Type
P plutonic rocks	**PA** acid	**PA1** granite
		PA2 tonalite (quartz-diorite)
		PA3 granodiorite
		PA4 aplite
		PA5 quartz-rich granitoids, quartzolite
	PQ acid to intermediate	**PQ1** foid-bearing syenite
	PI intermediate	**PI1** diorite
	PW intermediate to basic	**PW1** syenite
		PW2 monzonite
	PB basic plutonic rocks	**PB1** gabbro
	PU ultrabasic plutonic rocks	**PU1** peridotite
		PU2 pyroxenite
		PU3 horblendite
V volcanic rocks	**VA** acid	**VA1** rhyolite
		VA2 dacite
	VQ acid to intermediate	**VQ1** trachyte, trachydacite
	VI intermediate	**VI1** andesite, trachyandesite
	VW intermediate to basic	**VW1** basaltic-trachyandesit,
		VW2 phono-thephrite, tephri-phonolite
	VJ acid to basic	**VJ1** phonolite
	VB basic volcanic rocks	**VB1** basalt
	VU ultrabasic volcanic rocks	**VU1** picrobasalt
		VU2 basanite
	VP pyroclastic rocks (tephra)	**VP1** tuff, tuffstone, tuffite, pumice
		VP2 scoria
		VP3 pyroclastic-breccia
		VP4 volcanic ash
		VP5 ignimbrite
		VP6 lappilistone
M metamorphic rocks	**MA** acid metamorphic rocks	**MA1** quartzite
		MA2 gneiss
		MA3 phyllite, slate
		MA4 granulite
		MA5 migmatite
	MB basic metamorphic rocks	**MB1** slate, phyllite
		MB2 (mica-) schist
		MB3 (green-) schist
		MB4 gneiss rich in ferro-magnesian minerals
		MB5 amphibolite
		MB6 eclogite
		MB7 skarn
	MC calcareous metamorphic rocks	**MC1** metamorphic limestone(marble)
	MU metasomatic and hydrothermal rocks	**MU1** serpentine
		MU2 iron ore

Major class	Group	Type
S sedimentary rocks (consolidated)	**SP** psephite or rudite	**SP1** conglomerate
		SP2 breccia
	SA psammite or arenite	**SA1** sandstone
	SL pelite or lutite	**SL1** siltstone
		SL2 claystone
		SL3 shale
		SL4 mudstone
		SL5 diamictite
	SO calcareous rocks	**SO1** limestone, chalk, dolomite and other carbonate rocks
		SO2 marl, marlstone, and other mixtures
	SE evaporites	**SE1** anhydrite, gypsum
		SE2 halite, sylvite
	SQ organic-rich rocks	**SQ1** coal, bitumen & related rocks
	SS siliceous rock	**SS1** chert, hornstone, flint, diatomite, radiolarite
	SX phosphorites	**SX1** guano
	SI ironstone	**SI1** ironstone
U unconsolidated deposits (alluvium, slope deposits, glacial drift)	**UQ** gravelly	**UQxF** fluvial
		UQxM marine and estuarine
		UQxC colluvial
		UQxG glaciofluvial
		UQxT glacial till
	US sandy	**USxF** fluvial
		USxL lacustrine
		USxM marine and estuarine
		USxC colluvial
		USxG glaciofluvial
		USxT glacial till
		USxE eolian
	UT silty, loamy	**UTxF** fluvial
		UTxL lacustrine
		UTxM marine and estuarine
		UTxC colluvial
		UTxT glacial till
		UTxE eolian
	UY clayey	**UYxF** fluvial
		UYxL lacustrine
		UYxM marine and estuarine
		UYxC colluvial
		UYxT glacial till
		UYxE eolian
	UU diamicton (unsorted)	**UUxF** fluvial
		UUxL lacustrine
		UUxM marine and estuarine
		UUxC colluvial
		UUxG glaciofluvial
		UUxT glacial till
	UO group unknown	**UOOO** subgroup and type unknown
		UOOF subgroup unknown fluvial
		UOOCF subgroup unknown collo-fluvial
	UA anthropogenic/ technogenic	**UAN** redeposited natural materials
		UAI industrial/artisanal deposits
	UL lime-sediment	
	UP phosphate-sediment	
	UI iron-sediment	

Major class	Group	Type
	UX siliceous-ooze	
	UO peat & organic rich sediments	**UO1** rainwater fed peat
		UO2 groundwater fed peat
		UO3 sapropel
	UR weathering residuum	**UR1** bauxite

Groups of unconsolidated deposits are subgrouped, with the subgroup indicated as ‘x’ in Type column. The ‘x’ is to be replaced by subgroup indicator 0, 1 or 2, for not specified, non calcareous or calcareous, respectively.

Annex 6 Criteria applied for routine quality control

1) Referential integrity.

2) Data types.

3) Geo-location.
   a) Exclude: Identify, and subsequently check, profiles for which the geo-location (lat-lon) is unknown (0, 0) or not within the spatial domain of the profile's ISO country code. Correct coordinates, if possible, or exclude profile.

4) Layer upper and lower depths and sequential layer numbering.
   a) Identify profile layers with upper depth equal to- or exceeding lower; correct depths and update sequential numbering of layers.
   b) Identify sample layers with depth interval fitting within the depth interval of the associated horizon; adjust layer depths to horizon depths.
   c) Identify sample layers with depth interval not fitting within the depth interval of the associated horizon; adjust layer depths to sampled depths and update sequential numbering of layers.

5) Depth of profile observation.
   a) No routine controls applied.

6) Coarse fragment content (v%).
   a) Identify Coarse fragment content values outside the range of 0-100%, and correct or exclude value.

7) Coarse and fine sand.
   a) Identify values for the Sum of coarse and fine sand contents exceeding the Total sand content, permitting an inaccuracy of 1 %, and correct or exclude values for coarse and fine sand.

8) Fine earth fractions.
   a) Identify Sand content values outside the range of 0-100%, and correct or exclude values.
   b) Identify Silt content values outside the range of 0-100%, and correct or exclude values.
   c) Identify Clay content values outside the range of 0-100%, and correct or exclude values.

9) Sum of fine earth fractions.
   a) Identify reported values for Sum of sand, silt and clay fractions, different from re-calculated sum of Sand, Silt and Clay fractions, permitting an inaccuracy of ± 0.5%, and correct values.
   b) Identify values for the Sum of sand, silt and clay fractions outside the range of 90-110%, and correct or exclude values (of sand, silt, clay and sum).
   c) Subsequently, identify values for the sum of Sand, silt and clay outside the range of 98-102%, and flag values.

10) Bulk density (BlkDens).
   a) Identify Bulk density values outside the range of 0.1-2.7 kg/dm3, and correct or exclude values.
   b) Identify Bulk density values outside the range of 0.5-2.0 kg/dm3, and flag values.

11) Saturated hydraulic conductivity (KSat).
   a) Identify Saturated hydraulic conductivity values<0 dS/m, and correct or exclude values.

12) pH.
   a) Identify pHH2O, pHKCl and/or pHCaCl2 values outside the range of 2-12, and correct or exclude values.
   b) Identify pHKCl and/or pHCaCl2 values exceeding pHH2O values, permitting an inaccuracy of 0.1 while excepting layers of profiles classified as having geric property, and flag.
   c) Flag pH value for layers for which base saturation value is flagged.

13) Electrical conductivity.
   a) Identify Electrical conductivity values<0 dS/m, and correct or exclude values.
   b) Identify Electrical conductivity values exceeding 30 dS/m while pHH2O<7.5 or pHKCl<7 or pHCaCl2<7, and flag values.
   c) Identify Electrical conductivity values exceeding 0 dS/m while pHH2O<6.5 or pHKCl<6 or pHCaCl2<6, and flag values.

14) Soluble cations and anions.
   a) Identify Soluble cation and anion values outside the range of 0-2600 cmol/l, and correct or exclude values.
   b) Identify Soluble cation and anion values exceeding 0.1 cmol/l while pHH2O<7.5 or pHKCl<7 or pHCaCl2<7, and flag values.

15) Exchangeable bases.
   a) Identify Exchangeable calcium, magnesium, sodium or potassium values, of version 1 data outside the range of 0-200, 0-50, 0-200 and 0-20 cmol/kg, respectively, and of version 2 data outside the range of 0-100, 0-25, 0-100 and 0-10 cmol/kg, and correct or exclude values. If the data source is LREP then correct or exclude values by batch (district). Upper limits are based on visual outlier analysis.
   b) Identify Exchangeable calcium, magnesium, sodium or potassium values exceeding 100, 50, 100 and 20 cmol/kg, respectively, and flag values.
   c) Identify Sum of Exchangeable bases values exceeding 150 cmol/kg, and flag values. The sum of exchangeable bases is defined here as the sum of minimally 3 out of 4 bases.

16) Exchangeable acidity.
   a) Identify Exchangeable acidity values exceeding 50 cmol/kg, and flag values.
   b) Identify Exchangeable acidity values where Exchangeable hydrogen value exceeds 0.1 cmol/kg while pHH2O >6.5 or pHKCl >6 or pHCaCl2 >6, and flag values.
   c) Identify Exchangeable acidity values where Exchangeable aluminum or the sum of Exchangeable aluminum and hydrogen exceeds 0.1 cmol/kg while pHH2O >5.5 or pHKCl >5 or pHCaCl2 >5, and flag values.

17) Effective Cation Exchange Capacity.
   a) Identify eCEC values (mineral soils) exceeding 150 cmol/kg and flag values.
   b) Identify eCEC values exceeding 4 times CEC value, and flag values.

c) Flag eCEC values for layers for which the base saturation value or the exchangeable acidity value is flagged.

18) Cation Exchange Capacity.
   a) Identify Soil CEC values outside the range of 0-150 cmol/kg, and correct or exclude values for version 1 and 2 data. If the data source is LREP then correct or exclude values by batch (district). Upper limits are based on visual outlier analysis (often associated with peat soils).
   b) Identify Soil CEC values less than 1 cmol/kg, and flag values.
   c) Identify Soil CEC values exceeding 120 cmol/kg, and flag values.
   d) Identify Soil CEC values outside the range as determined by type and content of clay and organic carbon, and correct or exclude values for version 1 data. Lower limit is defined as [[clay (%) *1 (cmol/kg) /100] + [OrgC (‰) *100 (cmol/kg) /1000] * 1/a], and upper limit as [[clay (%) *150 (cmol/kg) /100] + [OrgC (‰) *600 (cmol/kg) /1000] * a], with a = 1.5. Soil CEC values less than a lower limit of maximally 2.5 cmol/kg are maintained.
   e) Identify Soil CEC values outside the range as determined by type and content of clay and organic carbon, and flag values. Lower limit is defined as [[clay (%) *1 (cmol/kg) /100] + [OrgC (‰) *100 (cmol/kg) /1000] * 1/a], and upper limit as [[clay (%) *150 (cmol/kg) /100] + [OrgC (‰) *600 (cmol/kg) /1000] * a], with a = 1.

19) Base saturation.
   a) Identify values for the ratio of Exchangeable calcium/CEC, magnesium/CEC, sodium/CEC or potassium/CEC outside the range of 0-5, 0-2, 0-5 and 0-1, respectively, and flag values. Upper limits are based on visual outlier analysis.
   b) Identify values for ExCa >0.5 cmol/kg and<ExMg, and flag values.
   c) Identify values for ExNa >0.5 cmol/kg and<ExK, and flag values.
   d) Identify base (over-) saturation values exceeding 300%, and flag values.
   e) Identify base saturation values exceeding 60%, while pHH2O<5.5 or pHKCl<5 or pHCaCl2<5, or base saturation values less than 40%, while pHH2O >5.5 or pHKCl >5 or pHCaCl2 >5 and flag values. Flagged values indicate possible inconsistencies in the values for ExCa, ExMg, ExNa, ExK, ExBases, eCEC, CEC, clay content, organic carbon content, pHH2O, pHKCl and/or pHCaCl2.
   f) Identify base saturation values exceeding 99%, while pHH2O<6.5 or pHKCl<6 or pHCaCl2<6, or base saturation values less than 99%, while pHH2O >6.5 or pHKCl >6 or pHCaCl2 >6 and flag values. Flagged values indicate possible inconsistencies in the values for ExCa, ExMg, ExNa, ExK, ExBases, eCEC, CEC, clay content, organic carbon content, pHH2O, pHKCl and/or pHCaCl2.

20) Free gypsum and lime.
   a) Identify CaSO4 and CaCO3 values outside the range of 0-1000 g/kg, and correct or exclude values.
   b) Identify CaSO4 values exceeding 0.1 g/kg, while pHH2O<6.5 or pHKCl<6 or pHCaCl2<6, and flag values.
   c) Identify CaCO3 values exceeding 0.1 g/kg, while pHH2O<6.5 or pHKCl<6 or pHCaCl2<6, and flag values.

21) Total carbon and inorganic carbon.
   a) Identify Total or Inorganic Carbon values outside the range of 0-1000 g/kg, and correct or exclude values.
   b) Identify Total carbon values exceeding organic carbon values, with >0.1 g/kg, while pHH2O<6.5 or pHKCl<6 or pHCaCl2<6, and flag values.
   c) Identify Inorganic carbon values exceeding 0.1 g/kg while pHH2O<6.5 or pHKCl<6 or pHCaCl2<6, and flag values.
   d) Identify Organic carbon values exceeding Total carbon values, and flag values.

22) Organic carbon and total nitrogen.
   a) Identify Organic carbon values outside the range of 0-580 g/kg (with ISRIC datasets as reference), and correct or exclude values.
   b) Identify Organic carbon values exceeding 140 g/kg, flag values.
   c) Identify Total nitrogen values outside the range of 0-40 g/kg (with ISRIC datasets as reference), and correct or exclude values.
   d) Identify Total nitrogen values exceeding 12 g/kg, and flag values.
   e) Identify C/N ratio values outside the range of 1-110, and correct or exclude values (of organic carbon and total nitrogen).
   f) Identify C/N ratio values outside the range of 4-45, and flag values.

23) Total phosphorus.
   a) Identify Total P values outside the range of 0-1,000,000 mg/kg, and correct or exclude values.
   b) Identify Total P values exceeding 1000 mg/kg and flag values.

24) Available phosphorus.
   a) Identify Available P values outside the range of 0-1,000,000 mg/kg, and correct or exclude values.

25) Volumetric moisture content at suctions from pF 0.0 – pF 5.8.
   a) Identify volumetric moisture content values outside the range of 0-98 %, and correct or exclude values (with values exceeding 98% set at 98%).
   b) Identify Volumetric moisture content values exceeding volumetric moisture content values at lower suction (VMCpF00 >10 >15 >20 >23 >25 >28 >29 >30 >37 >42 >VMCpF58), and correct or exclude value.

Note that the routine criteria applied on multiple attributes (e.g. inorganic carbon and pH, or base saturation and pH) are (too) simple. The criteria include cut off points (e.g. base saturation exceeding 60% while pH<5.5), yielding 'squared corner' selections out of clouds of data points. It is better, where the values of 2 attributes show some correlation, to assess the relationship (Y= aX) and to define the permited inaccuracy or confidence interval as (user defined) criterium.

Annex 7 Definition of key soil properties, inclusive of specific method of observation or measurement, according to GlobalSoilMap specifications

For GlobalSoilMap specifications, version 1, release 2.1 (July 2011), see: http://www.globalsoilmap.net/system/files/GlobalSoilMap_net_specifications_v2_0_edited_draft_Sept_2011_RAM_V12.pdf

Depth to rock
Depth in cm to a lithic or paralithic contact
Reference: SSS, 1993. USDA soil survey manual. Chapter 1, page 5.

Effective depth
Lower limit of soil, normally being the lower limit of biological activity, generally coinciding with the common rooting depth of native perennial plants.
The root restricting depth, in cm, is where root penetration is strongly inhibited because of physical and/or chemical characteristics, meaning the incapability (of the soil) to support more than few fine or very fine roots. The restriction may be below where plant roots normally occur.
Reference: SSS, 1993. USDA soil survey manual. Chapter 3, page 60.

Organic carbon
Mass fraction (g/kg) of carbon in the fine earth material (<2 mm) as determined by dry combustion at 900 C.
Reference: ISO 10694

pH
Soil reaction, as determined in a 1:5 soil: water mixture
Reference: ISO 10390

Clay
Mass fraction (g/kg) of particles of size 0-2 um in the fine earth material, as determined by using the pipette method
Reference: Burt, 2004. USDA soil survey laboratory methods manual. Page 347.

Silt
Mass fraction (g/kg) of particles of size 2-50 um in the fine earth material, as determined by using the pipette method
Reference: Burt, 2004. USDA soil survey laboratory methods manual. Page 347.

Sand
Mass fraction (g/kg) of particles of size 50-2000 um in the fine earth material, as determined by using the pipette method
Reference: Burt, 2004. USDA soil survey laboratory methods manual. Page 347.

Coarse fragments
Mass fraction (vol % ???) of particles of size >2000 um
Reference: Burt, 2004. USDA soil survey laboratory methods manual. Page 36.

Effective cation exchange capacity
Cations, extracted using BaCl2, plus exchangeable H + Al, expressed as mmol/kg
Reference: ISO 11260

Bulk density
Bulk density of the whole soil, including coarse fragments and fine earth material, in kg/l or kg/dm3, as determined by a method equivalent to the core method using a pedotransrfer function
Reference: ISO 11272

Bulk density
Bulk density of the fine earth material, in kg/l or kg/dm3, as determined by a method equivalent to the core method using a pedotransrfer function
Reference: ISO 11272

Available water capacity
Available water capacity (mm) computed over a depth interval using a specified pedotransfer function that references the values estimated for organic carbon, clay, silt, sand, coarse fragments and bulk density.
Reference: Burt, 2004. USDA soil survey laboratory methods manual. Page 137.

Electrical conductivity
Electrical conductivity (mS/m), as determined in 1: 1 saturated paste.

Annex 8a Statistics of profile attribute values, by country

Country:	AF	AO	BF	BI	BJ	BW	CD	CF	CG	CI	CM	ET	GA	GH	GN	GW	KE	LR	LS	MG
Profiles	18532	1132	911	36	894	901	396	90	73	255	460	1842	46	395	66	19	591	48	33	54
Incl lab data	15564	1132	548	36	894	901	396	90	73	251	460	1473	46	391	66	19	591	48	30	54
Incl geo & lab	14197	1038	534	36	738	901	381	89	73	251	457	1228	46	160	62	19	499	48	30	54
Map ID	8905	765	769	2	13	0	0	8	27	25	240	619	3	140	58	0	159	31	0	0
Map unit ID	4551	587	630	0	7	0	0	0	27	25	71	632	3	139	0	0	0	31	0	0
X lon DD	17160	1038	896	36	738	901	381	89	73	255	457	1597	45	164	62	19	498	48	33	54
Min	-17.2	12.0	-5.1	29.1	1.2	21.0	12.4	14.8	11.7	-8.2	8.9	34.3	10.3	-3.0	-14.0	-15.3	34.0	-11.4	27.2	44.5
Max	49.1	24.0	2.4	30.5	2.8	28.9	31.1	24.7	17.9	-4.1	15.4	44.9	14.1	0.8	-12.0	-15.0	40.0	-8.6	29.3	49.1
Average	21.7	15.1	-1.2	29.6	2.3	25.0	23.6	18.8	13.8	-6.4	11.0	38.2	12.2	-1.4	-12.4	-15.1	36.9	-9.4	27.7	47.5
Std. Deviation	16.3	1.8	1.4	0.4	0.3	1.6	6.2	2.0	1.3	0.8	1.3	1.7	1.0	1.1	0.6	0.1	1.6	1.1	0.5	0.8
Y lat DD	17160	1038	896	36	738	901	381	89	73	255	457	1597	45	164	62	19	498	48	33	54
Min	-34.3	-17.8	9.6	-4.2	6.3	-25.7	-11.8	3.7	-4.9	4.5	2.4	3.6	-2.4	4.9	10.2	11.0	-4.6	6.4	-29.8	-22.9
Max	17.6	-4.5	15.0	-2.7	10.8	-17.8	4.0	10.5	4.5	9.7	12.6	14.3	2.2	11.1	11.0	11.4	4.0	7.9	-28.9	-12.5
Ave	-2.7	-11.3	12.7	-3.3	7.3	-20.8	-2.7	6.7	-3.1	6.9	3.9	9.8	0.3	6.7	10.7	11.3	-0.7	7.3	-29.4	-19.0
SD	12.8	3.0	1.1	0.4	0.5	2.2	4.2	1.7	2.4	1.8	1.5	3.5	1.7	1.8	0.2	0.1	1.7	0.4	0.3	3.1
XY accuracy	14744	1038	780	32	187	889	369	90	73	255	457	1701	46	141	62	19	338	48	26	54
Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.02	0
Max	1	0.25	0.1	0.02	1	0.02	1	0.08	0.2	0.02	0.05	0.4	0.02	0.05	0.02	0	0.04	0.02	1	1
Ave	0.02	0	0	0.01	0.92	0	0.02	0.03	0.04	0.01	0.01	0.01	0.01	0.02	0	0	0.01	0.01	0.05	0.03
SD	0.12	0.02	0.01	0.01	0.28	0	0.05	0.03	0.04	0.01	0.01	0.03	0.01	0.01	0	0	0.01	0.01	0.19	0.13
Year	16331	1131	834	36	544	894	382	90	73	254	452	1264	46	181	66	19	428	48	33	34
Min	1938	1946	1966	1951	1965	1955	1954	1960	1956	1966	1938	1963	1959	1954	1962	1982	1972	1974	1967	1965
Max	2011	1986	2002	1984	1999	1990	2005	1978	1998	1997	1999	2008	1984	2009	1981	1983	2011	2008	1982	1979
Ave	1984	1959	1984	1975	1993	1986	1966	1969	1968	1985	1988	1999	1970	1965	1963	1983	1986	1998	1974	1974
SD	14	4	13	11	9	3	13	6	7	10	12	7	11	16	3	0	11	14	7	7
Depth observed	17670	1131	895	36	894	901	396	90	47	255	460	1296	46	395	66	19	514	48	33	54
Min	0	0	10	39	11	20	10	17	40	20	10	10	10	30	20	40	15	42	9	40
Max	2000	280	810	240	400	600	2000	1350	600	585	400	500	410	940	300	160	750	205	205	400
Ave	125	138	109	162	113	126	165	214	195	131	107	137	149	163	105	125	136	165	134	163
SD	65	40	65	54	37	45	109	192	106	84	62	67	74	88	54	34	63	41	50	61

Country:	ML	MR	MW	MZ	NA	NE	NG	RW	SD	SL	SN	SO	SZ	TD	TG	TZ	UG	ZA	ZM	ZW
Profiles	771	11	3153	282	65	494	1251	97	211	51	311	293	14	25	25	1711	13	659	532	321
Incl lab data	771	11	1016	272	65	490	1247	97	210	51	311	249	14	24	25	1695	13	659	524	321
Incl geo & lab	757	11	853	264	62	483	1197	96	197	12	311	202	14	5	9	1632	12	649	466	321
Map ID	405	0	3135	59	0	30	901	0	102	0	0	160	0	25	0	885	0	0	344	0
Map unit ID	126	0	0	108	0	27	868	0	86	0	0	0	0	0	0	883	0	0	301	0
X lon DD	757	11	2990	274	62	487	1201	96	198	12	311	245	14	5	9	1648	12	649	474	321
Min	-10.5	-15.8	32.7	32.0	13.6	1.0	2.8	28.9	24.2	-13.2	-17.2	42.5	31.1	14.8	0.4	30.4	30.0	16.6	22.7	25.6
Max	0.5	-11.2	35.9	40.5	21.4	7.2	14.4	30.7	36.1	-11.5	-11.7	45.6	32.1	20.8	1.3	40.4	32.6	32.3	32.5	33.0
Average	-6.8	-13.0	34.4	35.1	17.1	2.1	8.4	29.8	30.5	-12.1	-15.9	44.0	31.4	17.4	1.1	36.0	32.2	27.3	28.2	30.9
Std. Deviation	2.1	1.4	0.8	2.6	1.7	0.8	3.7	0.5	3.5	0.4	0.7	1.0	0.3	3.2	0.3	2.6	1.0	3.6	2.4	1.4
Y lat DD	757	11	2990	274	62	487	1201	96	198	12	311	245	14	5	9	1648	12	649	474	321
Min	11.3	14.8	-17.1	-26.8	-28.2	11.8	4.4	-2.7	6.2	7.9	12.5	0.0	-27.1	9.7	9.5	-11.0	-1.3	-34.3	-17.5	-22.3
Max	16.5	17.6	-9.5	-12.5	-17.5	14.4	13.6	-1.2	16.9	9.4	16.6	10.6	-25.9	14.7	10.3	-1.5	0.5	-22.3	-8.6	-15.8
Ave	13.3	16.1	-13.7	-20.6	-21.2	13.4	9.3	-1.9	10.7	8.9	14.0	4.3	-26.6	12.0	9.7	-5.0	0.2	-28.5	-13.1	-18.4
SD	1.1	0.9	1.9	5.0	3.0	0.6	2.3	0.3	3.1	0.3	0.6	3.9	0.3	2.1	0.3	1.9	0.7	3.0	2.3	1.3
XY accuracy	596	11	2980	127	10	485	1042	66	211	12	304	245	0	5	8	1377	12	40	473	135
Min	0	0.02	0	0	0	0	0	0	0.02	0.02	0	0	-	0.02	0.02	0	0	0	0	0
Max	0.08	0.02	0.01	0.02	0.02	0.02	1	0.02	0.02	0.02	0.02	0.02	-	0.05	0.02	1	0.02	0.02	0.05	0.02
Ave	0.02	0.02	0.01	0	0.01	0	0.07	0	0.02	0.02	0	0	-	0.03	0.02	0.01	0	0.01	0.01	0
SD	0.02	0	0	0.01	0.01	0	0.16	0.01	0	0	0.01	0	-	0.02	0	0.05	0.01	0.01	0.01	0.01
Year	770	11	2970	277	63	50	1245	97	211	51	302	214	14	25	25	1676	13	655	532	321
Min	1955	1983	1987	1961	1973	1979	1942	1963	1960	1966	1956	1968	1992	1954	1985	1964	1988	1941	1963	1961
Max	2001	1983	1998	1997	2000	1997	2010	1993	1982	1986	2005	2007	1996	1968	1997	2010	1988	2001	1983	2010
Ave	1986	1983	1989	1986	1995	1984	1978	1983	1975	1968	1997	1990	1994	1964	1989	1993	1988	1981	1975	1994
SD	9	0	1	12	10	6	9	4	7	3	13	14	2	3	3	13	0	9	5	12
Depth observed	746	11	3153	282	65	494	1251	97	126	51	311	293	14	25	25	1711	13	659	446	321
Min	8	46	4	15	10	20	5	37	40	64	20	10	30	30	100	8	102	10	10	15
Max	700	120	1220	670	140	300	1120	400	470	318	235	400	550	460	210	405	274	250	351	358
Ave	110	77	111	139	80	114	155	156	166	157	62	139	205	190	172	112	186	101	160	96
SD	55	23	48	73	37	51	68	56	62	43	57	60	134	114	32	64	47	36	54	69

Country:	AF	AO	BF	BI	BJ	BW	CD	CF	CG	CI	CM	ET	GA	GH	GN	GW	KE	LR	LS	MG
Rooted depth	3943	0	221	7	31	26	105	8	2	7	13	47	6	33	1	0	50	0	14	0
Min	0	-	0	185	17	82	9	10	250	100	15	15	100	30	12	-	25	-	40	-
Max	400	-	220	220	400	200	220	178	250	151	210	250	300	210	12	-	260	-	180	-
Ave	99	-	69	201	118	147	99	72	250	137	146	101	167	105	12	-	124	-	134	-
SD	51	-	46	12	74	32	47	58	0	22	62	62	68	51	-	-	47	-	39	-
Rock depth	3437	2	224	1	10	18	3	1	5	30	159	499	1	37	1	0	48	31	4	0
WRB ref group	6993	246	30	34	888	901	272	32	7	49	261	264	25	255	9	0	497	47	33	54
FAO 88	9707	246	133	34	888	901	272	39	53	55	284	967	25	273	8	0	575	17	33	54
FAO 74	5656	35	10	30	888	891	169	32	8	26	74	108	25	256	8	19	362	17	26	54
USDA	2577	23	42	28	1	56	94	2	0	111	107	58	3	26	0	0	83	17	15	20
CPCS	1342	0	446	0	28	0	0	49	67	111	76	0	0	20	58	0	0	0	0	0
Local class	4846	1108	167	32	7	2	396	54	23	89	269	38	32	178	37	19	29	2	32	52
Altitude. m	9295	295	127	34	504	549	299	76	61	76	274	914	38	60	3	2	477	15	30	43
Min	0	13	238	750	0	122	0	350	5	15	4	103	80	2	1	4	0	8	1495	435
Max	5405	1890	508	2160	490	1914	2900	1240	860	435	2134	5405	640	255	40	21	4958	550	2670	2200
Ave	836	1040	304	1532	149	991	871	514	363	231	531	1286	475	98	15	13	1244	108	1734	1358
SD	623	538	36	457	65	145	553	163	199	85	429	741	162	93	21	12	747	145	243	438
Slope. %	6913	19	331	12	3	22	122	31	32	88	115	786	21	86	0	2	89	39	19	33
Min	0	1	0	1	1	0	0	0	0	0	0	0	0	0	-	1	0	0	1	0
Max	100	25	45	75	2	5	60	25	40	52	75	65	30	12	-	1	40	85	16	65
Ave	4.8	7.0	2.3	17.0	1.7	1.2	9.4	5.1	10.2	6.1	11.3	3.8	8.1	2.0	-	1.0	5.6	14.8	5.4	19.1
SD	7.7	7.3	4.2	21.4	0.6	1.4	11.8	5.3	11.8	8.6	13.0	6.6	8.5	2.2	-	0.0	8.2	18.0	3.8	21.7
Topography	7672	0	369	9	36	28	160	0	45	112	221	820	22	121	21	0	66	30	0	0
Landform	9860	29	439	16	44	690	260	37	68	92	112	804	38	77	7	19	75	46	15	39
Slope position	7881	9	552	11	37	428	215	34	60	143	262	771	22	162	20	16	98	43	6	7
Parent material	8082	0	430	5	38	25	223	6	67	207	405	783	27	166	0	19	90	31	8	0
Land cover	2830	0	90	5	18	12	121	0	29	86	249	108	27	119	0	0	111	31	1	0
Land use	4410	27	212	11	36	583	86	31	2	51	297	345	44	76	7	4	207	48	14	53
Drainage	13704	246	469	35	893	892	392	40	71	159	339	811	45	323	66	19	548	48	33	54
Surface stoniness	3116	0	432	4	18	22	39	0	27	51	14	739	6	14	2	0	99	31	0	0

Country:	ML	MR	MW	MZ	NA	NE	NG	RW	SD	SL	SN	SO	SZ	TD	TG	TZ	UG	ZA	ZM	ZW
Rooted depth	437	10	1500	65	7	10	363	37	39	37	0	111	0	1	0	645	13	14	36	47
Min	0	15	0	40	40	61	10	0	5	63	-	2	-	35	-	0	81	22	50	59
Max	200	104	300	230	120	211	282	400	160	203	-	240	-	35	-	300	195	140	310	230
Ave	71	63	101	125	70	159	93	168	67	146	-	71	-	35	-	111	136	85	153	153
SD	41	29	47	40	31	46	49	68	43	33	-	62	-	-	-	48	38	33	49	45
Rock depth	675	0	159	112	18	11	359	8	31	0	6	79	1	2	0	775	1	67	54	5
WRB ref group	21	11	362	209	65	460	290	97	73	51	114	123	14	0	24	204	13	649	87	222
FAO 88	126	11	1006	257	65	480	591	97	168	51	114	121	14	0	24	651	13	654	185	222
FAO 74	51	11	8	63	49	490	725	83	168	51	109	92	0	0	24	223	13	40	323	95
USDA	59	10	0	48	4	47	575	67	167	11	9	63	9	0	16	421	12	26	316	31
CPCS	421	0	0	0	0	30	11	0	0	0	0	0	0	25	0	0	0	0	0	0
Local class	87	0	14	181	11	0	517	93	60	50	35	4	14	15	8	209	3	646	291	42
Altitude. m	246	0	834	216	61	446	672	97	164	11	8	44	14	0	7	1371	12	649	248	318
Min	225	-	0	0	0	150	0	910	350	5	1	0	107	-	300	0	1122	22	500	240
Max	767	-	2440	1325	1800	298	1495	4500	600	90	25	509	1399	-	700	2900	2448	2150	1800	2020
Ave	355	-	1129	192	1190	213	321	1872	459	75	16	102	675	-	480	949	1378	1025	1197	1110
SD	140	-	436	222	364	29	237	559	58	23	8	141	355	-	157	636	481	468	172	347
Slope. %	101	11	2757	112	4	33	561	22	149	10	0	14	0	0	1	729	12	33	364	150
Min	0	1	0	0	0	0	0	1	0	1	-	0	-	-	46	0	1	1	0	0
Max	70	7	100	40	1	6	30	92	24	12	-	1	-	-	46	55	12	33	10	21
Ave	3.7	3.7	5.6	2.7	0.3	1.5	3.6	23.3	2.5	4.1	-	0.5	-	-	46.0	3.6	5.5	6.9	1.5	3.2
SD	8.9	1.9	8.1	4.7	0.5	1.2	3.7	24.0	5.3	3.4	-	0.5	-	-	-	4.8	3.4	7.7	1.1	2.4
Topography	742	1	2680	113	10	11	611	33	144	39	200	13	0	0	0	733	9	16	226	31
Landform	749	4	2954	107	10	39	767	44	199	51	212	245	0	14	8	1019	12	39	430	50
Slope position	499	1	2281	98	10	41	344	37	112	46	197	29	0	3	1	951	6	37	268	24
Parent material	460	5	2201	95	11	41	791	35	138	39	199	224	0	25	0	873	5	15	354	41
Land cover	305	2	0	80	9	2	280	13	110	28	0	12	0	7	0	583	2	10	364	16
Land use	236	5	16	124	10	20	272	31	157	27	211	64	0	3	8	825	11	30	173	53
Drainage	635	5	2846	280	61	487	763	95	201	51	116	110	14	25	24	1122	12	648	525	201
Surface stoniness	152	0	350	115	10	3	101	36	120	7	5	88	0	0	0	541	6	13	36	35

Annex 8b Statistics of profile layer attribute values, by country

Country:	AF	AO	BF	BI	BJ	BW	CD	CF	CG	CI	CM	ET	GA	GH	GN	GW	KE	LR	LS	MG
Layer number	18532	1132	911	36	894	901	396	90	73	255	460	1842	46	395	66	19	591	48	33	54
Layers	74961	5791	3307	186	3669	3554	2227	436	319	1233	1984	6365	198	2410	242	81	2614	216	169	248
Min	0	1	1	0	1	1	0	1	0	1	1	1	1	1	1	1	1	1	1	1
Max	15	9	11	10	10	8	10	12	9	11	9	10	7	15	7	6	10	6	8	10
Average	2.8	3.2	2.5	3.3	2.7	2.7	3.4	3.3	2.8	3.4	2.8	2.6	2.8	3.8	2.6	2.7	2.9	2.8	3.4	3.2
Std Deviation	1.6	1.7	1.4	1.9	1.4	1.4	1.9	1.9	1.5	2.1	1.4	1.4	1.5	2.2	1.4	1.4	1.6	1.4	1.9	1.9
Average total	4.1	5.1	3.6	5.2	4.1	3.9	5.6	4.8	4.4	4.8	4.3	3.5	4.3	6.1	3.7	4.3	4.4	4.5	5.1	4.6
Upper depth	18531	1132	911	36	894	901	396	90	73	255	460	1842	46	395	66	19	591	48	33	54
Layers	74961	5791	3307	186	3669	3554	2227	436	319	1233	1984	6365	198	2410	242	81	2614	216	169	248
Min	-30	0	0	-3	0	0	-10	0	-30	0	0	0	0	0	0	0	0	0	0	0
Max	1900	230	800	200	300	400	1900	1100	425	480	300	480	360	894	230	117	700	195	180	300
Ave	42	43	35	53	35	41	51	77	56	46	32	50	42	55	35	38	44	52	53	54
SD	48	42	45	51	35	43	66	133	73	55	39	54	56	71	40	33	45	51	45	54
Lower depth	18531	1132	911	36	894	901	396	90	73	255	460	1842	46	395	66	19	591	48	33	54
Layers	74961	5791	3307	186	3669	3554	2227	436	319	1233	1984	6365	198	2410	242	81	2614	216	169	248
Min	0	2	1	0	2	1	0	2	0	1	2	1	3	3	5	9	1	7	5	5
Max	2000	280	810	240	400	600	2000	1350	600	585	400	500	410	940	300	160	750	205	205	400
Ave	73	70	65	84	62	73	80	121	100	74	57	87	76	82	64	68	73	88	79	90
SD	60	52	58	62	45	52	86	161	95	69	54	63	74	83	50	44	58	63	51	66
Horizon	9478	147	449	36	893	896	396	76	71	135	145	411	25	120	7	0	582	26	33	54
Color	8575	198	366	34	34	900	188	28	14	23	52	533	25	50	7	0	566	17	31	23
Mottles	4735	0	279	7	31	28	29	0	1	7	4	364	6	33	0	0	199	0	14	0
Structure	4563	72	124	25	31	88	118	0	28	7	4	87	6	40	0	0	525	0	30	0
Stickiness	1121	0	268	7	11	28	2	0	2	7	4	161	6	15	0	0	66	0	14	0
Salt & alkali	2466	5	42	7	31	29	29	0	2	7	7	102	6	35	0	0	67	0	14	0
Roots	2524	0	370	0	0	0	80	8	2	0	9	219	0	27	0	0	0	0	0	0
Field texture	7464	210	611	27	31	88	122	0	1	7	12	490	6	101	0	0	395	0	28	0
Fld coarse fragm	7709	213	433	23	33	48	103	4	29	19	41	591	3	80	1	1	400	5	26	0

Country:	ML	MR	MW	MZ	NA	NE	NG	RW	SD	SL	SN	SO	SZ	TD	TG	TZ	UG	ZA	ZM	ZW
Layer number	771	11	3153	282	65	494	1251	97	211	51	311	293	14	25	25	1711	13	659	532	321
Layers	2570	43	10859	1109	228	1997	5894	519	1047	230	724	1109	68	119	136	6564	93	2048	3084	1271
Min	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1
Max	11	5	11	10	9	9	11	9	9	7	7	8	7	9	7	13	9	9	12	11
Average	2.4	2.5	2.4	2.7	2.6	2.8	3.1	3.4	3.2	2.9	2.2	2.6	3.1	3.1	3.4	2.9	4.2	2.2	3.6	2.9
Std Deviation	1.4	1.2	1.3	1.5	1.6	1.6	1.7	1.9	1.8	1.5	1.4	1.3	1.7	1.8	1.8	1.6	2.2	1.2	1.9	1.8
Average total	3.3	3.9	3.4	3.9	3.5	4.0	4.7	5.4	5.0	4.5	2.3	3.8	4.9	4.8	5.4	3.8	7.2	3.1	5.8	4.0
Upper depth	771	11	3153	282	65	494	1250	97	211	51	311	293	14	25	25	1711	13	659	532	321
Layers	2570	43	10859	1109	228	1997	5894	519	1047	230	724	1109	68	119	136	6564	93	2048	3084	1271
Min	0	0	0	0	0	0	-13	-3	0	0	0	0	0	0	0	0	0	0	0	0
Max	600	90	242	600	110	230	430	215	375	203	175	250	200	400	165	290	244	220	305	348
Ave	31	27	33	45	29	38	51	61	52	47	25	47	60	65	53	42	70	35	51	41
SD	41	23	34	55	30	41	52	54	53	43	34	46	55	81	49	42	59	35	50	46
Lower depth	771	11	3153	282	65	494	1250	97	211	51	311	293	14	25	25	1711	13	659	532	321
Layers	2570	43	10859	1109	228	1997	5894	519	1047	230	724	1109	68	119	136	6564	93	2048	3084	1271
Min	1	3	2	3	4	1	0	0	1	8	1	2	15	1	6	2	10	1	3	2
Max	700	120	1220	670	140	300	1120	400	470	318	235	400	550	460	210	405	274	250	351	358
Ave	63	46	65	80	52	66	84	90	82	82	52	84	102	105	85	71	95	67	78	65
SD	54	27	48	70	35	51	65	60	62	57	47	58	92	100	60	53	64	40	61	55
Horizon	84	11	919	233	65	469	762	97	175	51	51	148	14	6	24	576	13	654	407	217
Color	142	11	2941	188	58	16	100	89	68	51	281	53	14	0	8	579	13	572	87	215
Mottles	132	11	3148	26	11	11	109	33	18	39	1	50	0	0	0	37	13	16	30	48
Structure	49	11	1642	137	60	11	103	83	18	37	87	49	14	0	0	245	13	625	30	164
Stickiness	53	11	6	25	9	11	69	19	18	16	0	28	0	0	0	169	13	16	26	41
Salt & alkali	53	11	1420	26	11	12	67	33	18	39	1	57	0	0	0	228	13	16	30	48
Roots	13	0	1504	62	0	0	76	4	25	0	0	68	0	2	0	54	0	1	0	0
Field texture	136	11	2947	188	62	11	386	82	34	39	88	89	14	6	0	233	13	630	162	204
Fld coarse fragm	385	2	2982	178	59	17	227	79	130	27	18	108	12	2	0	617	12	607	32	162

Country:	AF	AO	BF	BI	BJ	BW	CD	CF	CG	CI	CM	ET	GA	GH	GN	GW	KE	LR	LS	MG
Crs fragments	10280	1091	750	28	49	57	317	64	36	132	93	599	33	155	60	1	384	44	29	20
Layers	40177	5431	2616	129	196	228	1770	252	142	562	375	1838	122	846	177	3	1485	177	147	128
Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Max	100	100	100	90	90	95	95	100	90	95	95	95	90	95	90	70	95	95	90	80
Ave	9	3	16	5	23	17	5	18	7	32	13	11	4	19	18	23	7	27	9	3
SD	20	9	27	15	29	31	16	25	19	27	23	22	14	26	26	40	19	28	22	9
Sand	15151	1109	710	36	875	895	394	90	73	249	452	1468	46	235	64	19	580	48	29	53
Layers	58322	5539	2498	177	3505	2934	2120	391	253	994	1711	5096	171	1403	194	78	2422	172	139	241
Min	0	1	0	1	1	1	0	3	3	5	1	0	4	1	1	13	1	3	7	1
Max	100	100	98	95	98	98	98	98	98	98	96	94	100	94	90	98	98	96	85	97
Ave	54	68	54	40	62	70	44	49	47	55	43	33	43	48	35	67	40	55	44	48
SD	25	21	22	23	22	24	26	22	29	20	19	19	22	22	22	21	23	19	18	25
Silt	15151	1109	710	36	875	895	394	90	73	249	452	1468	46	235	64	19	580	48	29	53
Layers	58318	5539	2497	177	3505	2934	2120	391	253	994	1711	5096	171	1403	194	77	2422	172	139	241
Min	0	0	0	4	1	0	1	1	0	1	0	0	0	2	1	0	0	1	7	1
Max	100	46	87	94	79	67	78	70	64	72	91	86	54	69	81	40	84	60	42	64
Ave	16	7	19	21	15	8	16	20	19	16	15	27	12	23	35	12	19	17	25	25
SD	13	6	12	15	10	8	13	13	15	11	10	14	12	14	17	9	13	11	7	13
Clay	15151	1109	710	36	875	895	394	90	73	249	452	1468	46	235	64	19	580	48	29	53
Layers	58321	5539	2497	177	3505	2934	2120	391	254	994	1711	5096	171	1402	194	78	2421	172	139	241
Min	0	0	0	1	1	1	0	1	1	1	1	1	0	0	6	0	0	2	5	1
Max	97	88	97	82	94	87	93	88	78	66	91	94	79	86	78	75	96	64	67	69
Ave	30	25	27	39	23	22	40	30	34	29	42	40	45	29	31	21	42	28	31	27
SD	20	18	16	24	17	19	21	19	21	16	18	20	20	17	17	18	21	14	16	19
Sum fractions	15151	1109	710	36	875	895	394	90	73	249	452	1468	46	235	64	19	580	48	29	53
Layers	58320	5539	2497	177	3505	2934	2120	391	253	994	1711	5096	171	1403	194	78	2421	172	139	241
Min	63	63	93	90	92	94	90	96	98	91	99	98	100	99	100	99	90	100	99	100
Max	111	111	108	110	107	106	107	100	102	102	103	110	104	102	100	101	110	102	100	100
Ave	99.9	99.7	99.6	100.1	100.0	100.0	100.0	99.9	99.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.2	100.0	100.0
SD	0.8	1.4	0.8	1.5	0.3	0.3	0.4	0.4	0.5	0.4	0.2	0.2	0.3	0.1	0.0	0.2	0.5	0.4	0.2	0.0

Country:	ML	MR	MW	MZ	NA	NE	NG	RW	SD	SL	SN	SO	SZ	TD	TG	TZ	UG	ZA	ZM	ZW
Crs fragments	541	11	2983	212	63	43	437	89	158	48	19	109	12	22	25	644	13	617	110	182
Layers	1853	43	10290	732	206	176	2075	456	738	202	67	354	54	94	116	2801	91	1833	595	777
Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Max	98	3	95	95	90	90	95	90	95	90	90	98	90	95	76	95	90	90	95	90
Ave	11	0	7	4	18	13	15	11	8	17	21	22	8	10	17	8	10	7	3	10
SD	24	1	17	16	29	25	23	23	21	24	29	33	19	20	22	20	19	18	14	18
Sand	747	11	937	262	64	488	1184	92	210	51	304	283	13	25	25	1540	13	655	505	317
Layers	2314	43	2740	1003	192	1901	5320	477	961	219	625	1032	61	98	135	5414	90	1754	2800	1105
Min	2	27	18	0	16	1	0	0	1	1	1	0	4	2	15	0	8	2	2	4
Max	99	97	98	100	97	98	100	91	98	96	99	96	93	100	90	98	73	99	99	100
Ave	46	75	65	63	72	69	58	42	43	46	75	35	37	62	61	50	34	56	52	60
SD	21	22	16	28	18	23	24	18	29	25	23	21	23	27	18	24	15	25	24	25
Silt	747	11	937	262	64	488	1184	92	210	51	304	283	13	25	25	1540	13	655	505	317
Layers	2315	43	2740	1003	192	1901	5317	477	960	219	625	1032	61	98	135	5414	90	1754	2801	1105
Min	0	1	1	0	0	1	0	5	0	0	0	0	0	1	5	0	5	0	0	0
Max	100	35	55	80	63	70	89	80	76	56	67	89	56	30	45	79	35	62	72	64
Ave	27	12	8	12	13	13	16	20	18	20	10	26	16	12	15	16	13	15	16	13
SD	12	9	5	11	10	11	12	16	10	11	11	14	14	9	8	11	5	12	10	10
Clay	747	11	937	262	64	488	1184	92	210	51	304	283	13	25	25	1540	13	655	505	317
Layers	2314	43	2740	1003	192	1901	5320	477	961	219	625	1032	61	98	135	5414	90	1754	2801	1105
Min	1	1	0	0	0	0	0	1	1	1	0	2	4	0	1	0	14	0	0	0
Max	80	46	75	90	49	85	88	87	90	69	78	80	90	80	60	97	74	83	82	86
Ave	27	13	27	25	15	18	25	38	40	35	14	40	46	26	24	34	53	28	32	27
SD	16	13	15	21	11	15	19	19	24	16	14	17	21	22	15	20	16	18	19	20
Sum fractions	747	11	937	262	64	488	1184	92	210	51	304	283	13	25	25	1540	13	655	505	317
Layers	2314	43	2740	1003	192	1901	5320	477	961	219	625	1032	61	98	135	5414	90	1754	2800	1105
Min	91	99	100	99	93	100	90	99	97	99	90	96	90	99	100	90	100	91	90	90
Max	109	100	100	110	103	101	110	109	102	101	108	110	101	102	100	110	100	109	110	110
Ave	99.9	100.0	100.0	100.1	100.0	100.0	100.0	100.0	100.0	100.0	99.4	100.0	99.8	100.0	100.0	100.0	100.0	98.8	100.0	100.0
SD	0.6	0.2	0.0	0.6	0.7	0.0	0.5	0.6	0.3	0.1	1.5	0.6	1.3	0.3	0.0	1.1	0.0	1.8	0.4	1.1

Country:	AF	AO	BF	BI	BJ	BW	CD	CF	CG	CI	CM	ET	GA	GH	GN	GW	KE	LR	LS	MG
Bulk density	2589	2	92	10	130	66	14	1	1	65	48	349	4	20	7	0	361	10	14	2
Layers	9597	8	284	56	569	266	65	6	2	376	203	1030	14	85	28	0	1405	31	86	8
Min	0.16	1.36	1.00	0.70	1.10	0.54	1.24	1.02	1.80	1.01	0.47	0.51	1.05	0.64	0.64	-	0.16	0.91	1.16	0.31
Max	2.67	1.48	2.26	1.84	2.05	2.17	1.97	1.25	1.92	2.60	1.63	1.87	1.53	2.07	1.53	-	2.08	1.74	1.94	1.27
Ave	1.40	1.39	1.75	1.26	1.41	1.55	1.54	1.14	1.86	1.68	1.24	1.22	1.31	1.47	0.93	-	1.32	1.35	1.51	0.94
SD	0.25	0.04	0.20	0.29	0.17	0.24	0.16	0.09	0.08	0.27	0.24	0.20	0.14	0.39	0.26	-	0.19	0.17	0.17	0.41
pH H2O	14092	1110	523	36	876	898	396	87	71	250	308	1469	43	388	65	19	582	48	30	54
Layers	54867	5518	1784	176	3546	3036	2132	376	244	1003	1315	5131	156	2273	200	78	2436	173	143	246
Min	2.1	4.0	4.5	4.1	3.2	3.5	3.4	3.9	3.3	2.7	2.9	4.0	3.3	3.0	3.7	3.0	3.0	3.8	4.3	3.6
Max	11.3	9.9	9.4	10.3	9.4	10.8	10.9	9.5	8.9	9.1	10.3	11.3	6.2	9.1	8.5	6.5	11.0	6.4	9.1	8.2
Ave	6.2	5.9	6.6	6.0	6.3	6.8	5.4	5.7	5.1	5.3	5.1	7.3	4.7	5.6	4.8	4.8	6.4	5.0	6.1	5.1
SD	1.2	1.0	0.9	1.4	0.8	1.3	1.0	0.9	1.0	0.8	0.8	1.2	0.6	1.0	0.8	0.8	1.3	0.4	1.0	0.8
pH KCl	6772	874	336	26	546	28	74	71	1	217	87	516	16	38	56	19	477	37	28	0
Layers	27129	4392	1159	119	2368	167	412	323	5	813	449	1513	74	156	163	78	2042	122	136	0
Min	2.0	3.1	3.4	3.4	3.1	3.2	2.3	3.5	3.1	2.0	2.8	3.2	3.2	3.6	3.8	2.6	3.3	3.6	3.7	-
Max	10.7	8.8	8.0	7.2	7.8	9.7	7.3	8.6	4.9	7.4	6.1	10.0	5.2	7.9	5.8	5.5	10.5	5.9	8.2	-
Ave	5.0	4.8	5.2	4.7	5.3	5.6	4.2	4.9	3.9	4.4	4.1	5.9	4.0	4.8	4.6	3.8	5.4	4.4	4.9	-
SD	1.0	0.9	0.9	0.9	0.8	1.5	0.6	0.8	0.7	0.7	0.6	1.1	0.4	1.1	0.3	0.6	1.2	0.4	0.9	-
pH CaCl2	2162	0	0	10	0	816	13	1	0	1	66	0	0	24	1	0	47	0	16	20
Layers	9357	0	0	58	0	2723	78	1	0	6	281	0	0	127	5	0	250	0	97	122
Min	2.7	-	-	3.4	-	3.2	3.7	2.7	-	3.8	3.4	-	-	3.6	5.3	-	3.9	-	4.1	3.6
Max	10.3	-	-	8.5	-	10.3	6.1	2.7	-	5.2	9.3	-	-	8.3	6.1	-	8.2	-	7.6	5.8
Ave	5.6	-	-	5.1	-	6.1	4.3	2.7	-	4.1	4.7	-	-	5.3	5.5	-	5.4	-	5.5	4.2
SD	1.2	-	-	1.3	-	1.3	0.4	-	-	0.5	0.7	-	-	1.2	0.3	-	1.0	-	0.8	0.4
EC	7776	80	71	12	730	776	76	30	6	47	173	1325	25	234	6	19	491	48	2	50
Layers	28105	286	227	63	2403	2294	350	117	26	183	705	4534	110	1330	28	76	1995	174	3	234
Min	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0
Max	776.0	76.6	3.0	36.8	7.0	86.7	9.3	2.1	0.1	0.4	16.5	117.3	0.8	27.7	40.6	17.7	105.0	0.3	0.1	0.1
Ave	1.0	4.8	0.2	2.8	0.1	0.6	0.6	0.1	0.1	0.0	0.1	0.8	0.0	0.1	4.1	1.1	0.8	0.0	0.1	0.0
SD	12.0	9.7	0.5	7.6	0.2	2.9	1.8	0.2	0.0	0.1	0.8	3.5	0.1	1.2	10.8	3.0	5.2	0.1	0.0	0.0

Country:	ML	MR	MW	MZ	NA	NE	NG	RW	SD	SL	SN	SO	SZ	TD	TG	TZ	UG	ZA	ZM	ZW
Bulk density	18	0	10	45	9	414	266	25	111	38	45	53	3	0	17	123	13	1	45	157
Layers	70	0	69	121	24	1541	1096	137	393	157	93	80	13	0	92	433	81	5	227	443
Min	0.54	-	1.27	0.95	1.25	0.80	0.73	0.16	0.86	0.70	0.58	1.22	1.00	-	1.03	0.42	1.18	0.90	0.96	0.92
Max	2.04	-	1.93	1.73	1.76	2.02	2.14	2.03	2.27	1.90	1.99	1.80	1.53	-	1.99	1.80	2.12	1.30	2.10	2.67
Ave	1.55	-	1.53	1.34	1.55	1.44	1.31	1.24	1.44	1.32	1.68	1.50	1.32	-	1.61	1.30	1.50	1.17	1.43	1.52
SD	0.23	-	0.15	0.19	0.14	0.18	0.19	0.44	0.28	0.23	0.25	0.14	0.17	-	0.18	0.23	0.18	0.16	0.21	0.18
pH H2O	703	11	1014	267	64	438	1075	97	210	51	152	246	13	24	24	1577	13	655	145	60
Layers	2070	42	2995	1017	188	1657	5024	500	962	221	505	975	61	92	128	5447	91	1769	797	360
Min	4.1	5.0	4.0	3.3	5.0	2.9	3.6	3.4	4.0	2.1	2.4	6.4	4.1	3.4	4.5	2.5	4.2	4.1	3.6	4.1
Max	10.5	8.8	10.5	9.7	10.4	10.2	10.5	8.7	10.3	5.5	9.2	10.0	8.1	10.8	8.0	10.8	6.9	10.1	10.3	9.0
Ave	6.0	6.8	5.9	6.3	7.9	5.8	6.2	5.4	7.1	4.7	5.7	8.1	5.6	7.1	5.8	6.4	5.4	6.5	6.0	6.0
SD	1.0	1.1	0.8	0.9	0.9	1.1	1.1	0.9	1.3	0.4	1.2	0.4	1.1	1.8	0.8	1.2	0.6	1.2	1.1	1.1
pH KCl	513	0	10	254	11	239	374	94	10	48	39	5	13	9	15	1187	0	204	100	200
Layers	1654	0	75	954	65	1034	1803	486	53	209	130	28	57	42	89	3895	0	585	565	914
Min	3.2	-	4.0	3.1	4.6	3.0	3.4	3.0	3.6	3.0	2.9	7.1	4.0	3.2	3.1	2.0	-	3.6	2.8	3.4
Max	10.0	-	6.1	7.7	7.9	10.7	9.5	7.8	7.4	5.0	8.5	7.5	7.5	7.7	6.1	10.3	-	8.1	9.4	9.2
Ave	4.8	-	5.0	5.2	6.3	4.7	5.1	4.4	5.0	3.9	4.9	7.3	5.0	5.4	4.5	5.1	-	5.3	5.0	5.3
SD	1.0	-	0.5	0.9	0.9	1.0	1.1	0.8	0.9	0.4	1.0	0.1	0.9	1.2	0.6	1.1	-	1.0	1.2	1.1
pH CaCl2	14	11	10	1	0	11	143	36	71	0	1	5	0	0	15	325	13	21	422	48
Layers	87	42	75	6	0	72	415	212	400	0	5	29	0	0	90	1410	91	63	2315	297
Min	3.9	4.6	4.6	4.5	-	3.7	2.8	3.4	4.3	-	5.8	7.5	-	-	3.7	3.1	3.8	3.5	3.0	4.0
Max	7.9	8.4	6.6	5.6	-	7.7	8.7	7.8	8.9	-	6.7	8.0	-	-	6.4	9.9	6.7	8.2	8.8	8.1
Ave	4.7	6.5	5.5	5.1	-	4.9	5.6	4.7	7.4	-	6.1	7.7	-	-	4.9	5.8	4.9	5.7	4.9	5.2
SD	0.8	1.1	0.5	0.4	-	1.1	0.8	0.8	0.8	-	0.4	0.2	-	-	0.5	1.2	0.7	1.2	0.8	0.9
EC	68	1	91	223	37	371	495	12	167	12	45	258	0	7	7	1514	0	159	80	28
Layers	286	3	234	788	143	1280	2129	63	690	51	161	1020	0	30	26	5172	0	378	357	156
Min	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.5	0.0	0.0	-	0.0	0.0	0.0
Max	4.6	0.4	185.0	28.0	776.0	22.0	10.0	0.4	33.4	0.1	592.4	25.5	-	114.3	0.3	95.0	-	102.5	32.3	70.0
Ave	0.1	0.3	7.5	0.7	42.5	0.2	0.2	0.1	1.1	0.0	12.0	2.5	-	14.6	0.0	0.6	-	3.1	1.1	0.8
SD	0.3	0.1	28.4	2.3	133.6	0.9	0.6	0.1	3.3	0.1	67.7	3.3	-	28.7	0.1	3.0	-	9.3	3.9	5.8

Country:	AF	AO	BF	BI	BJ	BW	CD	CF	CG	CI	CM	ET	GA	GH	GN	GW	KE	LR	LS	MG
Soluble cations	124	0	2	2	0	9	10	1	0	0	0	8	0	2	0	0	16	0	2	0
Layers	435	0	10	16	0	42	39	2	0	0	0	16	0	7	0	0	28	0	11	0
Min	0.1	-	3.9	2.5	-	3.0	0.8	0.3	-	-	-	2.3	-	5.9	-	-	0.1	-	1.6	-
Max	2479.2	-	21.9	876.9	-	1695.2	7.9	2.9	-	-	-	336.1	-	144.6	-	-	2479.2	-	3.5	-
Ave	76.2	-	13.2	197.9	-	138.6	4.2	1.6	-	-	-	124.0	-	65.2	-	-	317.8	-	2.5	-
SD	239.7	-	7.4	264.0	-	311.4	2.1	1.8	-	-	-	114.1	-	50.7	-	-	756.4	-	0.6	-
Exch bases	13522	879	499	32	847	890	212	88	65	248	305	1409	36	375	65	18	579	48	30	42
Layers	51373	3833	1699	158	3279	2916	1116	364	199	986	1257	4900	104	2147	195	76	2396	151	143	181
Min	0.0	0.0	0.2	0.1	0.5	0.3	0.0	0.1	0.0	0.0	0.0	0.9	0.0	0.0	0.1	1.0	0.1	0.3	1.2	0.0
Max	206.1	57.9	142.1	80.5	91.2	145.4	136.0	72.5	26.1	66.8	156.9	161.6	17.2	103.2	33.3	32.0	206.1	32.8	62.3	24.0
Ave	12.6	4.2	8.5	9.7	9.4	17.3	5.7	5.4	2.2	2.8	4.1	35.9	1.2	6.4	3.0	4.7	17.2	4.6	17.2	1.6
SD	17.4	6.5	10.0	14.1	9.7	19.5	13.5	8.3	4.5	5.3	7.8	21.4	2.4	8.6	6.1	6.0	19.8	5.1	17.1	3.0
Exch acidity	8619	505	289	30	556	688	127	31	9	95	230	1105	10	162	4	19	354	16	30	29
Layers	26791	1825	742	125	1508	1943	495	48	23	379	905	3539	40	544	14	80	1267	74	110	138
Min	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.1	0.0	0.0
Max	76.7	13.0	4.5	19.5	1.3	3.7	43.8	0.1	0.2	35.3	76.7	22.8	9.0	12.7	2.2	16.3	38.5	4.6	17.7	11.5
Ave	0.7	1.9	0.1	2.2	0.1	0.0	1.7	0.1	0.0	4.2	3.2	0.0	3.4	0.5	0.6	2.3	1.7	1.5	2.0	1.6
SD	2.3	2.2	0.3	3.9	0.1	0.1	4.3	0.1	0.1	4.0	4.8	0.9	3.0	1.4	0.8	2.5	4.2	1.0	3.3	1.9
eCEC	8056	421	272	30	551	679	114	30	6	95	228	1052	7	152	4	18	352	16	30	22
Layers	24962	1554	693	122	1485	1899	475	46	14	377	907	3345	33	506	13	76	1257	53	110	124
Min	0.0	0.5	0.4	0.4	0.9	0.4	0.0	0.7	0.2	0.4	0.6	3.2	0.2	0.5	3.4	2.0	0.5	1.0	1.8	0.2
Max	206.1	57.9	142.1	80.5	91.2	145.4	173.2	39.1	25.5	66.9	156.9	161.6	11.1	103.2	33.3	48.3	206.1	6.6	62.9	11.9
Ave	20.0	9.1	13.9	11.9	11.8	22.7	11.8	12.1	6.8	8.2	6.3	43.0	4.1	12.3	11.7	7.1	25.3	3.0	20.5	2.7
SD	21.1	8.2	12.9	14.9	10.6	21.5	21.0	10.2	9.2	8.1	9.0	20.2	3.3	12.9	10.5	7.4	22.8	1.4	17.8	2.4
CEC soil	13755	912	495	34	879	893	395	85	56	250	330	1389	27	356	65	18	575	46	30	53
Layers	52886	4011	1684	172	3548	3015	2103	364	189	979	1229	4813	107	2057	199	76	2378	164	140	237
Min	0.0	0.1	0.0	1.1	0.6	0.1	0.6	0.5	0.1	0.7	0.3	3.0	0.2	0.1	2.0	2.1	0.4	3.0	2.7	0.8
Max	179.0	58.8	100.0	109.6	98.0	83.5	179.0	39.2	40.0	70.2	69.8	147.7	25.0	70.7	70.7	39.4	88.1	71.0	62.9	98.8
Ave	14.4	7.7	10.0	15.9	11.6	12.1	9.2	8.7	7.6	6.4	11.7	40.8	8.6	9.0	15.2	13.4	19.4	18.8	20.4	13.0
SD	15.1	6.8	9.3	13.9	10.3	12.6	9.7	7.7	6.8	5.7	9.6	18.1	5.6	8.4	9.5	9.6	12.6	13.4	17.0	12.1

Country:	ML	MR	MW	MZ	NA	NE	NG	RW	SD	SL	SN	SO	SZ	TD	TG	TZ	UG	ZA	ZM	ZW
Soluble cations	0	1	0	1	2	1	0	1	14	0	1	5	0	3	0	11	0	25	1	6
Layers	0	3	0	5	9	6	0	1	54	0	1	28	0	10	0	74	0	41	6	26
Min	-	5.5	-	20.1	32.0	3.9	-	5.3	4.8	-	5.7	4.6	-	0.3	-	2.0	-	0.2	2.4	0.2
Max	-	6.0	-	53.4	457.0	84.2	-	5.3	225.3	-	5.7	139.8	-	198.7	-	335.6	-	44.7	83.4	14.7
Ave	-	5.8	-	42.0	206.2	53.7	-	5.3	56.1	-	5.7	46.5	-	25.2	-	63.0	-	11.9	31.8	5.6
SD	-	0.3	-	13.5	174.1	32.4	-	-	62.5	-	-	49.6	-	61.5	-	99.2	-	12.3	38.8	3.1
Exch bases	641	11	561	255	60	407	1179	96	155	51	106	222	13	22	17	1666	13	654	510	216
Layers	1861	42	1700	962	178	1233	5208	482	682	209	348	864	61	85	102	5682	91	1761	2729	993
Min	0.1	0.6	0.5	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.1	1.2	0.3	0.4	0.2	0.1	0.8	0.0	0.0	0.0
Max	72.1	45.4	26.6	131.9	55.5	164.8	65.9	87.4	120.0	53.0	55.3	194.8	66.5	55.2	23.5	173.1	28.8	117.7	160.5	116.2
Ave	7.0	8.1	5.3	12.6	13.8	7.2	8.3	9.7	25.8	1.8	6.6	40.7	11.9	11.2	4.1	15.2	5.2	8.5	5.8	11.2
SD	7.6	11.6	3.3	16.6	11.1	9.7	11.1	15.9	30.4	5.9	9.9	23.3	16.3	13.1	4.2	17.3	4.5	11.0	12.0	18.5
Exch acidity	251	11	390	168	64	168	643	88	139	50	43	246	13	18	17	1082	10	598	190	141
Layers	530	38	863	546	173	476	2167	403	601	216	109	974	59	51	40	3005	49	1441	764	487
Min	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Max	13.0	0.4	3.3	66.8	0.0	2.6	20.9	47.2	7.2	12.8	2.1	0.0	3.8	0.0	1.2	21.0	5.4	11.6	10.4	11.0
Ave	0.8	0.0	0.1	1.4	0.0	0.1	0.3	3.4	0.1	2.1	0.0	0.0	0.6	0.0	0.1	0.3	1.3	0.5	0.9	0.5
SD	1.5	0.1	0.3	6.1	0.0	0.2	1.1	4.9	0.6	2.3	0.2	0.0	0.9	0.0	0.3	1.2	1.7	1.1	1.3	1.5
eCEC	245	11	198	164	60	157	627	88	91	50	34	222	13	17	10	1060	10	598	185	137
Layers	517	38	458	529	163	415	2124	393	387	204	82	862	59	46	13	2899	49	1441	729	465
Min	0.4	0.7	1.4	0.4	0.2	0.5	0.3	0.6	0.4	0.5	0.7	1.2	0.8	1.3	1.9	0.4	2.0	0.2	0.3	0.2
Max	72.1	45.4	27.1	131.9	55.5	164.8	60.1	99.1	120.0	13.2	55.3	194.8	66.7	55.2	9.6	173.1	28.8	117.8	160.5	116.2
Ave	12.2	8.7	7.0	18.9	14.5	10.5	13.6	11.6	42.4	3.1	13.4	40.7	12.7	16.2	4.9	22.2	5.7	9.7	15.1	18.4
SD	10.6	12.0	4.6	20.0	11.2	13.8	13.9	14.9	31.3	2.7	15.1	23.3	16.3	14.3	2.5	20.5	4.9	11.4	20.0	24.2
CEC soil	636	11	997	244	59	484	1075	97	183	51	102	248	13	9	25	1232	13	656	513	219
Layers	1900	42	2933	924	176	1711	4920	489	815	219	343	979	61	34	134	4088	91	1763	2795	1004
Min	0.4	0.9	0.3	0.0	0.1	0.5	0.1	0.3	0.3	0.6	0.6	0.1	2.0	1.2	0.6	0.2	4.3	0.1	0.2	0.1
Max	38.5	32.1	59.8	93.6	38.3	74.0	87.7	141.5	136.0	46.4	52.6	100.6	56.5	45.3	60.0	118.0	22.4	89.6	93.7	107.8
Ave	8.9	7.6	8.3	13.6	8.4	7.4	11.7	18.7	25.6	8.9	8.4	27.7	12.9	10.8	9.6	16.7	9.4	10.9	8.4	10.9
SD	6.7	9.6	5.7	15.5	7.8	8.4	11.8	20.3	23.6	6.7	8.9	14.8	13.0	14.3	10.9	14.2	4.5	9.9	10.4	14.4

Country:	**AF**	**AO**	**BF**	**BI**	**BJ**	**BW**	**CD**	**CF**	**CG**	**CI**	**CM**	**ET**	**GA**	**GH**	**GN**	**GW**	**KE**	**LR**	**LS**	**MG**
Base saturation	12659	880	495	32	846	884	212	85	51	248	178	1391	19	342	65	18	572	46	30	42
Layers	48003	3832	1682	157	3260	2877	1110	349	160	968	753	4804	51	1963	195	76	2340	144	140	179
Min	0.0	0.4	5.0	0.3	5.5	4.8	0.0	1.6	0.3	0.0	0.0	6.0	0.0	1.2	0.9	4.9	0.6	4.0	18.4	0.7
Max	116.3	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	116.3	100.0	100.0	100.0	100.0	100.0	100.0
Ave	64.7	43.2	75.3	45.8	70.4	85.1	34.7	47.1	25.1	37.1	35.2	79.0	17.5	63.9	18.1	34.9	67.5	23.3	72.0	14.5
SD	30.8	31.1	20.4	37.9	22.1	19.5	29.0	28.7	28.5	28.1	29.6	22.3	23.7	30.7	25.8	20.9	30.1	19.5	21.1	19.9
CaCO3	5084	688	75	10	764	514	77	33	7	19	51	755	17	227	7	0	211	17	10	51
Layers	19455	3354	218	53	2803	1286	346	125	29	67	213	2310	71	1245	27	0	781	80	21	233
Min	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0	0.0	0.0
Max	900.0	645.0	322.0	139.0	12.0	720.0	830.0	696.0	54.6	1.0	50.0	900.0	0.0	569.0	1.0	-	435.0	0.0	213.0	3.0
Ave	20.2	9.4	9.1	10.9	0.3	9.4	22.1	10.7	4.1	0.0	0.4	47.1	0.0	0.8	0.0	-	13.7	0.0	15.8	0.0
SD	61.8	49.2	36.3	22.2	0.5	62.1	104.0	81.4	13.2	0.2	4.2	69.5	0.0	17.6	0.2	-	40.7	0.0	47.8	0.2
Org C	14753	1017	547	34	861	842	396	86	70	251	459	1391	46	367	65	18	565	48	30	54
Layers	50040	4234	1787	165	2748	2596	1878	233	172	899	1711	4761	143	2079	192	74	2048	172	113	228
Min	0.0	0.1	0.0	0.5	1.0	0.0	0.1	0.3	0.4	0.0	0.0	0.1	0.3	0.1	1.0	0.8	0.2	1.1	1.2	0.3
Max	570.0	389.2	40.1	322.4	193.0	81.7	547.4	99.6	163.0	177.0	215.6	350.0	95.0	101.5	174.8	73.4	363.0	129.6	55.0	272.1
Ave	8.9	7.2	4.9	24.5	8.2	4.5	14.1	13.0	20.5	10.0	15.9	10.8	15.4	7.5	22.0	7.3	11.6	19.9	8.8	30.4
SD	15.3	10.5	4.5	39.4	9.8	6.9	27.7	13.0	23.2	12.9	19.2	11.0	15.8	10.0	23.0	10.3	18.8	20.6	9.5	38.3
Total N	11495	959	528	30	828	28	392	86	70	240	299	1284	46	319	65	18	316	43	30	51
Layers	36120	3969	1666	116	2569	70	1678	232	169	747	1200	4368	128	1606	192	72	603	128	63	213
Min	0.0	0.0	0.0	0.2	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.0	0.2	0.1	0.1	0.1	0.2	0.0
Max	31.2	31.2	2.8	29.4	9.5	8.7	14.0	5.6	11.6	11.7	21.8	19.0	6.1	9.2	13.2	4.3	16.0	7.2	4.8	19.8
Ave	0.8	0.5	0.4	2.1	0.7	0.8	1.2	0.9	1.4	0.8	1.5	1.0	1.3	0.8	1.5	0.7	1.9	1.4	1.0	2.0
SD	1.0	0.8	0.3	3.2	0.6	1.4	1.5	0.8	1.3	0.9	1.7	1.0	1.0	1.0	1.6	0.6	2.0	1.2	0.9	2.4
C/N ratio	11313	959	526	29	828	28	392	86	70	240	299	1246	46	316	65	18	315	43	30	51
Layers	35563	3966	1653	114	2557	70	1677	232	169	747	1198	4295	128	1590	192	70	599	128	63	213
Min	0.0	1.2	1.3	1.8	1.3	5.3	1.3	3.0	3.3	1.3	2.5	1.3	2.3	1.2	2.1	1.5	2.0	6.0	5.0	2.5
Max	109.5	44.1	88.2	29.8	71.5	30.0	109.5	30.7	65.3	94.3	60.0	84.0	40.0	75.3	28.9	60.1	91.0	33.0	19.5	46.0
Ave	12.1	13.3	11.8	13.9	12.3	13.3	11.8	12.9	13.3	12.8	9.7	11.2	12.3	10.6	14.0	11.5	10.1	15.0	11.5	15.2
SD	6.1	4.5	5.1	4.7	5.9	4.3	7.3	3.6	7.5	5.8	4.3	4.5	5.4	6.7	3.4	10.1	6.0	5.2	3.0	7.7

Country:	ML	MR	MW	MZ	NA	NE	NG	RW	SD	SL	SN	SO	SZ	TD	TG	TZ	UG	ZA	ZM	ZW
Base saturation	617	11	561	242	59	405	1064	96	155	49	98	221	13	9	17	1218	13	654	506	215
Layers	1813	42	1697	897	176	1219	4893	466	681	202	323	856	61	34	101	3974	91	1753	2703	981
Min	2.5	52.2	15.3	4.0	28.6	7.4	0.0	0.0	0.0	0.0	4.7	19.4	2.4	19.7	18.7	1.6	6.2	0.0	0.0	0.0
Max	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Ave	66.9	89.1	77.3	73.9	95.4	69.9	63.4	37.9	82.2	13.1	64.5	94.6	61.2	69.2	68.0	67.7	54.3	64.3	50.4	75.3
SD	25.8	16.6	16.7	25.6	12.6	24.8	30.3	31.3	23.0	17.5	28.5	13.4	31.0	21.2	20.9	27.7	22.7	33.4	30.5	26.3
CaCO3	48	8	3	124	23	439	159	18	119	12	18	218	0	11	4	194	0	24	96	33
Layers	166	26	4	440	78	1733	685	88	554	51	50	853	0	46	8	744	0	78	463	126
Min	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0	0.0	-	0.0	0.0	0.0
Max	556.0	0.0	0.0	267.0	689.0	50.0	49.5	860.0	620.0	0.0	517.0	373.5	-	275.0	1.0	612.0	-	29.0	890.0	572.0
Ave	11.6	0.0	0.0	4.2	98.1	0.2	3.3	26.1	32.8	0.0	51.2	178.6	-	32.3	0.3	24.2	-	3.1	7.5	28.9
SD	53.6	0.0	0.0	17.8	151.8	2.1	4.3	141.1	59.7	0.0	118.5	76.2	-	73.3	0.5	51.9	-	7.7	46.8	92.1
Org C	680	11	1006	255	64	484	1145	97	206	50	303	236	13	23	25	1649	13	648	519	179
Layers	1979	43	2533	904	187	1610	3924	503	815	214	575	658	59	51	126	5306	91	1747	1916	566
Min	0.0	0.4	0.3	0.0	0.2	0.1	0.0	0.3	0.1	0.6	0.1	0.3	0.1	0.5	0.3	0.0	0.9	0.0	0.0	0.0
Max	48.5	5.5	48.8	435.8	16.9	66.2	111.0	359.1	39.3	134.8	84.9	46.5	47.9	50.7	17.4	136.0	43.6	326.0	570.0	56.1
Ave	4.7	2.1	8.4	11.8	3.6	3.2	6.2	24.9	5.1	13.9	6.2	7.0	9.7	11.1	3.8	10.1	9.5	7.9	9.4	5.7
SD	4.8	1.3	7.1	38.3	2.6	5.5	7.4	48.3	4.1	15.6	7.8	5.3	9.3	14.2	3.6	10.9	10.0	15.6	24.3	7.1
Total N	684	11	833	248	51	415	975	47	134	0	105	230	13	24	19	1483	11	24	396	160
Layers	1764	21	1809	839	113	1183	2965	174	372	0	305	544	51	52	59	4293	33	99	1398	257
Min	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.1	-	0.0	0.1	0.1	0.1	0.1	0.0	0.4	0.1	0.0	0.1
Max	4.2	0.6	8.1	12.7	1.0	5.1	11.3	22.4	2.2	-	5.6	3.7	2.4	3.8	1.0	12.0	3.5	5.6	12.6	4.5
Ave	0.5	0.2	0.8	0.8	0.3	0.4	0.6	2.9	0.4	-	0.6	0.7	0.6	0.9	0.4	0.8	1.3	1.1	0.6	0.7
SD	0.4	0.1	0.6	1.4	0.2	0.5	0.7	4.5	0.3	-	0.6	0.4	0.5	1.1	0.2	0.8	0.9	0.8	0.9	0.6
C/N ratio	639	11	832	240	51	415	908	47	134	0	105	230	13	23	19	1476	11	24	393	155
Layers	1623	21	1789	789	113	1180	2857	174	372	0	305	541	51	50	58	4267	33	99	1328	252
Min	1.5	8.0	1.1	0.0	1.4	1.3	1.1	5.0	3.5	-	1.2	2.5	4.0	5.7	5.0	1.1	6.8	2.0	1.6	6.0
Max	67.0	18.0	45.0	89.0	41.9	90.0	90.0	36.0	100.0	-	37.9	71.0	99.0	22.9	24.6	100.0	17.3	42.4	70.0	30.3
Ave	13.3	12.6	11.1	11.2	12.2	9.8	12.3	13.7	12.3	-	12.1	10.6	19.5	11.5	13.3	12.7	11.5	14.9	14.6	14.4
SD	8.2	2.8	3.4	7.0	8.0	6.4	7.9	4.0	6.6	-	4.9	5.7	15.8	3.2	3.8	6.6	2.7	7.7	6.7	3.9

Country:	AF	AO	BF	BI	BJ	BW	CD	CF	CG	CI	CM	ET	GA	GH	GN	GW	KE	LR	LS	MG
Total P	1949	427	398	0	5	0	0	32	1	201	43	10	8	86	57	0	6	0	0	0
Layers	6886	1810	1202	0	22	0	0	77	6	717	176	30	18	467	159	0	7	0	0	0
Min	0	0	10	-	400	-	-	22	140	15	26	85	262	2	253	-	21	-	-	-
Max	11521	9470	5219	-	1400	-	-	1401	240	1410	6035	5804	1170	5576	11521	-	198	-	-	-
Ave	350	358	132	-	777	-	-	289	178	197	465	812	443	192	3787	-	106	-	-	-
SD	822	605	247	-	251	-	-	279	37	148	761	1333	236	334	2136	-	58	-	-	-
VMC pF 0.0	207	0	1	0	2	28	2	0	0	8	1	2	4	0	0	2	59	0	0	0
Layers	587	0	3	0	6	84	7	0	0	17	5	5	14	0	0	10	180	0	0	0
Min	5.0	-	30.3	-	34.5	5.0	37.3	-	-	26.0	58.0	47.3	40.4	-	-	24.5	28.2	-	-	-
Max	85.0	-	37.3	-	61.1	85.0	42.3	-	-	49.9	64.0	55.0	56.4	-	-	35.1	70.0	-	-	-
Ave	42.0	-	34.5	-	48.7	20.6	39.4	-	-	41.1	60.8	49.6	47.4	-	-	29.3	49.2	-	-	-
SD	14.7	-	3.7	-	10.8	17.0	2.1	-	-	6.5	2.6	3.1	4.4	-	-	3.4	9.0	-	-	-
VMC pF 2.0	357	0	9	0	2	19	2	0	0	7	0	3	4	7	0	0	54	0	0	0
Layers	1213	0	20	0	6	110	7	0	0	15	0	8	14	23	0	0	168	0	0	0
Min	3.7	-	3.7	-	10.5	5.1	19.2	-	-	21.4	-	31.6	19.6	7.8	-	-	10.0	-	-	-
Max	98.0	-	33.9	-	54.3	92.7	25.0	-	-	43.1	-	48.4	50.5	54.6	-	-	55.1	-	-	-
Ave	31.0	-	15.9	-	33.7	24.5	22.6	-	-	32.4	-	40.1	34.1	29.9	-	-	33.6	-	-	-
SD	15.9	-	9.1	-	20.3	19.8	2.1	-	-	7.0	-	6.4	10.0	10.2	-	-	10.6	-	-	-
VMC pF 2.5	2640	837	64	10	6	64	12	0	0	24	4	332	0	14	1	0	62	6	14	0
Layers	9909	4148	201	55	19	260	49	0	0	91	20	942	0	56	6	0	237	28	86	0
Min	1.0	1.3	1.4	9.1	5.4	2.0	5.9	-	-	10.4	24.8	11.4	-	6.5	7.0	-	4.0	21.0	6.4	-
Max	98.0	73.7	45.8	77.0	48.4	88.9	32.8	-	-	58.0	62.0	98.0	-	40.3	20.0	-	52.1	64.0	52.9	-
Ave	21.1	15.6	17.6	32.9	20.2	19.3	18.8	-	-	30.4	46.4	41.5	-	20.4	13.7	-	31.6	33.7	24.4	-
SD	14.0	9.0	9.2	14.5	12.7	17.2	5.7	-	-	10.0	11.7	13.5	-	9.3	5.8	-	10.3	9.3	11.6	-
VMC pF 4.2	2562	397	209	10	9	64	15	0	0	32	5	360	4	13	7	0	85	6	14	0
Layers	8913	1647	705	56	28	274	85	0	0	108	27	1054	14	73	28	0	300	28	90	0
Min	0.0	0.4	0.8	2.6	1.5	1.0	1.1	-	-	4.4	17.8	5.3	7.8	0.7	5.0	-	0.3	6.0	1.7	-
Max	83.3	37.2	31.6	47.0	40.4	44.4	31.6	-	-	41.8	50.0	68.3	39.6	27.4	45.0	-	46.5	18.0	40.0	-
Ave	14.6	10.1	9.0	18.2	14.3	10.7	10.7	-	-	18.6	33.7	29.1	21.1	12.4	20.8	-	19.2	10.9	15.4	-
SD	10.7	6.5	5.7	8.4	12.1	9.7	6.9	-	-	8.1	8.3	10.8	10.0	6.5	12.2	-	9.1	3.0	8.9	-

Country:	ML	MR	MW	MZ	NA	NE	NG	RW	SD	SL	SN	SO	SZ	TD	TG	TZ	UG	ZA	ZM	ZW
Total P	385	0	0	0	0	23	95	0	68	0	1	0	0	7	0	93	0	0	3	0
Layers	1129	0	0	0	0	80	413	0	251	0	6	0	0	21	0	292	0	0	3	0
Min	3	-	-	-	-	7	7	-	20	-	252	-	-	17	-	0	-	-	5	-
Max	974	-	-	-	-	326	1150	-	840	-	298	-	-	1471	-	6130	-	-	11	-
Ave	132	-	-	-	-	31	127	-	179	-	281	-	-	358	-	1216	-	-	7	-
SD	87	-	-	-	-	41	104	-	129	-	18	-	-	512	-	1501	-	-	3	-
VMC pF 0.0	10	0	0	16	0	9	15	1	9	0	5	0	3	0	1	23	0	0	6	0
Layers	20	0	0	41	0	27	46	5	23	0	9	0	7	0	4	56	0	0	18	0
Min	20.0	-	-	32.8	-	23.0	25.0	58.7	17.3	-	25.0	-	42.0	-	31.6	20.7	-	-	32.0	-
Max	77.5	-	-	64.0	-	56.0	51.6	72.9	64.7	-	32.0	-	61.0	-	38.7	70.3	-	-	55.0	-
Ave	43.2	-	-	46.2	-	38.3	37.7	68.7	42.8	-	29.3	-	50.0	-	36.0	48.9	-	-	44.5	-
SD	12.7	-	-	8.1	-	7.9	5.3	5.7	11.7	-	2.3	-	7.1	-	3.1	13.9	-	-	7.3	-
VMC pF 2.0	8	0	6	18	0	15	56	1	9	0	5	0	0	0	1	95	0	0	5	31
Layers	18	0	30	47	0	56	156	5	23	0	9	0	0	0	4	320	0	0	15	159
Min	7.4	-	9.5	8.9	-	3.7	6.0	42.0	13.5	-	4.5	-	-	-	13.6	7.3	-	-	11.9	4.2
Max	63.8	-	30.9	64.0	-	39.0	98.0	58.6	50.3	-	22.2	-	-	-	24.7	66.0	-	-	36.0	66.0
Ave	31.8	-	22.9	31.6	-	13.2	40.7	53.5	31.5	-	13.9	-	-	-	18.9	36.7	-	-	23.5	21.8
SD	14.1	-	6.8	11.7	-	7.8	20.8	7.1	13.3	-	6.8	-	-	-	6.0	12.4	-	-	8.6	12.3
VMC pF 2.5	179	0	10	48	0	41	55	20	33	48	2	5	3	0	0	49	13	602	42	40
Layers	466	0	68	142	0	166	187	109	95	206	7	27	7	0	0	149	75	1549	213	245
Min	1.1	-	7.9	2.0	-	2.7	4.5	3.5	5.5	1.3	6.8	11.2	30.0	-	-	4.8	15.8	1.0	3.1	3.6
Max	59.8	-	44.0	75.0	-	50.0	98.0	98.0	71.0	86.7	18.0	40.6	40.0	-	-	61.7	32.1	98.0	54.9	62.5
Ave	21.6	-	20.7	22.9	-	15.6	33.8	28.3	36.3	21.5	12.5	34.4	36.6	-	-	30.6	24.1	17.6	20.0	18.6
SD	9.5	-	5.8	16.7	-	9.8	20.6	19.4	15.3	10.6	4.5	6.0	3.6	-	-	13.0	4.0	12.1	9.7	11.4
VMC pF 4.2	194	11	10	57	0	45	66	38	33	48	7	5	3	0	1	104	13	602	48	47
Layers	517	43	75	166	0	197	218	219	169	206	16	29	7	0	4	363	90	1548	235	294
Min	0.5	0.5	2.7	0.9	-	0.5	1.1	0.9	1.2	0.6	2.0	5.2	8.0	-	2.8	0.5	5.5	0.0	0.8	1.1
Max	32.0	14.2	21.7	46.0	-	41.0	66.4	83.3	49.0	37.1	22.1	27.1	35.0	-	14.7	58.0	24.3	60.0	31.8	48.0
Ave	9.5	4.4	13.5	14.4	-	8.3	20.5	17.5	22.1	14.4	9.9	20.3	24.1	-	9.0	20.8	17.5	10.9	12.7	12.9
SD	6.0	4.4	4.6	11.0	-	7.5	13.5	11.5	10.0	7.1	7.8	4.2	9.4	-	6.4	10.5	3.9	7.9	6.2	9.8

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