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Soil Data Derived from SOTER for Environmental Studies in Central and Eastern Europe (SOVEUR Project)

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ABSTRACT

A uniform set of derived soil data is required for the "vulnerability" component of the Project GCP/RER/007/NET on *Mapping of Soil and Terrain Vulnerability in Central and Eastern Europe* (SOVEUR). To this avail, data for 662 soil profiles descriptions held in the Soil and Terrain Database (SOTER) compiled for the SOVEUR project area, were clustered first according to their classification in the Revised FAO Legend. Twenty two major soil groups occur in the SOVEUR area, corresponding with 83 different soil units. A preliminary analysis of the profile data indicated that measured data, for several of the attributes required for assessment of soil vulnerability, are under-represented in the SOTER set. To expand the set of measured data available for statistical analyses, similarly classified profiles from the ISRIC-WISE database were appended to the original SOTER profile data set. The considered WISE profiles (1271) originate from the "temperate and boreal zones" of the world (including Western Europe and North America). Following a screening on database integrity and consistency, the resulting 1933 profile descriptions were submitted to a statistical analysis that included an outlier rejection-scheme. Derived statistics for 17 soil attributes, commonly required for studies of environmental change, are presented by soil unit and depth zone (0-30 cm and 30-100 cm). Simple taxo-transfer rules are introduced to fill some of the gaps that remained in the derived data, notably where sufficient measured data were lacking for particular attributes. Results are presented digitally, as summary files of derived soil data.

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Project GCP/RER/007/NET on Mapping of Soil and Terrain Vulnerability in Central and Eastern Europe, SOVEUR, was signed between the Food and Agriculture Organization of the United Nations (FAO) and the Government of the Netherlands, within the framework of the FAO/Netherlands Government Programme. In view of the specific nature of the services to be rendered, the Project activities were implemented under a Contractual Service Agreement with the International Soil Reference and Information Centre (ISRIC). It was carried out in close collaboration with specialists from soil survey institutes in Belarus, Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Moldova, Poland, Romania, the Russia Federation (West of the Urals), Slovak Republic and the Ukraine, who collated the various national data sets using uniform guidelines.

1 INTRODUCTION

The Project GCP/RER/007/NET on Mapping of Soil and Terrain Vulnerability in Central and Eastern Europe, with the acronym SOVEUR, calls for the development of a geo-referenced information system for 13 countries in Central and Eastern Europe. The system is being developed for a geo-referenced assessment of the status of human-induced land degradation, with particular attention to issues of soil pollution, and an assessment of the vulnerability of soils to delayed-pollution (Batjes and Bridges, 1997). The databases are being developed at an observational scale of 1:2.5 million. SOVEUR is carried out in close collaboration with soil survey institutes in Belarus, Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Moldova, Poland, Romania, the Russia Federation (West of the Urals), Slovak Republic and the Ukraine.

The current report presents files of "derived", soil attribute data for subsequent use in the vulnerability mapping component of the SOVEUR project. Many of the derived soil data under consideration, however, will also be useful for a range of other studies, including soil gaseous emissions and food productivity, at the continental level (see Bouwman *et al.*, 1993; Cramer and Fischer, 1997; Scholes *et al.*, 1995).

2 METHODOLOGY

2.1 Background

Soils are chemically and biologically complex media comprising weathered and newly formed mineral fragments, organic matter in various stages of decomposition, micro-organisms, and solutes and gases in its pores. In Central and Eastern Europe they are diverse, ranging from shallow and stony Leptosols to poorly drained Histosols rich in organic matter. Depending on its inherent properties, such as content of clay, organic matter and calcium carbonate and cation exchange capacity, each soil will react in different ways to similar pollution and environmental changes.

Effects of contaminated soil often involve aspects of the environment about which very little is known (Sheppard *et al.*, 1992). A wealth of information on the behaviour of inorganic and organic contaminants, as influenced by changing soil-environmental factors, is available from the literature (Adriano, 1992; Blum, 1990; Blume and Brümmer, 1987; Fränzle, 1987). Less information is available, however, on how the various environmental triggers and capacity controlling soil factors may change over time scales of decades to centuries to affect the mobility and biotoxicity of chemicals (Arnold *et al.*, 1990; Ronse *et al.*, 1988), possibly leading to so-called Chemical Time Bombs (Hesterberg *et al*., 1992; Stigliani *et al*., 1991).

Regional differences in static and dynamic soil properties — both horizontally and vertically — largely control a soil's capacity to control movement of pollutants. As such, each soil may be viewed as a chromatographic column or system of geochemical barriers (Glazovskaya, 1991). The choice of the basic soil parameters determining contaminant behaviour, or "capacity controlling factors", is essentially dictated by the availability of sufficient profile data of adequate quality at the considered spatial scale and the contaminant under consideration.

2.2 Selection of Capacity Controlling Factors

The most important Capacity Controlling Factors, as defined by Hesterberg *et al.* (1992), affecting heavy metal binding are: soil depth, particle size distribution, content and type of organic matter, soil pH-redox conditions, the content of Fe-, Al-, and Mn-oxides, and the type of heavy metals (Kabata-Pendias and Pendias, 1992; Livens and Loveland, 1988). Sorption and desorption kinetics of heavy metals in soils are non-linear and further complicated when several metals compete for the same sorption sites, and as new derivatives are formed during their movement through the soils. Easily mobile trace elements such as Zn and Cd exist mainly as organically bound, exchangeable, and water soluble species. Cu and Mo predominate in organically bound and exchangeable species, and their behaviour is strongly influenced by changing soil conditions. Slightly mobile metals, such as Pb, Ni and Cr, are mainly bound in silicates (Kabata-Pendias, 1995).

The fate of Persistent Organic Pollutants (POP) in the soil is determined by a number of processes, including photolytic, chemical and microbial transformation, sorption, plant uptake, transport and volatilization, the interaction of which is complex and non-linear (Tiktak *et al*., 1996). Adsorption of pesticides to soils is determined largely by the character of the pesticide and soil to which they are added (Blume and Brümmer, 1987b; Briggs, 1990). The existence of functional groups such as -OH, $-NH_2$, -NHR, -CONH, -COOR and $-^{+}NR_3$ in the chemical structure encourages adsorption, especially on the humus. In general, the larger the pesticide molecule, everything else being equal, the greater is its adsorption. Some pesticides, such as Diquat and Paraquat are also adsorbed by silicate clays; this adsorption tends to be pH-dependent with maximum adsorption occurring at low pH where protonation occurs. The majority of pesticides degrade rapidly enough to prevent accumulation in the soils, but some of these may be contaminated with arsenic (As) creating another source of pollution (Brady, 1990).

The basic, “derived” soil data for the assessment of soil vulnerability thus should include:
(1) depth of soil horizons
(2) pH, and soil carbonate status
(3) soil texture (as: % sand, silt, and clay)
(4) organic matter content
(5) soil mineralogy
(6) soil drainage class (as an indicator of overall redox conditions)
(7) salinity

2.3 Source of soil profile data

Profile data for the SOVEUR project area were collated by the national collaborators from their archives. As the initial soil surveys were commissioned for different purposes, they are of varying resolution and completeness. Complete data sets are not always available for each sample or horizon for all the soil attributes selected. Consequently, the number of samples for each of these attributes will vary between soil units and with the depth range considered. The source of the profile data has been stored in the SOTER database for the region, together with aggregated information on the inferred reliability of the available information.

2.4 Soil units represented

Soil components in SOTER are characterized at the soil unit level of the Revised Legend (FAO, 1988). Thus this legend can be used to aggregate the available soil profile data and to link derived interpretations of soil properties with the polygons demarcated on a SOTER map. The usefulness of soil classes as carriers of soil information is well documented (Batjes *et al*., 1997; Bouma *et al*., 1998; FAO, 1995).

In total, 662 profile descriptions have been collated for the SOTER database for the SOVEUR region. They originate from: Belarus (95); Bulgaria (20); Czech Republic (39); Estonia (127); Hungary (40); Latvia (10); Lithuania (20); Moldova (45); Poland (22); Romania (26); the Russian Federation, West of the Urals (115); Slovak Republic (28); and the Ukraine (75).

Most national databases confirmed to the SOTER standards (Van Engelen and Wen, 1995), in terms of number of representative profiles collated. In the case of the Russian Federation, however, no representative profiles were provided for 18 soil units mapped for the country: CHw, CLl, CMg, FLc, FLt, GLd, GLe, HSl, LPe, LPi, LPq, LVa, PDi, PLm, PZb, PZc, PZf, and RGi. Furthermore, in some cases, there were few measured data for several of the attributes needed for the subsequent assessment of soil vulnerability. Therefore, similarly classified profiles — in terms of FAO (1988) soil unit classification — from all temperate and boreal zones of the world, as occurring in the ISRIC-WISE database (Batjes, 1997b), were added to the SOTER data set proper. This then led to a more comprehensive set of 1933 profile data sets (Table 1).

Table 1 Number of soil profiles by major soil group and soil unit (FAO, 1988)

Major soil group	Soil units			
AC: Acrisols	ACh= 1 (20)			
AN: Andosols	ANu= 1 (20)			
AR: Arenosols	ARb= 7 (15)	ARc= 4 (13)	ARh= 6 (16)	
AT: Anthrosols	ATu= 1 (2)			
CH: Chernozems	CHg= 1 (6)	CHh= 36 (49)	CHk= 23 (35)	CHl= 16 (19)
	CHw= 0 (0)			
CL: Calcisols	CLh= 1 (38)	CLl= 0 (15)		
CM: Cambisols	CMc= 12 (60)	CMd= 19 (81)	CMe= 16 (77)	CMg= 6 (28)
	CMi= 1 (17)	CMu= 1 (15)	CMx= 3 (12)	
FL: Fluvisols	FLc= 2 (56)	FLd= 2 (6)	FLe= 22 (69)	FLm= 3 (5)
	FLt= 0 (3)	FLu= 7 (8)		
GL: Gleysols	GLd= 0 (21)	GLe= 16 (48)	GLi= 6 (13)	GLk= 4 (7)
	GLm= 8 (26)	GLu= 15 (19)		
GR: Greyzems	GRg= 3 (3)	GRh= 16 (22)		
HS: Histosols	HSf= 33 (41)	HSl= 0 (0)	HSs= 65 (82)	HSt= 2 (4)
KS: Kastanozems	KSh= 7 (16)	KSk= 2 (16)	KSl= 5 (6)	
LP: Leptosols	LPd= 3 (4)	LPe= 0 (12)	LPi= 0 (0)	LPk= 17 (39)
	LPm= 5 (8)	LPq= 6 (9)	LPu= 4 (7)	
LV: Luvisols	LVa= 4 (19)	LVg= 6 (24)	LVh= 13 (88)	LVj= 14 (34)
	LVk= 6 (42)	LVv=1 (10)	LVx= 4 (59)	
PD: Podzoluvisols	PDd= 6 (11)	PDe= 75 (80)	PDg= 11 (12)	PDi= 0 (0)
	PDj= 5 (5)			
PH: Phaeozems	PHc= 3 (19)	PHg= 2 (10)	PHh= 11 (45)	PHj= 1 (3)
	PHl= 17 (77)			
PL: Planosols	PLd= 1 (11)	PLe= 4 (16)	PLm= 1 (12)	
PZ: Podzols	PZb= 5 (15)	PZc= 4 (7)	PZf= 0 (2)	PZg= 9 (26)
	PZh= 16 (50)	PZi= 3 (6)		
RG: Regosols	RGc= 5 (18)	RGi= 0 (2)		
SC: Solonchaks	SCg= 1 (13)	SCh= 3 (8)		
SN: Solonetz	SNg= 3 (16)	SNh= 4 (18)	SNm= 3 (6)	
VR: Vertisols	VRe= 12 (53)	VRk= 1 (38)		

Note: The first number refers to profiles derived from the SOTER database for the SOVEUR area, while the second figure, in parentheses, refers to the whole set of soil profiles used, including those extracted from the ISRIC-WISE database (see text for details). Total number of profile descriptions considered is: 662 (1933).

2.5 Data screening and analyses

General procedure

Data screening prior to the statistical analyses by soil unit involved 6 stages:

- allocation of individual samples of a profile to the topsoil and subsoil ,
- integrity-checks of the various national soil profile databases,
- screening by analytical methods,
- calculation of depth-weighted values, for the attributes under consideration,
- an outlier rejection scheme,
- statistical analysis of the "screened" data sets.

Allocation to a depth zone

All horizon or sample data were assigned to either the *topsoil* (0 to 30 cm) or *subsoil* (30 to 100 cm) based on their depth of occurrence in a profile. This stratification was done by taking into account the upper (*topdep*) and lower depth (*botdep*) of each layer, using uniform criteria:

Topsoil: (*botdep* - *topdep*) x ½ ≤ (30 - *topdep*) AND *botdep* ≤ 40 cm
else:
Subsoil: (*botdep* - *topdep*) x ½ ≤ (100 - *topdep*) AND *botdep* ≤ 120 cm

Integrity check of the soil profile databases

All alphanumeric and selected numeric data, such as pH, ∑(sand + silt + clay), and available water capacity were subjected to a rigorous scheme of data checks (see p. 52 in Batjes, 1995). Numeric data were further checked for possible errors in units of measurement (e.g., per cent (%) instead of pro mille (‰) organiccarbon), as well as for possible inconsistencies in "flagging" missing data. Nonetheless, a number of "oddities" are prone to remain in the screened data sets; hence the introduction of an outlier-rejection scheme (see below).

Comparability of soil analytical data

Soil profiles collated for SOTER have been analysed according to a range of analytical methods, as used in the national laboratories from which they originate. These methods are documented in separate attribute files so as to permit a screening by analytical procedures. Such a screening is often critical, in view of the limited comparability of the numerous analytical methods in use globally for the assessment of similar attributes (Pleijsier, 1989; Vogel, 1994). Because of existing differences in definitions of textural fractions in the Russian and FAO system, the problem of data comparability is always present (Stolbovoi, 1997). For example, most analytical results are expressed as a weight percentage of the "fine earth" fraction. This corresponds with the < 2 mm size-fraction in the FAO and USDA systems, and < 1 mm size-fraction in the Russian or Katschinski system. In addition, different dispersion methods may have been used. Therefore, a study of the comparability of soil analytical methods, commonly in use in Central and Eastern European laboratories, with those of the ISRIC and NRCS reference laboratories was initiated. This desk study, however, provided no usable procedures for converting the various attribute data to the later standards (A.J.M. Van Oostrum, 1998, *unpubl. data*). Conversion from the Katschinski scheme to the USDA scheme, for example, require data for more (> 4) particle-size fractions than are routinely considered in SOTER (see Rousseva, 1997; Wösten *et al*., 1998).

Criteria for the selection of soil profiles based on the inferred comparability of the analytical methods used, similar to those developed earlier by Batjes *et al.* (1997), thus could not be maintained for screening the current SOTER profiles. Therefore, a pragmatic approach to the comparability of soil analytical data had to be adopted for the SOVEUR project, pending more elaborate "comparability" studies at the Pan-European level. Although this approach may be considered acceptable at the observational scale of 1:2,5000,000 used for the SOVEUR project, this correlation must be done more accurately when more precise scientific research is considered.

Computation of depth-weighted soil data (by attribute)

Prior to the statistical analysis a depth-weighted value was calculated for each profile, and by depth zone, for each of the attributes considered in Table 2. All horizons in a profile for which there were no measured data for the attribute and depth zone under consideration were flagged and removed from the "working-file".

Table 2 List of derived soil attributes

Organic carbon
Total nitrogen
pH(H_2O)
CEC_{soil}
CEC_{clay} [R]
Base saturation (as % of CEC_{soil}) [R]
Effective CEC [†]
$CaCO_3$ content
Gypsum content
Exch. sodium percentage (ESP) [R]
bulk density
%sand (wt%)
%silt (wt%)
%clay (wt%)
Available Water Capacity (AWC_1; from pF 1.7 to pF 4.2, % v/v) [R]
Available Water Capacity (AWC_2; from pF 2.0 to pF 4.2, % v/v) [R]
Available Water Capacity (AWC_3; from pF 2.5 to pF 4.2, % v/v) [R]

R Calculated from other measured soil properties.

† ECEC is defined as (Exch.(Ca+Mg+K+Na)+ Exch(H+Al)), after (Van Reeuwijk, 1993).

Outlier rejection scheme

Although all profile descriptions have been subjected to an intensive screening prior to, and during, their entry into the SOTER database, a number of outliers may remain. In order to reduce the influence of such outliers, use of the median is generally preferred to the mean (Snedecor and Cochran, 1980). Testing for departure from the median, by attribute, at the 95% level-of-confidence was according to Pleijsier (1989). The sample population, which remained after exclusion of the outliers, was used for the final statistical analysis.

Statistical analysis

Statistical parameters generated in this study include sample size, medians, means, coefficients of variation, and 95%-confidence intervals (see App. 1). In addition, an *indicator* for the inferred level of "possible confidence" (*CONF*) in the means and medians has been introduced (Table 3). The underlying assumption is that the "confidence" in the results shown should increase with the size of the sample populations. The current analyses are based on a still relatively small, and not necessarily representative, selection of soil profile descriptions; thus, consideration of *CONF* in conjunction with expert knowledge will be essential when developing taxotransfer transfer rules to fill gaps in the derived data.

Table 3 Criteria for defining "confidence" in the derived data

CONF		*n*
V	Very high	>30
H	High	15-29
M	Moderate	5-14
L	Low	1-4
-	No data	0

* *n* is the sample size after the screening procedure.

2.6 Development of taxotransfer rules

Generalized procedures for filling gaps in the derived data, referred to as taxotransfer rules(see Batjes *et al*., 1997)[1)], are used whenever the confidence in a certain derived attribute is "low" (i.e., where $n < 5$). In order to keep track of the rule adopted, its nature has

1) A t*axotransfer* function is the estimation of soil parameters based on modal soil characteristics of soil units, as derived from a combination of their classification name or taxon (which by definition often implies a certain range for a number of properties), expert knowledge and empirical rules, and a statistical analysis of a large number of soil profiles belonging to the same taxon. A *pedotransfer* function is a mathematical relationship between two or more soil parameters which shows a reasonably high level of statistical confidence. This relationship is used to facilitate the estimation of a non-measured soil parameter from one or more measured ones.

been documented in the TTR-derived data sets together with information on the (original) confidence in the substituted data, the number of samples considered, and the substituted median (see App. 1 and 2).

The simple taxotransfer rules are:

Rule 0: If $n \geq 5$ for the considered combination of soil unit, attribute, and depth zone then use the median (*MED*) for the corresponding population (i.e., derived data remain as are).

Rule 1: If there are only a limited number of measured data ($n < 5$) for a specific combination of FAO soil unit, depth zone and soil attribute, but $n \geq 5$ for the corresponding combination of major soil group, depth zone and soil attribute, then the median for this major group, depth interval and soil attribute is substituted in the derived data set as the currently "best available" estimate.

Rule 2: If median pH(H_2O) for the considered combination of soil unit and depth zone is less than 5.5 and $n_{pH} \geq 5$, then the $CaCO_3$ content is set at 0 percent.

Rule 3: If median pH(H_2O) for the considered combination of soil unit and depth zone is less than 7.0 and $n_{pH} \geq 5$, then the gypsum content is set at 0 percent.

Rule 4: If median pH(H_2O) for the considered combination of soil unit and depth zone is less than 4.5 and $n_{pH} \geq 5$, then the exchangeable sodium percentage is set at 0 percent (tentative rule).

Rule 5: If the soil unit is dystric, and $n_{BSAT} < 5$, check whether the median base saturation (BSAT) for the relevant depthzone is <50%. For eutric members, check if BSAT>50%. If not substitute with the median BSAT value computed for dystric and eutric members, respectively, in the data set.

Rule 6: If the median BSAT for the considered combination of soil unit and depth zone is more than 100%, and $n_{BSAT} \geq 5$, then the base saturation is set at 100 percent.

Rule i: If there are no measured data (*NUM* = 0) for a certain combination of attribute, depth interval and soil unit, and *NUM* < 5 for the corresponding combination of major group, soil attribute and textural class, then no data substitution is made and the rule is flagged as "R?" (where R stands for 'rule'). The corresponding combinations of soil units, depth zones and attributes are off-loaded to a separate file (90_Nodata.txt), which may help to focus additional profile data collection activities in the future.

2.7 Application of taxotransfer rules

The above procedures have been applied to the various attributes, with the implicit understanding that the substituted values should still be subjected to a final check by a group of experts prior to their definitive use. Meanwhile, however, statistics for the mineral soils (excluding Anthrosols, Andosols, Vertisols, and Arenosols) may be used as "best-available" estimates where derived data are lacking for some mineral soils, should the need arise. This step must be flagged in the derived data set, for example as 'R9', so that the corresponding data/assumptions can be traced and readily updated should more extensive and better profile data become available.

3 RESULTS

3.1 Tables of derived soil data

Appendix 1 illustrates the substitution process, using Chernozems as an example. Similar summary tables are available for the other soil units occurring in the SOVEUR region. In view of their length, these data files are only presented in digital format. Table 4 gives a brief overview of the various files accompanying this report.

Table 4 Overview of derived soil data files

File types	Description
FA9_DERIF	Data file with all statistics by soil unit, attribute, and depth zone, and with derived attributes after application of taxotransfer rules.
90_*ATTR*.TXT	Summary ASCII text-files by *attri*bute listing medians by soil unit and depth zone, and documenting the taxotransfer rule used (see section 2.6). Excerpt from file FA9_DERIF.DBF.
90_NODATA.TXT	File showing the soil units, depth zones and attributes for which the pedotransfer rules could not be applied, due to insufficient measured data.
SUMTAB90.DBF	Overall summary file of medians, for all considered attributes, with information on taxotransfer rules used.

* Database structures are described in Appendix 3.

3.2 Regional overviews of derived soil data

As a follow-up activity, regional parametric overviews can be generated as single value maps using GIS. A selection of these single value maps (or attribute files) may then be used to identify areas of land with differing propensities for accumulation or leaching of heavy metals and other contaminants to the groundwater. The type of pollutant and research purpose will determine which single attribute or single value maps are of importance in a special case (Table 5).

Table 5 Conceptual framework for assessment of soil propensity to contaminant accumulation (see Batjes, 1997a)

Soil Component[†]	Median soil properties					Relative propensity to cont. accumulation			
	pH	OC	$CaCO_3$	texture	...	Pb	Cd	Hg	..
RO001/1/1 - Orthic Luvisol	7.5	3.3%	2.2%	SCL		H	H	H	-
RO001/1/2 - Orthic Gleysol	6.5	3.0	0.2	CL		M	M	M	-
.... -	-	-	-	-		-	-	-	-

Note: Each Soil Component in SOTER is characterized by its dominant soil units (FAO, 1988) , for which characteristics have been generated. Classes of relative propensity for element-accumulation range from 'lowest' (L) to 'highest' (H); medians and ratings shown are *hypothetical* only.

4 CONCLUSIONS

! Generalisation of measured soil (profile) data by soil unit and depth zone — to permit linkage with the soil components considered on a SOTER map — for use in environmental applications, involves the transformation of variables that show a marked spatial and temporal variability, and that have been determined in a wide range of laboratories according to various analytical methods.

! There is a dire need for reference soil laboratories to collaborate in developing standardized procedures for “harmonizing” soil analytical data sets available for Western and Eastern Europe. Such procedures will not only be critical for implementing SOTER, but also for the database development activities of the European Soil Bureau.

! The median soil attributes presented should be seen as “best possible” estimates, based on the currently available selection of profile data.

! The fact that a certain derived attribute currently may get a high “confidence” rating, does not necessarily imply that this derived value will be representative for the soil unit under consideration. Profile selection for SOTER, like for any other regional or global database, is not probabilistic but based on available data. Also, several of the soil attributes under consideration are not diagnostic in the Revised Legend (FAO, 1988).

! The current study presents a framework for generating derived soil attributes for use in environmental studies, including an assessment of the vulnerability of soils to pollution, for the SOVEUR area. In principle, the approach can be adapted for use with other SOTER databases (e.g., FAO *et al*., 1998).

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APPENDIX

App. 1 Example of derived statistics for Chernozems

FAO_90	ATTRIB	DEPZONE	NUM	MED	MEA	CVA	MIN	LLI	ULI	MAX	REJ0	CONF	R_MED	R_CONF	RULE
CH	APARCEC	A	61	95.00	98.42	24	51.90	92.26	104.58	155.20	67	V	95.00	V	R0
CH	APARCEC	B	74	85.75	88.76	28	35.30	83.06	94.47	145.70	79	V	85.75	V	R0
CH	AWC1	A	7	18.00	16.43	45	5.00	9.64	23.22	26.00	7	M	18.00	M	R0
CH	AWC1	B	7	16.00	16.43	52	6.00	8.49	24.36	29.00	7	M	16.00	M	R0
CH	AWC2	A	2	19.00	19.00	-1	-1.00	-1.00	-1.00	-1.00	2	L	-9.00	-9	R?
CH	AWC2	B	2	19.00	19.00	-1	-1.00	-1.00	-1.00	-1.00	2	L	-9.00	-9	R?
CH	AWC3	A	10	15.50	14.90	16	10.00	13.23	16.57	17.00	12	M	15.50	M	R0
CH	AWC3	B	12	13.00	14.25	25	8.00	11.97	16.53	20.00	13	M	13.00	M	R0
CH	BSAT	A	20	100.00	100.00	0	100.00	100.00	100.00	100.00	39	H	100.00	H	R0
CH	BSAT	B	31	99.00	98.16	2	93.00	97.34	98.98	100.00	37	V	99.00	V	R0
CH	BULKDENS	A	73	1.20	1.21	9	1.00	1.18	1.23	1.45	81	V	1.20	V	R0
CH	BULKDENS	B	87	1.32	1.33	8	1.10	1.31	1.35	1.60	95	V	1.32	V	R0
CH	CACO3	A	28	2.20	3.51	134	0.00	1.69	5.33	18.40	42	H	2.20	H	R0
CH	CACO3	B	52	11.50	48.73	112	0.00	33.54	63.92	169.00	62	V	11.50	V	R0
CH	CECCLAY	A	5	24.10	19.04	54	4.70	6.28	31.80	28.90	5	M	24.10	M	R0
CH	CECCLAY	B	54	27.25	27.16	60	0.30	22.73	31.59	65.70	57	V	27.25	V	R0
CH	CECSOIL	A	66	30.40	31.04	33	9.60	28.55	33.53	52.90	67	V	30.40	V	R0
CH	CECSOIL	B	79	28.30	27.51	36	6.80	25.28	29.74	48.80	79	V	28.30	V	R0
CH	CLAY	A	95	32.00	32.22	35	6.00	29.90	34.54	75.00	95	V	32.22	V	R0t
CH	CLAY	B	109	32.00	31.96	37	7.00	29.72	34.21	85.00	109	V	31.96	V	R0t
CH	ECEC	A	39	30.90	31.41	24	17.20	29.00	33.81	45.40	40	V	30.90	V	R0

FAO_90	ATTRIB	DEPZONE	NUM	MED	MEA	CVA	MIN	LLI	ULI	MAX	REJ0	CONF	R_MED	R_CONF	RULE
CH	ECEC	B	37	29.30	29.21	22	16.20	27.10	31.32	40.30	38	V	29.30	V	R0
CH	ESP	A	41	1.00	1.10	84	0.00	0.81	1.39	4.00	43	V	0.00	-"	R4
CH	ESP	B	41	1.00	1.39	80	0.00	1.04	1.74	4.00	43	V	0.00	-"	R4
CH	GRAVEL	A	73	0.00	0.00	-1	0.00	0.00	0.00	0.00	76	V	0.00	V	R0
CH	GRAVEL	B	83	0.00	0.00	-1	0.00	0.00	0.00	0.00	89	V	0.00	V	R0
CH	GYPSUM	A	38	0.00	0.00	-1	0.00	0.00	0.00	0.00	38	V	0.00	-"	R3
CH	GYPSUM	B	31	0.00	0.00	-1	0.00	0.00	0.00	0.00	31	V	0.00	-"	R3
CH	ORGC	A	88	22.30	23.11	31	10.00	21.61	24.61	39.60	95	V	22.30	V	R0
CH	ORGC	B	100	11.28	11.58	43	2.92	10.60	12.56	23.10	109	V	11.28	V	R0
CH	PHH2O	A	89	7.20	7.24	7	6.00	7.13	7.35	8.20	89	V	7.20	V	R0
CH	PHH2O	B	99	7.50	7.53	6	6.60	7.44	7.62	8.40	102	V	7.50	V	R0
CH	SAND	A	95	11.00	17.22	96	0.00	13.87	20.57	79.00	95	V	17.22	V	R0t
CH	SAND	B	109	10.00	16.86	99	0.00	13.69	20.03	84.00	109	V	16.86	V	R0t
CH	SILT	A	95	54.00	50.64	26	15.00	47.95	53.33	79.00	95	V	50.64	V	R0t
CH	SILT	B	109	55.00	51.27	28	9.00	48.59	53.95	78.00	109	V	51.27	V	R0t
CH	TEB	A	59	30.60	31.09	27	11.50	28.90	33.28	47.80	62	V	30.60	V	R0
CH	TEB	B	58	27.35	27.23	28	11.40	25.22	29.23	41.70	60	V	27.35	V	R0
CH	TOTN	A	75	2.10	2.09	29	1.00	1.95	2.22	3.60	84	V	2.10	V	R0
CH	TOTN	B	90	1.21	1.34	42	0.33	1.23	1.46	2.49	93	V	1.21	V	R0
CH	TOTPORES	A	73	55.00	54.47	8	46.00	53.49	55.44	62.00	81	V	55.00	V	R0
CH	TOTPORES	B	87	50.00	49.93	8	41.00	49.11	50.76	58.00	93	V	50.00	V	R0
CHg	APARCEC	A	5	92.50	93.14	26	62.30	63.05	123.23	122.60	5	M	92.50	M	R0
CHg	APARCEC	B	6	81.80	81.20	30	49.70	55.21	107.19	115.10	6	M	81.80	M	R0
CHg	AWC1	A	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	18.00	M'	R1
CHg	AWC1	B	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	16.00	M'	R1

FAO_90	ATTRIB	DEPZONE	NUM	MED	MEA	CVA	MIN	LLI	ULI	MAX	REJ0	CONF	R_MED	R_CONF	RULE
CHg	AWC2	A	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	-9.00	-9	R?
CHg	AWC2	B	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	-9.00	-9	R?
CHg	AWC3	A	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	15.50	M'	R1
CHg	AWC3	B	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	13.00	M'	R1
CHg	BSAT	A	3	100.00	99.67	1	99.00	98.23	101.10	100.00	4	L	100.00	H'	R1
CHg	BSAT	B	4	91.50	90.75	8	82.00	79.32	102.18	98.00	4	L	99.00	V'	R1
CHg	BULKDENS	A	5	1.40	1.44	19	1.16	1.11	1.77	1.71	5	M	1.40	M	R0
CHg	BULKDENS	B	5	1.45	1.49	9	1.36	1.32	1.66	1.72	6	M	1.45	M	R0
CHg	CACO3	A	2	3.00	3.00	-1	-1.00	-1.00	-1.00	-1.00	3	L	2.20	H'	R1
CHg	CACO3	B	4	22.45	41.88	129	1.50	-44.31	128.06	121.10	5	L	11.50	V'	R1
CHg	CECCLAY	A	2	14.40	14.40	-1	-1.00	-1.00	-1.00	-1.00	2	L	24.10	M'	R1
CHg	CECCLAY	B	6	29.15	33.22	64	13.50	11.01	55.42	65.70	6	M	29.15	M	R0
CHg	CECSOIL	A	5	35.00	27.88	48	10.90	11.20	44.56	41.70	5	M	35.00	M	R0
CHg	CECSOIL	B	6	31.25	28.38	50	11.50	13.61	43.15	42.80	6	M	31.25	M	R0
CHg	CLAY	A	5	32.00	31.00	55	14.00	10.00	52.00	57.00	5	M	31.00	M	R0t
CHg	CLAY	B	6	36.50	37.00	50	17.00	17.70	56.30	70.00	6	M	37.00	M	R0t
CHg	ECEC	A	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	30.90	V'	R1
CHg	ECEC	B	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	29.30	V'	R1
CHg	ESP	A	4	1.00	1.25	101	0.00	-0.75	3.25	3.00	4	L	0.00	-"	R4
CHg	ESP	B	3	1.00	1.00	0	1.00	1.00	1.00	1.00	5	L	0.00	-"	R4
CHg	GRAVEL	A	2	0.00	0.00	-1	-1.00	-1.00	-1.00	-1.00	2	L	0.00	V'	R1
CHg	GRAVEL	B	3	0.00	0.00	-1	0.00	0.00	0.00	0.00	3	L	0.00	V'	R1
CHg	GYPSUM	A	2	0.00	0.00	-1	-1.00	-1.00	-1.00	-1.00	2	L	0.00	-"	R3
CHg	GYPSUM	B	1	0.00	0.00	-1	-1.00	-1.00	-1.00	-1.00	1	L	0.00	-"	R3
CHg	ORGC	A	5	22.30	22.06	32	14.70	13.18	30.93	32.35	5	M	22.30	M	R0

FAO_90	ATTRIB	DEPZONE	NUM	MED	MEA	CVA	MIN	LLI	ULI	MAX	REJ0	CONF	R_MED	R_CONF	RULE
CHg	ORGC	B	6	8.47	10.75	67	3.00	3.18	18.32	21.97	6	M	8.47	M	R0
CHg	PHH2O	A	4	7.35	7.35	8	6.70	6.39	8.31	8.00	4	L	7.20	V'	R1
CHg	PHH2O	B	5	7.60	7.52	7	6.70	6.84	8.20	8.10	5	M	7.60	M	R0
CHg	SAND	A	5	16.00	31.00	78	9.00	1.11	60.89	61.00	5	M	31.00	M	R0t
CHg	SAND	B	6	17.00	26.50	78	8.00	4.93	48.07	56.00	6	M	26.50	M	R0t
CHg	SILT	A	5	29.00	38.00	40	25.00	19.09	56.91	57.00	5	M	38.00	M	R0t
CHg	SILT	B	6	36.50	36.83	39	18.00	21.91	51.76	55.00	6	M	36.83	M	R0t
CHg	TEB	A	4	30.60	26.70	44	10.40	8.17	45.23	35.20	4	L	30.60	V'	R1
CHg	TEB	B	4	27.05	25.60	38	13.10	9.99	41.21	35.20	4	L	27.35	V'	R1
CHg	TOTN	A	5	2.10	2.16	30	1.50	1.35	2.96	3.21	5	M	2.10	M	R0
CHg	TOTN	B	5	1.15	1.17	56	0.45	0.36	1.99	2.16	5	M	1.15	M	R0
CHg	TOTPORES	A	5	47.00	45.60	23	35.00	32.83	58.37	56.00	5	M	47.00	M	R0
CHg	TOTPORES	B	5	45.00	43.80	12	35.00	37.09	50.51	49.00	5	M	45.00	M	R0
CHh	APARCEC	A	24	96.10	99.54	16	74.80	92.63	106.45	139.20	28	H	96.10	H	R0
CHh	APARCEC	B	36	91.70	95.53	28	53.40	86.44	104.61	151.90	38	V	91.70	V	R0
CHh	AWC1	A	5	18.00	14.80	50	5.00	5.66	23.94	21.00	5	M	18.00	M	R0
CHh	AWC1	B	5	16.00	15.20	50	6.00	5.69	24.71	24.00	5	M	16.00	M	R0
CHh	AWC2	A	2	19.00	19.00	-1	-1.00	-1.00	-1.00	-1.00	2	L	-9.00	-9	R?
CHh	AWC2	B	2	19.00	19.00	-1	-1.00	-1.00	-1.00	-1.00	2	L	-9.00	-9	R?
CHh	AWC3	A	6	15.00	14.83	12	12.00	13.03	16.64	17.00	6	M	15.00	M	R0
CHh	AWC3	B	5	13.00	12.20	21	8.00	8.99	15.41	15.00	6	M	13.00	M	R0
CHh	BSAT	A	10	100.00	100.00	0	100.00	100.00	100.00	100.00	15	M	100.00	M	R0
CHh	BSAT	B	8	100.00	100.00	0	100.00	100.00	100.00	100.00	15	M	100.00	M	R0
CHh	BULKDENS	A	31	1.18	1.19	11	0.90	1.14	1.24	1.42	33	V	1.18	V	R0
CHh	BULKDENS	B	41	1.32	1.32	9	1.14	1.28	1.35	1.56	43	V	1.32	V	R0

FAO_90	ATTRIB	DEPZONE	NUM	MED	MEA	CVA	MIN	LLI	ULI	MAX	REJ0	CONF	R_MED	R_CONF	RULE
CHh	CACO3	A	8	11.45	11.21	90	0.00	2.77	19.65	28.80	10	M	11.45	M	R0
CHh	CACO3	B	14	4.50	4.42	78	0.00	2.44	6.40	12.00	22	M	4.50	M	R0
CHh	CECCLAY	A	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	24.10	M'	R1
CHh	CECCLAY	B	19	21.60	23.41	70	0.30	15.54	31.27	54.30	20	H	21.60	H	R0
CHh	CECSOIL	A	28	27.40	28.08	36	9.60	24.11	32.05	52.90	28	H	27.40	H	R0
CHh	CECSOIL	B	38	26.10	26.39	42	6.80	22.73	30.05	48.80	38	V	26.10	V	R0
CHh	CLAY	A	39	29.00	29.54	35	6.00	26.22	32.86	49.00	39	V	29.54	V	R0t
CHh	CLAY	B	49	31.00	29.00	35	7.00	26.09	31.91	49.00	49	V	29.00	V	R0t
CHh	ECEC	A	14	35.05	33.51	16	22.20	30.41	36.61	41.50	15	M	35.05	M	R0
CHh	ECEC	B	13	33.50	32.48	17	18.90	29.14	35.82	40.10	15	M	33.50	M	R0
CHh	ESP	A	12	1.00	1.00	0	1.00	1.00	1.00	1.00	16	M	0.00	-"	R4
CHh	ESP	B	9	1.00	1.00	0	1.00	1.00	1.00	1.00	17	M	0.00	-"	R4
CHh	GRAVEL	A	29	0.00	0.00	-1	0.00	0.00	0.00	0.00	31	H	0.00	H	R0
CHh	GRAVEL	B	38	0.00	0.00	-1	0.00	0.00	0.00	0.00	40	V	0.00	V	R0
CHh	GYPSUM	A	17	0.00	0.00	-1	0.00	0.00	0.00	0.00	17	H	0.00	-"	R3
CHh	GYPSUM	B	18	0.00	0.00	-1	0.00	0.00	0.00	0.00	18	H	0.00	-"	R3
CHh	ORGC	A	38	23.70	23.61	30	10.00	21.32	25.91	39.40	39	V	23.70	V	R0
CHh	ORGC	B	47	12.58	13.55	47	2.92	11.69	15.40	26.70	49	V	12.58	V	R0
CHh	PHH2O	A	33	7.10	7.18	6	6.30	7.03	7.33	8.00	37	V	7.10	V	R0
CHh	PHH2O	B	45	7.30	7.37	5	6.60	7.25	7.49	8.20	47	V	7.30	V	R0
CHh	SAND	A	39	11.00	18.77	103	0.00	12.51	25.02	79.00	39	V	18.77	V	R0t
CHh	SAND	B	49	9.00	17.00	112	0.00	11.54	22.46	84.00	49	V	17.00	V	R0t
CHh	SILT	A	39	55.00	51.74	28	15.00	47.00	56.49	79.00	39	V	51.74	V	R0t
CHh	SILT	B	49	57.00	54.04	26	9.00	49.95	58.13	78.00	49	V	54.04	V	R0t
CHh	TEB	A	25	30.60	30.04	28	11.50	26.58	33.50	46.20	25	H	30.60	H	R0

FAO_90	ATTRIB	DEPZONE	NUM	MED	MEA	CVA	MIN	LLI	ULI	MAX	REJ0	CONF	R_MED	R_CONF	RULE
CHh	TEB	B	24	29.30	27.35	32	11.40	23.62	31.08	40.10	25	H	29.30	H	R0
CHh	TOTN	A	30	2.00	2.02	28	1.00	1.81	2.23	3.50	34	V	2.00	V	R0
CHh	TOTN	B	40	1.20	1.49	46	0.33	1.27	1.71	2.94	42	V	1.20	V	R0
CHh	TOTPORES	A	30	55.00	54.80	8	46.00	53.15	56.45	62.00	33	V	55.00	V	R0
CHh	TOTPORES	B	42	50.00	50.21	8	41.00	48.90	51.53	57.00	42	V	50.00	V	R0
CHk	APARCEC	A	20	88.85	89.42	24	52.50	79.23	99.60	129.50	23	H	88.85	H	R0
CHk	APARCEC	B	22	85.75	86.72	29	35.30	75.55	97.90	145.70	24	H	85.75	H	R0
CHk	AWC1	A	1	26.00	26.00	-1	-1.00	-1.00	-1.00	-1.00	1	L	18.00	M'	R1
CHk	AWC1	B	1	29.00	29.00	-1	-1.00	-1.00	-1.00	-1.00	1	L	16.00	M'	R1
CHk	AWC2	A	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	-9.00	-9	R?
CHk	AWC2	B	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	-9.00	-9	R?
CHk	AWC3	A	4	16.50	15.00	22	10.00	9.64	20.36	17.00	5	L	15.50	M'	R1
CHk	AWC3	B	5	17.00	15.80	20	12.00	11.93	19.67	19.00	5	M	17.00	M	R0
CHk	BSAT	A	7	100.00	99.71	0	99.00	99.26	100.17	100.00	12	M	100.00	M	R0
CHk	BSAT	B	8	99.50	98.50	2	95.00	96.83	100.17	100.00	11	M	99.50	M	R0
CHk	BULKDENS	A	26	1.18	1.19	10	1.00	1.14	1.23	1.38	27	H	1.18	H	R0
CHk	BULKDENS	B	21	1.30	1.30	4	1.19	1.28	1.33	1.43	29	H	1.30	H	R0
CHk	CACO3	A	16	2.10	1.81	90	0.00	0.94	2.67	4.80	25	H	2.10	H	R0
CHk	CACO3	B	27	106.10	121.54	92	0.00	77.09	166.00	387.20	27	H	106.10	H	R0
CHk	CECCLAY	A	2	27.25	27.25	-1	-1.00	-1.00	-1.00	-1.00	2	L	24.10	M'	R1
CHk	CECCLAY	B	20	28.45	29.71	63	4.90	20.95	38.46	67.40	21	H	28.45	H	R0
CHk	CECSOIL	A	22	31.85	33.85	25	22.60	30.10	37.59	49.60	23	H	31.85	H	R0
CHk	CECSOIL	B	23	30.00	29.98	20	17.30	27.33	32.64	41.70	24	H	30.00	H	R0
CHk	CLAY	A	33	32.00	34.27	31	12.00	30.52	38.03	57.00	33	V	34.27	V	R0t
CHk	CLAY	B	35	33.00	33.80	29	10.00	30.42	37.18	60.00	35	V	33.80	V	R0t

FAO_9 0	ATTRIB	DEPZONE	NUM	MED	MEA	CVA	MIN	LLI	ULI	MAX	REJ0	CONF	R_MED	R_CONF	RULE
CHk	ECEC	A	12	27.55	27.32	24	19.80	23.08	31.55	42.00	13	M	27.55	M	R0
CHk	ECEC	B	12	25.50	27.20	23	18.90	23.16	31.24	40.30	12	M	25.50	M	R0
CHk	ESP	A	15	1.00	1.20	78	0.00	0.68	1.72	3.00	15	H	0.00	-"	R4
CHk	ESP	B	12	1.00	1.08	62	0.00	0.66	1.51	2.00	14	M	0.00	-"	R4
CHk	GRAVEL	A	25	0.00	0.00	-1	0.00	0.00	0.00	0.00	26	H	0.00	H	R0
CHk	GRAVEL	B	26	0.00	0.00	-1	0.00	0.00	0.00	0.00	28	H	0.00	H	R0
CHk	GYPSUM	A	9	0.00	0.00	-1	0.00	0.00	0.00	0.00	9	M	0.00	-"	R3
CHk	GYPSUM	B	5	0.00	0.00	-1	0.00	0.00	0.00	0.00	5	M	0.00	-"	R3
CHk	ORGC	A	29	20.30	20.89	25	10.78	18.90	22.88	33.60	33	H	20.30	H	R0
CHk	ORGC	B	30	10.10	10.05	31	3.59	8.87	11.23	15.87	35	V	10.10	V	R0
CHk	PHH2O	A	31	7.60	7.46	6	6.80	7.31	7.62	8.20	32	V	7.60	V	R0
CHk	PHH2O	B	32	7.85	7.79	5	6.90	7.65	7.93	8.50	34	V	7.85	V	R0
CHk	SAND	A	33	9.00	13.58	85	2.00	9.51	17.64	50.00	33	V	13.58	V	R0t
CHk	SAND	B	35	10.00	13.49	78	1.00	9.85	17.12	42.00	35	V	13.49	V	R0t
CHk	SILT	A	33	54.00	52.21	20	26.00	48.58	55.85	68.00	33	V	52.21	V	R0t
CHk	SILT	B	35	54.00	52.86	22	19.00	48.93	56.79	71.00	35	V	52.86	V	R0t
CHk	TEB	A	17	29.20	28.21	32	8.50	23.52	32.89	47.80	18	H	29.20	H	R0
CHk	TEB	B	17	26.20	27.05	27	12.80	23.25	30.85	41.70	17	H	26.20	H	R0
CHk	TOTN	A	27	2.00	1.99	30	1.05	1.75	2.22	3.30	29	H	2.00	H	R0
CHk	TOTN	B	30	1.22	1.29	37	0.51	1.12	1.47	2.24	30	V	1.22	V	R0
CHk	TOTPORES	A	21	55.00	54.29	5	49.00	52.93	55.64	59.00	27	H	55.00	H	R0
CHk	TOTPORES	B	27	50.00	49.81	7	44.00	48.48	51.15	56.00	29	H	50.00	H	R0
CHl	APARCEC	A	9	128.10	123.08	18	91.60	106.16	140.00	160.00	11	M	128.10	M	R0
CHl	APARCEC	B	11	81.80	80.57	25	43.90	67.21	93.94	107.20	11	M	81.80	M	R0
CHl	AWC1	A	1	15.00	15.00	-1	-1.00	-1.00	-1.00	-1.00	1	L	18.00	M'	R1

FAO_90	ATTRIB	DEPZONE	NUM	MED	MEA	CVA	MIN	LLI	ULI	MAX	REJ0	CONF	R_MED	R_CONF	RULE
CHl	AWC1	B	1	10.00	10.00	-1	-1.00	-1.00	-1.00	-1.00	1	L	16.00	M'	R1
CHl	AWC2	A	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	-9.00	-9	R?
CHl	AWC2	B	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	-9.00	-9	R?
CHl	AWC3	A	1	24.00	24.00	-1	-1.00	-1.00	-1.00	-1.00	1	L	15.50	M'	R1
CHl	AWC3	B	2	15.50	15.50	-1	-1.00	-1.00	-1.00	-1.00	2	L	13.00	M'	R1
CHl	BSAT	A	8	95.50	93.88	8	79.00	87.53	100.22	100.00	8	M	95.50	M	R0
CHl	BSAT	B	7	97.00	96.86	3	93.00	94.16	99.55	100.00	7	M	97.00	M	R0
CHl	BULKDENS	A	11	1.23	1.24	3	1.20	1.21	1.27	1.30	16	M	1.23	M	R0
CHl	BULKDENS	B	10	1.37	1.37	2	1.34	1.36	1.39	1.41	17	M	1.37	M	R0
CHl	CACO3	A	3	0.00	1.67	173	0.00	-5.51	8.84	5.00	4	L	2.20	H'	R1
CHl	CACO3	B	8	63.65	56.51	86	1.20	15.84	97.18	129.20	8	M	63.65	M	R0
CHl	CECCLAY	A	1	11.90	11.90	-1	-1.00	-1.00	-1.00	-1.00	1	L	24.10	M'	R1
CHl	CECCLAY	B	9	33.20	32.29	26	18.50	25.77	38.80	47.10	10	M	33.20	M	R0
CHl	CECSOIL	A	11	39.50	34.38	30	20.50	27.49	41.27	48.00	11	M	39.50	M	R0
CHl	CECSOIL	B	11	24.50	26.75	37	7.90	20.13	33.36	40.90	11	M	24.50	M	R0
CHl	CLAY	A	18	32.50	34.61	38	16.00	28.05	41.17	75.00	18	H	34.61	H	R0t
CHl	CLAY	B	19	33.00	34.63	45	12.00	27.15	42.12	85.00	19	H	34.63	H	R0t
CHl	ECEC	A	12	32.20	34.23	23	19.40	29.23	39.22	45.40	12	M	32.20	M	R0
CHl	ECEC	B	11	28.70	28.73	19	19.50	25.14	32.31	35.40	11	M	28.70	M	R0
CHl	ESP	A	6	0.50	0.67	122	0.00	-0.19	1.52	2.00	8	M	0.00	-"	R4
CHl	ESP	B	7	1.00	2.00	100	0.00	0.15	3.85	5.00	7	M	0.00	-"	R4
CHl	GRAVEL	A	17	0.00	0.00	-1	0.00	0.00	0.00	0.00	17	H	0.00	H	R0
CHl	GRAVEL	B	16	0.00	0.00	-1	0.00	0.00	0.00	0.00	18	H	0.00	H	R0
CHl	GYPSUM	A	10	0.00	0.00	-1	0.00	0.00	0.00	0.00	10	M	0.00	-"	R3
CHl	GYPSUM	B	7	0.00	0.00	-1	0.00	0.00	0.00	0.00	7	M	0.00	-"	R3

FAO_90	ATTRIB	DEPZONE	NUM	MED	MEA	CVA	MIN	LLI	ULI	MAX	REJ0	CONF	R_MED	R_CONF	RULE
CHl	ORGC	A	18	29.50	29.58	43	10.70	23.19	35.96	57.90	18	H	29.50	H	R0
CHl	ORGC	B	19	12.06	11.48	44	3.51	9.05	13.91	20.09	19	H	12.06	H	R0
CHl	PHH2O	A	15	6.90	6.95	6	6.30	6.73	7.17	7.80	16	H	6.90	H	R0
CHl	PHH2O	B	12	7.55	7.53	3	7.20	7.39	7.66	8.00	16	M	7.55	M	R0
CHl	SAND	A	18	13.00	16.72	83	3.00	9.81	23.64	49.00	18	H	16.72	H	R0t
CHl	SAND	B	19	13.00	19.68	91	1.00	11.08	28.29	60.00	19	H	19.68	H	R0t
CHl	SILT	A	18	53.00	48.89	27	21.00	42.28	55.50	67.00	18	H	48.89	H	R0t
CHl	SILT	B	19	52.00	45.74	33	14.00	38.50	52.97	64.00	19	H	45.74	H	R0t
CHl	TEB	A	15	32.40	34.38	27	16.50	29.23	39.53	47.30	15	H	32.40	H	R0
CHl	TEB	B	13	28.30	27.74	20	19.50	24.44	31.03	35.40	14	M	28.30	M	R0
CHl	TOTN	A	14	2.43	2.54	30	1.50	2.10	2.99	3.90	16	M	2.43	M	R0
CHl	TOTN	B	16	1.26	1.23	37	0.45	0.98	1.47	1.94	16	H	1.26	H	R0
CHl	TOTPORES	A	11	54.00	53.18	3	51.00	52.19	54.17	55.00	16	M	54.00	M	R0
CHl	TOTPORES	B	13	49.00	49.85	6	47.00	47.97	51.72	56.00	17	M	49.00	M	R0
CHw	APARCEC	A	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	95.00	V'	R1
CHw	APARCEC	B	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	85.75	V'	R1
CHw	AWC1	A	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	18.00	M'	R1
CHw	AWC1	B	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	16.00	M'	R1
CHw	AWC2	A	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	-9.00	-9	R?
CHw	AWC2	B	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	-9.00	-9	R?
CHw	AWC3	A	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	15.50	M'	R1
CHw	AWC3	B	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	13.00	M'	R1
CHw	BSAT	A	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	100.00	H'	R1
CHw	BSAT	B	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	99.00	V'	R1
CHw	BULKDENS	A	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	1.20	V'	R1

FAO_90	ATTRIB	DEPZONE	NUM	MED	MEA	CVA	MIN	LLI	ULI	MAX	REJ0	CONF	R_MED	R_CONF	RULE
CHw	BULKDENS	B	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	1.32	V'	R1
CHw	CACO3	A	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	0.00	-"	R2
CHw	CACO3	B	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	0.00	-"	R2
CHw	CECCLAY	A	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	24.10	M'	R1
CHw	CECCLAY	B	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	27.25	V'	R1
CHw	CECSOIL	A	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	30.40	V'	R1
CHw	CECSOIL	B	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	28.30	V'	R1
CHw	CLAY	A	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	32.22	V'	R1
CHw	CLAY	B	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	31.96	V'	R1
CHw	ECEC	A	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	30.90	V'	R1
CHw	ECEC	B	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	29.30	V'	R1
CHw	ESP	A	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	0.00	-"	R4
CHw	ESP	B	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	0.00	-"	R4
CHw	GRAVEL	A	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	0.00	V'	R1
CHw	GRAVEL	B	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	0.00	V'	R1
CHw	GYPSUM	A	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	0.00	-"	R3
CHw	GYPSUM	B	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	0.00	-"	R3
CHw	ORGC	A	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	22.30	V'	R1
CHw	ORGC	B	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	11.28	V'	R1
CHw	PHH2O	A	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	7.20	V'	R1
CHw	PHH2O	B	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	7.50	V'	R1
CHw	SAND	A	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	17.22	V'	R1
CHw	SAND	B	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	16.86	V'	R1
CHw	SILT	A	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	50.64	V'	R1
CHw	SILT	B	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	51.27	V'	R1

FAO_90	ATTRIB	DEPZONE	NUM	MED	MEA	CVA	MIN	LLI	ULI	MAX	REJ0	CONF	R_MED	R_CONF	RULE
CHw	TEB	A	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	30.60	V'	R1
CHw	TEB	B	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	27.35	V'	R1
CHw	TOTN	A	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	2.10	V'	R1
CHw	TOTN	B	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	1.21	V'	R1
CHw	TOTPORES	A	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	55.00	V'	R1
CHw	TOTPORES	B	0	-1.00	-1.00	-1	-1.00	-1.00	-1.00	-1.00	0	-	50.00	V'	R1

Notes:

1) "A", under the heading "DEPZONE", stands for topsoil and "B" for subsoil (i.e. the 0-30 cm and 30-100 cm depth zone respectively; see text for criteria used).
2) Available Water Capacity (AWC) is given in v/v %: AWC1 from pF1.7 to pF4.2, AWC2 is from pF2.0 to pF4.2; AWC3 from pF2.5 to pF4.2.
3) CECclay, is corrected for contribution of OC (using 2.4 cmol(+) kg^{-1} OC (Scheffer and Schachtschabel, 1984).
4) The mean (*MEA*), median (*MED*), coefficient of variation (*CVA*), minimum (*MIN*), maximum (*MAX*), and lower and upper 95% confidence limits (*LLI* and *ULI*) are shown by sample population.
8) REJ0: size of profile population (after first, integrity screening); NUM (REJ2): as above, after outlier-rejection based on median test at 95% confidence level (Pleijsier, 1989)
6) Confidence in results shown should increase with sample size, and be lowest where NUM is 1 (CONF: -, NUM= 0; Low, 0< NUM ≤5; Moderate, 5< NUM ≤15; High, 15< NUM ≤ 30; Very High, 30 < NUM).
7) This table shows both results as "is", i.e. before the application of taxotransfer rules, and after the application of taxotransfer rules (see *R_MED*, *R_CONF*, and *RULE*).
8) Similar data for the other soil units are included in the file FA9_DERIF.DBF.
9) FAO_90 is the classification according to the Revised Legend (FAO, 1988).
10) See Appendix 2 for abbreviations for soil attributes under consideration.
11) The numeric Data are presented as is, that is without rounding. A “-1" stands for missing data.

App. 2 Codes for physical and chemical attributes

Attribute	Explanation
APARCEC	Apparent CEC (cmol(+) kg^{-1})
AWC1	Available water capacity (for 5 to 1500 kPa suction; % v/v)
AWC2	Available water capacity (for 10 to 1500 kPa; % v/v)
AWC3	Available water capacity (for 33 to 1500 kPa; % v/v)
BSAT	Base saturation (% of CEC_{soi}l)
BULKDENS	Bulk density (g cm^{-3})
CACO3	Calcium carbonate (g/kg, or ‰, by weight)
CECCLAY	Calculated CEC of clay fraction ($cmol_c$ kg^{-1})
CECSOIL	Calculated CEC of soil fraction (mainly 1 *M* NH_4OAc at pH 7; $cmol_c$ kg^{-1})
ECEC	Effective CEC ($cmol_c$ kg^{-1})
ESP	Exchangeable sodium percentage (as % of CEC_{soil})
GYPSUM	Total gypsum, as $CaSO_4.2H_2O$ (‰ by weight)
ORGC	Organic carbon content (g/kg by weight)
PHH2O	pH water
TEB	Total exchangeable bases (Ca + Mg + K + Na)
TOTN	Total nitrogen (g/kg by weight)
TOTPORES	Total porosity (% v/v)

App. 3 Structure of digital data files

File: FA9_DERIF.DBF

Field Name	Type	Width	Dec	Description
FAO_90	Character	3		Classification in FAO Revised Legend
ATTRIB	Character	8		Code for attribute under consideration (see App. 2)
DEPZONE	Character	3		Depth interval (A=topsoil; B= subsoil)
NUM	Numeric	4	0	Number of observations after outlier rejection based on median test (at 95% confidence level; after Pleijsier, 1989)
MEA	Numeric	6	2	Arithmetic mean (in respective units of measurement)
MED	Numeric	6	2	Median (in respective units of measurement)
CVA	Numeric	3	0	Coefficient of variation (in %)
MIN	Numeric	6	2	Minimum
MAX	Numeric	6	2	Maximum
LLI	Numeric	6	2	Confidence interval, 95%, lower limit
ULI	Numeric	6	2	Confidence interval, 95%, lower limit
REJ0	Numeric	3	0	Size of sample population after first screening, plus exclusion of missing values for attribute under consideration (for criteria see text)
CONF	Character	1		Indicator for confidence in results (see text)
R_MED	Numeric	8	2	Median after use of taxotransfer rules (see text)
R_CONF	Character	2		Confidence in above
RULE	Character	2		Code for taxotransfer rule used (R_0 to R_j)

File: SUMTAB90.DBF

Field Name	Type	Width	Dec	Description
FAO_90	Character	3		Classification in FAO Revised Legend
ORGC_TM	Numeric	6	2	Organic matter content, **m**edian for the **t**opsoil (TM)
ORGC_TR	Character	2		Number of taxotransfer **r**ule used content for **t**opsoil (TR)
ORGC_BM	Numeric	6	2	Organic matter content, **m**edian for the su**b**soil (SM)
ORGC_BR	Character	2		Number of taxotransfer **r**ule used content for su**b**soil (SR)
PHH2O_TM	Numeric	6	2	As above, but for pH(H_2O)
PHH2O_TR	Character	2		As above, but for pH(H_2O)
PHH2O_BM	Numeric	6		As above, but for pH(H_2O)
PHH2O_BR	Character	2		As above, but for pH(H_2O)
CECSOIL_TM	Numeric	6	2	As above, but for CEC_{soil}
CECSOIL_TR	Character	2		As above, but for CEC_{soil}
CECSOIL_BM	Numeric	6	2	As above, but for CEC_{soil}
CECSOIL_BR	Character	2		As above, but for CEC_{soil}
CECCLAY_TM	Numeric	6	2	As above, but for CEC_{clay}
CECCLAY_TR	Character	2		As above, but for CEC_{clay}
CECCLAY_BM	Numeric	6	2	As above, but for CEC_{clay}
CECCLAY_BR	Character	2		As above, but for CEC_{clay}
TEB_TM	Numeric	6	2	As above, but for Total Exchangeable Bases
TEB_TR	Character	2		As above, but for Total Exchangeable Bases
TEB_BM	Numeric	6	2	As above, but for Total Exchangeable Bases
TEB_BR	Character	2		As above, but for Total Exchangeable Bases
BSAT_TM	Numeric	6	2	As above, but for base saturation
BSAT_TR	Character	2		As above, but for base saturation
BSAT_BM	Numeric	6	2	As above, but for base saturation
BSAT_BR	Character	2		As above, but for base saturation
ESP_TM	Numeric	6	2	As above, but for Exchangeable Sodium Percentage
ESP_TR	Character	2		As above, but for Exchangeable Sodium Percentage
ESP_BM	Numeric	6	2	As above, but for Exchangeable Sodium Percentage
ESP_BR	Character	2		As above, but for Exchangeable Sodium Percentage
ECEC_TM	Numeric	6	2	As above, but for Effective Cation Exchange Capacity
ECEC_TR	Character	2		As above, but for Effective Cation Exchange Capacity
ECEC_BM	Numeric	6	2	As above, but for Effective Cation Exchange Capacity
ECEC_BR	Character	2		As above, but for Effective Cation Exchange Capacity
CACO3_TM	Numeric	6	2	As above, but for calcium carbonate content
CACO3_TR	Character	2		As above, but for calcium carbonate content
CACO3_BM	Numeric	6	2	As above, but for calcium carbonate content
CACO3_BR	Character	2		As above, but for calcium carbonate content

(File SUMTAB.DBF, cont.)

Field Name	Type	Width	Dec	Description
GYPSUM_TM	Numeric	6	2	As above, but for gypsum content
GYPSUM_TR	Character	2		As above, but for gypsum content
GYPSUM_BM	Numeric	6	2	As above, but for gypsum content
GYPSUM_BR	Character	2		As above, but for gypsum content
BULK_TM	Numeric	6	2	As above, but for bulk density
BULK_TR	Character	2		As above, but for bulk density
BULK_BM	Numeric	6	2	As above, but for bulk density
BULK_BR	Character	2		As above, but for bulk density
TOTPOR_TM	Numeric	6	2	As above, but for total porosity
TOTPOR_TR	Character	2		As above, but for total porosity
TOTPOR_BM	Numeric	6	2	As above, but for total porosity
TOTPOR_BR	Character	2		As above, but for total porosity
AWC1_TM	Numeric	6	2	As above, but for Available Water Capacity (AWC1)
AWC1_TR	Character	2		As above, but for Available Water Capacity (AWC1)
AWC1_BM	Numeric	6	2	As above, but for Available Water Capacity (AWC1)
AWC1_BR	Character	2		As above, but for Available Water Capacity (AWC1)
AWC2_TM	Numeric	6	2	As above, but for Available Water Capacity (AWC2)
AWC2_TR	Character	2		As above, but for Available Water Capacity (AWC2)
AWC2_BM	Numeric	6	2	As above, but for Available Water Capacity (AWC2)
AWC2_BR	Character	2		As above, but for Available Water Capacity (AWC2)
AWC3_TM	Numeric	6	2	As above, but for Available Water Capacity (AWC3)
AWC3_TR	Character	2		As above, but for Available Water Capacity (AWC3)
AWC3_BM	Numeric	6	2	As above, but for Available Water Capacity (AWC3)
AWC3_BR	Character	2		As above, but for Available Water Capacity (AWC3)
SAND_TM	Numeric	6	2	As above, but for sand
SAND_TR	Character	2		As above, but for sand
SAND_BM	Numeric	6	2	As above, but for sand
SAND_BR	Character	2		As above, but for sand
SILT_TM	Numeric	6	2	As above, but for sand
SILT_TR	Character	2		As above, but for silt
SILT_BM	Numeric	6	2	As above, but for silt
SILT_BR	Character	2		As above, but for silt
CLAY_TM	Numeric	6	2	As above, but for clay
CLAY_TR	Character	2		As above, but for clay
CLAY_BM	Numeric	6	2	As above, but for clay
CLAY_BR	Character	2		As above, but for clay

Note: A "-9" in this file refers to no data.