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Parameter estimates for the main soil units on a 0.5 by 0.5 degree global grid

(Version 1.0)

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ISRIC World Soil Information

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ABSTRACT

Soil data layers on a 0.5 by 0.5 degree grid are presented for the world in Arc View® format. They show parameter estimates for the topsoil (0-0.3 m) and subsoil (0.3-1.0 m) for the main soil unit of each terrestrial grid cell. The median relative extent of the main soil unit in a grid cell is 44 %, the first quartile being 34 % and the third quartile 58 %. The data set has been derived from version 2.0 of ISRIC's WISE database. It includes: organic carbon content (weight %); pH water; CECsoil; CECclay; base saturation; exchangeable sodium percentage; electrical conductivity; weight percentage sand, silt and clay size minerals; soil texture; profile available water capacity (-10 to -1500 kPa, to 1 m depth); profile depth; and soil drainage class. All GIS themes are shown with a generalized legend. The associated attribute table list medians for the selected parameters, by FAO soil type and depth zone. More detailed analyses should be based on datasets that consider the full map unit composition.

Keywords: GIS; FAO soil units; soil parameter estimates; WISE database

1. INTRODUCTION

Generalisation of soil data for use in regional and global models requires transforming heterogeneous data into harmonized, uniform information that is considered to be representative at a much lower spatial resolution. The most comprehensive and detailed geographic overview on world soil resources is the Soil Map of the World (FAO-Unesco 1974-1981). This map, at scale 1:5 million, is a compilation of national and regional maps based on a common legend. At the time of compilation, in the 1960s to early 80s, soil maps for many countries were available for limited areas only and at various scales. Only a limited number of regionally representative profiles were available at the time. As a result, the initial interpretations were often of a qualitative nature and based on expert-estimates.

With the completion of the Digital Soil Map of the World (FAO 1995) and the World Inventory of Soil Emission Potentials (WISE) database at ISRIC, it became possible to list parameter estimates for each soil unit of the world. Staff at ISRIC, IIASA (International Institute for Applied Systems Analysis), and FAO subsequently developed a methodology for deriving a set of 20 parameters identified as being important in the context of regional and global agro-ecological zoning (Batjes *et al.* 1997). That study was later refined in a study with the International Food Policy Research Institute (Batjes 2002b). A main guiding criterion has been that results must allow linkage with the digital Soil Map of the World, and its grid-based derivatives, through the FAO soil legend code.

Examples of applications of WISE-derived data sets include modelling of global environmental change, up scaling and downscaling of greenhouse gas emissions, studies of soil carbon stocks and change, global emissions of NH_3 and agro-ecological zoning. Full references to these studies may be found elsewhere (see Batjes 2002b)

The worldwide set of soil parameter estimates, described in this report, considers only the main, or spatially predominant, soil unit of each terrestrial 0.5 by 0.5 degree grid cell: as such it is a "summary" set. Section 2 presents the data and methods used, while possible limitations are discussed in Section 3. Meta data and the installation procedure are described in the Appendix.

2. DATA AND METHODS

Median parameter values for the soil types of the world (Batjes 2002b) have been linked to a 0.5 by 0.5 degree resolution version of FAO's Soil Map of the World (WISE database, see Batjes *et al.* 1995). Linkage is through the soil unit code of the main soil unit of a given grid cell.

Each grid cell in the WISE database may contain up to 10 components. Therefore, the grid cells have first been clustered into cells that consist mainly (> 50%) of oceans or inland water bodies (WT), land ice or glaciers (GL) or that are mainly terrestrial (≥50 %) .

The data set includes 15 views (Figure 1):

a) Data for the topsoil (0 to 0.3 m) and subsoil (0.3 to 1.0 m):

- Organic carbon content (%)
- pH water
- CEC_{soil} ($cmol_c\ kg^{-1}$)
- CEC_{clay} ($cmol_c\ kg^{-1}$, corrected for contribution of organic matter)
- Base saturation (% of CEC_{soil})
- Exchangeable sodium percentage (% of CEC_{soil})
- Electrical conductivity ($dS\ m^{-1}$)
- Sand, silt and clay content (weight %)
- Soil texture

b) Data for the profile:

- Profile available water capacity (to 1 m; for -10 to -1500 kPa)
- Profile depth (cm; maximum depth described)
- Soil drainage class

Themes within a view are presented with a generalized legend, using so-called binned classes. The classification and relative extent of the main FAO-Unesco (1974) unit, and un-binned values for the soil parameters (medians) are described in the underlying attribute table (file: wise_pds.dbf).

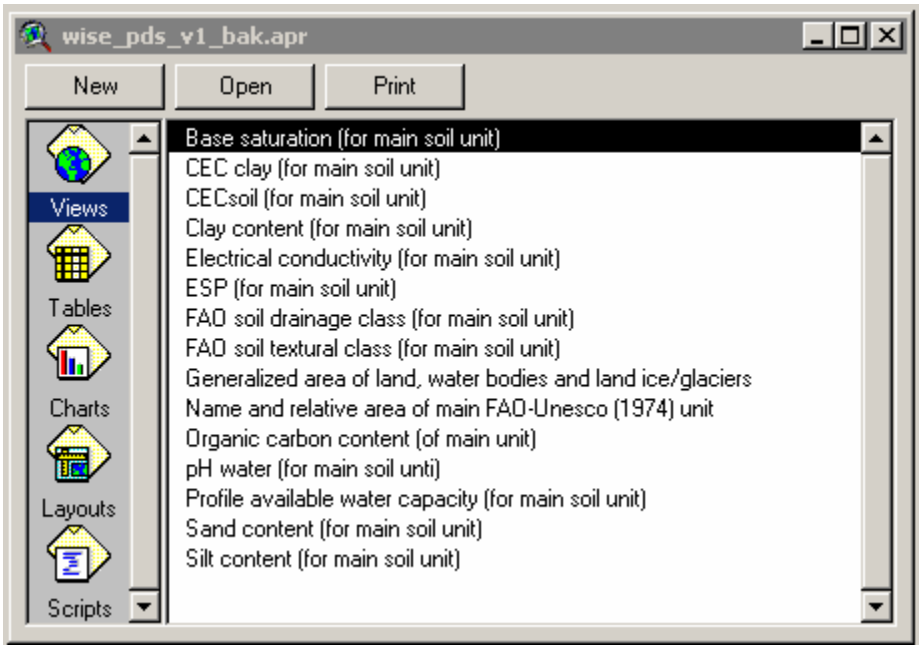

Figure 1. List of views represented in the GIS data set

3. DISCUSSION AND CONCLUSIONS

Several authors have reviewed the advantages and disadvantages of the Soil Map of the World and its grid-based derivatives (Batjes and Bridges 1994; Bouwman *et al.* 1999; Nachtergaele 1999). The geographic data are known to be outdated and the associated area data, of necessity, have been derived from composition rules (FAO 1995). The density and quality of the available soil profiles also varies greatly from one natural region to the other (Batjes 2002b). Hence the ongoing update of the information on the world's soil resources at scale 1:5 million in SOTER, the World Soils and Terrain Database programme (Oldeman and van Engelen 1993; Van Engelen 1999).

Like what has been the case for the 1 by 1 degree data set of Zobler (1986), the present data set only considers the main component of intrinsically compound map units, albeit on a 0.5 by 0.5 degree global grid. This type of simplification is *fraught with uncertainty* because the relative extent of the main soil unit can vary widely between grid cells. In

the present data set, the median relative area of the main soil unit in a terrestrial grid cell is 44 per cent, with quartiles of 34 and 58 per cent. More detailed analyses should be based on datasets that consider the full map unit composition, that is take into accoint that each 0.5 by 0.5 degree grid cell may comprise up to 10 different soil units. However, when the full soil composition of a grid cell is considered the derived data can only been shown meaningfully as binned classes (Batjes 2002a).

A comprehensive update of the soil geographic and soil parameter estimates and for the world, at scale 1:5 million, will first become feasible upon the completion of the World Soil and Terrain (SOTER) programme (Nachtergaele 1999; Van Engelen 1999).

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APPENDIX

DATA SET DESCRIPTION

Data Set Name:

Parameter estimates for the main soil units on a 0.5 by 0.5 degree global grid (version 1.1)

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http:\\www.isric.org (via the 'soil data' page)

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DATA SET DESIGN

Lineage:

The current data set has been derived from the World Inventory of Soil Emission Potentials database (WISE ver. 2.0) which consists of: (1) a file with data on the type and relative extent of the component soil units of each ½° latitude by ½° longitude grid cell of the world, derived from the corrected 1:5 M scale FAO-UNESCO Soil Map of the World; and (2) selected physical and chemical data for over 9600 soil profiles considered representative for the respective soil units of the world.

Main profile data contributors were the USDA Soil Conservation Service (SCS-NRCS), Food and Agriculture Organization (FAO), International Soil Reference and Information Centre (ISRIC), and a wide range of national soil survey organizations and soil scientists (for details see Batjes, 2002a).

The first version of WISE has been developed at ISRIC in the framework of the Dutch National Research Programme on Global Air Pollution and Climate Change (Project 851039). Preliminary analyses WISE, version 1,0, for use in worldwide and regional AEZ studies were carried out in 1997 in a

collaborative activity of ISRIC, IIASA and FAO. In 2001, the WISE data set was further expanded and the analyses refined in the context of Research Agreement Contract No. 2001X020.ISR with the International Food Policy Research Institute (IFPRI).

Geographic coverage:

Worldwide

Maximum Latitude	+ 90 degrees (N)
Minimum Latitude	- 90 degrees (S)
Maximum Longitude	+180 degrees (E)
Minimum Longitude	-180 degrees (W)

Geographic sampling:

Spatial soil data derived from centre-point sampling of 5 by 5 minute grid cells of the 1:5 M scale FAO-UNESCO Soil Map of the World, giving the full soil unit composition for these cells. This information was then aggregated to half-degree grid cells using FAO's Soil Composition Rules (see FAO World Soil Resources Report 67; gridding algorithms developed by Dr F.O. Nachtergaele, FAO-AGL). Each grid cell may consist of up to 10 different soil units. The current data set only presents parameter estimates for the main or spatially predominant soil unit (for terrestrial grid cells where soil units cover over 50 % of the grid).

Temporal sampling:

Parameter estimates (medians) were derived from over 9600 soil profiles considered to be representative for the 106 soil units shown on the Soil Map of the World, collected between 1950 and 2001.

SPATIAL DATA SETS

Variables/themes:

a) Medians for the topsoil (0-0.3 m) and subsoil (0-1.0 m):

- Organic carbon (%)
- pH water
- CEC_{soil} ($cmol_c\ kg^{-1}$)
- CEC_{clay} ($cmol_c\ kg^{-1}$; corrected for contribution of organic matter)
- Base saturation (% of CEC_{soil})
- Exchangeable sodium percentage (% of CEC_{soil})
- Electrical conductivity ($dS\ m^{-1}$)
- Sand, silt and clay content (weight %)

b) For profile

- Profile available water capacity (to 1 m, held between -10 to -1500 kPa)
- Soil texure class
- Profile depth (cm; maximum depth described)
- Soil drainage class

The legend classes are documented by theme within each view. Un-binned attributes (medians) for the main soil units, per grid cell, may be found in the corresponding attribute file (wise_pds.dbf).

Projection:

Geographic: lat/lon; decimal degrees
Grid cell size: 0.5 decimal degrees (720 columns x 360 rows)

Data representation:

Various classes and explanatory notes on these classes (see theme/map legends). Un-binned parameter estimates are shown in the corresponding attribute tables.

Size:

Un-compressed data volume is about 44 Mb.
Content: 44 files in 4 folders.

DATA-SET INSTALLATION

The WINZIP®-compressed documentation and data files are distributed through the ISRIC home page (http:\\www.isric.org), via menu item "soil data". After having downloaded the zip file (*ISRIC-WISE--DomSolProp_v1b.zip)*, its contents should be decompressed to folder *D:\WISE—PDS* (default) for the project's apr file to work properly.

ArcView® must be installed on your PC-system in order to access and manipulate the data files. Entering *wise_pds_v1.apr* will open the project: reading and joining the various files may take several minutes on some systems.

Date of last revision: December 2003.