

4 Soil data from Austria

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4.1 Introduction

Work of the Institute for Land and Water Management Research of the Federal Agency for Water Management (BAW) has a main focus on evaluation of the soil water relationship of the unsaturated zone. For this reason, soil physical analyses are carried out routinely as part of various project activities (research and consulting) around this issue. During the years BAW has obtained a large volume of results on soil physical properties for many Austrian regions. The results presented here however, constitute a selected portion of his data set. Selection was done in a way to represent as many Austrian landscapes and soil types as possible. Due to time span of the data collection methodological approaches for particular methods may have changed in some cases. This is especially true for the more time demanding methods of the determination of unsaturated hydraulic conductivity. They are undergoing a steady modification as new approaches for measurement and evaluation are being developed. All results have been performed by the technical staff of BAW.

4.2 Number of samples, geographical distribution and pedological variability

The distribution of sampling sites within Austria is given in Figure 4.1. The sample consists of 68 sampling sites with a total of 204 samples, taken from different soil depths. Results for undisturbed samples are already means of between 3 and 5 cylinders that were taken per sampling depth. On all samples the determination of dry bulk density, coarse fraction, determination of water retention characteristic, particle-size analysis and determination of organic carbon (respectively organic matter on few samples) was carried out. In addition, the determination of porosity and carbonate content was done on 140 samples and hydraulic conductivity was determined on 152 samples.

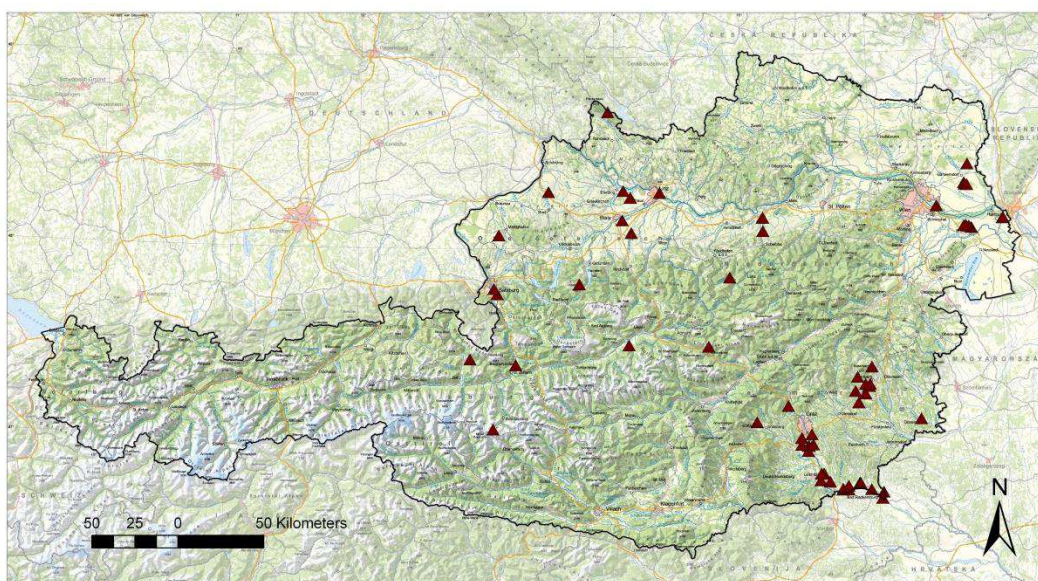


Figure 4.1 Location of sampling points across Austria

Table 4.1 gives an overview about the different soil types that are represented in the data base. The biggest group of data has been derived from Cambisols (n=32). This reflects the distribution of soil types in Austria with about 30% of all soils belonging to Cambisols.

Table 4.1. Number of soil types (WRB) represented in the database

Pedological Unit	n
Eutric Fluvisols	6
Calcaric Fluvisols	5
Eutric Cambisols	19
Dystric Cambisols	1
Spodo-Dystric Cambisols	4
Stagno-Gleyic Cambisols	8
Dystric Histosols	1
Orthic Luvisols	9
Stagno-Gleyic Luvisols	6
Orthic Rendzinas	3
Haplic Chernozems	4
Dystric Lithosols	1
Haplic Phaeozems	1

Table 4.2 gives an overview about the spread of some basic properties of the soil samples. Again it appears, that the sample covers a wide range of different physical and chemical properties with clay contents from between 1% and 51% and organic carbon contents from between 0.12% to 11.92%.

4.3 Measured soil properties and methods

4.3.1 Determination of dry bulk density (ÖNORM L 1068)

Core samples of known volume are taken with a sampling tool. The sample is dried in an oven (105°C), the dry material is weighed and considering the volume of the core the dry bulk density is calculated.

4.3.2 Determination of coarse fragments (ÖNORM L 1061-1)

Particles not passing a 2 mm sieve are weighed.

Table 4.2. Number available data, means, median values, minimum and maximum values for the data set

Determination of	n	Min	Max	Mean	Median
Porosity [Vol.-%]	140	34,4	68,7	47,2	46,7
Dry bulk density [g/cm ³]	204	0,77	1,79	1,41	1,43
Coarse fragments [Mass-%]	204	0	55,9	4,8	0,2
Organic carbon [Mass-%]	204	0,12	11,92	1,05	0,76
Carbonate content [Mass-%]	140	0	43,0	6,8	0,1
Clay content [Mass-%]	204	1	51	19	20
Saturated hydraulic conductivity [cm/d]	140	0,3	27600	398	58,8

4.3.3 Determination of porosity (ÖNORM L 1068)

The porosity is calculated from dry bulk density and particle density.

4.3.4 Determination of organic carbon (ÖNORM L 1081)

This determination is done by wet oxidation. The sample is mixed with potassium dichromate and sulfuric acid and heated. After the addition of deionized water and phosphoric acid the sample is titrated with ferrous sulfate heptahydrate, using diphenylamine as an indicator.

4.3.5 Determination of soil organic matter (ÖNORM L 1079)

This determination is done by loss of ignition. The sample is ashed at 550 ° C in a muffle furnace, the residue is weighed and the content of organic matter is calculated.

4.3.6 Determination of carbonate content (ÖNORM L 1084)

The soil carbonates are destroyed by adding a 10% hydrochloric acid solution. The resulting carbon dioxide is determined volumetrically using the apparatus of "Scheibler".

4.3.7 Determination of particle size < 2 mm (ÖNORM L 1061-2)

Particle size distribution is determined by a combination of sieving and sedimentation, starting from air-dried soil. Particles passing a 2 mm sieve, but retained on a 0.063mm sieve, are determined by wet sieving. Particle size distribution of particles passing the latter sieve is determined by sedimentation by pipette method.

4.3.8 Determination of water retention characteristic (ÖNORM L 1063)

Soil cores are placed in contact with a porous ceramic plate contained within a pressure chamber. A gas pressure is applied to the air space above the samples and soil water moves through the plate and is collected in a burette. At equilibrium status, soil samples are weighed, oven dried and reweighed to determine the water content at the predetermined pressures.

4.3.9 Determination of saturated hydraulic conductivity (ÖNORM L 1065)

The volume of water filtrating through a soil cylinder in a defined period of time is measured. Considering the hydraulic potential and the water flux the hydraulic conductivity is calculated by Darcy's law.

4.3.10 Determination of unsaturated hydraulic conductivity (ISO 11275)

Undisturbed soil samples are wetted in the laboratory and then evaporating from the top. Pressure heads are measured at different depths in the sample, using tensiometers. At known times the decrease of the mass of the sample and the pressure heads are recorded. The experiment ends when air enters the uppermost tensiometer. The water content of each compartment is estimated from the water content of the whole sample and the tensiometer readings. From these data the retention characteristic and the conductivity are calculated, using an adaptation (Halbertsma, 1994) of Wind's evaporating method (Wind, 1966) or the approach of Schindler (1980).

4.4 References

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5 Soil data from Belgium

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5.1 Introduction

The dataset was compiled in the framework of some projects at Ghent University and KULeuven, Belgium. These projects aimed at evaluating pedotransfer functions (Cornelis et al., 2001), evaluating the effect of soil management on soil quality (e.g., D’haene et al., 2008, Arthur et al., 2010), assessing the predictive quality and usefulness of soil maps and historical soil profile data of forest soils (De Vos et al., 2005; Cornelis et al., 2005), among others.

5.2 Number of samples, geographical distribution and pedological variability

The dataset contains 241 samples taken from 120 soil profiles spread mostly over the Flemish Region, and to a small extent the Brussels-Capital Region and the Walloon Region of Belgium. The samples cover a wide variety of soil textures as depicted in Figure 5.1. They were collected from soils under different land uses including farmland, pasture and forests.

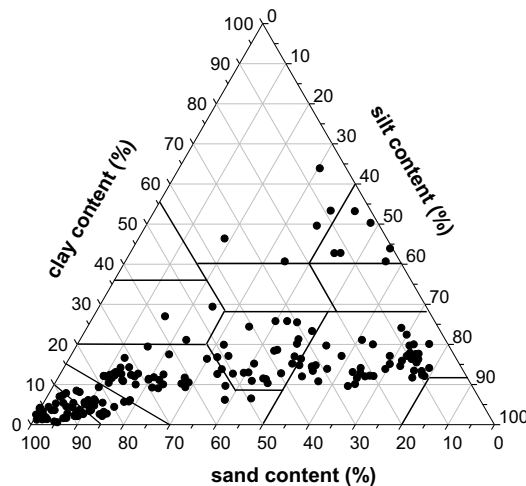


Figure 5.1 Clay (0–2 μm), silt (2–50 μm), and sand (50–2000 μm) content of the dataset

Table 5.1 shows the summary statistics of the dataset.

Table 5.1. Summary statistics of the dataset

Soil property	N	Mean	SD	Min	Max
Sand content (%)	241	52.8	29.6	0.6	96.9
Silt content (%)	241	33.0	23.8	0.0	79.0
Clay content (%)	241	14.2	10.6	0.5	63.8
OC content (%)	241	1.32	1.22	0.06	6.69
Bulk density (g cm^{-3})	241	1.44	0.18	0.31	1.77

5.3 Measured soil properties and methods

5.3.1 Basic soil properties

All samples were analysed for at least bulk density, organic carbon content and particle size distribution. Additionally, CaCO₃ content, pH-H₂O, and pH-KCl was available for 66 samples, and CEC and EC for 31 samples.

Bulk density was determined with the core method on undisturbed soil samples contained in standard sharpened steel 100-cm³ sized Kopecky rings (diameter 5.1 cm, height 5 cm). Cores were driven in the soil with a push ring (Dirksen, 1999), with a hammer head and guide cylinder (Eijkelkamp Agrisearch Equipment, Giesbeek, the Netherlands), or with an auger with closed ring holder after having prepared a flat sampling platform with a Riverside auger (Eijkelkamp Agrisearch Equipment). The samples were then brought to the laboratory in dedicated boxes to avoid disturbance during transport (Eijkelkamp Agrisearch Equipment).

Particle size distribution (PSD) was for most samples determined using the conventional pipette-sieve method (Gee and Bauder, 1986; ISO 11277) on disturbed pretreated air-dried samples (<2 mm). The pretreatment included removal of organic matter with H₂O₂ and of CaCO₃ with HCl, and dispersion with Na₂CO₃ and (NaPO₃)_x. PSD of part of the dataset (#48) was determined on air-dry samples, pretreated in a similar fashion as above, using a Coulter LS200 laser diffractometer, calibrated and validated using the above ISO 11277 procedures.

Organic carbon was measured according to Walkley and Black (1934; ISO 14235:1998), CaCO₃ with acid-base titration (Van Ranst et al., 1999), pH-H₂O and pH-KCl with a Model 420 pH meter (Thermo Orion Inc, USA) on respectively a 1:5 and 1:2 extract (ISO 10390:2005), EC on a saturation extract using an Orion conductivity meter (Orion Inc., USA; ISO 11265:1994) and CEC by using an ammonium acetate solution extract at pH 7 according to Van Ranst et al. (1999). All chemical analyses were performed on air-dried samples (<2 mm).

5.3.2 Soil hydraulic properties

Water retention curves (WRC) were constructed by measuring soil-water content at eight to nine soil-matric potentials using undisturbed soil samples contained in standard sharpened steel 100-cm³ sized Kopecky rings (diameter 5.1 cm, height 5 cm), taken in a similar way as described above for determining bulk density. For the pressure potentials ranging from -1 kPa to -10 kPa, the sand box apparatus (Eijkelkamp Agrisearch Equipment) was used, whereas between -20 kPa and -1500 kPa pressure chambers (Soilmoisture Equipment, Santa Barbara, CA) were employed, following the procedures outlined in Cornelis et al. (2005) for samples from Ghent University, and Vereecken et al. (1989) for samples from KULeuven. After having obtained hydraulic equilibrium between the applied pressure and the water present in the sample, water content was determined gravimetrically and multiplied with bulk density to convert to volumetric water content.

In the current dataset, we did not include hydraulic conductivity K. However, in the course of 2013, on top of the basic properties and WRC, K data should become available from measurements with tension infiltrometers in the field and the constant water head method in the lab, at locations different from those considered here.

5.4 Acknowledgements

I would like to acknowledge all students, researchers and technicians of Ghent University who helped in collecting and analysing the samples over several years. I would further like to thank Jan Feyen and Lode Hubrechts from KULeuven, who provided me more than 10 years ago their dataset.

5.5 References

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