Metadata Supporting Document for Chimney Meadow Soil Water Retention Dataset

Objective

To determine soil characteristics within the top metre of soil to relate to soil moisture and Electrical Resistivity Tomography measurements

Experimental design/Sampling regime

Church Field, Chimney Meadow NNR site run by Berks, Bucks and Oxfordshire Wildlife Trust. A single site was chosen to be representative of the soil type on which an Electrical Resistivity Tomography experiment was located. The samples were collected from a soil pit dug 13.75m from the north end of the ERT transect and offset 1.0m to the west of the transect line so as not to interfere with the ERT measurements.

Transect end points: OSGB Grid Ref. E436108 N201187.9, Ht AOD 66.856; E436112.7 N201156.7, Ht AOD 66.143. Soil Pit location: E436109 to 436109.7, N201173.6 to 201174.5

Fieldwork and Laboratory instrumentation

Fixed volume (769.77cm^3) soil samples were collected by carefully inserting stainless steel rings of dimension 100mm deep x 99mm I.D. into the soils so as not to disturb or compact the soil sample (Blake and Hartige, 1986). Sample depth increments of 10cm were used up to a maximum depth of 1.0m. At each depth increment, 2 samples were collected from a level, horizontal step cut into the side of the soil pit. The samples were carefully trimmed to obtain an accurate volume and polythene end caps were placed over the stainless steel rings to fully retain the sample during transport to the laboratory.

Four types of laboratory instrument were used to analyse the soil samples:

Stage 1. to apply a range of pressures from pF 0 (saturation) to pF 2.0 (-100hPa). Sand is used to convey the suction from the drainage system (controlled by a manometer) to the soil samples (Eijkelkamp, 2005, Klute, 1986)

Stage 2. Eijkelkamp 08.02 Sand/kaolin box to apply a range of pressures from pF 2.0 (-100hPa) to pF 2.7 (-500hPa). Kaolin on sand is used to convey the suction from the drainage system (controlled by an electric pump) to the soil samples. (Eijkelkamp, 2005, Klute, 1986).

Stage 3. Soil Moisture Equipment Corporation 5 bar pressure plate extractor. Compressed air within the pressure vessel forces water from the soil sample through the micro-pores of a ceramic plate. (Soil Moisture Equip. Corp. Operating instructions for the 5 bar pressure plate extractor, 2002, Klute, 1986)

Stage 4. Soil Moisture Equipment Corporation 15 bar pressure plate extractor. Compressed air within the pressure vessel forces water from the soil sample through the micro-pores of a ceramic plate. (Soil Moisture Equip. Corp. Operating instructions for the 15 bar pressure plate extractor 2002, Klute, 1986)

Calibration steps and values

The Eijkelkamp 08.01 Sandbox relies on a given column of water to apply suction to the soil samples and the reference scale is set relative to the sand surface. The Eijkelkamp 08.02 Sand/kaolin box uses a certificated pressure transducer in an enclosed air reservoir to switch a vacuum pump which applies suction to the soil samples. When selecting the required suction, an offset is applied to correct for ambient air pressure. The Soil Moisture Equipment Corporation pressure plates are pressurised using a compressed air source in excess of 15 bar pressure. Pressure in the vessels is set via a single pressure regulator valve for the 15 bar plates and double regulator valves for the 5 bar plate. All equipment is maintained to certified standards. Soil moisture content was determined by weighing a fixed volume of soil at each pressure step, this being the ultimate method of calibration.

Analytical Methods

The samples were stood in a water bath until they reached an equilibrium (saturated) weight. The samples were then placed in 1) a sand bath 2) a sand/kaolin bath 3) pressure vessels set at a range of suctions in order to progressively dry out the samples. Samples were determined to have reached equilibrium when the daily weight difference was < 0.1g. Water-release curves were constructed for each soil depth which indicated the presence two soil types of predominantly clay soil. The two soil types were not found in fixed horizons, but were interleaved which indicates the process of changing soil deposition over time within the flood plain of the River Thames.

Nature and Units of recorded values

Total weight = weight of soil + water weight + weight of sample ring

Soil weight = total weight - weight of sample ring

Water weight = total weight - weight of sample ring – weight of dry soil

MVF (moisture volume fraction) = weight of water / volume of soil sample

NOTE: All weights are in grams (g)

Converting between water potential units: MPa, kPa, Bar and pF

1bar = 100kPa

1Mpa = 1000kPa

-1.0MPa = -10bar

By convention, the upper limit of plant available water is taken as -0.033 MPa (-0.33 bar, pF 2.53[1]).

The lower limit is -1.5 MPa (-1500kPa, -15 bar, pF 4.18) – 'Permanent wilting point'

pF = $\log_{10}$ (negative pressure head in cm of water)

[1]pF is defined as the base 10 logarithm of the suction expressed in cm of water. To convert between MPa and pF, first convert MPa to cm of water. The conversion factor is 10200 cm/MPa. Ignore the negative sign since you can't take the logarithm of a negative number. Now take the base 10 logarithm to get pF. -1 MPa corresponds to pF 4.01.

pF	cm H_2O (hPa)
0	1
1	10
1.5	32
1.8	63
2	100
2.3	200
2.7	500
3.486	3000
3.71	5000
4.185	15000
7	10000000

Quality Control

All sampling and analysis was carried out using recognised procedures. Errors in results resulting from stones or air spaces in the soil samples were minimised through the use of large volume (769.77cm^3) soil cores. Two sets of samples were acquired for each depth in the soil profile which enabled comparisons to be made at each stage of the soil analysis. By plotting both results together, any obvious anomalies in procedure would be readily spotted.

Format of stored data

Comma-separated values (.csv)

Miscellaneous

Soil type

Church Field lies on a clay lens which overlies surrounding sand and gravel soils. Apart from the A and B horizons, the clay was found to be fairly homogenous down to the maximum depth of 1.1m of the access pit. On the 1:250,000 Soil Map of South East England the location falls into the soils category 832 Kelmscott Association which comprise mostly permeable fine loamy soils over limestone gravel and variably affected by groundwater and

with some risk of flooding. However, on the more detailed 1:25,000 scale Sand and Gravel Resources Map of the Thames Valley (IGS Mineral Assessment Report 23, HMSO 1976) the clay lens is depicted as Oxford Clay substrate without sand and gravel cover, surrounded by sand and gravel terraces cropping out at the surface.

Photographs

A series of explanatory images are available though the CEH Image Catalogue. The work was undertaken as part of the CEH SCWAFL project, NEC04396.

REFERENCES

Blake, G.R. and Hartge, K.H., 1986. Bulk Density Procedure. IN: A. Klute (Ed.) 1986, Methods of Soil Analysis, Part 1 – Physical and Mineralogical Methods, Second Edition, Chpt. 13, Section 2.2.1, p366, Soil Soc. of America.

Eijkelkamp 08.01 Sandbox method and 08.02 Sand/Kaolin box method operating instructions, p1-24, Eijkelkamp Agrisearch Equipment B.V., Giesbeek, The Netherlands, June 2005.

Klute, A., 1986. Water retention: laboratory methods. IN: Methods of Soil Analysis, Part 1 – Physical and Mineralogical Methods, Second Edition, Chpt. 26, p635-662, Soil Soc. of America.

Soil Moisture Equipment Corporation Operating Instructions for 5 bar and 15 bar pressure plate extractor, March 2002. Soil Moisture Equipment Corporation, Santa Barbara, USA