

FutMon/ICP Forests Combined Expert Meeting, 12 – 16 January 2009

Combined Meeting of Expert Panels on Soil and Meteorology

Physical soil analysis for water budget modelling (Action D3)

Meeting 12

Hamburg, Germany, Thursday 15 January 2009

Minutes

Bruno De Vos (Chair FSEP) and Stephan Raspe (Chair Meteo)

Agenda: SEE ANNEX 1

Participants: SEE ANNEX 2

Welcome and opening

Bruno De Vos opened the meeting, welcomed the panel members of the two expert panels (EP) and presented the agenda for adoption. The aim of the meeting was to focus on the requirements for physical soil analysis needed for water budget modelling in action D3 of the FutMon project. Since meteo and soil data should be combined at the D3 plots, expert knowledge of both EPs was required and a joint expert meeting seemed therefore logical and essential.

The agenda (Annex I) was adopted without amendments.

Aims and experimental design of the FutMon D3 project

Stephan Raspe, action leader of D3, presented the aims and experimental design of the D3 action on water budgets. He explained that water supply is a key factor for tree vitality, forest condition, nutrient uptake, growth rate and responses to (biotic) stress. The amount of water supply is estimated from water budget measurements and modelling. Action D3 is linked with action D2 (nutrient cycling) and D1 (growth).

Main objectives of D3 are to:

- demonstrate the feasibility of more intensive soil moisture measurements
- collection of (physical) data (soil and meteo)
- development and implementation of water budget modelling on intensive monitoring plots

Specific surveys on D3 plots are required in order to meet these objectives: (1) determination of soil volumetric water content, (2) matric potential, (3) stand precipitation, (4) soil temperature, (5) leaf area index, (6) determination of hydraulic functions and (7) IM1 meteo data. Surveys regarding the variables 1,2 and 6 were tackled in this Meeting 12. The other variables were discussed in Meeting 13 (Expert Panel on Meteo, see these minutes).

Soil physical data is essentially needed for the parameterisation of the water budget models. Stephan Raspe illustrated schematically the general experimental design of D3 plots. Meteo data should be available from the open field nearby a forest D3 plot, or from above the canopy. This is essential to quantify incoming precipitation data for the forest ecosystem. Within the stand gutters are preferred to collect throughfall water and preferentially 5 soil profiles could be assessed for soil moisture measurements according to horizons or layers. The number of profiles and type and number of layers

was discussed later during the meeting. It was stressed that soil moisture measurements, matric potential and soil physical measurements should be determined at the same depths within each profile. Deliverables of this D3 action according to the proposal will be: (i) Data on soil moisture and water fluxes needed to determine soil water availability and drought stress indices, (ii) data for calibration and validation of water budget models and (iii) drought stress indicators (Ta/Tp, Tdiff). Hence, the most important task is harmonised data collection.

The number of FutMon plots assessed in action D3 is 132, but probably 10 extra plots will be added (mainly Switzerland). The distribution of the plots according to forest types is discussed. The number of plots in thermophilous deciduous forest and coniferous Mediterranean forest is low (2 and 6 plots respectively), which may be a drawback, especially for inference of drought stress indicators for these forest types. The spatial variation of the D3 plots shows a high density in central and Western Europe. Southern Europe is underrepresented. Spain is willing to move its D3 plots foreseen in the north towards the south.

Compared proportionally to the level I distribution over forest types, FutMon D3 plots in Beech, Montane Beech, acid. Oak, mesophilous deciduous and Alpine coniferous forest are more represented, but less in nemoral coniferous and boreal forest.

In order to determine reliably soil water retention functions, an interlaboratory physical soil ringtest should be organised for all laboratories involved in action D3. This is foreseen in FutMon and the organisation will be discussed in this meeting.

Google discussion group on Physical soil analysis

Bruno De Vos reported on the status of the dedicated internet discussion forum for soil physical analysis. The google group is called FSEG Soil Physics. At that moment 8 members are registered and a few documents are present. The google group needs further activation. The combined EP decided that:

- the Google discussion group will be the main forum for further discussion on soil physical analysis;
- output of discussions (e.g. drafted guidelines) will be systematically published in the GG;
- exchange of experience and relevant documentation is encouraged;
- problems encountered during the soil water retention ringtest may be announced and discussed using this forum.

Fourteen extra participants of the meeting provided their email address for more information on how to register to the FSEG Soil physics. They were invited shortly after the meeting.

Soil physical analysis for Futmon D3

The data needs for water budget models are listed in Table 1. If BioSoil was assessed on the D3 (or IM1) plots basic information on soil horizons, soil texture, organic carbon content, dry bulk density, coarse fraction (gravel) and maximum rooting depth should be available in the BioSoil database. If not assessed in BioSoil, these data according to fixed depths could be found in the level II soil database and/or other national databases.

Table 1. Overview of required data for water budget models and availability if D3 plots were assessed in BIOSOIL

Data needs for water budget models: variables to be determined

Variable	unit	range	BIOSOIL	
name of horizon			yes (profile)	Mainly available (BIOSOIL)
thickness	mm	1-1000	yes (profile)	
texture:	class			
Mass fraction of sand for fine material	%	0-100	yes (profile)	
Mass fraction of silt for fine material	%	0-100	yes (profile)	
Mass fraction of clay for fine material	%	0-100	yes (profile)	
Mass fraction of organic carbon	%	0-100	yes (profile)	
Dry bulk density including gravel	kg m ⁻³	500-5000	yes (profile)	
Mass fraction of gravel	%	0-100	yes (profile)	
water retention curve:				Target FutMon Action D3
water content at FC (pF 1.8)	Vol%	0-100	no	
water content at PWP (pF 4.2)	Vol%	0-100	no	
Available water capacity (AWC)	mm	10-1000	no	
hydraulic conductivity:				Optional D3 Listing data availability
saturated	cm/d	0-1000	no	
unsaturated	cm/d	0-1000	no	
fine root distribution			visual (profile)	
density / mass	g/cm ⁻³	0-100	no	
or density / length	mm/cm ⁻³	0-100	no	
or density / number	tips/cm ⁻²	0-100	no	

If the basic soil data are not known for the D3 plots, a BioSoil alike survey should be conducted on these plots, since there is written in the proposal: “This action (D3) will only be conducted on plots on which the full set of surveys (including Biosoil soil survey) from Action Group IM1 is carried out” .

Specifically on D3 plots, the target of action D3 is to determine the soil water retention curves in order to estimate the available water capacity at plot level. For the models at least water content at field capacity (FC) and permanent wilting point (PWP) should be determined. Much better is the complete soil water retention curve for each layer/horizon. The combined EP decided not to determine hydraulic conductivity (since it was not mentioned in the proposal) although it may be assessed optionally. The same holds true for the fine root distribution with depth. However, during the FutMon phase I (2009-2010) the existing data availability of root distribution and hydraulic conductivity data for D3 plots will be listed and documented.

Compilation and selection of suitable methods for SWR measurements

Winfried Grimmeisen presented the approach of the LFW (Bayerische Landesanstalt für Wald und Forstwirtschaft) for measuring soil water retention.

The technical implementation of the HYPROP system based on the evaporation method according to Wind and Schindler is clearly described and illustrated.

For this method 250 ml steel cores are applied using soil moisture sensors and tensiometers. The latter enable measurements for matric potentials up to 200 kPa. The EP invites Mr Grimmeisen to take part in the upcoming physical ringtest so that this method may be compared to the conventional systems.

Bruno De Vos presented the determination of the soil water retention curves according to ISO 11274 as the conventional laboratory assessment. Since most soil methods in the ICP forests manual IIIa are based on ISO standards, this method was also suggested for use as the reference method (FutMon lab

protocol). This international standard is available at www.iso.ch and costs 65 euro. The standard describes four assessment methods covering different ranges of soil water pressures and guidelines how to select the most suitable methods. A FutMon draft guideline will be developed and presented end of January in the google group for further discussion.

The combined EP adopts the ISO 11274 as the lab reference standard for the ringtest and measurements on D3 plots. All methods are allowed but method 2 (Determination of soil water characteristic using a porous plate and burette).

The EP decides to use kPa as conventional unit for matric pressure and $\text{m}^3 \text{m}^{-3}$ for volumetric moisture content, in line with ISO recommendations.

Table 2. Mandatory and optional points of the soil water characteristic to determine in action D3, their units and numerical precision.

D3 assessment	Matric Pressure pF/kPa	Moisture content unit	Precision moisture content	Recommended instrument
mandatory	pF0.0 / 0	$\text{m}^3 \text{m}^{-3}$	0.0001	Sand suction table
mandatory	pF1.0 / -1	$\text{m}^3 \text{m}^{-3}$	0.0001	Sand suction table
mandatory	pF1.7 / -5	$\text{m}^3 \text{m}^{-3}$	0.0001	Sand suction table
optional	pF2.0 / -10	$\text{m}^3 \text{m}^{-3}$	0.0001	Sand suction table
mandatory	pF2.5 / -33	$\text{m}^3 \text{m}^{-3}$	0.0001	Kaolin suction table
optional	pF3.0 / -100	$\text{m}^3 \text{m}^{-3}$	0.0001	Kaolin suction table
optional	pF3.4 / -250	$\text{m}^3 \text{m}^{-3}$	0.0001	Ceramic plates
mandatory	pF4.2 / -1500	$\text{m}^3 \text{m}^{-3}$	0.0001	Ceramic plates
mandatory	pF7.0 / -10⁶	$\text{m}^3 \text{m}^{-3}$	0.0001	Oven

After some discussion the combined EP decides to select 6 matric pressures as mandatory for measurement in the lab (Table 2). These matric pressures allow immediate inference of the hydraulic soil properties: maximum water holding capacity (0 kPa), field capacity (-5 or -33 kPa), permanent wilting point (-1500 kPa) and dry bulk density (-10⁶ kPa). Selection of these points enables basic curve fitting according to the Van Genuchten model (or others), but fitting will be more reliable if also the optional points are determined.

The matric pressures match also those of the Hypres database for European (agricultural) soils.

Field sampling scheme for hydrological assessment

A discussion was held on the spatial sampling pattern for the soil moisture measurements and core sampling for determination of the soil water retention curves. Taking into account that most level II measurements were done on fixed depths in the past, and not according to horizons, a compromise was reached on how to harmonise sampling:

- the measurement of soil moisture (using sensors) and the sampling location for the undisturbed sampling for determination of the SWRC should be at the same depths (i.e. same layer, same pedogenetic horizon)

- in each profile measured, at least 3 samples should be taken where each sample/sensor is located in one specific depth interval:
 - 0-20 cm
 - 20-40 cm
 - 40-80 cm
- The exact depth of the measurement (centre of sensor and sample core) with reference the top of the mineral soil (0 cm) has to be reported
- The pedogenetic horizon in which the centre of the sensor and sample core is located has to be reported
- If the forest floor has a thickness > 5 cm a core sample has to be taken also for this holorganic layer and soil moisture measurements are required
- Optionally, deeper layers or specific horizons may be sampled if relevant for hydrological assessment of the profiles.

Preferentially, other measurements (e.g. soil temperature) and soil data (e.g. texture, organic content) should be available at the same depths.

The next discussion was on the spatial implementation within the plot. Since most countries have different experimental designs some basic rules are adopted:

- For each layer (depth) at least 3 replicates per D3 plot at different locations are required. These locations should be representative for the plot (so not in just 1 profile);
- It is up to the countries to define plot design and installation, but the design should be clearly documented;
- The undisturbed soil sampling for determination of the SWRC will be done once in a wet period (soils near field capacity);
- The frequency for soil moisture measurements will be determined by the leader of D3 and the Meteo Expert Panel.

From the discussions it is clear that frequent measurement of soil moisture (more than once a day) requires high capacity dataloggers which are not installed on most D3 plots yet and not always foreseen in the budget of associated beneficiaries.

In the weeks after the meeting, this plot design, especially the three replicates per sampling depth for soil moisture measurements and the daily measurements received much criticism (Denmark, Flanders, Italy) as the project proposal did not foresee sufficient budgetary space to purchase such a high number of TDR instruments and dataloggers. Therefore it was made clear that during the current FutMon project countries are encouraged to follow the new proposal as close as possible. For the planned FutMon II project, however, the present field protocol will be mandatory.

Guidelines and reporting

The FSCC and the EP on Meteo will jointly develop data formats for reporting of the survey data.

For the soil water retention characteristic, for each soil layer both raw data (data of Table 2) and derived hydrological data (bulk density, FC, PWP, Van Genuchten parameters) will be stored in the FutMon database.

Reporting guidelines will be mentioned in the measurement protocols.

Soil physical ringtest

During FutMon, the first physical soil interlaboratory ringtest for determination of the soil water characteristic will be organised. In the initial project proposal for five years, it was planned to conduct the laboratory assessments on the D3 plots after the results of the ringtest would be available and discussed. This would enable countries to select the best performing labs for their D3 assessment. But since the project runs only for 2 years, the initial time table is not realistic and the partners are encouraged to start the field sampling and analysis in 2009. This ring test will then provide information on the actual quality of the data.

Following rules for implementation of the ringtest were adopted:

- Participation in the ringtest is mandatory for all D3 associated beneficiaries (#23)
- Participation is optional for other EU and non-EU countries
- Each associated beneficiary selects and suggests a physical laboratory for participation in the ringtest
- The coordination and organisation of the ringtest is done by the FSCC
- All registered labs follow strictly the timetable provided by FSCC
- Participating labs send in their own empty steel rings to FSCC (dimensions of rings allowed according to protocol)
- Labs will receive their own steel rings with compacted soil reference material for water retention analysis
- Labs will submit their retention data according to the reporting format in time to FSCC
- FSCC will report on the ringtest results in time using the same ISO methodology as for chemical soil ringtests

FSCC will prepare for each lab 5 replicates of a test sample based on one single soil texture. In future ringtests, after the problem solving of the first ringtest and further finetuning of procedures a ringtest can be organised with different soil materials.

Initial testing using a hydraulic compression technique in the field with real life soil samples revealed acceptable variation among sample cores (CV of dry bulk density of different cores was typically less than 3 %). The approach for making the test samples is accepted by the panel.

The timetable for the physical ringtest is given in Table 3. Some EP members indicate that time is short for finding a suitable laboratory for physical analysis. Nevertheless the deadlines for performing the ringtest are accepted. During the weeks after the meeting, FSCC was contacted by some associated beneficiaries to provide more time in finding a suitable laboratory. See the amendments in Table 3.

The evaluation of results will be performed according to the same ISO methodology as for chemical soil ringtest. This comprises assessment of between lab reproducibility and within lab repeatability (=measurement uncertainty).

Table 3. Timetable for the soil physical ringtest

Deadline	Action
15.01.09	Announcement of ringtest
20.02.09	Invitation by email & start of registration – method is clear (adopted during Meeting 12) – reporting format is ready
27.03.09	Deadline for registration via FSCC
31.03.09	Deadline for sending empty steel rings (containers)+ covers to FSCC (registered labs only)
15.04.09	Final deadline for sending ringtest samples to the labs
15.08.09	Deadline for reporting ringtest results to FSCC
30.09.09	Report available on-line at FSCC homepage
October 2009	Presentation and discussion of results at meeting of Heads of the labs

In blue: updated after the meeting based on difficulties in finding suitable laboratories

Based on the results, determination of tolerable limits based on lab performance will be discussed in the QA/QC working group and suggested to the EPs.

The overall laboratory performance for the ringtest will also be discussed during the meeting of head of the labs in Poland.

Closing of the meeting

The chairs explain that they will bring the main conclusions of the joint meeting to the plenary session on Friday 16/01 afternoon. Minutes of the meeting will be spread before the end of the month.

The meeting was closed at 12:40 h.

FutMon Combined Expert Panel Meeting

Expert Panel on Soil and Soil solution

Expert Panel on Meteo

Meeting 12

Annex I: AGENDA

Thursday 15th January 2009: 8:30 – 12:30

8:30 Opening and focus of the meeting (B. De Vos, S. Raspe, J. Derome)

8:40 - 9:00 Aims and experimental design of the FutMon D3 project (S. Raspe)

9:00 - 9:10 Google discussion group on Physical soil analysis: status report (De Vos)

9:10 – 10:20 Soil physical analysis for Futmon D3

- Data needs for water budget models: variables to be determined
- Compilation and selection of suitable methods
 - Hydrological methods: a measurement system for all hydraulic parameters needed for water budget modelling (W. Grimmeisen)
 - Laboratory assessments: determination of soil water retention curve according to ISO 11274 (B. De Vos)
- Discussion on methods

10:20 – 10:45 Coffee Break

10:45 – 11:30 Guidelines and reporting (S. Raspe & De Vos)

- Data elaboration – pedotransfer functions
- Drafting guidelines for testing in D3
- Data handling and storage

11:30 -12:30 Soil physical ringtest (B. De Vos & N. Cools)

- Rules for implementation
- Test Sample preparation and sending
- Timetable
- Evaluation of results

Annex II: List of participants to Meeting 12 and/or 14

First Name	Name	Country	Email	Survey
Franz	Mutsch	Austria	franz.mutsch@bfw.gv.at	soil
Karl	Gartner	Austria	karl.gartner@bfw.gv.at	meteo
Nathalie	Cools	Belgium	nathalie.cools@inbo.be	soil
Bruno	De Vos	Belgium	bruno.devos@inbo.be	soil
Vit	Šrámek	Czech Rep.	sramek@vulhm.cz	meteo
Vera	Fadrhonsová	Czech Rep.	fadrhonsova@vulhm.cz	
Lars	Vesterdal	Denmark	lv@life.ku.dk	soil
Endla	Asi	Estonia	endla.asi@metsad.ee	soil
John	Derome	Finland	John.Derome@metla.fi	soil
Egbert	Beuker	Finland	egbert.beuker@metla.fi	
Erwin	Ulrich	France	erwin.ulrich@onf.fr	soil
Nils	König	Germany	Nils.Koenig@nw-fva.de	laboratory
Henning	Meesenburg	Germany	henning.meesenburg@nw-fva.de	soil
Nicole	Wellbrock	Germany	nicole.wellbrock@vti.bund.de	soil
Winfried	Grimmeisen	Germany	gri@lwf.uni-muenchen.de	meteo
Stephan	Raspe	Germany	ras@lwf.uni-muenchen.de	meteo
Oliver	Granke	Germany, vTI	oliver.granke@vti.bund.de	vTI
Richard	Fischer	Germany, vTI	richard.fischer@vti.bund.de	vTI
Susanne	Iost	Germany, vTI	Susanne.iost@gmx.de	vTI
Panagiotis	Michopoulos	Greece	mipa@fria.gr	soil
Miklós	Manninger	Hungary	manningerm@erti.hu	meteo
Fiona	Harrington	Ireland	Fiona.harrington@coillte.ie	soil
Guia	Cecchini	Italy	guia.cecchini@unifi.it	soil
Stefano	Carnicelli	Italy	stefano.carnicelli@unifi.it	soil
Giuseppe	Parisi	Italy	g.parisi@corpoforestale.it	meteo
Dagnija	Lazdina	Latvia	dagnija.lazdina@silava.lv	soil
Arta	Komorovska	Latvia	arta.komorovska@silava.lv	soil
Albertas	Kasperavicius	Lithuania	alber_k@lvmi.lt	meteo
Pawel	Lech	Poland	P.Lech@ibles.waw.pl	meteo
Lucian	Dinca	Romenia	biometrie@icas.ro	soil
Radu	Cenusa	Romenia	biometrie@icas.ro	meteo
Maria	Orlova	Russia	mashunyaorlova@gmail.com	soil
Pavel	Pavlenda	Slovakia	pavlenda@nlcsk.org	soil
Anna	Stancikova	Slovakia	stancikova@nlcsk.org	soil
Zuzana	Sitkova	Slovakia	sitkova@nlcsk.org	meteo
Marko	Kovac	Slovenia	marko.kovac@gozdis.si	soil
Tom	Levanic	Slovenia	tom.levanic@gozdis.si	meteo
Ana	de la Cruz	Spain	calleja@inia.es	soil
Mayte	Minaya	Spain	minaya@inia.es	meteo
Lars	Lundin	Sweden	Lars.Lundin@ma.slu.se	soil
Elisabeth	Graf Pannatier	Switzerland	elisabeth.pannatier@wsl.ch	soil
Marcus	Schaub	Switzerland	marcus.schaub@wsl.ch	meteo
Matthias	Dobbertin	Switzerland	dobbertin@wsl.ch	meteo
Andrew	Moffat	UK	andy.moffat@forestry.gsi.gov.uk	soil
Matt	Wilkinson	UK	matthew.wilkinson@forestry.gsi.gov.uk	meteo