FACCE-MACSUR

Task C1.3: Data format for model in- and output

Task leader: T. Palosuo* (P92)
Partner involved:
K.C. Kersebaum (P147)
C. Kollas (P147)
C. Nendel (P147)
M. Bindi (P62)
J.E. Olesen (P189)
M. Trnka (P17)
R. Rötter (P92)

[1] MTT Agrifood Research Finland, Mikkeli, Agrosystems Modelling Group (P 92)

*taru.palosuo@mtt.fi

Deliverable type: Report
File name: Report WP1 task C1.3.docx
Deliverable reference num.: C1.3

Instrument:	Joint Programming Initiative
Topic:	Agriculture, Food Security, and Climate Change
Project:	Modelling European Agriculture with Climate Change for Food Security (FACCE-MACSUR)
Due date of deliverable:	month 6
Submission date:	2013-04-20
Start date of project:	1 June 2012
Duration:	36 months
Deliverable lead partner:	K.C. Kersebaum
Revision:	1.0
Work Package:	CROPM 1.3
Document ref number:	C1.3 v1.0

Abstract

A common format for model input variables and model output variables has been defined to be distributed to modellers participating in the model inter-comparison and improvement. The aim of common formats is to support the communication between the modellers, those providing empirical data of the experiments and those analysing the simulation results. The input format facilitates the model application in a way that each cropping-system to be modelled will be defined in the same way. Data will be delivered in EXCEL sheets with sub-tables for each block of inputs. Tables are mostly organized in a way that allows export and sequential read-in by the models. The common output format enables effective processing of results estimating model performance indicators.

Table of Contents

Task C1.3: Data format for model in- and output i
Abstract 1
Table of Contents 1
Introduction 2
Methods 3
Discussion 7
Acknowledgements 7
References 8

Introduction

The crop modelling community dealing with a model inter-comparison study will lance several steps of preparation: The research question has to be defined, crops or cropping systems have to be identified, suitable models will be selected and an appropriate experimental agricultural dataset will be selected. Experience from former model inter-comparison studies showed that it was beneficial to define a common data in- and output format, which facilitates both, the data processing on the modeller`s side as well as the work-flow on the side of the result processing. Common format also supports the communication and reduces the misinterpretations on all sides. Both sides demand a format that is a) comprehensive, b) precisely defining units, dates and treatments, c) easy to understand, d) simple to reproduce, to export and at best sequentially readable by computer programs. The format reported here for CropM WP1 model-intercomparison studies has been defined in close collaboration with WP 2.

Methods

The formats for data in- and output were developed based on the former COST 734 and AgMIP protocols and formats (Palosuo et al. 2011, Rötter et al. 2012, Asseng et al. 2013). The former formats have been adapted due to the sequences of crops in rotations that will be modelled. Experiences gathered in above mentioned studies have been exploited to achieve formats as clear and easy to understand as possible. Lists of crops and their cultivation data, tillage, fertilisation and irrigation are given in a vertical sequence to be easily readable. The number of lines is always given in the header to enable automatic read-in. Weather data are given as daily values covering the input requirements of most of the models.

The results of the development of in- and output data format is reported in two EXCEL® files uploaded to the MACSUR web site:

http://macsur.eu/index.php/internal-documents/CropM/model_input_conventionVer1.xlsx

http://macsur.eu/index.php/internal-documents/CropM/model_output_conventionVer1.xlsx

Results

Input and management format

On the basis of the requirements of crop modelling, the input format was organised according to the following subjects, represented in “sheets” within an Excel-file (Fig. 1):

1. **Cultivation**
   First, this sheet (Fig. 1) provides detailed information about the dataset, such as the unique dataset identifier, the publisher, the location with geographic coordinates and altitude and time of creation. Second, specifications concerning the species and sequence of crops within the rotation are given. For each crop sowing and harvesting dates, sowing depth and density, and removal or remain of residues are defined. Additionally, information about the surface remained residues from a previous crop not included in the crop rotation sequence is provided.

2. **Fertilisation**
   In that sheet dates, amounts (kg N ha^{-1}) and types of nitrogen fertilizer applications are listed.

3. **Tillage**
   The sheet contains information on dates, depth (cm) and type of tillage.

4. **Irrigation**
   The sheet describes dates and amounts (mm) of irrigation given.

5. **Phenology**
   Here, phenological stages following BBCH code and the date of accomplishment per crop species can be defined. Important stages for cereals are pre-defined. However, the list can be extended by other relevant stages for other crops

6. **Soil profile**
   The sheet provides important soil characteristics layer by layer. Thickness of each layer is defined by the depth of the lower layer boundary. For each layer the texture (sand, silt, clay %), bulk density, stone content, pH, values for wilting point, field capacity and total pore space, organic carbon content, C:N-ratio are provided (if data are available). An estimation of rooting depth is also included for the whole profile. Additional information is provided concerning the texture classification system as boundaries between fractions can vary between these systems.

7. **Initial values**
   The soil water content and mineral soil nitrogen amount can be provided for different layers. Preferably values should be close to the date of sowing of the crops. Initial values can be given only at the beginning of the crop rotation for model runs over the whole rotation or for each crop of the rotation as initial values for single crop simulations.

8. **Crop codes**
   Abbreviations (3 digit code), Latin names and use of the most important crops used in the cultivation sheet are given here. New crop codes can be added here if required. Explaining comments are possible for each crop.

9. **Fertilizer codes**
   This sheet contains abbreviations (3 digit code) of fertilizers. New fertilizer codes can be added here if required. For each fertilizer the percentage of mineral N and

organic N from total N content is defined. Ammonia and urea percentage from mineral N content is also provided.

10. **Weather variable explanation**
    Daily weather variables are given for the time of the experiment. In the header, coordinates and altitude of the weather station is given which might be different from the experimental site. Also height of wind measurement is provided. The weather variables comprise: precipitation (mm, daily sum), minimum and maximum temperature (°C), radiation (J/cm^{-2}, daily sum), wind speed (m sec^{-1}, average), relative humidity (%, daily average), vapour pressure (kPa) and dew point temperature (°C). Sunshine duration might be used if global radiation measurements are not available. Conversion to radiation data should be done uniformly by the data distributers to ensure that all modeller work with the same data.

Name_dataset	Netherl_AA3						Unique dataset identifier
Contact_person	chris.kollas@zalf.de						Person to which questions concerning this dataset should be addressed
Publisher	Mustermann						Author of the dataset
Year_first	1981						Starting year of the experiment
Number_of_years	3						Duration of the experiment
Name_location	Wageningen						Common name of the location where the experiment took place
X_location	53.12						Coordinates of the experiment in Geographic coordinate system, decimal degrees
Y_location	7.15						
Altitude (m)	569						Elevation of the experiment
	pre-crop	**residue (kg C/ha)**	**C/N ratio**	**date**			Agricultural residues from the the season before experiment startet, at the soil surface
Initial_surface_residue	potato	4000	10	30.09.1980			Origin (crop) of the residual, amount (Kg C/ha), cn-ratio, day of application(YYYYDOY))
Crop_rotation							
Number_crops_in rotation	3						Number of crops within the rotation
crop	**cultivar**	sowing date	Plants per m^2	sowing depth (cm)	harvest date	residues	
WHB	Cubus	17.10.1980	25	3	07.08.1981	1	Chronological sequence of crops,see crop_code table
SBT	Alabama	10.04.1982	50	5	12.10.1982	0	residues: 0 = exported, 1= remaining, 2 = complete crop remains
MAZ	DKC2960	20.04.1983	5	5	18.09.1983	1	

cultivation / fertilisation / tillage / irrigation / phenology / soil_profile / initial_values / crop_codes / fertilizer_codes / weather variables

Fig. 1: Example of model input format

Output format

The requirements of expected result analysing led to the following two temporal aggregations, represented in “sheets” within an EXCEL®-file (Fig. 2):

1. **Annual crop summary**

   The sheet is used to identify the modelled dataset, the model used, and the editor. For each crop within the rotation it provides several status variables at relevant stages or at end-of-the-season. The output comprises: final yield (t ha^{-1}, dry matter), above ground biomass at anthesis and maturity (t ha^{-1}, dry matter), maximum LAI, date of anthesis and maturity, total nitrogen in above ground biomass at anthesis and maturity and final grain N (kg N ha^{-1}), number of grains m^{-2}, cumulative values (rotation: sowing first crop to harvest last crop; single crop: sowing to harvest) for percolation and actual ET (mm), nitrate leaching, denitrification, N volatilisation, N minaralisation and immobilisation (kg N ha^{-1}), plant available water (mm) and soil mineral nitrogen (kg N ha^{-1}) down to maximum rooting depth at maturity. If available, organic carbon content in top soil (kg C ha^{-1} until tillage depth) can be provided.

2. **Daily dynamics**

In that sheet day-by-day outputs of output variables shall be listed for the whole simulation period. The daily output comprises: weight of storage organs and above ground biomass (t ha^{-1}, dry matter), LAI, occurrence of simulated development stages (BBCH), total nitrogen in above ground biomass and in storage organs (kg N ha^{-1}), number of grains m^{-2}, cumulative values for percolation and actual ET (mm), nitrate leaching, denitrification, N volatilisation, N mineralisation and nitrogen immobilisation (kg N ha^{-1}), plant available water (mm) and soil mineral nitrogen (kg N ha^{-1}) down to maximum rooting depth and for a pre-defined depth of measurement (to be comparable to observed values).

CropM crop_rotation_experiment

Name_dataset	Netherl_AA3			Unique dataset identifier
Year_first	1981			Starting year of the experiment
Number_of_years	3			Duration of the experiment
Name_location	Wageningen			Common name of the location where the experiment took place
Crop_sequence	WHB	SBT	MAZ	Chronological sequence of crops,see crop_code table
Modeller_name	Mustermann			Person to which questions concerning this dataset should be addressed
Modeller_email	muster@mann.de			
Model_version	SIMFO 1.1			Model name and Version
Temporal_resolut	daily			Temporal resolution of this output sheet

Crop	**Info_level**	**Location**	**yield d.m.** (t/ha)	at_anthesis **Above-ground_biomass** (t/ha)	at_maturity **Above-ground_biomass** (t/ha)	**Max_LAI** (-)	**Anthesis_date** (YYYYDOY)	**Maturity_date** (YYYYDOY)	**Cumulative N-leached** (kg N/ha)	**Cumulative water_loss** (mm)	at anthesis **Total_above-ground_N** (kg N/ha)
WHB	low	Netherlands	na	na	na	na	na	na	na	na	na
SBT	low	Netherlands	na	na	na	na	na	na	na	na	na
MAZ	low	Netherlands	na	na	na	na	na	na	na	na	na

annual_crop_summary / daily_dynamics

Fig. 2: Example of model output format

Discussion

The model in- and output formats presented here have been discussed among WP1 and WP2 leaders, which agreed on this compilation. Data format of measured state variables from the experiments which will be used for comparison with simulated outputs and later for calibration/validation will use the same format as the model output files. As this deliverable is very technical it is not planned to publish this in a journal. Data formats will be further modified, if needed, during the model-intercomparison exercises.

Acknowledgements

We thank all the CropM partners contributing to the discussion of the formats.

This paper is a contribution to the FACCE MACSUR knowledge hub.

The work was funded by Federal Ministry of Agriculture and Nutrition (BLE) Germany, Finish Ministry of Agriculture and Forestry and Academy of Finland via the FACCE MACSUR knowledge hub.

References

ASSENG, S., EWERT, F., ROSENZWEIG, C., JONES, J.W., HATFIELD, J.L., RUANE, A., BOOTE, K.J.,THORBURN, P., RÖTTER, R.P., CAMMARANO, D., BRISSON, N., BASSO, B., MARTRE, P., AGGAR-WAL, P.K., ANGULO, C., BERTUZZI, P., BIERNATH, C., CHALLINOR, A., DOLTRA, J., GAYLER, S.,GOLDBERG, R., GRANT, R., HENG, L., HOOKER, J., HUNT, T., INGWERSEN, J., IZAURRALDE,C., KERSEBAUM, K.C., MÜLLER, C., NARESH KUMAR, S., NENDEL, C., O'LEARY, G., OLESEN,J.E., OSBORNE, T.M., PALOSUO, T., PRIESACK, E., RIPOCHE, D., SEMENOV, M., SHCHERBAK,I., STEDUTO, P., STÖCKLE, C., STRATONOVITCH, P., STRECK, T., SUPIT, I., TAO, F., TRAVASSO,M., WAHA, K., WALLACH, D., WHITE, J., WILLIAMS, J.R., WOLF, J., 2013. Quantifying uncertainties in simulating wheat yields under climate change. Nature Climate Change, in press.

PALOSUO, T., KERSEBAUM, K.C., ANGULO, C., HLAVINKA, P., MORIONDO, M., OLESEN, J.E., PATIL, R.H., RUGET, F., RUMBAUR, C., TAKÁČ, J., TRNKA, M., BINDI, M., ÇALDAĞ, B., EWERT, F., FERRISE, R., MIRSCHEL, W., ŞAYLAN, L., ŠIŠKA, B., RÖTTER, R. (2011) Simulation of winter wheat yield and its variability in different climates of Europe: A comparison of eight crop growth models. European Journal of Agronomy, 35: 103- 114

RÖTTER R.P., T. PALOSUO, K.C. KERSEBAUM, C. ANGULO, M. BINDI, F. EWERT, R. FERRISE, P. HLAVINKA, M. MORIONDO, C. NENDEL, J.E. OLESEN, R.H. PATIL, H, F. RUGET, J. TAKÁČ, M. TRNKA (2012). Simulation of spring barley yield in different climatic zones of Northern and Central Europe: A comparison of nine crop models. Field Crops Research, 133: 23-36