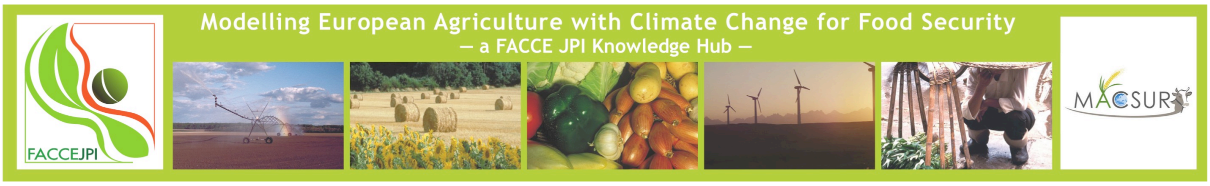

FACCE-MACSUR

Datasets classification and criteria for data requirements

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Abstract/Executive summary

This deliverable focuses on the collation, screening, and consolidation of data for selected grassland sites in Europe and peri-Mediterranean regions.

Table of Contents

Introduction

Pasture growth simulation models are a major part of integrated agro-ecosystem models, which are applied to support decision making at different spatial and temporal scales. Applications range from field to global scales, targeting the evaluation of management and policy options. With increasing spatial extent of the area under investigation, input data for mechanistic grassland and livestock models are scarce and uncertain and data to test relevant state variables are insufficiently available. There is also an increasing demand by both model users and decision makers for analysis of the robustness of models and the uncertainties of model results. The bulk of pasture and livestock models faces with a range of continuously evolving environmental conditions (e.g. greenhouse gas emissions, extreme weather events), which can also be substantially different from those under which these models have been originally developed and evaluated. Currently there are climate data being generated for the 5th Report of the Intergovernmental Panel on Climate Change, in a large scale and well-coordinated effort in an attempt to describe and maybe to narrow uncertainties in future climate projections. However, such projections are often fed into impact models that in some cases have not been properly evaluated with experimental data concerning unprecedented climate and atmospheric CO_2 conditions, have seldom been inter-compared and for which the uncertainties in estimates can thus be large. Efforts have been limited at global scale to evaluate grassland and livestock models across the same datasets with the purpose to identify uncertainties. Also there has been little focus on methodologies for applying these models across a range of spatial scales and for coupling them with socio-economical models.

Supporting climate change impact studies include an up-to-date geographical coverage of climate, soil and vegetation data, and access to secondary information (e.g. soil information obtained via transfer functions from the primary data), as associated with changes in management options.

Grassland datasets

Nine datasets were collected on permanent grassland sites either from multi-year field experiments or observational studies (Table 1). They cover a broad gradient of geographic and climatic conditions in Europe and peri-Mediterranean regions as well as a variety of management practices.

Table 1. List of permanent grassland sites.

Site	Latitude	Longitude	Elevation (m a.s.l.)	Notes
Laqueuille, France	45°38’ N	02°44′ E	1040	Flux-tower grazed site, either extensively or intensively managed
Oensingen, Switzerland	47°17′ N	07°44′ E	450	Flux-tower mowed site, established on a ley-arable rotation
Monte Bondone, Italy	46°00′ N	11°02′ E	1500	Flux tower Alpine hay meadow with occasional grazing in late autumn
Grillenburg, Germany	50°57° N	13°30’ E	380	Flux-tower mowed, extensively managed site
Kempten, Germany	47°43° N	10°20’ E	730	Experimental sward with different levels of nitrogen and cutting management
Lelystad, The Netherlands	52°30’ N	05°28’ E	-4	Experimental sward with alternative nitrogen management options
Matta, Israel	31°42’ N	35°03’ E	620	Dwarf shrubland in association with herbaceous annual species
Rothamsted, United Kingdom	51°48° N	00°21’ E	128	Experimental sward with alternative nitrogen management options
Sassari, Italy	40°39’ N	08°21’ E	68	Mixed Mediterranean grassland with

The grassland sites of Table 1 are described in LiveM deliverable L.2.1.1. Further details are supplied in Table 2 with respect of the usability of datasets (in terms of both inputs and outputs) for model-based analyses and testing. This is essential to permit development of a uniform protocol for handling model inter-comparison and evaluating skills of alternative models in simulating relevant processes in grassland-livestock production systems.

Input data: gap filling

Gaps in weather and soil data collection were filled using a scheme of expert rules or transfer functions making use of one or more readily available data to estimate values of a missing variable (e.g. Acock and Pachepski, 2000; Pachewksi and Rawls, 2004; Donatelli et al., 2010).

For small gaps in weather data series, estimations were made using data from before and after the day with no data (Kempten, Germany; Matta, Israel; Rothamsted, United Kingdom; Sassari, Italy). Relative humidity was estimated at Matta (Israel) via an empirical relationship with the available air temperature data, supplied by Linacre (1992) and based on a parameterization by Pérez et al. (1994). At Rothamsted (United Kingdom), relative humidity was derived by measured data of actual vapour pressure and temperature (Tetens, 1930). At Matta (Israel), measured data of maximum daily wind speed were converted into mean daily wind speed using a cyclical daily function based on daylight estimates (Porter et al., 2000). At this site, a model based on Bristow and Campbell (1994) was used to calculate daily solar radiation based on daily temperature range and a parameterization supplied with RadEst software (through http://www.sipeaa.it/tools/RadEst/RadEst.htm) for a nearby site (Tel Hadya, Syria, 36°40' N; 37 ° 20'; 390 m a.s.l.).

Daily mean values of relative humidity and temperature were available at Lelystad (The Netherlands), which were used to generate maximum and minimum daily temperatures (based on Tetens, 1930). Wind speed data were missing at Sassari and they were replaced with data taken at Alghero airport (40°38' N; 8°18' E; 23 m a.s.l.), located at about 10 km away from the experimental site (small gaps were filled in by interpolation).

As textural components (sand, silt and clay) were available from soil surveys at Lelystad (The Netherlands), Matta (Israel), Rothamsted (United Kingdom) and Sassari (Italy), pedotransfer functions were used to add value to this basic information by translating it into estimates of other soil properties functions. According to Saxton et al. (1986), sand and clay fractions were used to determine soil hydraulic characteristics such as water content at field capacity, permanent wilting point and saturation, as well as hydraulic conductivity and bulk density. For Lelystad (The Netherlands), bulk density data were available and were used to estimate some missing components of soil texture.

Both transfer functions and expert rules have been flagged in Table 2 to provide an indication of the quality and uncertainties associated with the input data used in the modelling exercise.

Output data

Flux-tower sites are the most data-rich grasslands in Europe. Each of these sites is equipped with an eddy covariance system to determine the net ecosystem exchange (NEE) of CO_2. They thus allow covering a variety of components of grassland ecosystem, including gross primary production (GPP), an estimate of the plant production of organic compounds from atmospheric CO_2, and ecosystem respiration (RECO), the latter playing an important role to estimate global carbon balances of terrestrial ecosystems (NEE = GPP - RECO). At two sites, Oensingen (Switzerland) and Monte Bondone (Italy), data are also available of leaf area index (LAI). Calculated as one sided green leaf area per unit ground area, LAI is a measure of the plant light use capacity, which is basic to prediction of photosynthetic primary production, evapotranspiration and vegetation growth. The biophysical knowledge

of the grassland ecosystem is complemented at flux-tower sites with two soil variables, water content and temperature, and actual evapotranspiration, the latter being the major loss flux of water from the system (depending on both air and ground surface temperatures).
Other sites essentially focus on grass yield, the amount of dry matter biomass that is removed from the field at each cutting event, that is, simultaneous removal of carbon and nitrogen from mown and mown/grazed grassland systems. Each of these sites strengthens the ability to model different grassland systems while expanding geographical coverage and the variety of management options tested.

Table 2. Database of permanent grassland sites with associated information.

Coloured cells indicate that a complete series was constructed by interpolating across the observations (yellow), estimating missing variable values based on the available values of surrogate variables (red), replacing missing values with values from another site in the area (orange). Different approaches were applied in association if needed.

Type of data	Laqueuille (France)	Oensingen (Switzerland)	Monte Bondone (Italy)	Grillenburg (Germany)	Kempten (Germany)	Lelystad (The Netherlands)	Matta (Israel)	Rothamsted (United Kingdom)	Sassari (Italy)
	Permanent grassland sites								
	Flux-tower sites				**Other sites**				
	Input data								
Site description	X	X	X	X	X	X	X	X	X
Years	2004-2010	2008-2008	2003-2010	2004-2008	2004-2009	1994-1998	2007-2011	1981-2011	1983-1988
Climate	X	X	X	X	X	X	X	X	X
precipitation	hourly	hourly	hourly	hourly	daily	daily	daily	daily	daily
relative humidity or vapour pressure	hourly	hourly	hourly	hourly	daily	daily	daily	daily	daily
temperature (max, min)	hourly	hourly	hourly	hourly	daily	daily	daily	daily	daily
solar radiation	hourly	hourly	hourly	hourly	daily	daily	daily	daily	daily
wind speed	hourly	hourly	hourly	hourly	daily	daily	daily	daily	daily
Soil	X	X	X	X	X	X	X	X	X
depth	X	X	X	X	x	x	x	x	x
layers	X	X	X	X	x	x	x	x	x
texture	X	X	X	X	x	x	x	x	x
hydrologic properties	X	X	X	X	x	x	x	x	x
Management	X	X	X	X	X	X	X	X	X
Cutting / grazing	X	X	X	X	x	X	X	X	X
Nitrogen fertilization	X	X	X	X	x	X	X	X	X
	Output data								
Carbon fluxes (daily)	X	X	X	X					
Gross primary productivity	X	X	X	X					
Net ecosystem exchange	X	X	X	X	-	-	-	-	-
Ecosystem respiration	X	X	X	X					
Energy fluxes (daily)	X	X	X	X					
Actual evapotranspiration	X	X	X	X					
Soil temperature (top 10 cm)	X	X	X	X	-	-	-	-	-
Soil moisture (top 10 cm)	X	X	X	X					
Plant growth (occasional)	X	X	X	X	X	X	X	X	X
Harvested aboveground biomass	-	-	-	-	x	x	x	x	x
Standing aboveground biomass	X	X	X	X	-	-	-	-	-
Leaf area index	-	X	X	-	-	-	-	-	-

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