EU H2020 - MOSES innovation action

CRITeRIA TUTORIAL 1.0

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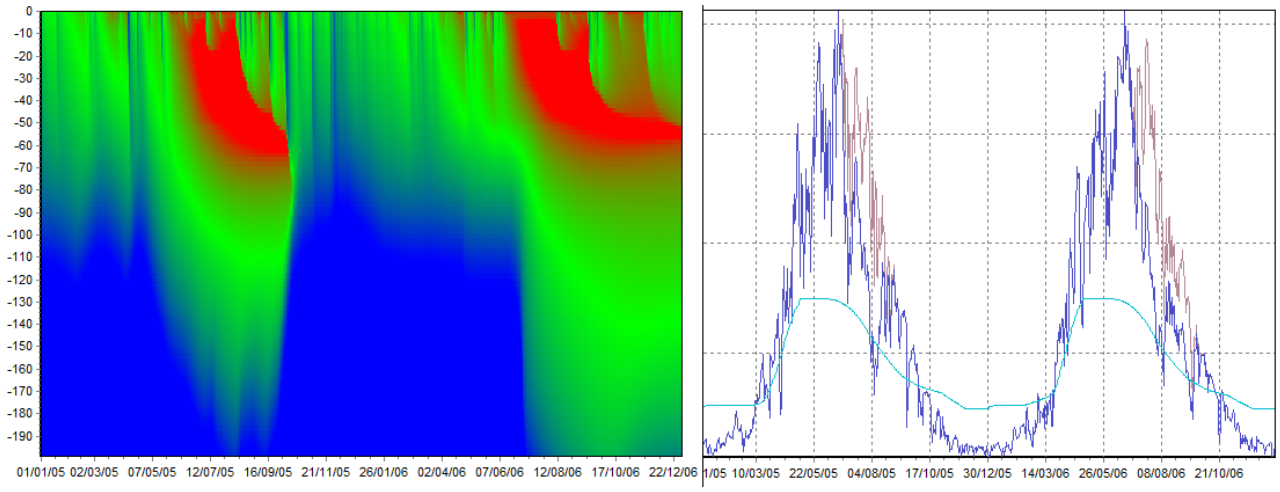


Arpae, February 2016

Sommario

AIM OF THE PRESENT DISTRIBUTION

The MOSES platform includes water balance and crop development procedures based on the CRITeRIA model. All the MOSES partners involved in the setup of DAs are invited to install the CRITeRIA model and to test it on local case studies in order to carry out a first calibration of the parameters using local data (crops, soils and weather data typical of each MOSES DA).

To foster this task, Arpae has provided:

- an installation package of CRITeRIA in English version;
- a MOSES test project with some examples of case studies;
- a technical and a user manual, available into the directory: ..\CRITeRIA\Documents.

The aim of this tutorial is to explain in few steps the main features of CRITeRIA case studies, how to create a case study, how to calibrate crop and irrigation parameters and how to check simulation results.

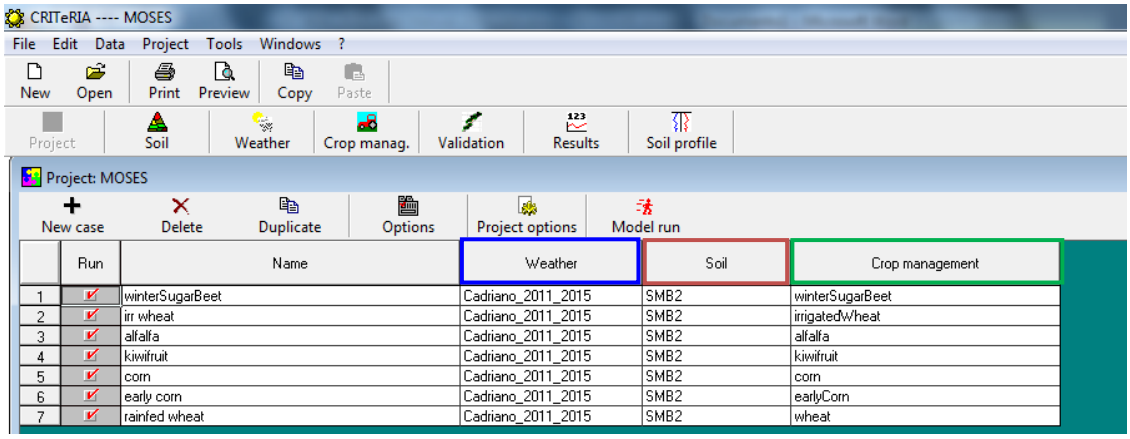
HOW TO INSTALL CRITeRIA

1) unzip CRITeRIA_SETUP.zip
2) run setup.exe
3) ONLY for Windows7: during the installation, change the installation directory in C:\CRITeRIA
4) after the installation go to the directory: ..\CRITeRIA\caseStudies and unzip in the same directory ('extract here') the two test projects: *kiwifruit.zip*, *MOSES.zip*. Two new folders named **kiwifruit** and **MOSES** will be created.

WHAT IS A CRITeRIA CASE STUDY ?

A CRITeRIA case study is composed by 3 data sources: **weather** data (blue rectangle in the figure), **soil** data (red) and **crop management** data (green). As shown in the image below, each case study is identified by a number and a name.

Once opened the MOSES test project, a main window will be displayed where some test case studies are listed.



	Run	Name	Weather	Soil	Crop management
1	✓	winterSugarBeet	Cadriano_2011_2015	SMB2	winterSugarBeet
2	✓	irr wheat	Cadriano_2011_2015	SMB2	irrigatedWheat
3	✓	alfalfa	Cadriano_2011_2015	SMB2	alfalfa
4	✓	kiwifruit	Cadriano_2011_2015	SMB2	kiwifruit
5	✓	corn	Cadriano_2011_2015	SMB2	corn
6	✓	early corn	Cadriano_2011_2015	SMB2	earlyCorn
7	✓	rainfed wheat	Cadriano_2011_2015	SMB2	wheat

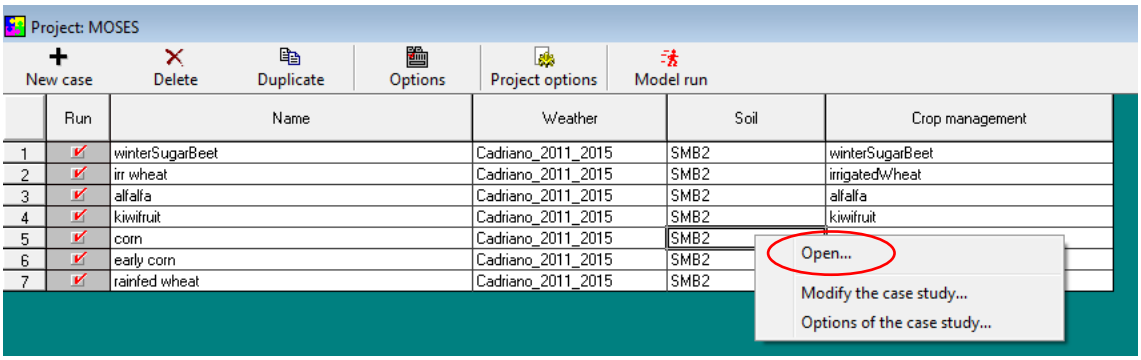
CRITeRIA case study framework

The data of weather, soil and crop management that you'll find in the MOSES test project are provided as example by Arpae and they should be substituted with specific case study data for each DA.

HOW TO MODIFY A CRITeRIA CASE STUDY

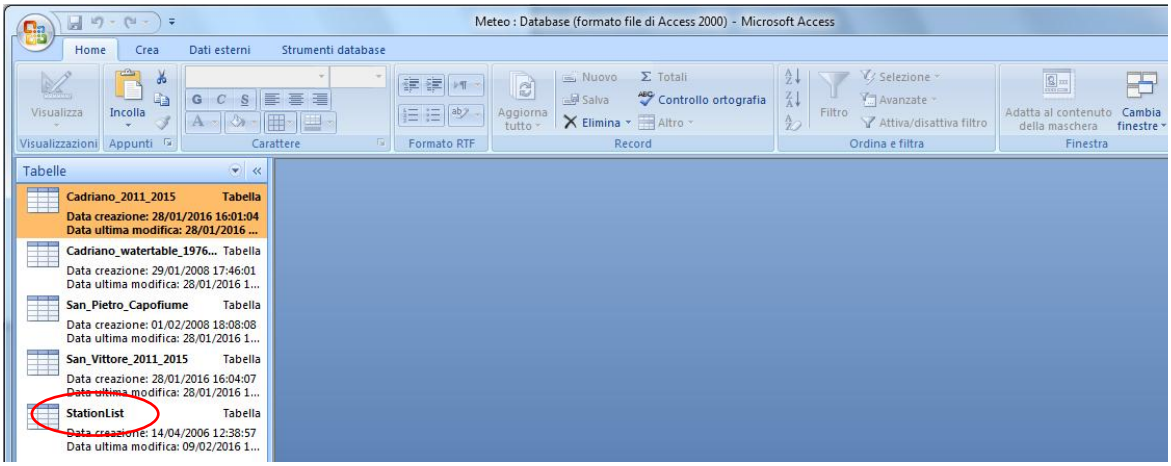
To display and modify the weather/soil/crop management data to be used for a specific case study, right-click on the cell corresponding to the weather/soil/crop management field and choose Open in the contextual menu (see image below).

For more details, see the CRITeRIA User manual. For weather data see pages 26-31; see also page 6, where explanations about weather data import from csv file are provided. For soil data see pages 18-25, for crop management see pages 32-37.



How to open and display/modify the soil data of a specific case study

Another way to create a new weather series is to open and modify directly the **Meteo.mdb** in the project directory (for instance: ..\CRITeRIA\studyCases\MOSES) using Microsoft Access, as you can see in the figure below.



The meteo.mdb and StationList table

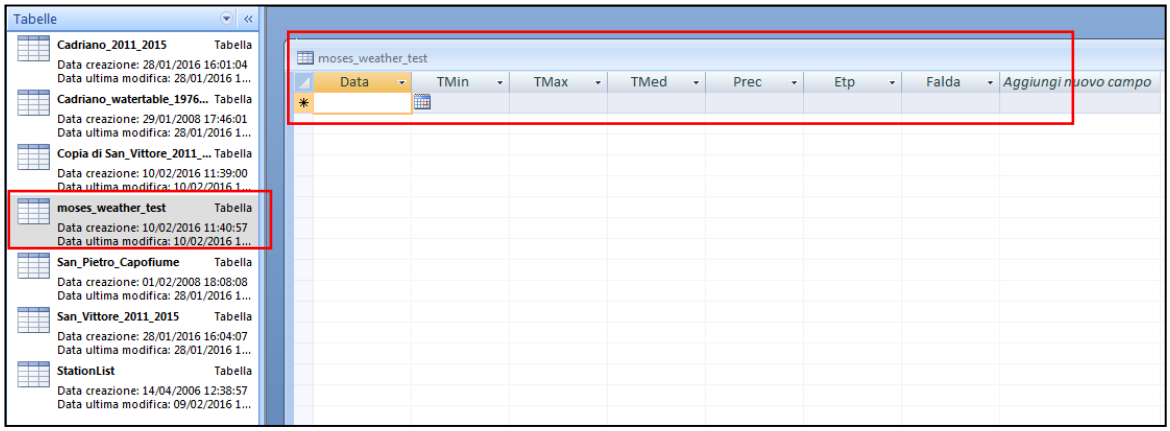
Open table **StationList**, where the station identities will be displayed. To add a new weather station, add a new row filling the specific fields (see the figure below). It is mandatory to fill the UserID, Name, Latitude and Longitude fields.

StationID	UserID	Name	Provincia	Comune	Latitude	Longitude	Height	Notes
1	Cadriano_watertable_1976_20	Cadriano_watertable_1976_2013	BO	Granarolo	44.5	11.6	33	
2	San_Pietro_Capofiume	San_Pietro_Capofiume	BO	Molinella	44.6	11.6	30	
3	Cadriano_2011_2015	Cadriano_2011_2015	BO	Granarolo	44.5	11.6	33	ERG5 grid cell 1460
4	San_Vittore_2011_2015	San_Vittore_2011_2015	FC	Cesena	44.1	12.2	50	ERG5 grid cell 1989
7	moses_weather_test	moses_weather_test			44.5	116	33	
(Nuovo)					0	0	0	

Example of the new weather series "moses_weather_test"

Close the **StationList** table; to create the table containing the weather data (in the example "moses_weather_test" series) copy and paste one of the existing tables without copying the data. Rename it with the new UserID recorded in the **StationList** table.

Copy the weather data series into the table following the order of the fields: Data (Date), TMin, TMax, TMed (Tavg), Prec, Etp, Falda (water table depth).

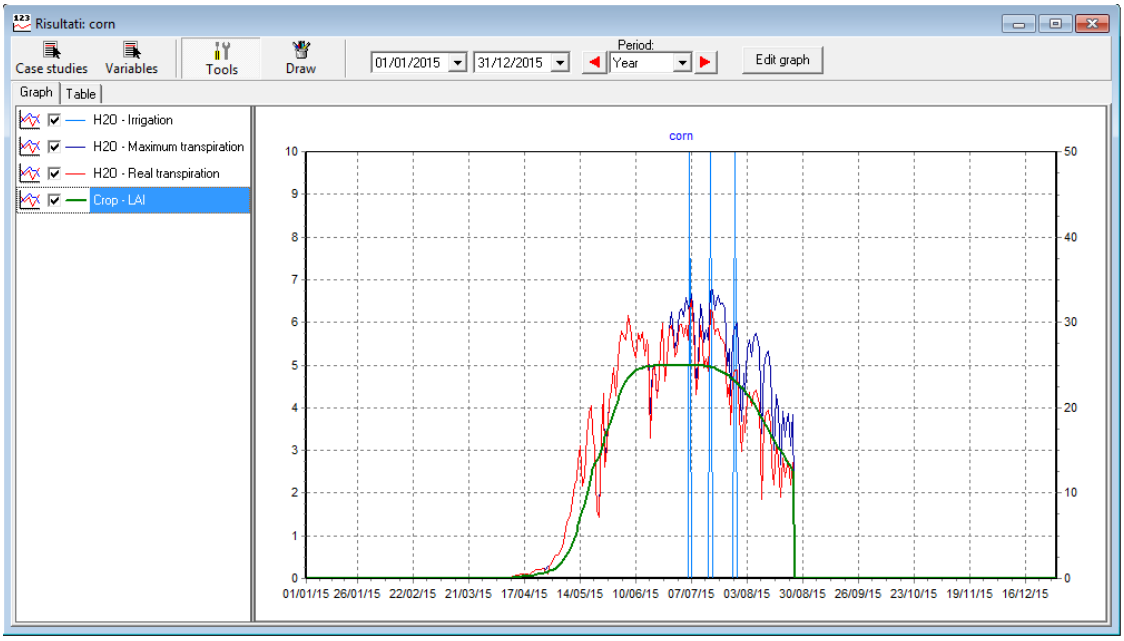


Example of void weather series table

CHECKING THE RESULTS

The general result visualization features are described in the User manual in the **Data/Results** paragraph, chapter **3.7.1. Main Bar commands**.

In order to calibrate CRITeRIA on the DA case study, the suggested key variables to check are: LAI curve, irrigation, maximum transpiration and actual transpiration, as shown in the figure below.



Example of window results for irrigated corn in Italian DA, year 2015

The available **Variables** list in the results window is subdivided into two tabs: **water** and **crop**. The LAI variable is included in the crop tab, whereas the other variables are in the water tab.

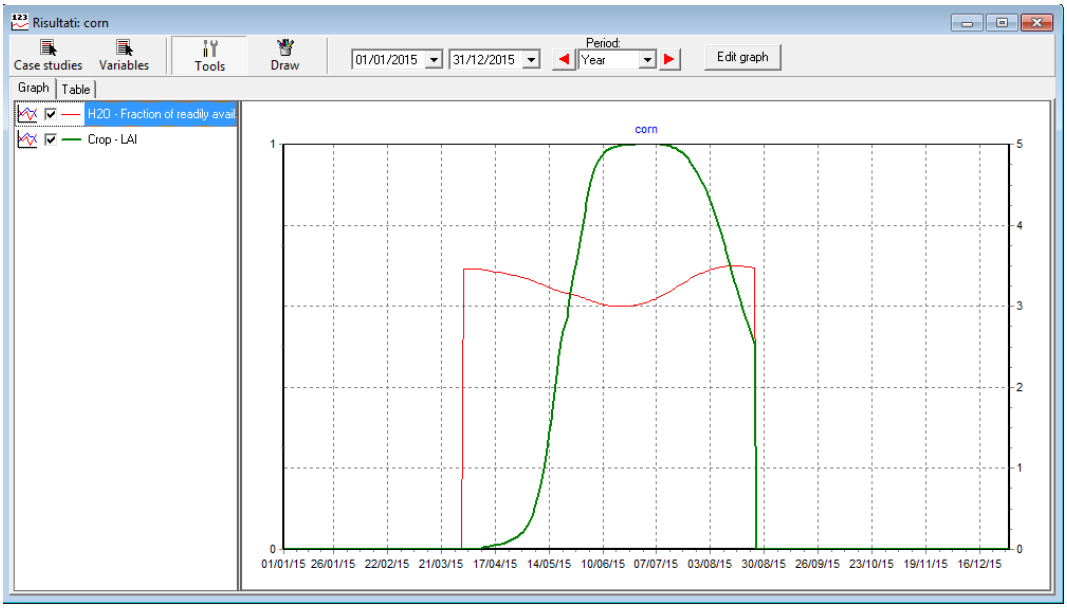
To compare the **LAI** curve (green line in the figure) with LAI observations can be useful in order to check the crop phenological development and the harvest date (the last date before the LAI drops to zero) with actual phenological stages and observed harvest date. The parameters that rule crop development are listed in the next paragraph.

The plot of the simulated curves of actual transpiration (red line) versus maximum transpiration (blue line) provides a crucial information about crop water availability. When the curves are overlapping or very close, the crop is in optimal water conditions, whereas when the actual transpiration is below the maximum transpiration, crop water stress is occurring.

The irrigation process is controlled by many parameters (see the table in the next paragraph for the whole list):

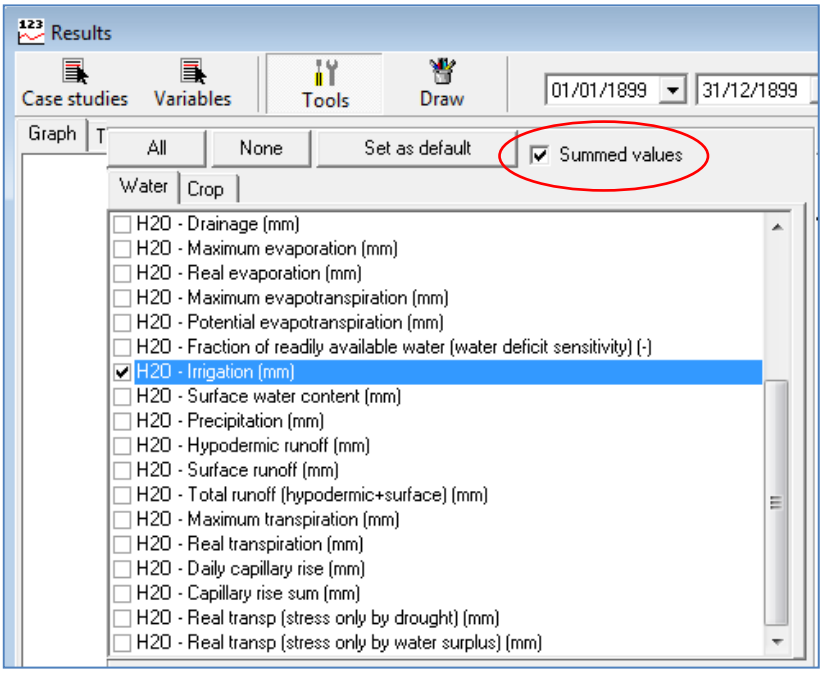
- The **irrigation period** parameters assess the start and end of typical (or allowed) irrigation. This period is expressed by day of year and degree days sum. If you want to use just degree days the doy fields have to be filled with the values: 1 (start) and 365(end).
- The **technical features** assess the irrigation volume (mm/day) and time shift (where this is needed).

- The **physiological features** assess the water stress sensitivity curve, specific for crops and phenological phases. The curve of crop sensitivity (see figure below) represents the threshold defining the **fraction of crop readily available water** during the crop cycle; when the available water in the root system is lower than 1-sensitivityTreshold, water stress occurs and the model simulates an irrigation.



Example of LAI curve and crop sensitivity to water stress

The simulated irrigation data can be compared with observed data on different irrigation variables (water volumes, irrigation dates, irrigation shift and irrigation cumulated value for the whole crop season) in order to verify that the simulated total crop water need is reliable with the observed agronomical values typical of the DA. To this aim it is possible to check the **Summed value** flag in the **Results** window, tab **Variables** (see figure below).



Results window, how to display summed up irrigation values

PARAMETER LIST EDITABLE FROM THE INTERFACE

In the table below, key parameters for crop development and irrigation are listed. Unlike the weather/soil/crop data, that are specific for a single case study, these parameters are valid for all the case studies of a project.

You can modify them by the menu **Tools→Parameters**, see the CRITeRIA User manual (pages 46-48) for more details and the technical manual for the model description.

CRITeRIA parameter	Parameter description	Unit
CROP parameters		
Crop cycle	Crop cycle max duration	days
Thermal threshold	Thermal threshold	°C
LAI increase	Degree days sum for LAI increase	°C
LAI decrease	Degree days sum for LAI decrease	°C
LAI_{min}	Minimum value of LAI	$m^2\ m^{-2}$
LAI_{max}	Maximum value of LAI	$m^2\ m^{-2}$
a_{LAI}	Factor *a* of exponential curve of LAI increase	[-]
b_{LAI}	Factor *b* of exponential curve of LAI increase	[-]
Kc max	Value of crop coefficient (Kc) corresponding to the maximum LAI	[-]
Root depth start	Start of rooting system depth	m
Root depth max	Max root depth	m
Root cycle	Degree days sum for the maximum development of the rooting system	°C
Root shape	Root shape (gamma function, cardioid, cylinder, ellipsoid)	[-]
Psi Leaf	Leaf resistance	hPa
IRRIGATION parameters		
Irrigation doy start	Starting day irrigation period	day of year
Irrigation doy end	Ending day irrigation period	day of year
Irrigation dd start	Degree days sum for the start of the irrigation period	°C
Irrigation dd end	Degree days sum for the end of the irrigation period	°C
Irrigation shift	Minimum number of days from the last irrigation	days
Irrigation volume	Crop irrigation volume	mm/day
Controlled stress	Tolerated threshold on the ratio Tr/Tmax (actual vs maximum transpiration; 1 = no controlled stress).	[-]
$fRAW_{min}$	Fraction of readily available water during the minimum sensibility phase to water stress	[-]
$fRAW_{max}$	Fraction of readily available water during the maximum sensibility phase to water stress	[-]
Degree days Sens max	Degree days sum corresponding to the phenological stage of maximum sensitivity to water stress	°C

HOW TO INSERT A NEW CROP (or new agronomic cycle)

Many crops and earliness classes are already available in CRITeRIA. If you want to add a new crop or a new earliness class, contact the authors of this document, because this functionality requires to modify a database file.

Hence, only in this case, we ask to provide a CRITeRIA case study containing the data linked to the DA, including local weather series and soil data. Moreover to calibrate this new crop, some data are mandatory: typical sowing and harvest dates, LAI observations, a brief description of the crop cycle, typical irrigation water needs.

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