



Reference Manual

AquaCrop plug-in program

(Version 3.1+)

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Developed by

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AquaCrop plug-in program (Version 3.1+)

The calculation procedures in the AquaCrop plug-in program are identical to the AquaCrop standard window program (Version 3.1+) but the plug-in program has no user interface. By running the program (ACsaV31plus.EXE) a list of projects, pre-defined in the standard window version of AquaCrop, are carried out and results are stored in output files. The plug-in program can be used in applications where iterative runs are required (e.g. GIS environment).

1. Input

In the absence of a user interface only pre-defined simulation runs can be carried out in the AquaCrop plug-in program. Therefore the input need to consist of project files, which contains all the required information for a simulation run (Tab.1). These project files can only be created¹ with the standard window AquaCrop program (i.e. the AquaCrop model with the user interface).

To run the projects in the plug-in program, the created project files need to be copied from the DATA subdirectory (of the AquaCrop window program where they were created) to the LIST subdirectory of the standalone version (Fig. 1). Since these project files contain all information to run the simulations (Tab. 2), other data files, such as the files containing the characteristics of the selected environment (climate, crop, soil, field and irrigation management) and the files with the corresponding initial and off-season conditions, need not to be copied to the LIST directory.

Table 1. Project file (files with extension 'PRO' or 'PRM')

<p>A project file is a file which contains all the required information for a simulation run. Distinction is made between projects containing the required information for a single simulation run (with 'PRO' as the filename extension) and projects consisting of a set of successive runs (for simulations in successive years), the so called multiple run projects (with 'PRM' as the filename extension). A project file contains (Tab. 2):</p> <ul style="list-style-type: none">– the period(s) of the growing cycle (from day 1 after sowing/transplanting to crop maturity);– the simulation period(s): the first and last day of the simulation period which need not to coincide with the growing cycle;– the file names (with their directory) containing the characteristics of the selected environment (climate, crop, irrigation management, field management and soil file);– the file names (with their directory) containing the initial and off-season conditions; and– the specific program settings for the run(s).

¹ Chapter 2 of the reference manual of AquaCrop describes how projects are created (section 2.17.2) and updated (section 2.17.3).

Table 2. Structure and example of a project file

<i>Title (Line 1) and Version number (Line 2)</i>	
Winter wheat in Tunis	
3.1	: AquaCrop Version (3.1plus January 2011)
<i>The simulation period (Line 3 and 4) and the period of the growing cycle (Line 5 and 6) for the (first) simulation run – See Table 3 for calculation of day numbers</i>	
28702	: First day of simulation period - 1 August 1979
28914	: Last day of simulation period - 29 February 1980
28790	: First day of cropping period - 28 October 1979
28914	: Last day of cropping period - 29 February 1980
<i>Setting of the program parameters (Line 7 to 23)</i>	
4	: Evaporation decline factor for stage II
1.10	: Ke(x) Soil evaporation coefficient for fully wet and non-shaded soil surface
5	: Threshold for green CC below which HI can no longer increase (% cover)
70	: Starting depth of root zone expansion curve (% of Zmin)
5.00	: Maximum allowable root zone expansion (fixed at 5 cm/day)
-6	: Shape factor for effect water stress on root zone expansion
20	: Required soil water content in top soil for germination (% TAW)
1.0	: Adjustment factor for FAO-adjustment soil water depletion (p) by ETo
3	: Number of days after which deficient aeration is fully effective
1.00	: Exponent senescence coeff. adjusting drop in photosynthetic activity dying crop
12	: Decrease of p(sen) once early canopy senescence is triggered (% of p(sen))
30	: Depth [cm] of soil profile affected by water extraction by soil evaporation
0.30	: Considered depth (m) of soil profile for calculation of mean SWC (CNadjusted)
1	: CN is adjusted to Antecedent Moisture Class
12.0	: Default minimum temperature (°C) if no temperature file is specified
28.0	: Default maximum temperature (°C) if no temperature file is specified
3	: Default method for the calculation of growing degree days
<i>The file names with their directory (path) containing the characteristics of the selected climatic conditions (Line 24 to 38) for the (first) simulation run</i>	
-- 1. Climate (CLI) file	
Tunis.CLI	
C:\Program Files\FAO\AquaCrop\DATA\	
1.1 Temperature (TMP) file	
Tunis.TMP	
C:\Program Files\FAO\AquaCrop\DATA\	
1.2 Reference ET (ETo) file	
Tunis.ETo	
C:\Program Files\FAO\AquaCrop\DATA\	
1.3 Rain (PLU) file	
Tunis.PLU	
C:\Program Files\FAO\AquaCrop\DATA\	
1.4 Atmospheric CO2 (CO2) file	
MaunaLoa.CO2	
C:\Program Files\FAO\AquaCrop\SIMUL\	

Table 2. Structure and example of project file ... continued

<i>The file name with its directory (path) containing the characteristics of the selected crop (Line 39 to 41) for the (first) simulation run</i>
-- 2. Crop (CRO) file DEFAULT.CRO C:\Program Files\FAO\AquaCrop\
<i>The file name with its directory (path) containing the characteristics of the selected irrigation management (Line 42 to 44) for the (first) simulation run</i>
-- 3. Irrigation (IRR) file (None) (None)
<i>The file name with its directory (path) containing the characteristics of the selected field management (Line 45 to 47) for the (first) simulation run</i>
-- 4. Management (MAN) file (None) (None)
<i>The file name with its directory (path) containing the characteristics of the selected soil (Line 48 to 50) for the (first) simulation run</i>
-- 5. Soil (SOL) file LOAM.SOL C:\Program Files\FAO\AquaCrop\DATA\
<i>The file names with its directory (path) containing the initial conditions (Line 51 to 53) for the (first) simulation run</i>
-- 6. Initial conditions (SW0) file WP10.SW0 C:\Program Files\FAO\AquaCrop\DATA\
<i>The file name with its directory (path) containing the off-season conditions (Line 54 to 56) for the (first) simulation run</i>
-- 7. Off-season conditions (OFF) file (None) (None)
<i>In case of multiple projects: - the simulation period, - the crop growth cycle, - file names containing the characteristics of the selected environment, - file names containing the initial and off-season conditions for each of the successive run(s) are given in the next lines (Line 57 to ...)</i>
....

AquaCrop uses day numbers to specify the start and end of the simulation period and the period of the growing cycle. The day number refers to the days elapsed since 0th January 1901 at 0 am (Tab. 3).

Table 3.
Number of days elapsed since 0th January 1901, 0 am

Validity The method is valid from 1901 to 2099 only (time range in AquaCrop)	
Rules <ol style="list-style-type: none"> 1. Subtract 1901 from the year 2. Multiply by 365.25 3. According to the month add: <ul style="list-style-type: none"> - January : 0 - February : 31 - March : 59.25 - April : 90.25 - May : 120.25 - June : 151.25 - July : 181.25 - August : 212.25 - September : 243.25 - October : 273.25 - November : 304.25 - December : 334.25 4. Add the number of the day within the month 5. Take the integer 	
Example For 24 August 1982	
1. Subtract 1901 from the year	$1982 - 1901 = 81$
2. Multiply by 365.25	$81 \times 365.25 = 29585.25$
3. Add 212.25 for August	$29585.25 + 212.25 = 29797.5$
4. Add the number of the day	$29797.5 + 24 = 29821.5$
5. Take the integer	29821
Reference Gommes, R.A. 1983. Pocket computers in agro meteorology. FAO Plant production and protection paper Nr. 45, Rome, Italy.	

2. Running simulation(s)

When the AquaCrop plug-in program is launched, the software runs one by one the projects listed in its LIST directory. Since the AquaCrop plug-in program obtains its input from files in the DATA subdirectory of the AquaCrop standard window program, both programs need to be installed on the same computer (Fig. 1).

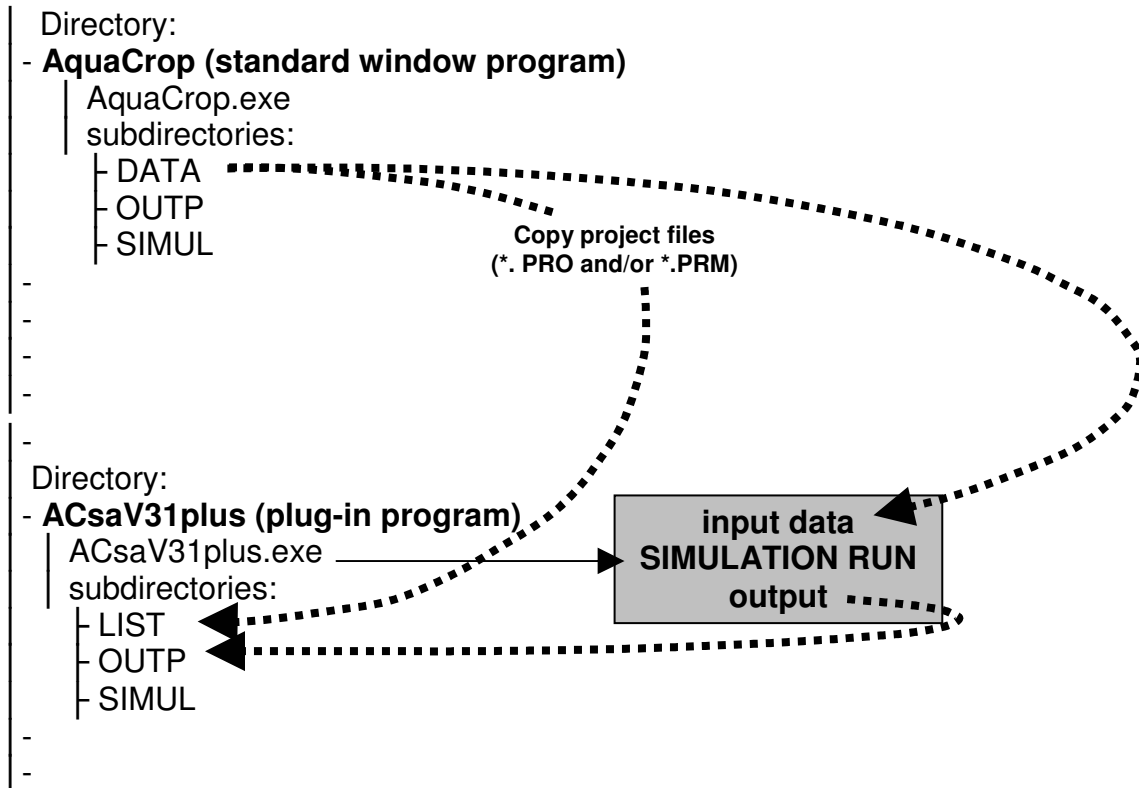


Figure 1.
Input and output data for running the AquaCrop plug-in program

- For each project (or for each run of a multiple project), the software obtains from the project file (Tab. 2):
 - the starting and end date of the simulation period and growing cycle;
 - the program settings; and
 - the path of the filenames containing the characteristics of the selected environment (climate, crop, irrigation management, field management and soil file) and the initial and off-season conditions;
- Before starting a simulation run, the program checks if:
 - the structure of the project file is correct (example presented in Tab. 2);
 - all files describing the environment are available at the specified path.If not so, the project is skipped and no output will be generated.
- While running the successive projects the results are saved in files in the OUTP directory. When all projects listed in the LIST directory are run, the program stops automatically.

3. Output

When running a project, intermediate and final simulation results are stored in an output file in the OUTP directory of the plug-in program (Fig. 1).

- **File name**

The filename of each output file (filename which extension OUT) corresponds with the filename of the corresponding project file but extended with 'PRO' (for single projects) or 'PRM' (for multiple projects). There are as many output files as project files listed in the LIST directory.

- **Intermediate results**

The simulation results of each of the projects listed in the LIST subdirectory are stored in its corresponding output file (in the OUTP directory). Depending on the number specified at the start of the first line of the 'AggregationResults.SIM' file (file available in the SIM subdirectory) either none, daily, 10-daily or monthly intermediate simulation results will be provided next to the final simulation results (Tab.4). The following code applies:

- 0 : for no intermediate results
- 1 : for daily results
- 2 : for 10-daily intermediate results
- 3 : for monthly intermediate results

In the absence of the 'AggregationResults.SIM' file, no intermediate results will be provided.

Table 4.

Example of the AggregationResults.SIM' file (file available in the SIM subdirectory) generating 10-daily intermediate simulation results

2 : Time aggregation for intermediate results (0 = none ; 1 = daily; 2 = 10-daily; 3 = monthly)

- **Recorded simulation results**

In each output file there are for each simulation run as many lines as intermediate results plus one extra line for the totals of the simulation run. The results are presented in 26 columns (Tab. 5) and contain information of the length and dates of the simulation period, and the totals for climatic and soil water parameters, for biomass production, crop yield and crop water productivity.

Table 5. Information available in the 26 columns of the output file

Nr	Symbol	Length of period	Unit
1	Period	- Tot(Number simulation run) : for total simulation run - Day : for intermediate daily results - 10Day : for intermediate 10-daily results - Month : for intermediate monthly results	-
<i>First day of considered period</i>			
2	Day1	Day at start of period	-
3	Month1	Month at start of period	-
4	Year1	Year at start of period	-
<i>Climatic parameters for considered period</i>			
5	Rain	Rainfall	mm
6	ETo	Reference evapotranspiration	mm
7	GDD	Growing degree days	°C day
8	CO2	Atmospheric CO ₂ concentration	ppm
<i>Soil water parameters for considered period</i>			
9	Irri	- Amount of water applied by irrigation - Net irrigation requirement (if requested)	mm
10	Infilt	Amount of water infiltrated in the soil profile	mm
11	E	Amount of water evaporated from the soil surface	mm
12	E/Ex	Relative mean soil evaporation (100 E/Ex)	%
13	Tr	Amount of water transpired by the crop	mm
14	Tr/Trx	Relative mean crop transpiration (100 Tr/Trx)	%
15	Drain	Amount of water drained out of the soil profile	mm
<i>Biomass production in considered period</i>			
16	Biomass	Above-ground biomass produced	ton/ha
17	Br(w)	Relative biomass (Reference: well watered and well fertilized soil)	%
18	Br(wsf)	Relative biomass (Reference: given soil fertility but well watered soil)	%
19	WPet(B)	ET Water Productivity for biomass (kg biomass produced per m ³ water evapotranspired)	kg/m ³
<i>Crop yield (only specified at end of simulation run)</i>			
20	HI	Harvest Index	%
21	Yield	Yield (HI x Biomass)	ton/ha
22	WPet(Y)	ET Water Productivity for yield part (kg yield produced per m ³ water evapotranspired)	kg/m ³
<i>Last day of considered period</i>			
23	DayN	Day at end of period	-
24	MonthN	Month at end of period	-
25	YearN	Year at end of period	-
<i>Project</i>			
26	File	Project file name	-

4. Installation

▪ Standard procedure

Zipped files containing the executable program for installing (i) the Standard Window and (ii) the Plug-in program of AquaCrop can be downloaded from the FAO website.

<http://www.fao.org/nr/water/aquacrop.html>

1. Copy the zipped file to the PC;
2. Unzip; and
3. Run SETUP.EXE.

When running the installation file, a series of windows will pop up. By selecting 'Next >' in each of the windows, the AquaCrop program will be installed by default in a subfolder of the 'Program Folder' of the PC (which will be created if not available):

- for the AquaCrop standard window program: C:\Program Files\FAO\AquaCrop
- for the AquaCrop plug-in program: C:\Program Files\FAO\ACsaV31plus

▪ Windows Vista and Windows 7

Installing AquaCrop according to the standard procedure will create problems with Windows Vista and Windows 7 since these versions no longer allow programs to write in its 'Program Files' folder. Consequently the normal operation of AquaCrop is hampered since storing input data and writing simulation results require a constant and free access to the 'Program Files' folder.

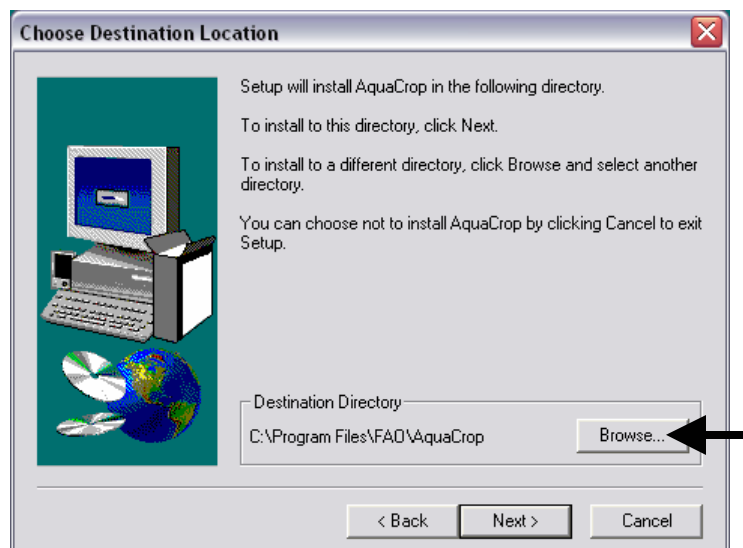


Figure 2.

The 'Choose Destination Location' window of the installation program of AquaCrop

The solution consists in specifying another directory than the default destination directory when installing the software. Therefore:

1. Select 'Browse...' in the 'Choose Destination Location' window (Fig. 2);
2. Specify another directory than the default:
 - e.g. C:\FAO\AquaCrop for the standard window program;
 - e.g. C:\FAO\ACsaV31plus for the plug-in program;
3. Click 'Next >' to continue the installation at the specified location.

▪ **64-bit PC**

Notwithstanding that the AquaCrop program is not compatible with 64-bit PCs, an elegant solution consists in installing a 'Virtual PC' (2007). This is a free program from MicroSoft. Once installed, an operating system (such as XP) and AquaCrop have to be installed on the Virtual PC. AquaCrop can run in that environment. It is a simple solution, often done for software that is not compatible with a 64-bit system.

Another possibility is to install AquaCrop on a regular 32-bit PC and to copy the whole folder with its subfolders to the 64-bit PC. Experience shows that this work as well.

▪ **Once installed**

When AquaCrop is properly installed, you will find in the AquaCrop directory:

For the AquaCrop standard window program:

- the AquaCrop executable file (AquaCrop.EXE);
- some files with extension PAR (these are the last selected settings for program parameters);
- the default crop and soil file (DEFAULT.CRO and DEFAULT.SOL);
- the list of soil characteristics for default soil types (SOILS.DIR);
- a DATA subdirectory, with the calibrated and validated crop files by FAO and some examples files with environmental data (climate, soil, ..);
- an OUTP subdirectory, where simulation results will be stored by default;
- a SIMUL subdirectory, with the Mauna Loa CO2 file.

For the AquaCrop plug-in program:

- the AquaCrop executable file (ACsaV31plus.EXE);
- a LIST subdirectory, where the copied project files should be stored;
- an OUTP subdirectory, where simulation results will be stored;
- a SIMUL subdirectory, with the 'AggregationResults.SIM' file.