Food and Agriculture Organization of the United Nations

# Crop Module 4
# Interpreting AquaCrop outputs

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(2023)

Food and Agriculture Organization of the United Nations

# Content

**Day 1**

- How do crop models work?
- AquaCrop interface
- AquaCrop: climate, crop, management and soil modules (AquaCrop modules 1 and 2)
- Run simulations and interpret results

**Day 2**

- Input requirements
- Create/import climatic files on AquaCrop
- Create a crop file
- Run simulations for wheat in Badin

**Day 3**

- Interpreting the AquaCrop outputs for wheat in Badin
- Calibrating and validating the AquaCrop model

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# Interpreting AquaCrop outputs: climate info.

**Step 1.** Open **AquaCrop** desktop folders and click on **OUTP** (outputs)

| | | | |
|---|---|---|---|
| DATA | 02/12/2022 19:02 | Carpeta de archivos | |
| IMPORT | 01/12/2022 8:49 | Carpeta de archivos | |
| OBS | 01/12/2022 8:49 | Carpeta de archivos | |
| OUTP | 02/12/2022 19:28 | Carpeta de archivos | |
| SIMUL | 03/12/2022 9:33 | Carpeta de archivos | |
| _DEISREG.ISR | 01/12/2022 8:49 | Archivo ISR | 1 KB |
| _ISREG32.DLL | 01/12/2022 8:49 | Extensión de la ap... | 40 KB |
| AquaCrop | 01/12/2022 8:49 | Aplicación | 16.459 KB |
| AquaCrop | 01/12/2022 8:49 | Icono | 2 KB |
| DeIsL1.isu | 01/12/2022 8:49 | Archivo ISU | 10 KB |

**Step 2.** Open the file

OS (C:) > FAO > Pakistan > GUI_AC71 > AquaCropV71No13102023 > OUTP

| Nome | Ultima modifica | Tipo | Dimensione |
|---|---|---|---|
| Wheat_BadinClim.OUT | 28/11/2023 17:20 | File OUT | 14 KB |
| Wheat_BadinCompEC.OUT | 28/11/2023 17:20 | File OUT | 26 KB |
| Wheat_BadinCompWC.OUT | 28/11/2023 17:20 | File OUT | 26 KB |
| Wheat_BadinCrop.OUT | 28/11/2023 17:20 | File OUT | 35 KB |
| Wheat_BadinHarvest.OUT | 28/11/2023 17:20 | File OUT | 1 KB |
| Wheat_BadinInet.OUT | 28/11/2023 17:20 | File OUT | 1 KB |
| Wheat_BadinProf.OUT | 28/11/2023 17:20 | File OUT | 20 KB |
| Wheat_BadinRun.OUT | 28/11/2023 17:20 | File OUT | 4 KB |
| Wheat_BadinSalt.OUT | 28/11/2023 17:20 | File OUT | 20 KB |
| Wheat_BadinWabal.OUT | 28/11/2023 17:20 | File OUT | 27 KB |

**Step 3.** Visualize the **climatic** outputs

AquaCrop 7.1 (August 2023) - Output created on (date) : 28/11/2023 at (time) : 17:20:34
Climate input data

** Run number: 1

| Day | Month | Year | DAP | Stage | Rain mm | ETo mm | Tmin °C | Tavg °C | Tmax °C | CO2 ppm |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 11 | 2010 | 1 | 1 | 0.0 | 4.3 | 21.6 | 28.4 | 35.1 | 390.74 |
| 2 | 11 | 2010 | 2 | 1 | 0.0 | 4.2 | 20.0 | 26.9 | 33.9 | 390.74 |
| 3 | 11 | 2010 | 3 | 1 | 0.0 | 4.1 | 18.7 | 25.8 | 32.8 | 390.74 |
| 4 | 11 | 2010 | 4 | 1 | 0.0 | 4.0 | 17.6 | 24.8 | 32.0 | 390.74 |
| 5 | 11 | 2010 | 5 | 2 | 0.0 | 4.1 | 17.5 | 25.0 | 32.5 | 390.74 |
| 6 | 11 | 2010 | 6 | 2 | 0.0 | 4.2 | 17.7 | 25.4 | 33.1 | 390.74 |
| 7 | 11 | 2010 | 7 | 2 | 0.0 | 4.2 | 17.9 | 25.6 | 33.4 | 390.74 |
| 8 | 11 | 2010 | 8 | 2 | 0.0 | 4.1 | 17.9 | 25.4 | 33.0 | 390.74 |
| 9 | 11 | 2010 | 9 | 2 | 0.0 | 4.0 | 18.4 | 25.6 | 32.9 | 390.74 |
| 10 | 11 | 2010 | 10 | 2 | 0.0 | 3.9 | 18.5 | 25.6 | 32.6 | 390.74 |
| 11 | 11 | 2010 | 11 | 2 | 0.0 | 3.8 | 18.6 | 25.4 | 32.3 | 390.74 |
| 12 | 11 | 2010 | 12 | 2 | 0.0 | 3.8 | 19.0 | 25.8 | 32.6 | 390.74 |
| 13 | 11 | 2010 | 13 | 2 | 0.0 | 3.8 | 18.3 | 25.3 | 32.2 | 390.74 |

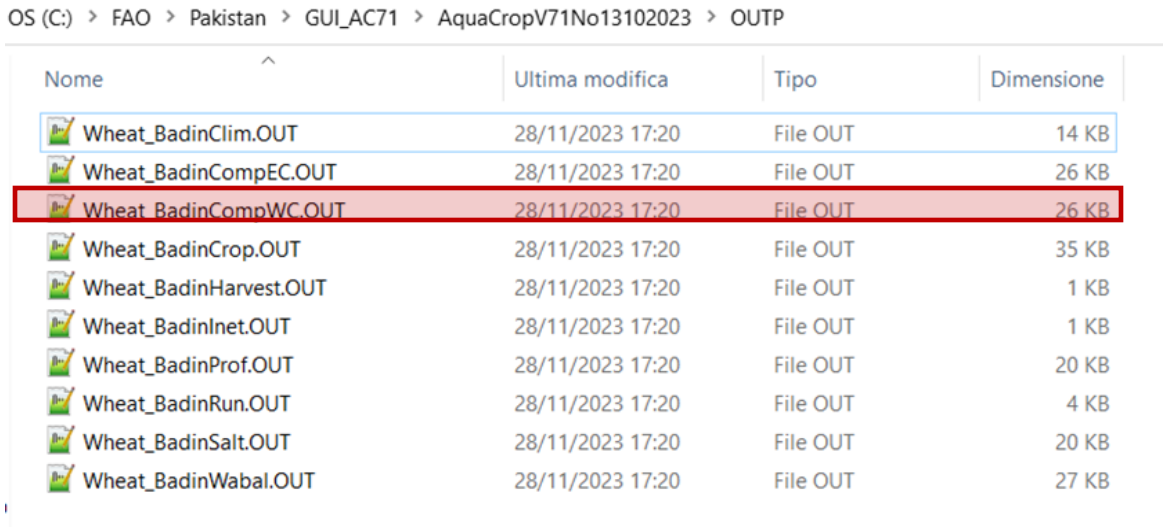
Legend

DAP : Days after planting
Stage : 0: before/after planting
Stage : 1: emergence or transplant recovery
Stage : 2: vegetative stage
Stage : 3: flowering
Stage : 4: yield formation and ripening
Rain : Rainfall
ETo : Reference evapotranspiration
Tmin : Minimum air temperature
Tavg : Average air temperature
Tmax : Maximum air temperature
CO2 : Atmospheric CO2 concentration

*At the bottom of the txt. file you will find the legend!*

# Interpreting AquaCrop outputs: soil water content

**Step 1.** Open the file **Wheat_BadinCompWC**




*At the bottom of the txt. file you will find the legend for each variable!*

```
Legend

DAP          : Days after planting
Stage        : 0: before/after planting
Stage        : 1: emergence or transplant recovery
Stage        : 2: vegetative stage
Stage        : 3: flowering
Stage        : 4: yield formation and ripening
```

**Step 2.** Visualize the **water content** outputs

```
** Run number:  1
                        at depth (m):    0.05     0.15     0.25     0.35     0.45     0.55     0.67     0.82     0.97
   Day Month  Year   DAP Stage  WC1(vol%) WC2(vol%) WC3(vol%) WC4(vol%) WC5(vol%) WC6(vol%) WC7(vol%) WC8(vol%) WC9(vol%)
     1    11  2010     1     1      19.4      21.0      21.0      21.0      21.0      21.0      21.0      21.0      21.0
     2    11  2010     2     1      18.1      21.0      21.0      21.0      21.0      21.0      21.0      21.0      21.0
     3    11  2010     3     1      17.1      21.0      21.0      21.0      21.0      21.0      21.0      21.0      21.0
     4    11  2010     4     1      16.1      21.0      21.0      21.0      21.0      21.0      21.0      21.0      21.0
     5    11  2010     5     2      15.1      21.0      21.0      21.0      21.0      21.0      21.0      21.0      21.0
     6    11  2010     6     2      14.5      20.7      21.0      21.0      21.0      21.0      21.0      21.0      21.0
     7    11  2010     7     2      21.7      20.7      21.0      21.0      21.0      21.0      21.0      21.0      21.0
     8    11  2010     8     2      18.2      20.7      21.0      21.0      21.0      21.0      21.0      21.0      21.0
     9    11  2010     9     2      17.1      20.7      21.0      21.0      21.0      21.0      21.0      21.0      21.0
```

# Interpreting AquaCrop outputs: crop info.

**Step 1.** Open the file **Wheat_BadinCrop**

*At the bottom of the txt. file you will find the legend for each variable!*

OS (C:) > FAO > Pakistan > GUI_AC71 > AquaCropV71No13102023 > OUTP

| Nome | Ultima modifica | Tipo | Dimensione |
|---|---|---|---|
| Wheat_BadinClim.OUT | 28/11/2023 17:20 | File OUT | 14 KB |
| Wheat_BadinCompEC.OUT | 28/11/2023 17:20 | File OUT | 26 KB |
| Wheat_BadinCompWC.OUT | 28/11/2023 17:20 | File OUT | 26 KB |
| Wheat_BadinCrop.OUT | 28/11/2023 17:20 | File OUT | 35 KB |
| Wheat_BadinHarvest.OUT | 28/11/2023 17:20 | File OUT | 1 KB |
| Wheat_BadinInet.OUT | 28/11/2023 17:20 | File OUT | 1 KB |
| Wheat_BadinProf.OUT | 28/11/2023 17:20 | File OUT | 20 KB |
| Wheat_BadinRun.OUT | 28/11/2023 17:20 | File OUT | 4 KB |
| Wheat_BadinSalt.OUT | 28/11/2023 17:20 | File OUT | 20 KB |
| Wheat_BadinWabal.OUT | 28/11/2023 17:20 | File OUT | 27 KB |

```
Legend

DAP          : Days after planting
Stage        : 0: before/after planting
Stage        : 1: emergence or transplant recovery
Stage        : 2: vegetative stage
Stage        : 3: flowering
Stage        : 4: yield formation and ripening
GD           : Growing degrees
Z            : Effective rooting depth
StExp        : Percent water stress reducing leaf expansion
StSto        : Percent water stress inducing stomatal closure
StSen        : Percent water stress triggering early canopy senescence
StSalt       : Percent salinity stress
StWeed       : Relative cover of weeds
CC           : Green total Canopy Cover of crop and weeds
CCw          : Green crop Canopy Cover in weed infested field
StTr         : Percent temperature stress affecting crop transpiration
Kc(Tr)       : Crop coefficient for transpiration
Trx          : Maximum total transpiration of crop and weeds
```

**Step 2.** Visualize the **stress** and **canopy development** outputs

```
Crop development and production

** Run number:  1
   Day Month  Year   DAP Stage    GD     Z    StExp StSto StSen StSalt StWeed   CC    CCw   StTr  Kc(Tr)  Trx   Tr    TrW
                                °C-day     m      %     %     %     %      %     %     %     %      -     mm    mm    mm
     1    11  2010     1     1  23.0  0.30       -9    -9    -9     0     -9   0.0   0.0     0   -9.00   0.0   0.0   0.0
     2    11  2010     2     1  23.0  0.30       -9    -9    -9     0     -9   0.0   0.0     0   -9.00   0.0   0.0   0.0
     3    11  2010     3     1  22.4  0.39       -9    -9    -9     0     -9   0.0   0.0     0   -9.00   0.0   0.0   0.0
     4    11  2010     4     1  21.8  0.46       -9     4     0     0      0   3.4   3.4     0    0.06   0.3   0.2   0.2
     5    11  2010     5     2  21.8  0.53       -9     6     0     0      0   4.0   4.0     0    0.07   0.3   0.3   0.3
     6    11  2010     6     2  21.9  0.58      100     8     0     0      0   4.0   4.0     0    0.07   0.3   0.3   0.3
     7    11  2010     7     2  21.9  0.63        2     0     0     0      0   4.6   4.6     0    0.08   0.4   0.4   0.4
     8    11  2010     8     2  21.9  0.68       35     0     0     0      0   5.0   5.0     0    0.09   0.4   0.4   0.4
     9    11  2010     9     2  22.2  0.73       76     0     0     0      0   5.2   5.2     0    0.09   0.4   0.4   0.4
    10    11  2010    10     2  22.3  0.78       81     0     0     0      0   5.3   5.3     0    0.10   0.4   0.4   0.4
```

# Interpreting AquaCrop outputs: crop info.

**Step 3.** Continue visualizing **crop production** outputs

| Tr/Trx % | WP g/m2 | Biomass ton/ha | HI % | Y(dry) ton/ha | Y(fresh) ton/ha | Brelative % | WPet kg/m3 | Bin ton/ha | Bout ton/ha |
|---|---|---|---|---|---|---|---|---|---|
| 100 | 15.8 | 0.000 | -9.9 | 0.000 | -9.000 | -9 | 0.00 | 0.000 | 0.000 |
| 100 | 15.8 | 0.000 | -9.9 | 0.000 | -9.000 | -9 | 0.00 | 0.000 | 0.000 |
| 100 | 15.8 | 0.000 | -9.9 | 0.000 | -9.000 | -9 | 0.00 | 0.000 | 0.000 |
| 96 | 15.8 | 0.010 | -9.9 | 0.000 | -9.000 | 96 | 0.00 | 0.000 | 0.000 |
| 94 | 15.8 | 0.020 | -9.9 | 0.000 | -9.000 | 95 | 0.00 | 0.000 | 0.000 |
| 92 | 15.8 | 0.031 | -9.9 | 0.000 | -9.000 | 89 | 0.00 | 0.000 | 0.000 |
| 100 | 15.8 | 0.044 | -9.9 | 0.000 | -9.000 | 88 | 0.00 | 0.000 | 0.000 |
| 100 | 15.8 | 0.059 | -9.9 | 0.000 | -9.000 | 87 | 0.00 | 0.000 | 0.000 |
| 100 | 15.8 | 0.074 | -9.9 | 0.000 | -9.000 | 84 | 0.00 | 0.000 | 0.000 |
| 100 | 15.8 | 0.089 | -9.9 | 0.000 | -9.000 | 80 | 0.00 | 0.000 | 0.000 |

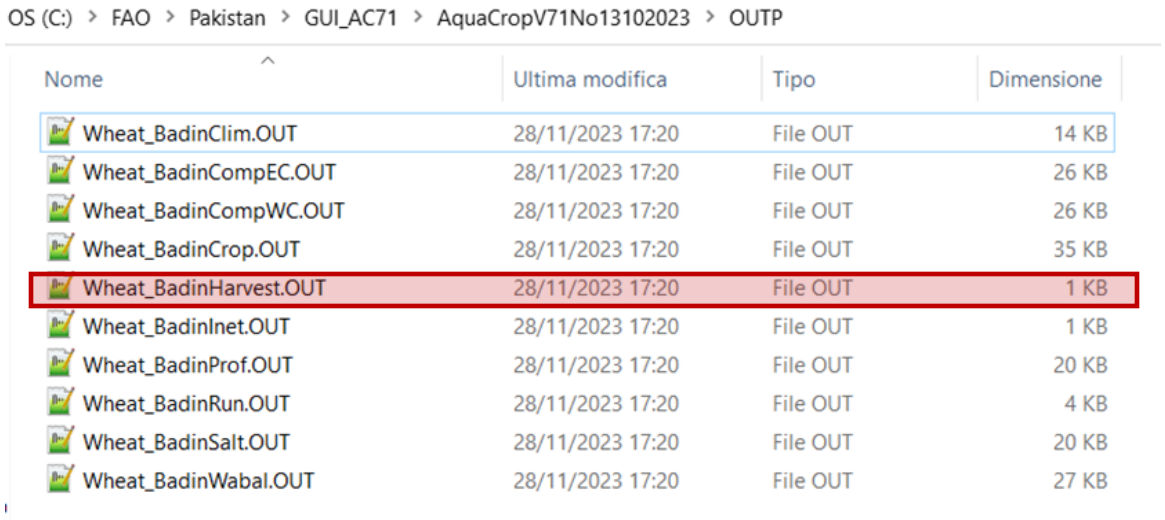
Legend

```
Trx          : Maximum total transpiration of crop and weeds
Tr           : Total transpiration of crop and weeds
TrW          : Crop transpiration in weed infested field
Tr/Trx       : Relative total transpiration of crop and weeds (100 Tr/Trx)
WP           : Crop water productivity adjusted for CO2, soil fertility and products synthesized
Biomass      : Total above-ground dry biomass
HI           : Harvest Index adjusted for failure of pollination, inadequate photosynthesis and water stress
Y(dry)       : Dry crop yield (HI x Biomass)
Y(fresh)     : Fresh crop yield
Brelative    : Relative biomass (Reference: no water, no soil fertility, no soil salinity stress, no weed infestation)
WPet         : ET Water productivity for yield part (kg yield produced per m3 water evapotranspired)
Bin          : Daily mass of assimilates mobilized from root system at start of season
Bout         : Daily mass of assimilates stored in root system at end of season
```

*At the bottom of the txt. file you will find the legend for each variable!*

# Interpreting AquaCrop outputs: harvest info.

**Step 1.** Open the file **Wheat_BadinHarvest**




**Step 2.** Visualize values at **harvest** (dry yield and biomass)

```
Biomass and Yield at Multiple cuttings

** Run number:  1
    Nr    Day  Month Year   DAP Interval  Biomass    Sum(B)   Dry-Yield  Sum(Y) Fresh-Yield  Sum(Y)
                                    days    ton/ha    ton/ha    ton/ha    ton/ha    ton/ha    ton/ha
     0     1    11  2010                            0.000               0.000
  9999    26     3  2011                            7.272               2.869

Legend

DAP          : Days after planting
Interval     : Number of days between events
Nr = 0       : At start of season
Nr = 1 to n  : Harvest event
Nr = 9999    : At end of season
```

*At the bottom of the txt. file you will find the legend for each variable!*

# Interpreting AquaCrop outputs: water balance info.

**Step 1.** Open the file **Wheat_BadinWbal**

OS (C:) › FAO › Pakistan › GUI_AC71 › AquaCropV71No13102023 › OUTP

| Nome | Ultima modifica | Tipo | Dimensione |
|---|---|---|---|
| Wheat_BadinClim.OUT | 28/11/2023 17:20 | File OUT | 14 KB |
| Wheat_BadinCompEC.OUT | 28/11/2023 17:20 | File OUT | 26 KB |
| Wheat_BadinCompWC.OUT | 28/11/2023 17:20 | File OUT | 26 KB |
| Wheat_BadinCrop.OUT | 28/11/2023 17:20 | File OUT | 35 KB |
| Wheat_BadinHarvest.OUT | 28/11/2023 17:20 | File OUT | 1 KB |
| Wheat_BadinInet.OUT | 28/11/2023 17:20 | File OUT | 1 KB |
| Wheat_BadinProf.OUT | 28/11/2023 17:20 | File OUT | 20 KB |
| Wheat_BadinRun.OUT | 28/11/2023 17:20 | File OUT | 4 KB |
| Wheat_BadinSalt.OUT | 28/11/2023 17:20 | File OUT | 20 KB |
| Wheat_BadinWabal.OUT | 28/11/2023 17:20 | File OUT | 27 KB |

```
Legend

DAP         : Days after planting
Stage       : 0: before/after planting
Stage       : 1: emergence or transplant recovery
Stage       : 2: vegetative stage
Stage       : 3: flowering
Stage       : 4: yield formation and ripening
WCTot       : Water content in total soil profile
Rain        : Rainfall
Irri        : Water applied by irrigation
Surf        : Stored water on soil surface between bunds
Infilt      : Infiltrated water in soil profile
RO          : Surface runoff
Drain       : Water drained out of the soil profile
CR          : Water moved upward by capillary rise
Zgwt        : Depth of the groundwater table (-9.90 if absent)
Ex          : Maximum soil evaporation
E           : Soil evaporation
E/Ex        : Relative soil evaporation (100 E/Ex)
Trx         : Maximum crop transpiration
Tr          : Total transpiration of crop and weeds
Tr/Trx      : Relative transpiration (100 Tr/Trx)
ETx         : Evapotranspiration maximale
ET          : Evapotranspiration
ET/ETx      : Evapotranspiration relative (100 ET/ETx)
```

*At the bottom of the txt. file you will find the legend for each variable!*

Soil Water balance

** Run number: 1

| Day | Month | Year | DAP | Stage | WCTot | Rain | Irri | Surf | Infilt | RO | Drain | CR | Zgwt | Ex | E | E/Ex | Trx |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | mm | mm | mm | mm | mm | mm | mm | mm | m | mm | mm | % | mm |
| 1 | 11 | 2010 | 1 | 1 | 323.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -9.90 | 4.7 | 1.6 | 34 | 0.0 |
| 2 | 11 | 2010 | 2 | 1 | 322.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -9.90 | 4.6 | 1.3 | 27 | 0.0 |
| 3 | 11 | 2010 | 3 | 1 | 321.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -9.90 | 4.5 | 1.0 | 23 | 0.0 |
| 4 | 11 | 2010 | 4 | 1 | 320.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -9.90 | 4.1 | 0.8 | 19 | 0.3 |
| 5 | 11 | 2010 | 5 | 2 | 319.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -9.90 | 4.2 | 0.7 | 16 | 0.3 |
| 6 | 11 | 2010 | 6 | 2 | 318.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -9.90 | 4.3 | 0.6 | 14 | 0.3 |
| 7 | 11 | 2010 | 7 | 2 | 325.9 | 0.0 | 11.0 | 0.0 | 11.0 | 0.0 | 0.0 | 0.0 | -9.90 | 3.4 | 3.4 | 100 | 0.4 |
| 8 | 11 | 2010 | 8 | 2 | 322.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -9.90 | 3.4 | 3.1 | 92 | 0.4 |
| 9 | 11 | 2010 | 9 | 2 | 321.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -9.90 | 3.2 | 0.7 | 23 | 0.4 |
| 10 | 11 | 2010 | 10 | 2 | 320.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -9.90 | 3.1 | 0.6 | 19 | 0.4 |
| 11 | 11 | 2010 | 11 | 2 | 319.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -9.90 | 3.0 | 0.5 | 16 | 0.4 |
| 12 | 11 | 2010 | 12 | 2 | 318.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -9.90 | 3.0 | 0.4 | 14 | 0.4 |

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# Crop Module 4
# Calibrating & Validating the AquaCrop model

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(2023)

Food and Agriculture Organization of the United Nations

# Calibration and validation of AquaCrop model

- The calibration and validation is a critical step towards achieving meaningful modelling outputs.
- **5 to 10 years** of historical yield data (for a specific location) are necessary to compare observed and simulated yields values.
- To test the performance of the AquaCrop model against observed values in the field, different statistical indicators are used.
- For example, while the **root-mean square error** (RMSE, Eq. 1) is useful for testing the differences between predicted and observed values, the **normalized-RMSE** (NRMSE, Eq. 2) provides relevant information about the average of the measured data ranges.
- AquaCrop findings are considered highly performant when the differences between observed and simulated NRMSE values **are below 5%,** and good when ranging between **6 to 15%.**
- **Willmott's index** of agreement (d, Eq. 3) provides a measure of the agreement of the deviation of modelled and observed values from the observed mean, where 0 indicates disagreement and 1 perfect agreement between simulated and observed values.

# Calibration and validation of AquaCrop model

- $\text{RMSE} = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(Oi - Pi)^2}$

- $\text{NRMSE} = (\frac{RMSE}{\hat{O}}) \times 100$

- $\text{d} = 1 - \frac{\sum_{i=1}^{n}(Oi-Pi)^2}{\sum_{i=1}^{n}(P_i'+O_i')^2}$

Where $O_i$ and $P_i$ corresponds to the observed and simulated values, respectively, and $n$ to the number of observations. While the RMSE has the same units as that of the variable being simulated (t/ha), NRMSE units are displayed as a percentage. In addition, $O'_i = [O_i - \hat{O}]$ and $P'_i = [P_i - \hat{P}]$ shows the differences between observed and simulated values, with $\hat{O}$ and $\hat{P}$ as the observed and simulated means, respectively.

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# Calibration and validation of AquaCrop model

**Step 1.** You first **calibrate** in one location (Badin)

**CALIBRATION (Badin)**

*Here we introduce the observed values in the field and the simulated values from AquaCrop!*

| Badin (SOUTH) -CALIBRATION | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | OBSERVED | SIMULATED | RMSE | MAE | EF | I *Pi-Oave* I | I *Oi-Oave* I | d | MAPE | Difference |
| 2011 | 2,965 | 2,869 | 0,01 | 0,10 | 0,00 | 0,11 | 0,02 | | 0,03 | 0,01 |
| 2012 | 2,738 | 2,999 | 0,07 | 0,26 | 0,06 | 0,02 | 0,11 | | 0,10 | 0,07 |
| 2013 | 3,067 | 2,874 | 0,04 | 0,19 | 0,01 | 0,10 | 0,02 | | 0,06 | 0,04 |
| 2014 | 3,039 | 2,996 | 0,00 | 0,04 | 0,00 | 0,02 | 0,10 | | 0,01 | 0,00 |
| 2015 | 3,065 | 2,722 | 0,12 | 0,34 | 0,01 | 0,25 | 0,17 | | 0,11 | 0,12 |
| | 2,975 | | **0,22** | **0,19** | **-2,04** | 0,50 | 0,42 | **0,73** | **3,17** | **0,23** |
| | | | | | | | | | | 0,22 |
| | | | | | | | | | NRMSE (as %) | 7,28 |

**Step 2.** You **validate** against one other location (Multan)

**VALIDATION (Multan)**

| MULTAN (NORTH) - VALIDATION | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | OBSERVED | SIMULATED | RMSE | MAE | EF | I *Pi-Oave* I | I *Oi-Oave* I | d | MAPE | Difference |
| 2011 | 2,811 | 2,567 | 0,06 | 0,24 | 0,03 | 0,41 | 0,33 | | 0,09 | 0,06 |
| 2012 | 2,600 | 2,761 | 0,03 | 0,16 | 0,14 | 0,21 | 0,13 | | 0,06 | 0,03 |
| 2013 | 2,907 | 3,130 | 0,05 | 0,22 | 0,00 | 0,16 | 0,24 | | 0,08 | 0,05 |
| 2014 | 2,953 | 3,079 | 0,02 | 0,13 | 0,00 | 0,10 | 0,19 | | 0,04 | 0,02 |
| 2015 | 3,022 | 2,856 | 0,03 | 0,17 | 0,00 | 0,12 | 0,04 | | 0,05 | 0,03 |
| | 2,859 | | **0,19** | **0,18** | **-0,02** | 1,00 | 0,92 | **0,95** | **3,23** | **0,18** |
| | | | | | | | | | | 0,19 |
| | | | | | | | | | NRMSE (as %) | 6,61 |

# Thank you!

**Contact details:**
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