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AI4Water

Running AquaCrop for the Capitanata case study (April 1, 2026)

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1. AquaCrop characteristics: a recap

- AquaCrop is designed as a single-crop, field-scale model

- **One crop** over **one field** (assumed spatially homogeneous) at a time
- One soil profile, one crop type, one irrigation schedule

- If we have a field with multiple crops:
    - **aggregate** crops into a single “representative crop” for the whole field.
    - treat each crop separately (as its own field) and later **combine results**

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1. AquaCrop characteristics: a recap

- We run a simulation of a crop over a field at time t; t can be
  - **current time**/date (for real-time support)
  - any historical date (using observed weather and management data)
  - a future date (using weather forecasts or climate scenarios)

- AquaCrop simulation **propagates the state** (soil moisture, crop development, etc.) forward over a period of time from any starting date, regardless of whether that starting time is in the past, present or future

- The optimization process (GA) only cares that the simulation returns feasible solutions and their yield at the end of the simulation or along the way

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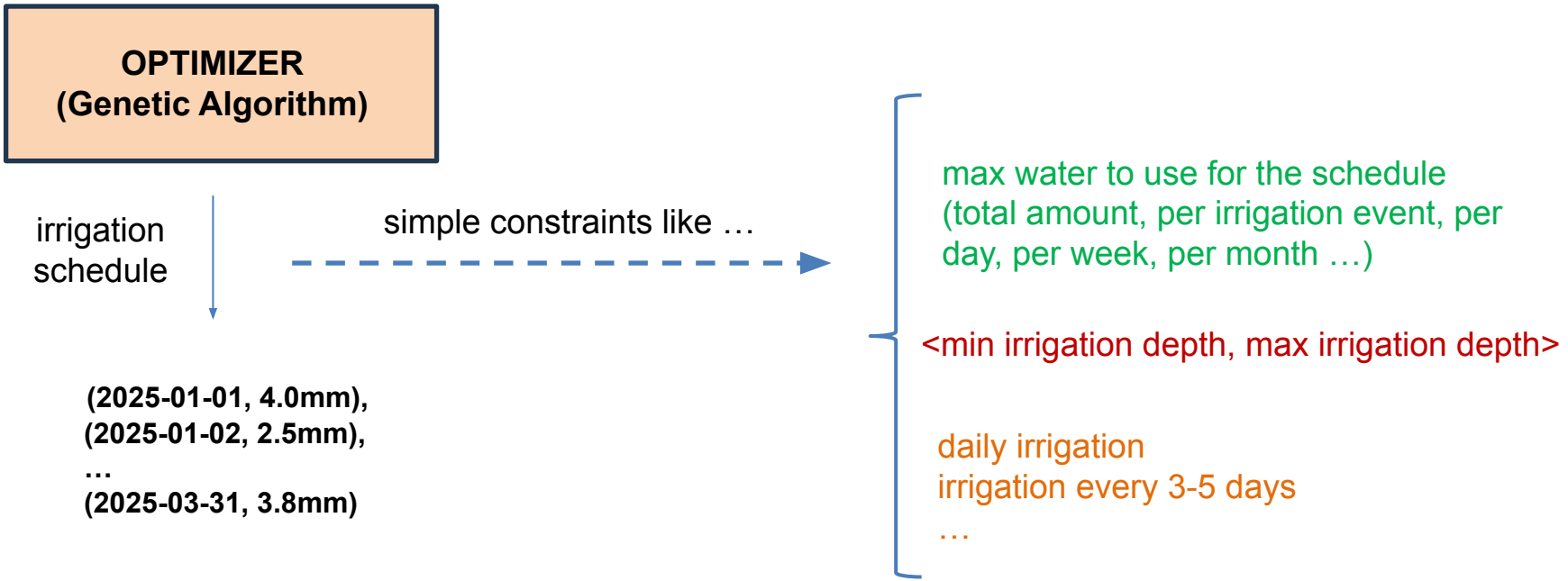
2. AquaCrop input data (in detail)



2. AquaCrop input data (in detail)

same dates as in the irrigation schedule

(2025-01-01, 4.0mm),
(2025-01-02, 2.5mm),
…
(2025-03-31, 3.8mm)

```
def run_single_simulation(imgmt, crop, problem):
    model = AquaCropModel(
        sim_start_time=problem.start_date,
        sim_end_time=problem.end_date,
        weather_df=problem.wdf,
        soil=problem.soil,
        crop=crop,
        initial_water_content=problem.initWC,
        irrigation_management=imgmt,
    )
```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2. AquaCrop input data (in detail)

initially available soil water
(typically set to the Field Capacity)

```
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```


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2. AquaCrop input data: the crop

crop type: maize, pulses, tomato, maize-late season, …

crop calendar parameters: planting date, time to flowering, time to maturity, …

growth-related parameters: (CC over LAI)
- maximum canopy cover [0,1]
- time to reach max CC

```
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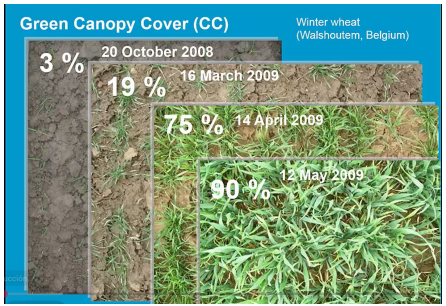
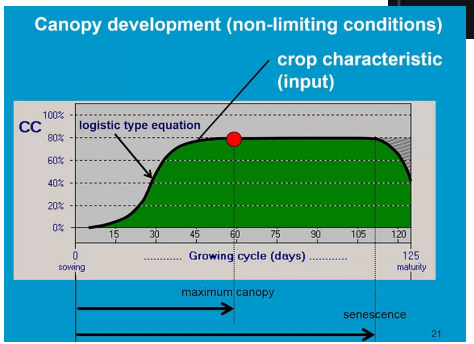
```





2. AquaCrop input data: the crop

root-zone parameters:
- minimum effective rooting depth (germination)
- maximum effective rooting depth (mature crop)
- rate describing how the root expands (e.g., cm per day)

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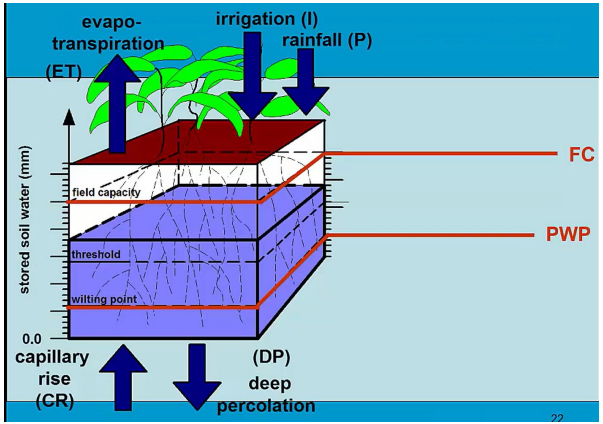
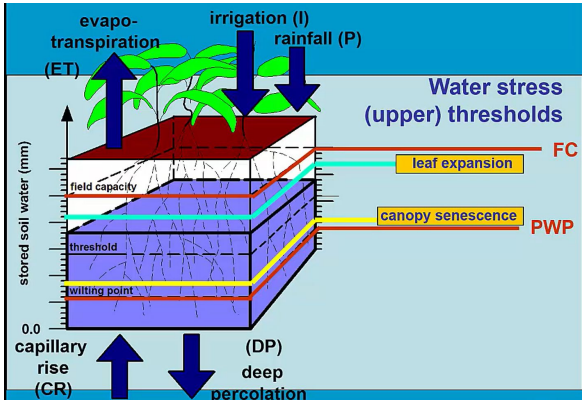
    )
```

to calculate **water stress** in the root zone, AquaCrop simulates the soil water balance





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2. AquaCrop input data: the crop

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        crop=crop,
        initial_water_content=problem.initWC,
        irrigation_management=imgmt,
    )
```

other crop-specific parameters:

- water-stress thresholds (e.g., response to water stress at different stages).
- reference crop coefficients
- tuning parameters: fertility-related, yield response to water ….

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2. AquaCrop input data: the soil

This will be explained in detail in the next presentation

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```


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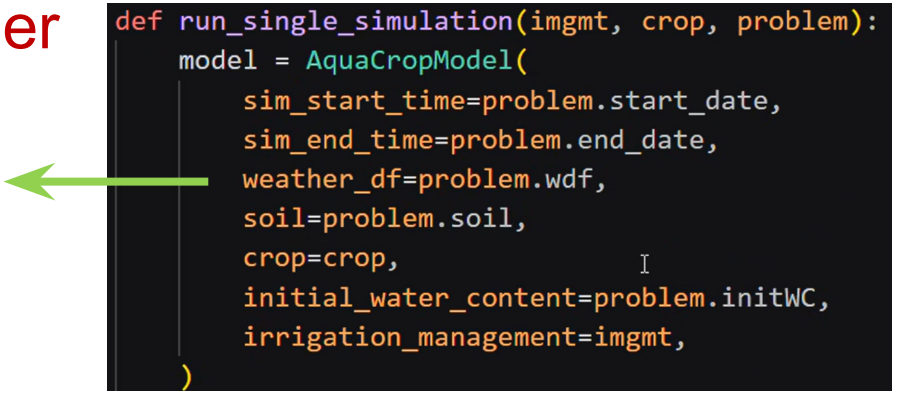
2. AquaCrop input data: the weather

time-series variables that define the **climate conditions at the field** over the simulation period.



AquaCrop accepts weather and climate data at **three temporal scales**:

- **Daily**
- **10-day**
- **Monthly**

2. AquaCrop input data: the weather

Weather and climate data are used to compute:

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        crop=crop,
        initial_water_content=problem.initWC,
        irrigation_management=imgmt,
    )
```

- rainfall
- reference evapotranspiration ETo
- (optionally) CO_2

standard mode: ETo precomputed

embedded ETo calculator

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2. AquaCrop input data: the weather

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        initial_water_content=problem.initWC,
        irrigation_management=imgmt,
    )
```

Temperature

Minimum and maximum air temperature for each day (or 10-day / monthly, if daily data is not available)

AquaCrop uses the **minimum and maximum temperature** to inteporlate back to daily values internally

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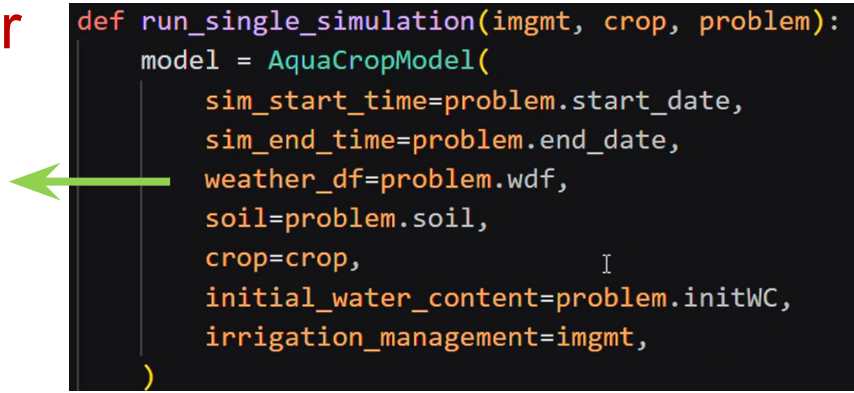
2. AquaCrop input data: the weather

Temperature

AquaCrop uses daily temperature for:



- to determine ***when*** the crop reaches key stages and how temperature extremes affect it.
- to adjust biomass and Water Productivity based on CO2, climate and temperature

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2. AquaCrop input data: the weather

Rainfall

If only 10-day or monthly rainfall data exist, AquaCrop can internally disaggregate it to daily values, but daily rainfall is strongly preferred because rainfall is highly variable in time

Daily total rainfall (usually in mm) over the simulation period

Used to:

- Add to **soil-moisture inputs**,
- Adjust net irrigation requirements (i.e., **effective rainfall**)

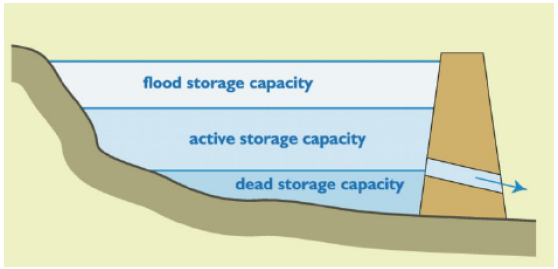
Amount of water that must be delivered to the root zone to satisfy the crop's water needs (optimal growth)

$$NIR = ETc - (R_e + S_m + G_w)$$

fed to the optimization?

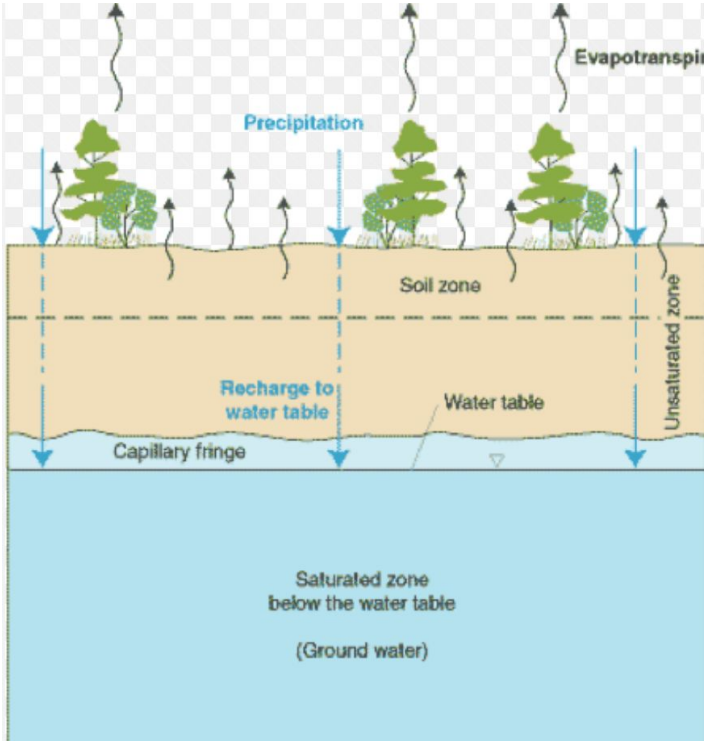
3. Overview

Artificial water resource: reservoir



Irrigation

Three natural water resources

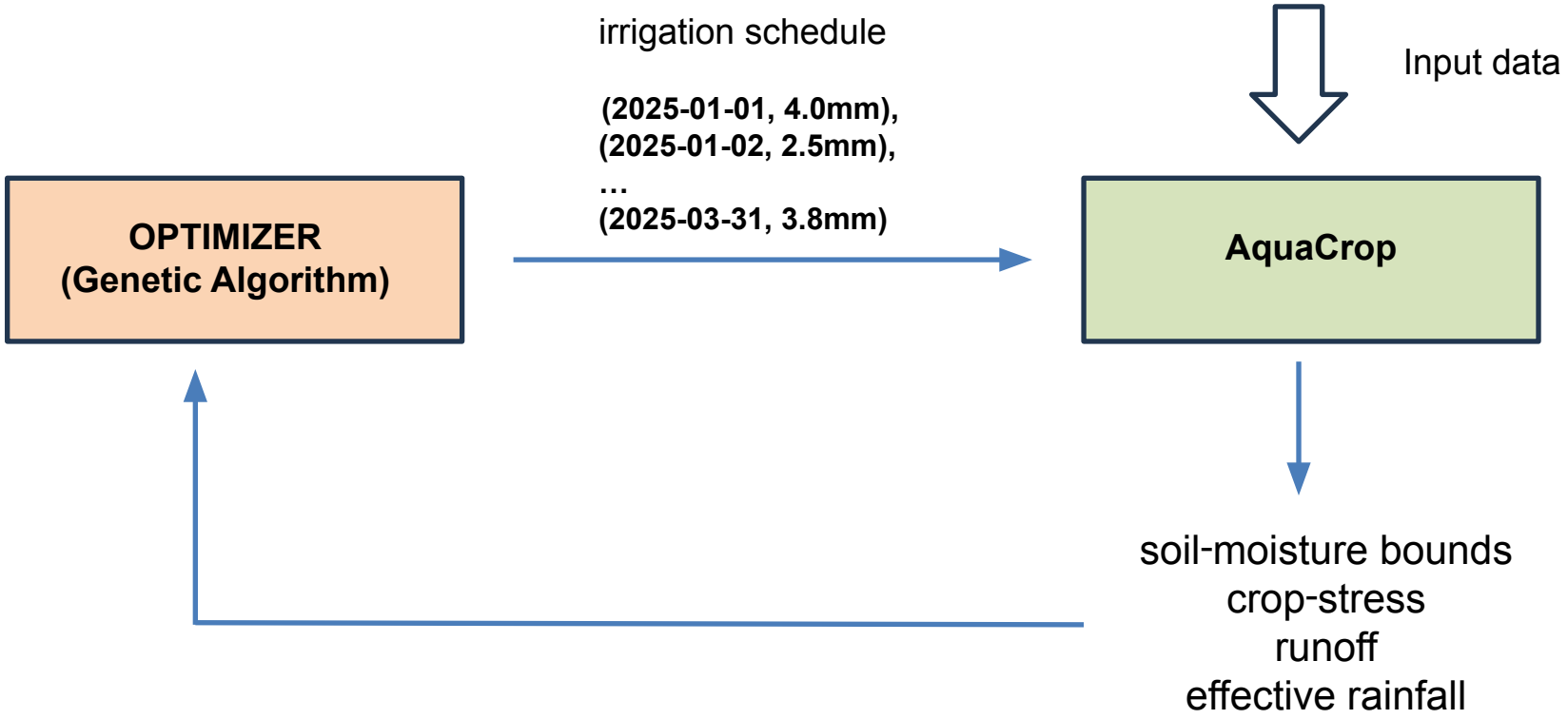


Precipitation

Stored soil water (root zone)

Groundwater

3. Overview


irrigation schedule
(2025-01-01, 4.0mm),
(2025-01-02, 2.5mm),
…
(2025-03-31, 3.8mm)
Input data
OPTIMIZER
(Genetic Algorithm)
AquaCrop
soil-moisture bounds
crop-stress
runoff
effective rainfall