



This project is part of the PRIMA programme supported by the European Union

AI4Water

AquaCrop Soil generation with
SoilGrids dataset



Università
di Brescia



Université
de Lille



UNIVERSITAT
POLITÈCNICA
DE VALÈNCIA



Index

1. `Soil` object for AquaCrop-OSPy
2. SoilGrids Dataset
3. Calculation of `Soil` properties
4. `Soil` properties example

1. Soil object for AquaCrop-OSPy

- Represents the **physical and hydraulic properties of a soil profile** in AquaCropOS-Py
- **Key input parameters** used to characterize the soil:
 - **Field Capacity** (θ_{FC})
 - **Wilting Point** (θ_{WP})
 - **Saturation** (θ_s)
 - **Saturated Hydraulic Conductivity** (K_{sat})
 - **Curve Number** (CN)
 - **Readily Evaporable Water** (REW)
- These parameters control water availability, infiltration, drainage, and overall soil–plant interactions

2. SoilGrids Dataset (I)

- **SoilGrids** is a global, high-resolution soil dataset that provides spatial predictions of key soil properties (such as texture, bulk density, and organic carbon) across multiple depth layers
- For the Capitanata district, we have `.tif` files containing spatially distributed measurements of these variables at each pixel of the image.
- Our objective is to compute the soil hydraulic properties for every pixel across the study area.



2. SoilGrids Dataset (II)

Variable Code	Name	Description
bdod	Bulk density	Fine earth fraction (<2 mm)
cfvo	Coarse fragments	Volumetric fraction > 2mm
clay	Clay content	< 0.002 mm fraction
sand	Sand content	0.05 - 2 mm fraction
silt	Silt content	0.002 - 0.05 mm fraction
wv0033	Water Content (33 kPa)	Volumetric water content at pF 2.5 (Field Capacity)
wv1500	Water Content (1500 kPa)	Volumetric water content at pF 4.2 (Wilting Point)

3. Calculation of Soil properties (I)

- **Field Capacity (θ_{FC})** is obtained from the **wv0033 files**, which provide soil moisture estimates under conditions where excess water has drained and the soil retains water available for plants (around -33 kPa).
- **Wilting Point (θ_{WP})** is obtained from the **wv1500 files**, which represent the soil moisture level at which plants can no longer extract water (around -1500 kPa).
- These two variables are **computed directly from the dataset**, meaning they do not require any additional processing or transformation.

3. Calculation of Soil properties (II)

- **Saturation (θ_s)** is estimated from the soil bulk density (***bdod* files**) using the relationship between bulk density and total porosity, assuming a particle density of 2.65 g/cm³.

$$\theta_s = 1 - \frac{\textit{bulk density}}{\textit{particle density}}$$

- **Ksat** can be computed using the `calculate_soil_hydraulic_properties` function from AquaCrop-OsPy based on the values of θ_{FC} , θ_{WP} , and θ_s (given as parameters)

3. Calculation of Soil properties (III)

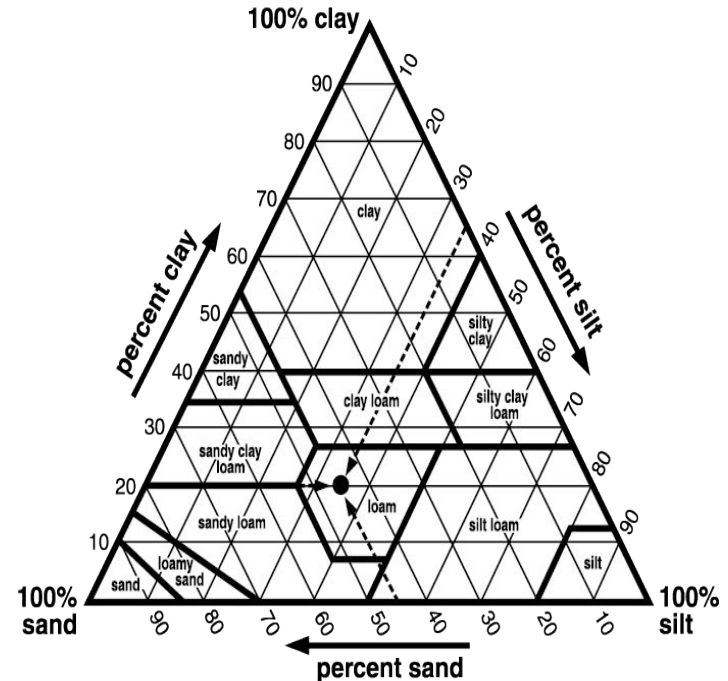
- Soil is made of:
 - **Fine earth (< 2mm)**: can store water.
 - **Coarse fragments (stones, gravel)**: do not store water.
- SoilGrids provides water content (wv files) estimated for fine soil.
- If part of the soil is composed of Coarse fragments, the real content is lower.
- We apply a correction factor using the Coarse fragments volumetric fraction (**cfvo** files)

$$\theta_{WP}, \theta_{FC}, \theta_S \leftarrow \theta \times \left(1 - \frac{cfvo}{100}\right)$$

3. Calculation of Soil properties (IV)

- Curve Number (CN) and Readily Evaporable Water (REW)

1. Obtain the **average soil composition of the top 30 cm (sand, silt, clay files)** using a weighted average (weighted by thickness of layer).
2. Use the **USDA soil texture triangle** to determine soil texture based on the percentages of sand, clay, and silt.
3. Use the internal **AquaCrop-OSPy database** to determine the **suggested CN and REW values**.



3. Calculation of Soil properties (V)

- Soil properties are computed **for each depth layer**
- **Depth levels considered:** 0–5, 5–15, 15–30, 30–60, 60–100, 100–200 cm

```
for pixel in image:

    soil = Soil(...)
    for depth in layers:
        data = extract_values(depth)

         $\theta_{WP}$  = compute_wp(data)
         $\theta_{FC}$  = compute_fc(data)
         $\theta_S$  = compute_saturation(data)
        Ksat = compute_ksat(...)

        soil.add_layer_to_soil_profile(...)

    CN, REW = get_USDA_Texture(data)
    soil.set(CN=CN, REW=REW)
```

4. Soil properties example

Non-corrected values				
Depth	θ_{FC}	θ_{WP}	θ_s	Ksat (mm/d ay)
0-5cm	0.322	0.192	0.498	320.1
5-15cm	0.316	0.201	0.472	218.0
15-30cm	0.307	0.207	0.445	150.2
30-60cm	0.315	0.210	0.449	138.1
60-100cm	0.315	0.208	0.434	98.3
100-200cm	0.306	0.202	0.423	92.9

Corrected values			
θ_{FC}	θ_{WP}	θ_s	Ksat (mm/d ay)
0.276	0.165	0.426	205.1
0.267	0.170	0.399	133.7
0.264	0.178	0.383	97.1
0.272	0.181	0.388	90.2
0.268	0.177	0.369	61.4
0.260	0.171	0.359	57.9

CN=72
REW=14

4. Comparison with AquaCrop

- For **Silt Clay soil texture** (default behaviour of one layer):

	AquaCrop Default	Inferred from SoilGrids
θ_{FC}	0.50	[0.26, 0.32]
θ_{WP}	0.32	[0.16, 0.21]
θ_s	0.54	[0.35, 0.50]
Ksat (mm/day)	100	[58, 320]

- AquaCrop defaults represent **idealized soil classes**
- SoilGrids provides **spatially explicit, real-world estimates**
- Differences are expected and reflect **local soil conditions**

- Todo:** If available, compare parameters obtained from SoilGrids with another dataset of the same region.