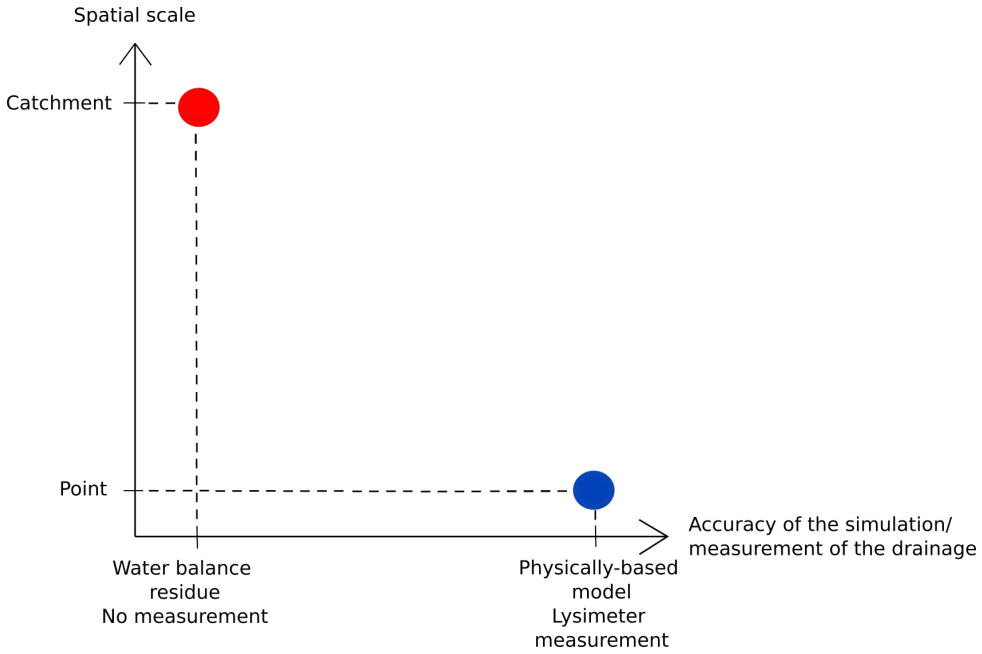
Estimating the drainage of irrigated crops from the field to the irrigation district

H2020-PRIMA-S2-2019, 2020-2023, GA# ANR-19-P026-0003

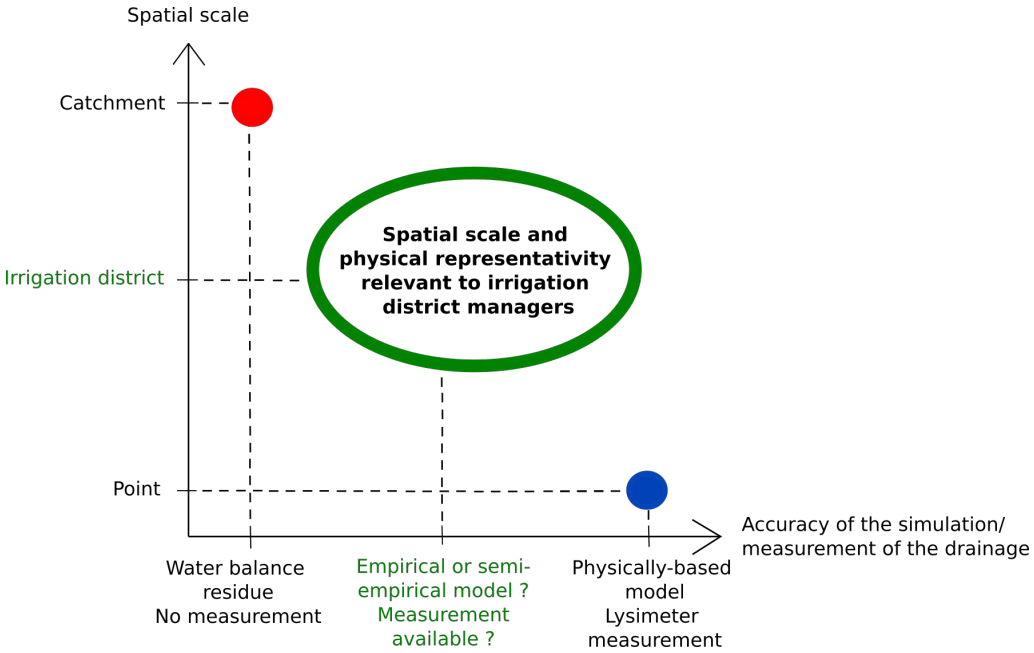
Open Project Day

isardSAT, Barcelona | March 11th, 2022

Context


Spatial scale
Catchment
Point
Accuracy of the simulation/
measurement of the drainage
Water balance
residue
No measurement
Physically-based
model
Lysimeter
measurement

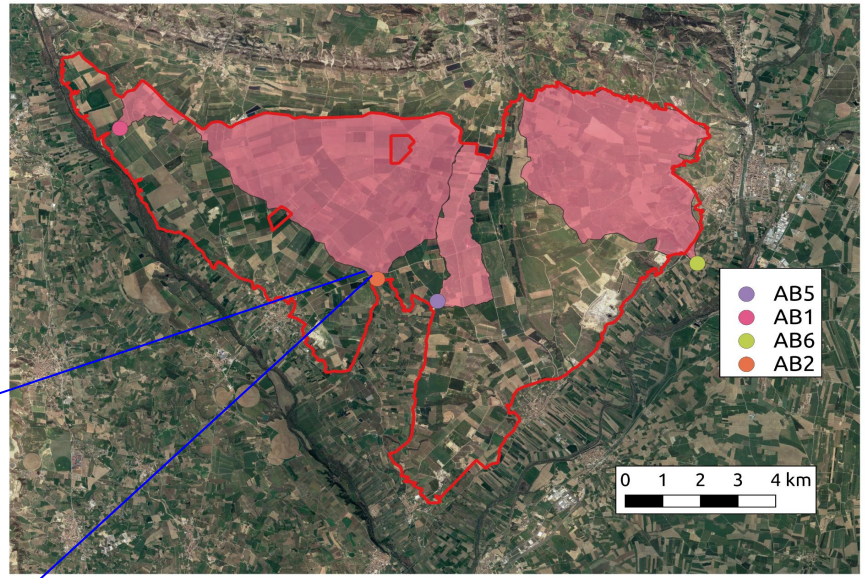
Context


Spatial scale
Catchment
Irrigation district
Point
Spatial scale and physical representativity relevant to irrigation district managers
Accuracy of the simulation/ measurement of the drainage
Water balance residue No measurement
Empirical or semi-empirical model ? Measurement available ?
Physically-based model Lysimeter measurement

Sub-basin scale drainage data

Study area: Algerri-Balaguer irrigation district close to Lleida

- 8,000 irrigated hectares
- A network of buried drains and ditches and have been set up early 2000's (42.8 km of drainage network)
- 4 sub-catchments AB1, AB2, AB5, AB6 continuously monitoring drainage



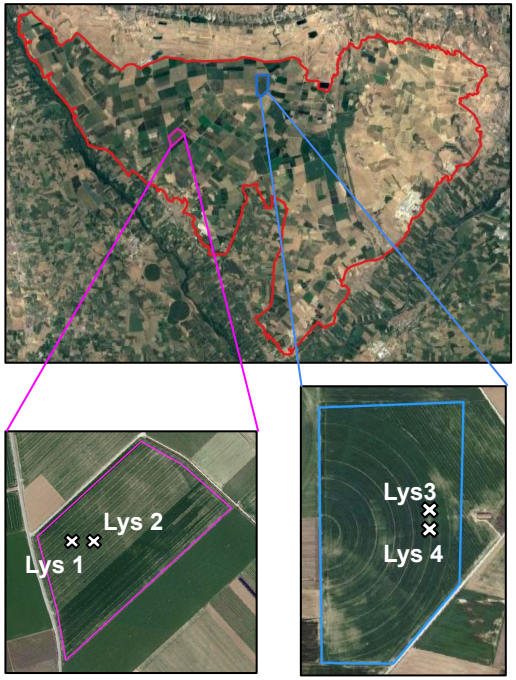
Field-scale drainage data

Drainage data at the field scale:

- 4 passive lysimeters were installed at the end of June 2021 on two fields
- Irrigation volume counters were installed on each fields
- Soil texture analyses were performed

For the moment we are waiting to collect more data with the lysimeters

Algerri-Balaguer area and instrumented sites



Albesa: 18 ha, sprinkler irrigation

Castello Farfanya:
25 ha, pivot irrigation

G3 lysimeter being installed

Extraction of drainage water with a hand pump

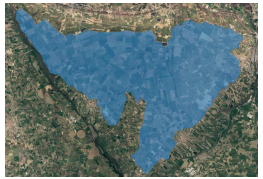
Overview of drainage retrieval strategy

MAIN OBJECTIVE
Develop a method to effectively simulate drainage at the whole irrigation district scale

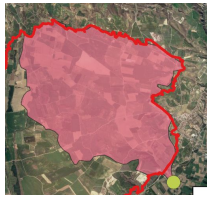
Develop this method by building on sub-basin scale validation data from the 4 outlets
--> Retrieve drainage observed in the 4 outlets (sub-basin scale)

Evaluate SAMIR's drainage formalism by building on field scale validation data (physically-based models and/or lysimeters)
--> Retrieve drainage simulated by a physically based model and/or observed with lysimeters (field scale)

Irrigation district scale



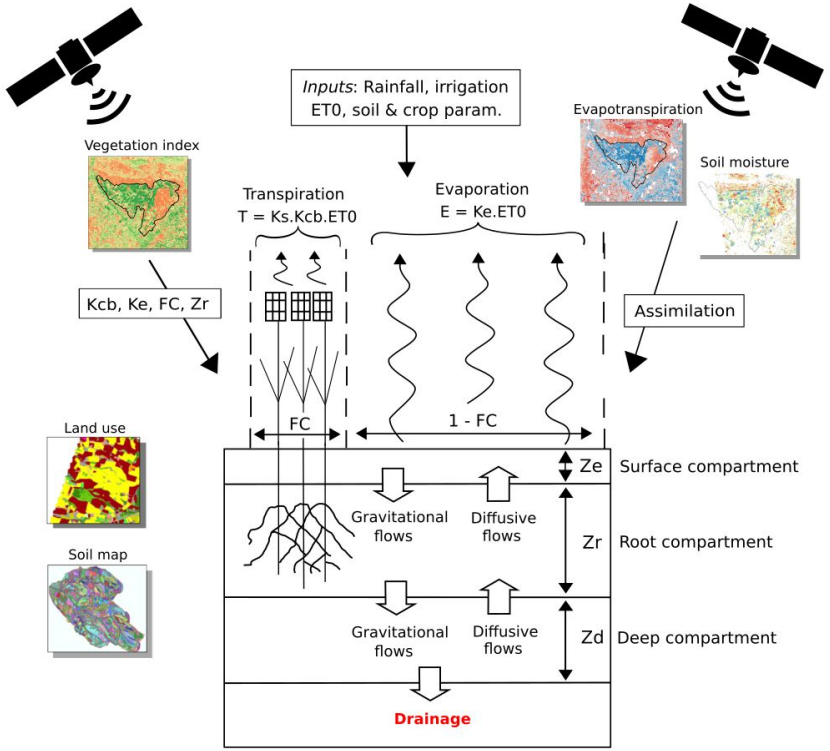
Sub-catchment scale



Field scale

Tool used: SAMIR model

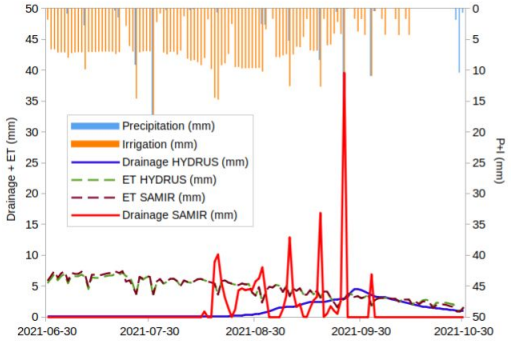
- SAMIR is a crop water balance model based on the estimation of evapotranspiration using the FAO-2Kc method
- Uses remote sensing observations to simulate the vegetation development and status
- 3 subsurface compartments
- If soil humidity > FC : directly drainage
- *14 parameters:*
  - *6 soil parameters*
  - *4 crop parameters*
  - *4 remote sensing parameters*

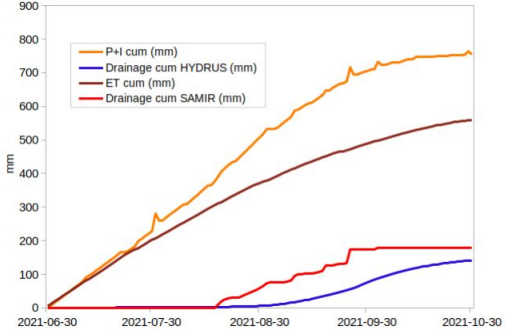


Field-scale drainage retrieval: SAMIR evaluation

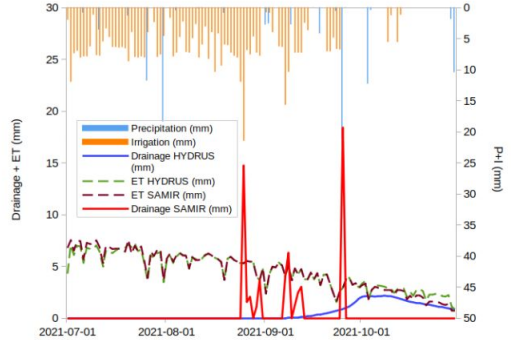
SAMIR: simple crop water model spatializable *VS*
HYDRUS-1D: complex physically based model

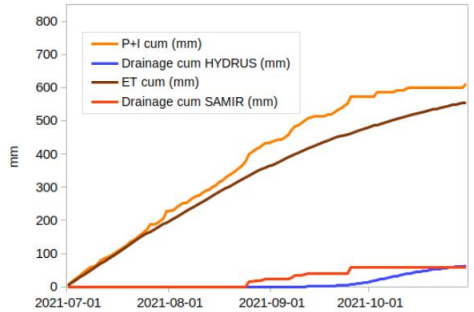
a) Albesa crop





b) Castello-Farfanya crop





Daily drainage dynamics:

- SAMIR drainage occurs instantaneously
- HYDRUS-1D drainage is progressive

Four months cumulative drainage:

- 2 models are very close at the end of the season

Conclusion:

- Large temporal scale (>2 or 3 months):

  → SAMIR could be sufficient

- Finer temporal scale (day, week, month):

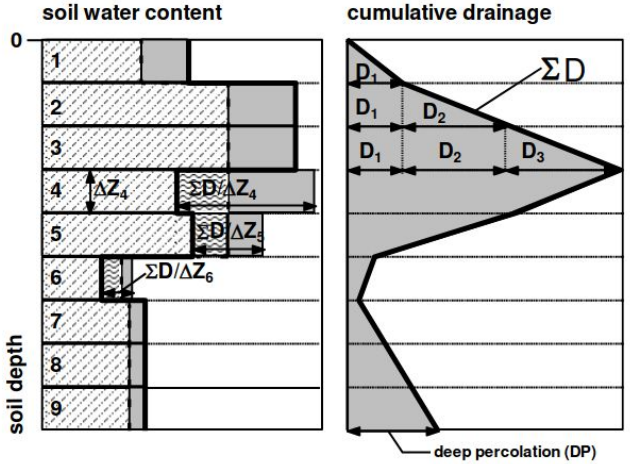
  → need to improve SAMIR formalism to take into account the physical processes associated with soil hydrodynamic properties

Field-scale drainage retrieval

Testing the Raes et al. 2012 method (AquaCrop) to simulate drainage as a function of soil hydraulic properties

Raes method:

- Dividing the soil column into 12 compartments
- Water flows from one compartment to another according to semi-empirical equations taking into account the hydraulic conductivity at saturation Ks, the soil moisture at saturation Qs, & the soil moisture at FC



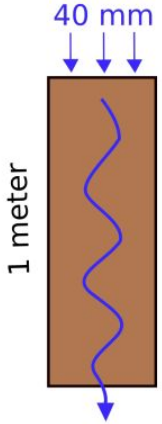
From Raes et al. 2012

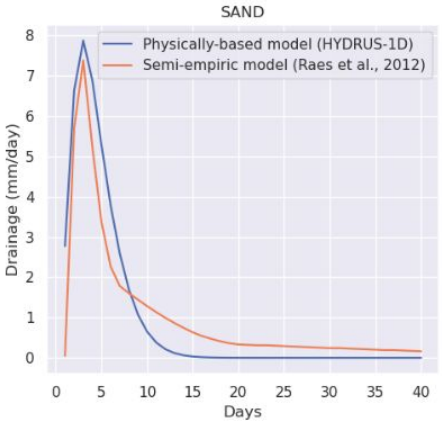
Drainage:

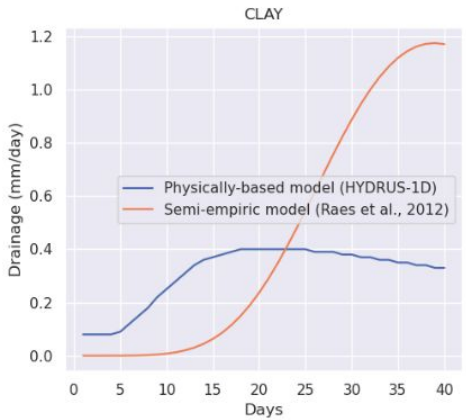
$$\frac{\Delta\theta_i}{\Delta t} = \tau\,(\theta_{SAT} - \theta_{FC})\,\frac{e^{\theta_i - \theta_{FC}} - 1}{e^{\theta_{sat} - \theta_{FC}} - 1}$$

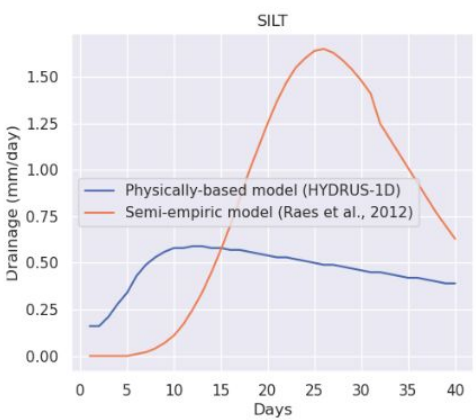
with $0 \le \tau = 0.0866\,Ksat^{0.35} \le 1$

Field-scale drainage retrieval



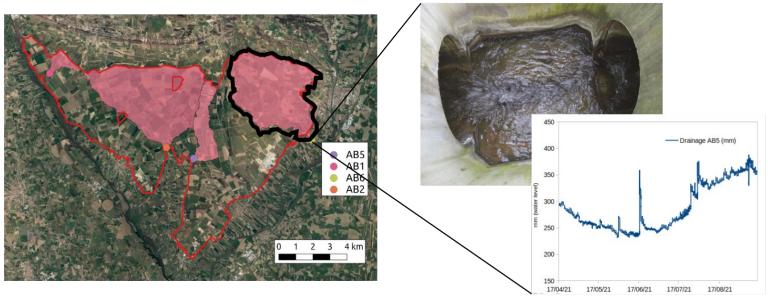






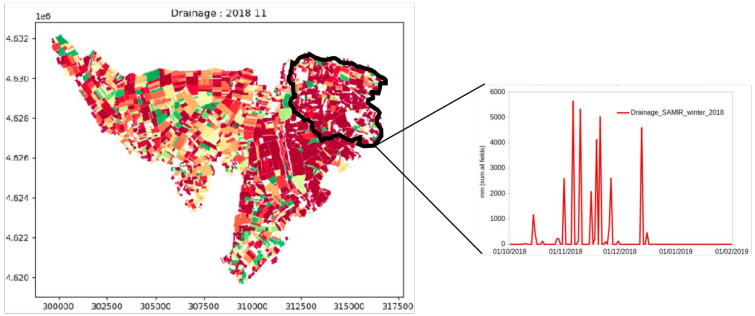
Irrigation district scale drainage retrieval

1) Sub-catchment drainage measurement



VS

2) Spatialized drainage simulation with SAMIR at sub-catchment scale



3) Calibration of SAMIR drainage based on measured drainage

with measured irrigation data

4) Calibration of SAMIR with SM and ET products

with irrigation data derived from satellite products

ACCWA IDEWA

Thank you!