Under the High Patronage of His Majesty King Mohammed VI

International Water Resources Association
IWRA

XIX WORLD WATER CONGRESS
International Water Resources Association (IWRA)
Marrakech, Morocco | 1-5 December 2025

Kingdom of Morocco
Ministry of Equipment and Water

Advancing digital solutions for sustainable irrigation water management in Mediterranean agriculture

Andrea Borgo
CMCC Foundation – Euro-Mediterranean Centre on Climate Change, Lecce, Italy
01/12/2025

Introduction – Context

Competition of water among sectors

Water scarcity and degradation

Climate Change

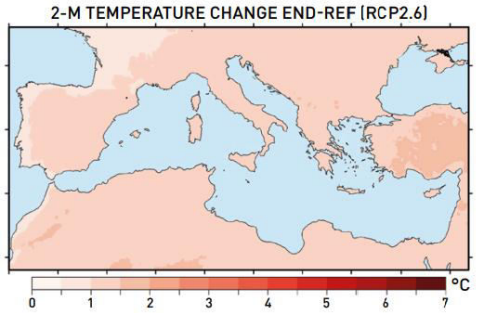
Temperature

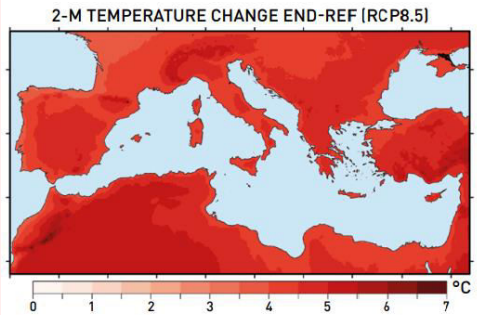
Precipitation

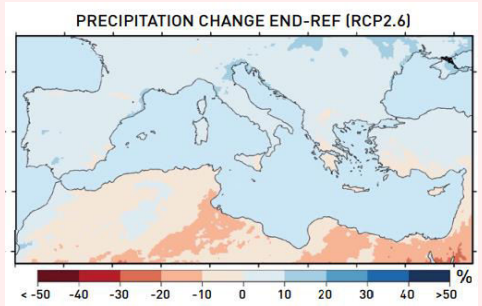
Irrigation demand

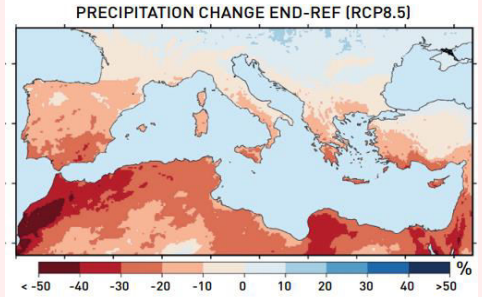
Need for tools to **optimize water use**

- Digitalization of agriculture
- Decision Support Tools

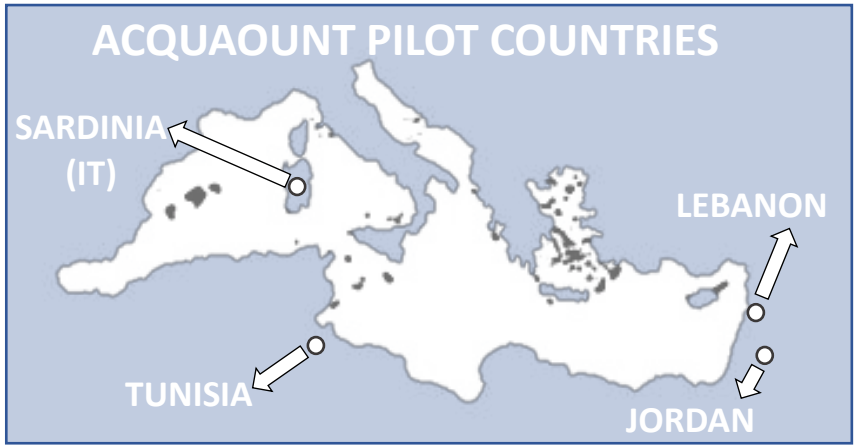








Introduction – the project



Web of Thing (WoT) platform → Near real-time services → Farm level: optimal irrigation

Near real-time services → Basin level: integrated water management

Development of **real-time irrigation models** to suggest **optimal irrigation inputs** by minimizing deep percolation and crop water stress.

Simplified irrigation model, with a **minimal and easy-access** set of input variables

Predict the **evolution** of soil moisture and irrigation demand for the **following week**.

Input variables

Crop
- Selection of crop
- Planting and harvesting date
- Plant layout
- Crop table

Climate variables
- Climate zone (Arid or Mediterranean)
- Latitude
- Elevation
- Weather station's variables
  (Temperature, Precipitation, Short wave radiation, Relative humidity, wind)
- Weather forecast
  (Temperature, Precipitation, Short wave radiation, Relative humidity, wind)

Irrigation
Irrigation method
(sprinkler, drip, subterranean)
Sprinkler:
- Number of emitters
- sprinkler rate

Drip (& subterranean):
- Number of emitters per line
- Emitter spacing
- Emitter rate
- Wetted length
- (dripper depth)

- Irrigation recorded from water meters

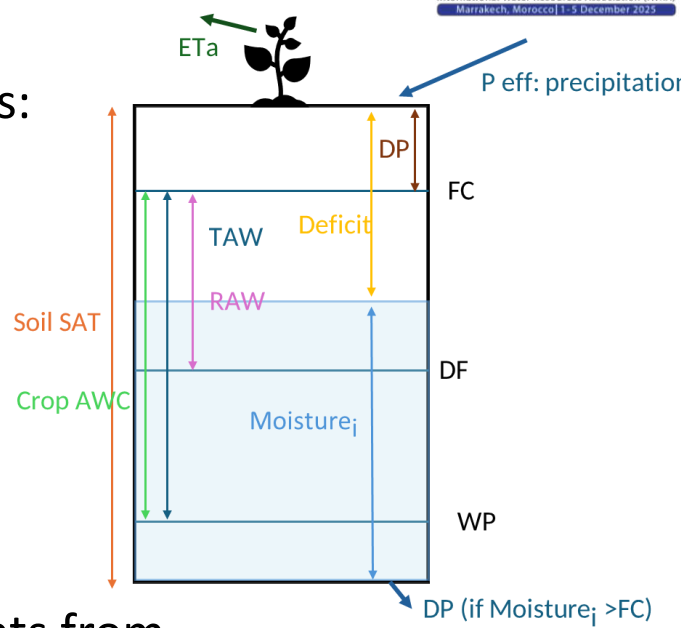
Soil
- Percentage Sand, silt, clay
- Soil water content at saturation
- Saturated hydraulic conductivity
- Bulk density
- Field capacity
- Wilting point

Soil Moisture
- Soil moisture
- Sensor spacing
- Max previous run

DATA SOURCE
- **User**
- **On-site sensors**
- **Weather Forecast**
- **WoT Platform**

Soil water balance - main concept

Describe main steps of the model, subdivided in the following steps:



- Definition of **daily rooting depth**
- Daily dual crop-specific coefficient **kc**
- Water stress coefficient **ks** and Actual Evapotranspiration **ETa**
- **Correction of crop coefficient**, to correct future irrigation events from deep percolation and water scarcity
- Definition of **irrigation requirements**
- Definition of irrigation recommendations: **Early, Late and Limit** events

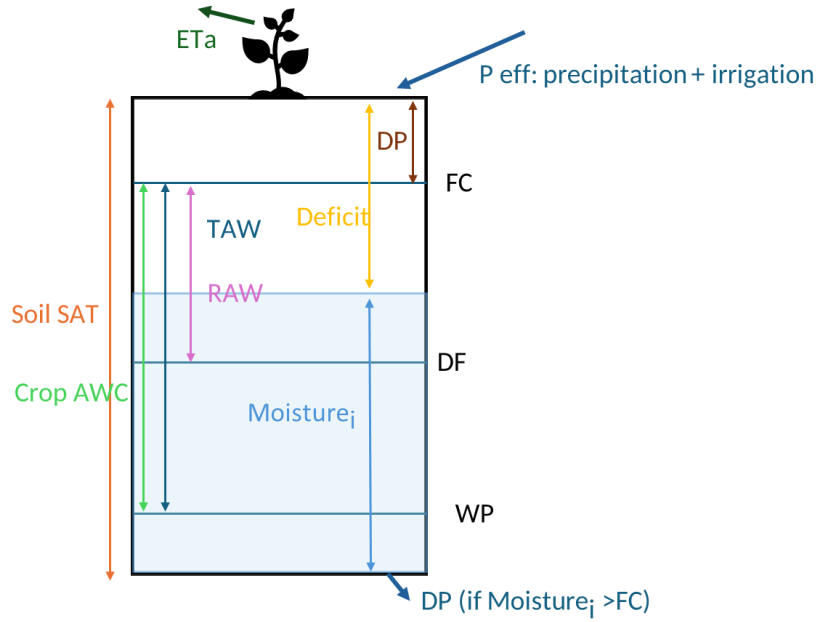
Soil water balance – irrigation recommendations

Root zone Depletion (Dr) and Irrigation requirements:

- Irr req. = Dr if (ETa < ETc)

Dynamic adjustment of depletion factor (DF):

- $RAW^1 = TAW^2 \times DFadj$
- DFadj = DFtab + 0.1 x (4 – ET0), when ET0 ≥ 4 mm/day



Irrigation recommendations:

Estimate **the days of early, late and limit irrigation**, according to Dr thresholds

Early: Dr = 0.5 x RAW*

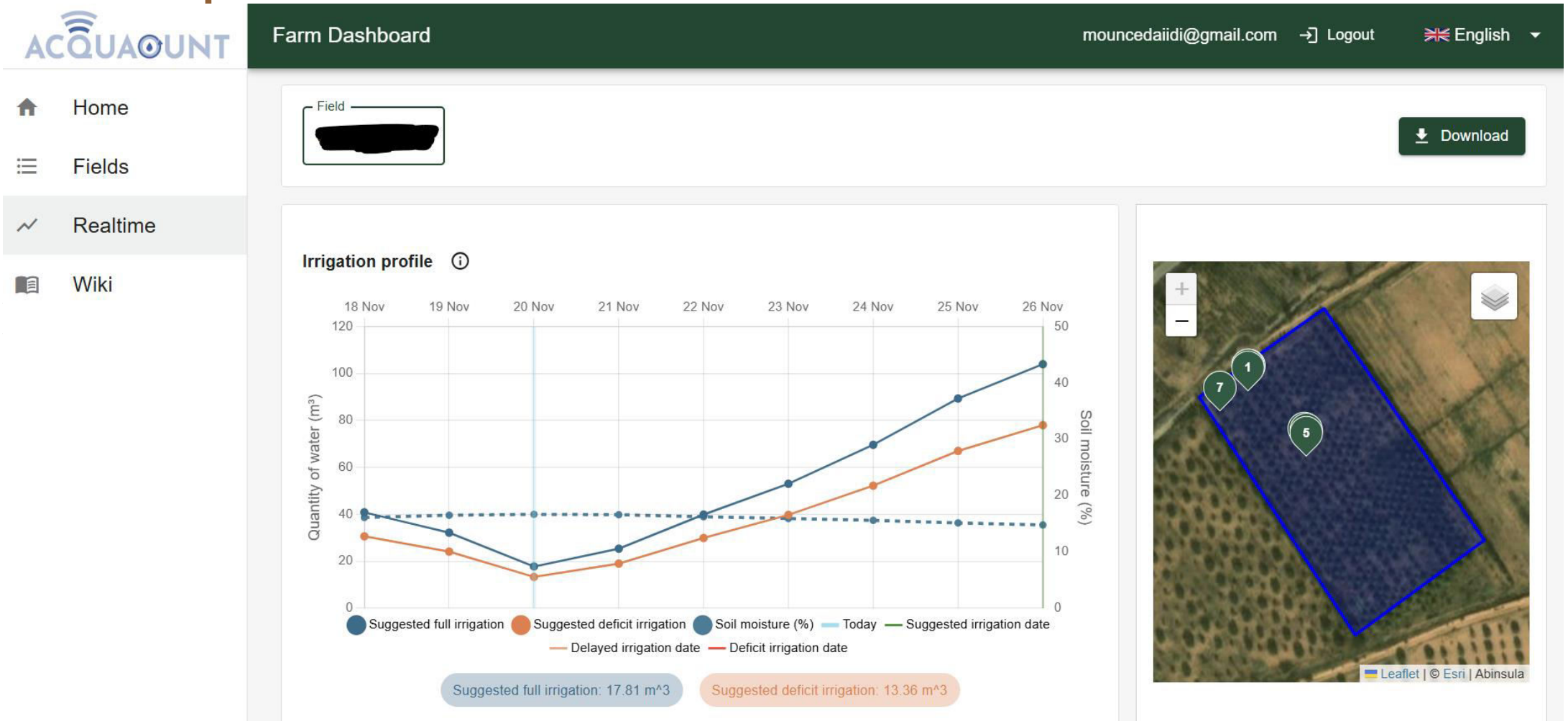
Late: Dr = RAW

Limit: Dr = 1.4 x RAW

[1]RAW: Readily Available Water

[2]TAW: Total Available Water

Output and data visualization



Test performance – Tunisian pilots

Farm	AM	JD	SG	NR
Crop	citrus	citrus	potato	potato
Season 2024	01/05/2024 - 15/11/2024	01/05/2024 - 31/12/2024	30/09/2024- 15/01/2025	01/10/2024- 15/01/2025
Season 2025	01/05/2025 - 15/11/2025	01/05/2025 - 31/12/2025	12/02/2025 - 05/06/2025	12/02/2025 - 05/06/2025
Soil composition: sand (%)	63.8	85	90.8	75.5
Soil composition: silt (%)	20.9	6.1	1.6	13.3
Soil composition: clay (%)	15.3	8.9	7.6	11.2
Area (ha)	0.35	0.88	0.22	0.1
Irrigation system	drip (2 drips/line, spacing 1 m, 4 L/h)	drip (1 drip/line, spacing 2 m, 8 L/h)	drip (1 drip/line, spacing 0.4 m, 4 L/h)	drip (1 drip/line, spacing 0.4 m, 4 L/h)

Test performance – Tunisian pilots

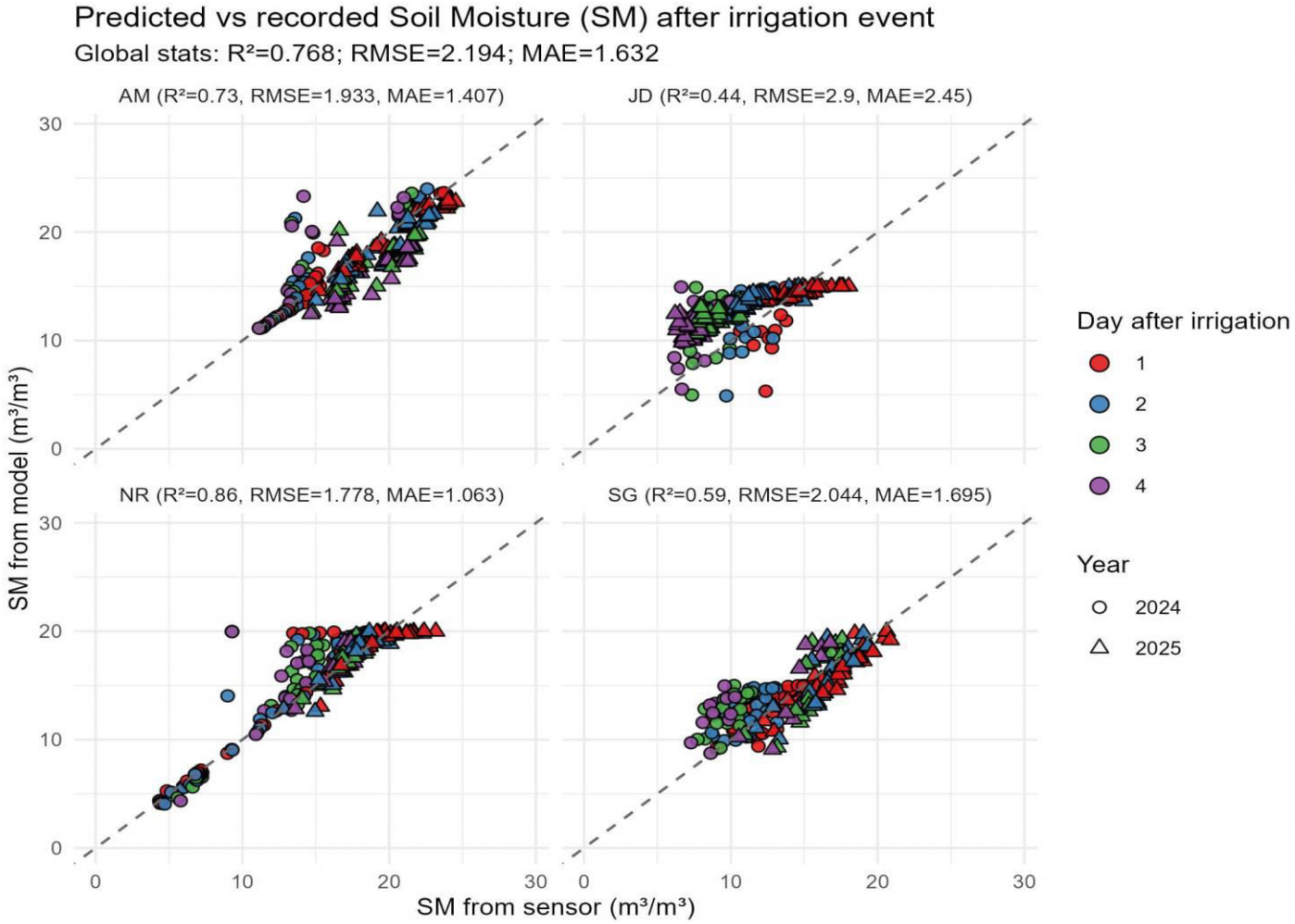


Figure 2: Difference between predicted vs measured daily soil moisture values at 1, 2, 3 and 4 days after an irrigation event. Results are provided for the four farms and for years 2024 and 2025.

Test performance – Tunisian pilots

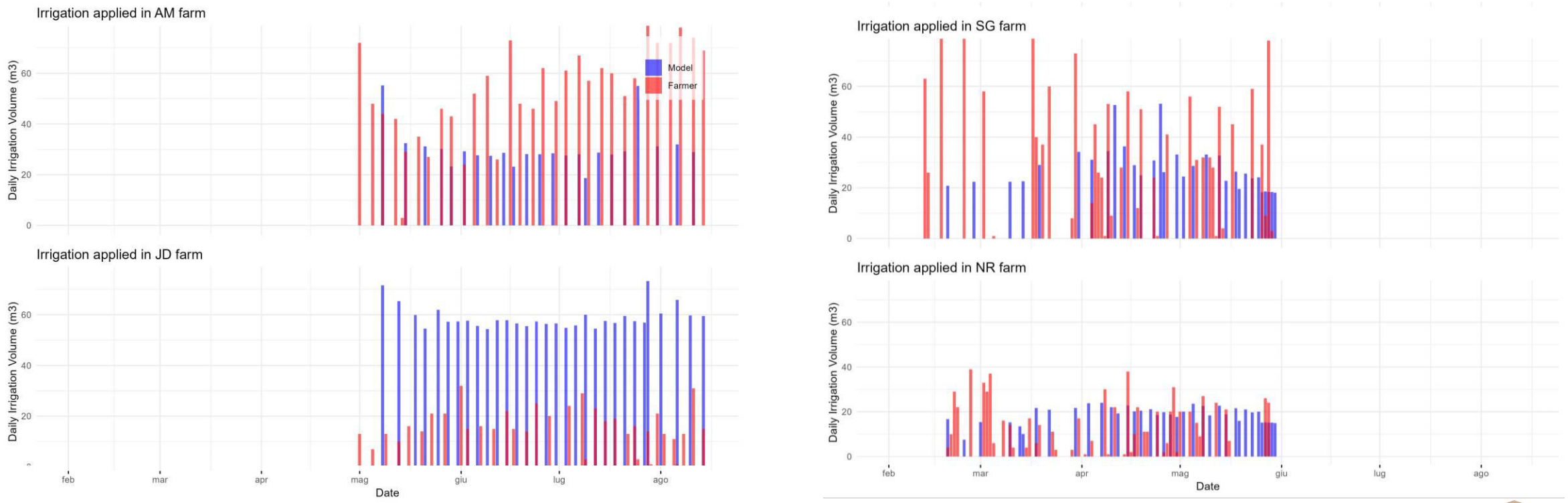


Figure 3: Comparison between the irrigation applied by the farmer vs the irrigation suggested by the model over the growing season 2025. The model applies irrigation as soon as the "Early" threshold is reached.

Test performance – Tunisian pilots

Farm	AM			JD			SG			NR		
month	model	sensor	Water saving	model	sensor	Water saving	model	sensor	Water saving	model	sensor	Water saving
2025-02	-	-	-	-	-	-	43	283	85%	24	104	77%
2025-03	-	-	-	-	-	-	108	360	70%	119	214	45%
2025-04	-	-	-	-	-	-	352	387	9%	248	237	-5%
2025-05	172	389	56%	428	115	-272%	353	467	24%	300	193	-55%
2025-06	221	439	50%	566	174	-225%	-	-	-	-	-	-
2025-07	246	575	57%	586	184	-219%	-	-	-	-	-	-
2025-08	151	564	73%	421	162	-160%	-	-	-	-	-	-
2025-09	98	387	75%	269	86	-213%	-	-	-	-	-	-
Total	**888**	**2354**	**62%**	**2270**	**721**	**-215%**	**856**	**1497**	**43%**	**691**	**748**	**8%**

Final remarks

- Performance on Tunisian farm:
  - Daily soil moisture’s forecast can reproduce soil's dynamics (**R2 > 0.76**)
  - In 3 out of 4 farms, the irrigation model recommends **lower applications** than the amount given by the farmer over the season (potential for water savings!)
- Final considerations:
  - The key feature of this irrigation model resides in its **simplified nature**, making its implementation **accessible** to a wide range of users
  - Providing **flexible irrigation scheduling can** support farmers who depend on irrigation distribution systems to **plan irrigation events** according to water availability

Under the High Patronage of His Majesty King Mohammed VI

XIX WORLD WATER CONGRESS
International Water Resources Association (IWRA)
Marrakech, Morocco | 1-5 December 2025

Thank you!

andrea.borgo@cmcc.it

www.worldwatercongress.com

International Water Resources Association
IWRA

WWCongress | wwcongress | worldwatercongress

Kingdom of Morocco
Ministry of Equipment and Water