



PROGRAMME OF THE
EUROPEAN UNION



co-founded with



COPERNICUS4REGIONS 2025

DIGITAL TWINS AND REMOTE SENSING FOR MANAGING DROUGHT IN CATALONIA

Joaquim Bellvert, Jaume Casadesús, Magí Pamies-Sans Joan Girona, Jaume Sió

Efficient Use of Water in Agriculture Program. Institute of Agrifood Research and Technology (IRTA) | Spain
General secretary of the Departament of Agriculture, Livestock, Fisheries and Food in Catalonia

“

Having reliable, near real-time information on crop water requirements and the expected impacts of water restrictions allows us to make better-informed decisions, optimize water allocation, and increase the resilience of irrigated agriculture during drought periods.

Jaume Sió,

Department of Agriculture, Livestock, Fisheries and Food (DARPA), Government of Catalonia

”

✓ Drought in Catalonia | Canva

The drought in Catalonia during 2023 and 2024 reached critical levels, prompting urgent measures to conserve water resources. Restrictions on water use were implemented, including in the agricultural sector. In response, we developed a suite of digital solutions utilizing digital twins and remote sensing. These tools proved highly effective in mitigating the drought's impacts and provided valuable support to water agencies, irrigation district managers, and government authorities in making informed decisions to ensure the resilience of the agricultural sector.

THE CHALLENGE

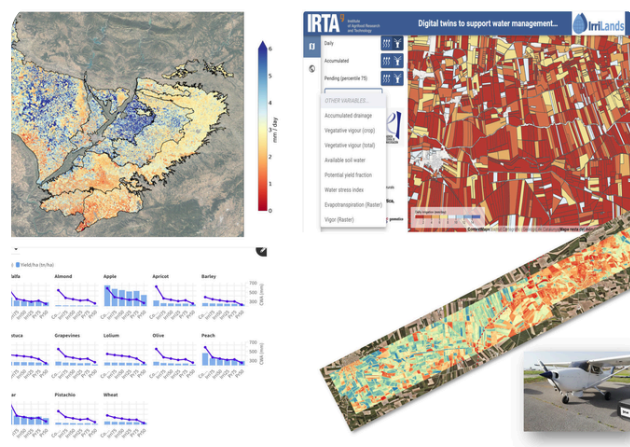
In Mediterranean regions like Catalonia, climate change is causing reduced precipitation, more frequent droughts, and prolonged water scarcity. As reservoir levels drop, irrigated areas often impose water restrictions to improve efficiency and protect crops. To address these challenges, water agencies and irrigation managers need solutions to answer critical questions:

- What are the water demands of an irrigation district until the end of the growing season?
- If water is insufficient, how should it be distributed across space and time?
- Can crop water stress be monitored in real-time with remote sensing to guide water allocation?
- What is the impact of varying water restrictions on crop productivity under different climatic scenarios?
- What is the minimum water needed to ensure crop survival?

THE SPACE SOLUTIONS

Four satellite-based solutions were deployed in Catalonia to help mitigate the effects of water scarcity in irrigated agriculture:

- **Real-time ET and stress monitoring:** Crop evapotranspiration (ET) and water stress were monitored at a 20-meter resolution in near real-time using surface energy balance models fed by satellite and airborne remote sensing. This work builds on advances from the Sentinels for Evapotranspiration project (www.esa-sen4et.org).
- **Early-season crop type mapping:** A methodology was developed that integrates satellite time-series with deep learning algorithms to generate early-season crop type maps. These maps are key inputs for digital twin models and help estimate crop water requirements.
- **Digital twin decision support system:** A decision support system was created based on the digital twin paradigm. It integrates diverse data sources-including satellite imagery and meteorological data with real-time crop simulations to forecast water demands throughout the growing season under varying land use and weather conditions.
- **Water restriction impact simulations:** Simulations were run to evaluate how different levels of water allocation restrictions affect crop productivity, differentiating by irrigation district and crop type. These were informed by remote sensing-derived ET data and FAO-56 crop water response functions.



✓ **Project Dashboard** | Screenshot

THEMATIC AREA



Climate, Water
and Energy

REGION OF APPLICATION



Region of Lleida,
Other regions in Catalonia

SENTINEL MISSION USED



S2, S3

COPERNICUS SERVICE USED



CAMS, C3S

THE BENEFITS AND THE BENEFICIARIES

Water is essential for agriculture, which accounts for 72% of global freshwater withdrawals. FAO projections indicate that by 2050 agricultural production must increase by nearly 50% compared to 2012 levels to meet global demand. Achieving this target requires major improvements in water management efficiency. In this context, implementing the proposed tool across irrigation districts would generate significant benefits at multiple levels.

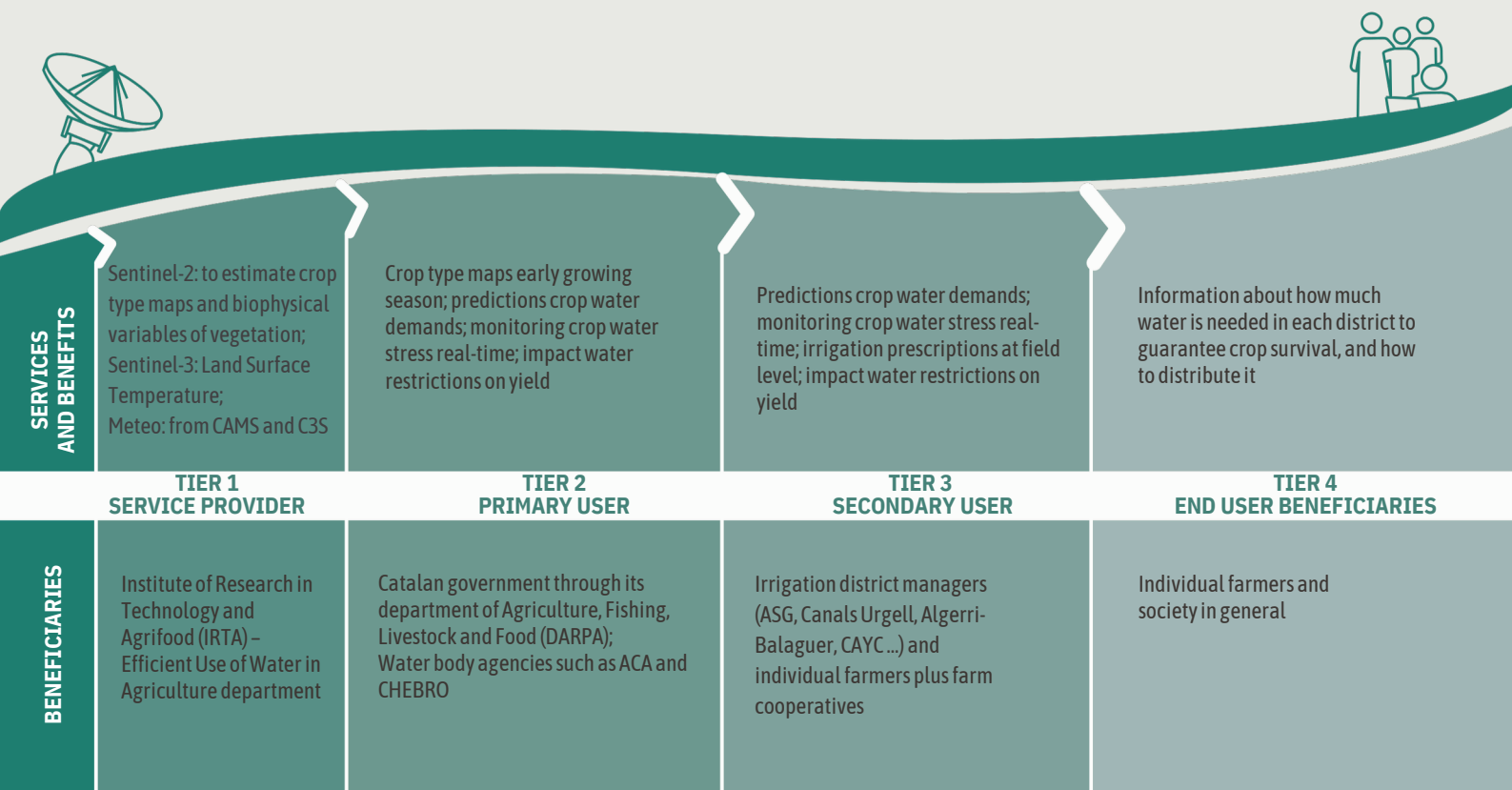
At farm level, it helps to anticipate the effects of water restrictions on yields, support crop and irrigation decisions, reduce economic uncertainty during drought, and improve water productivity (kg/m³).

At irrigation district level, it enable managers to test alternative allocation strategies before implementation, quantify production

losses under different restriction scenarios, and promote fairer and more transparent water distribution, strengthening drought resilience.

At regional level, it supports the economic sustainability of highly agricultural areas such as Lleida (>100,000 ha), enhance food security under limited water availability, and improve environmental sustainability.

Technically, the tool would provide real-time data on crop water requirements and stress, updated crop maps, and yield simulations, supporting irrigation districts and water authorities in proactive, data-driven drought management.



EU POLICY / DIRECTIVE



EU Water Framework Directive

TYPE OF SERVICE PROVIDER



Public Service

TYPE OF FUNDING SOURCE



National or regional
non space Programme

USAGE MATURITY LEVEL



5



A FUTURE WITH COPERNICUS

The solutions implemented rely on various Copernicus-based products. For example, we used Sentinel-2 and Sentinel-3 data, along with meteorological information from ERA-5. Looking ahead, the future of Copernicus presents exciting opportunities and challenges. Monitoring crop evapotranspiration is crucial for improving agricultural water management, which requires high-resolution land surface temperature (LST) imagery. The upcoming launch of ESA's new LSTM mission will therefore be a significant advancement. Additionally, it would be beneficial to develop a global, open-access ET product.



DID YOU KNOW?

Crop evapotranspiration and water stress maps in near real-time at 20 m resolution. Also, biophysical variables of vegetation from Sentinel-2 at 20 m, used as input of water balance model.



Acknowledgements

These actions were supported by the Department of Climate Action, Food and Rural Agenda (DACC) of the government of Catalonia. In addition, these developments were conducted during last seven years through the following projects: ET4DROUGHT (No. PID2021-127345OR-C31) and DIGISPAC (TED2021-131237B-C21) from MICINN-AEI, COMREG4ET (56 30074 2021 P4 – Demos 01.02.01) and IrriTer (PECT Girona).



Contacts

Joaquim Bellvert | joaquim.bellvert@irta.cat
Jaume Casadesús | jaume.casadesus@irta.cat
Magí Pamies-Sans | magi.pamies@irta.cat
Joan Girona | joan.girona@irta.cat
Jaume Sió | jaume.sio@gencat.cat

ABOUT COPERNICUS4REGIONS

This user story is part of the Copernicus4Regions collection, which is managed by NEREUS under an assignment from ESA. The views expressed in the Copernicus User Stories are those of the Authors and can in no way be taken to reflect the official opinion of the European Space Agency or of the European Commission. Copernicus4Regions is funded by the European Union, in collaboration with NEREUS. Paging, printing and distribution funded by the European Space Agency. Graphical design by the ESA EO Graphics Bureau. IPR Provisions apply. Copernicus4Regions material may be used exclusively for non commercial purposes and provided that suitable acknowledgment is given.

www.copernicus.eu
www.nereus-regions.eu/copernicus4regions

Browse this story at :
<https://www.nereus-regions.eu/copernicus4regions/2024-user-stories-2>