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Integrating Earth Observation for the precise monitoring of novel farming systems and water harvesting techniques to address extreme drought in the Mediterranean region, including saline and drought-resilient species – WaterMellon Project

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INTRODUCTION

The Mediterranean basin is increasingly vulnerable to water scarcity due to climate change, with frequent droughts, soaring temperatures, and declining water resources threatening agricultural productivity. Predominantly reliant on rainfed agriculture, the region faces low yields, economic hardship for farmers, and accelerating land abandonment. The WaterMellon initiative aims to enhance the resilience of Mediterranean dryland agriculture through the integration of ancestral hydro-technologies, modern irrigation practices, and innovative Earth Observation (EO) and Geographic Information System (GIS) tools.

This interdisciplinary approach includes the revitalization of traditional water harvesting systems, complemented by nature-based solutions and smart farming practices, such as drought-resistant crop varieties, underutilized species, and energy-efficient irrigation technologies (Fig. 1).

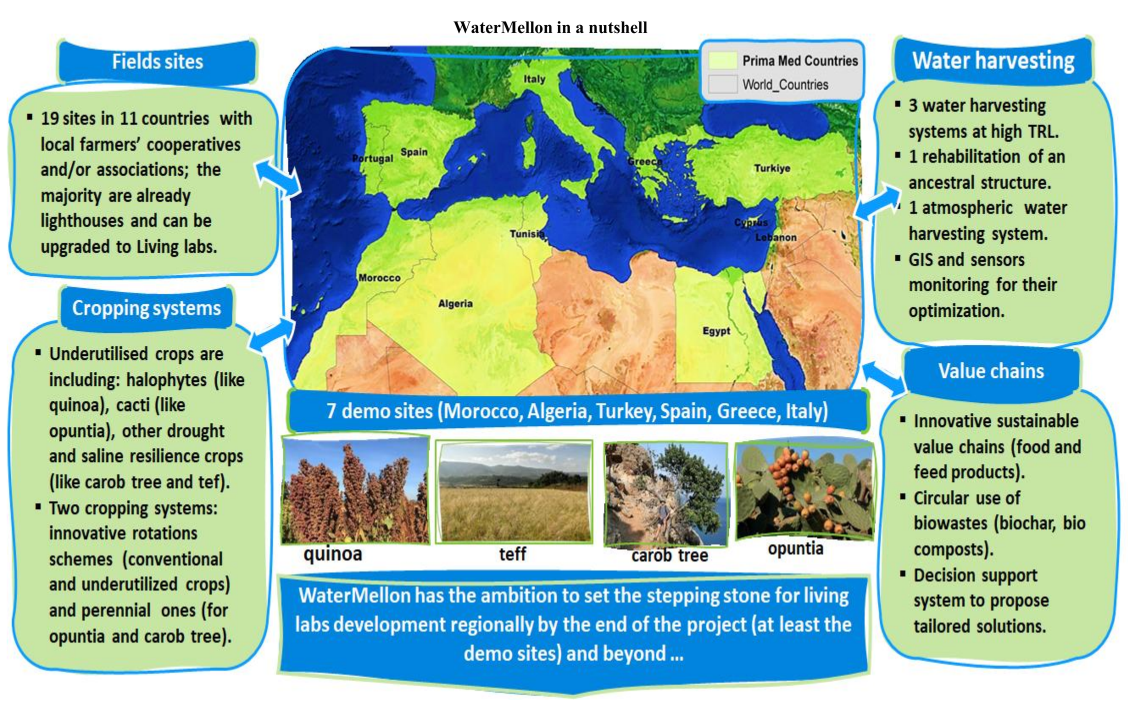

Fig. 1 WaterMellon project overview

EO and GIS play a central role in the project's methodology by supporting spatial analysis of water balance, site selection for water harvesting structures, and soil and crop health monitoring across demonstration sites. High-resolution satellite data equipped with thermal, multispectral, and LiDAR sensors, and in-situ soil moisture sensors will be employed to track crop water stress, soil conditions, evapotranspiration, and system leakages.

METHODS

The WaterMellon project, as illustrated in Figure 2, adopts a holistic approach by uniting diverse elements necessary for promoting sustainable agriculture in the Mediterranean basin. Key elements are the establishment of demo fields, the application of innovative water management systems, the exploitation of drought and saline-resistant crops, the introduction of new products, value chains, and organizational models. The project emphasizes training and engaging local farmers, communities, and stakeholders, upgrading them into self-sustaining 'lighthouses/living labs' that serve as hubs for agricultural innovation. WaterMellon aims to enhance food and feed security, optimize resource utilization, and ensure the resilience, adaptability, and sustainability of farming systems in the face of challenging environmental conditions (Fig. 2).

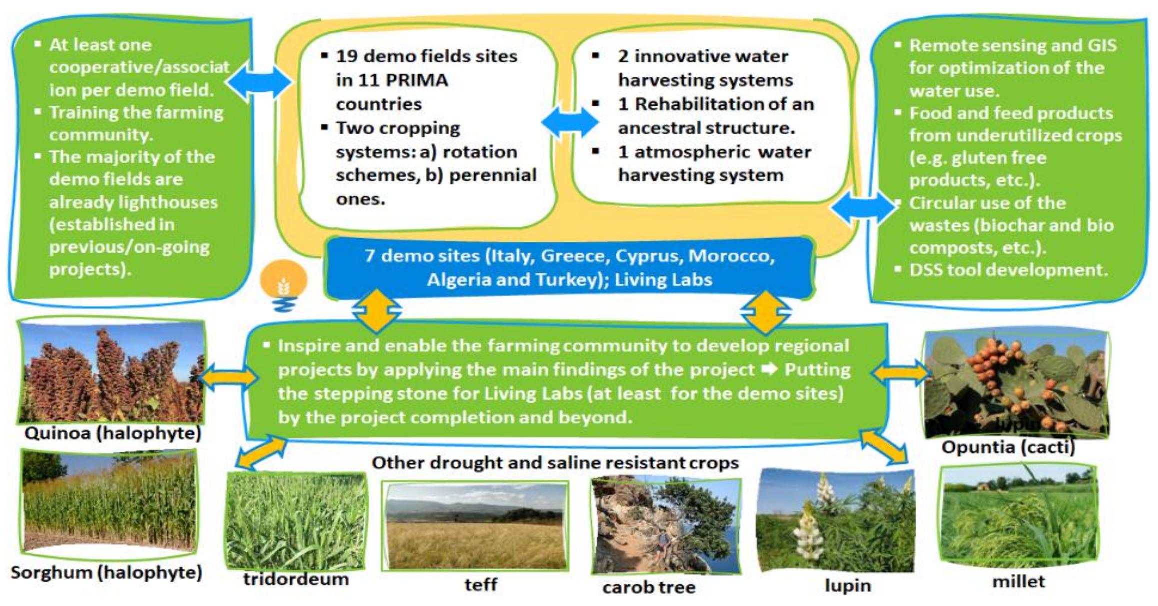

Fig. 2 WaterMellon Concept and Methodology

Advanced remote sensing and GIS techniques with innovative Satellite and Unmanned Aerial Systems (PlanetScope, Sentinel-1, Sentinel-2, etc.; Mavic3m, Matrice 350 with H20T and L2 sensors) will support dynamic assessments of water harvesting, vegetation health, drought severity, and cropping patterns, using vegetation and drought indices, thermal infrared characteristics, and LiDAR dense cloud data analysis (Fig. 3). Furthermore, machine learning models will be explored to estimate yields and correlate them with water use efficiency and environmental variables.

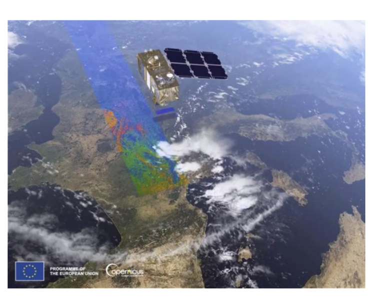

Fig. 3a Sentinel-2

Fig. 3b Mavic 3M

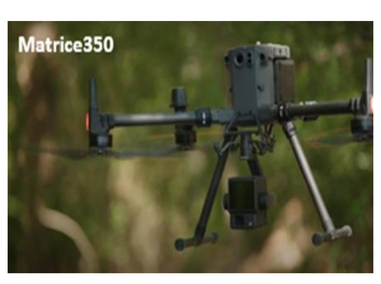

Fig.3c Matrice 350

RESULTS

The EO-derived data and GIS analysis will provide essential information to track vegetation vigor (Fig. 4), distinguish phenological development stages, estimate crop yield, assess crop water stress conditions, reveal ideal water harvesting points, and provide proof about accurate biomass modelling (especially in perennial systems; Fig. 5) and plant density analysis for row crops helps identify spatial variability and stress patterns

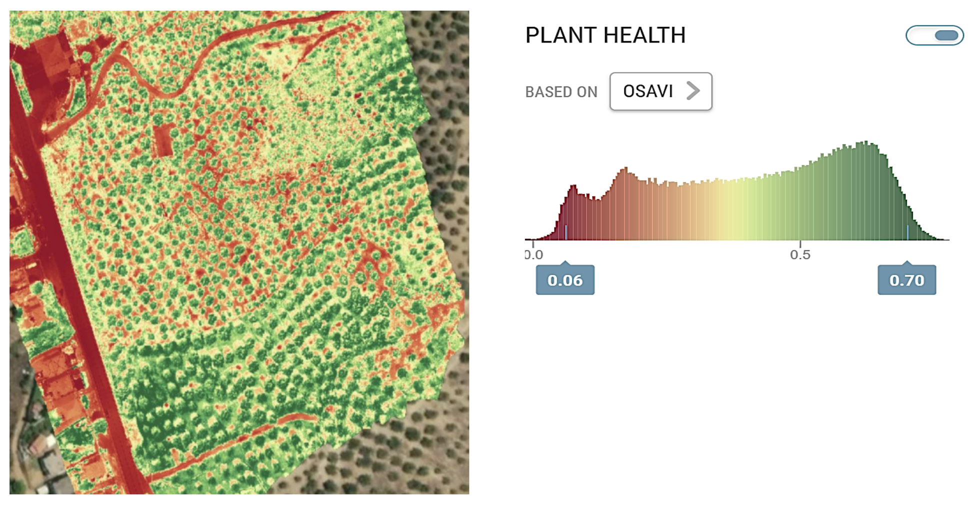

Fig. 4 Vegetation index from tree crops for calculating tree vigor and growth conditions

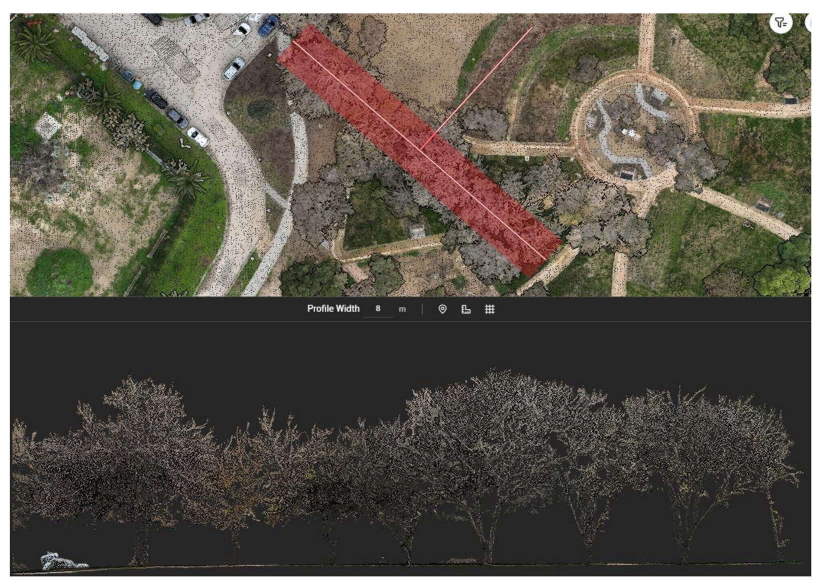

Fig. 5 Digital point cloud from LiDAR L2 camera. Tree row in horizontal projection (up) and cross-section (down)

CONCLUSIONS

WaterMellon contributes practical, scalable solutions for climate-adaptive farming, empowering smallholder farmers with data-driven tools to improve food security and economic viability in water-stressed environments. The project demonstrates how EO and GIS technologies can be effectively harnessed to support sustainable agriculture under the pressures of climate change

REFERENCES

1. Psomiadis, E.; Toubaridis, C.; Avramidou, M. Combining Multispectral Data from Unmanned Aerial System and Sentinel-2 for Kiwifruit and Cotton Monitoring and Yield Assessment. 2024, 4312–4315, doi:10.1109/IGARSS53475.2024.10642542.

2. Psomiadis E., Alexandris S., Proutsos N, Charalampopoulos I. Coupling multiscale remote and proximal sensors for the estimation of crop water requirements", Proc. SPIE 12727, Remote Sensing for Agriculture, Ecosystems, and Hydrology XXV, 127271L; https://doi.org/10.1117/12.26801253.

3. Dalezios, N.R.; Dercas, N.; Spiropoulos, N. V; Psomiadis, E. Water Availability and Requirements for Precision Agriculture in Vulnerable Agroecosystems. Eur. Water 2017, 59, 387–394.

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