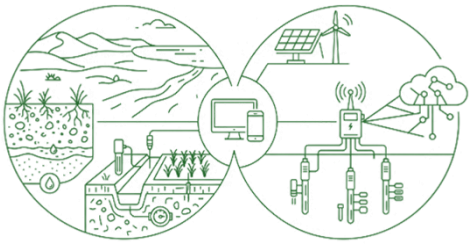
### Roots in the sand: the battle for water in the Mediterranean

The SWAMED project's pilot sites address complex and varied soil and climate conditions across the Mediterranean macro-region. In the Medjerda Valley in Tunisia or the Axios River delta in Greece, the efficiency of irrigation is severely impaired by water scarcity and soil variability, ranging from the sandy soils of Egypt to the sandy loam soils of Greece. The solution to these challenges lies in the implementation of a high-precision monitoring network. Sandy soils exhibit limited water and nutrient retention, combined with problems of salinity in the irrigation water (often around 600 ppm), which block the irrigation sprinklers. In contrast, in environments such as Greek canals and rice fields, continuous monitoring of the levels of biochemical parameters in the water is required so as not to change the ecological balances protected by international protocols (Ramsar/Natura 2000).

### Details of the ground-based IoT network

The IoT telemetry system implemented at field level utilises NB-IoT and 2G mobile transmission technologies, with data automatically sent to the cloud every 30 minutes and self-powered via photovoltaic panels. To map water dynamics, SWAMED employs stations fitted with 3-pin metal sensors operating at frequencies above 50 MHz with SDI12 outputs. These instruments not only measure humidity (up to 0.60 $m^3/m^3$ in mineral soils) but also incorporate sensors for temperature (accuracy ≤±0.5°C) and mass electrical conductivity (Bulk EC), which is essential for contrasting salt stress and optimising fertilization in real time.



**Field synergy:**

The selection of ground-based technology works in perfect harmony with local weather data to provide a detailed and objective picture of actual water requirements

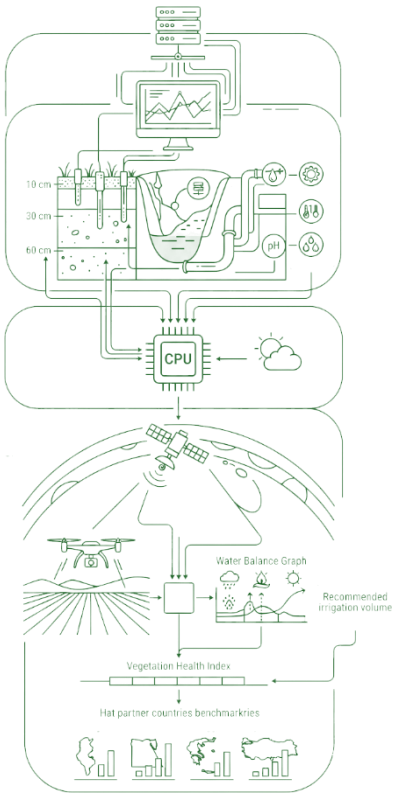
### Software infrastructure

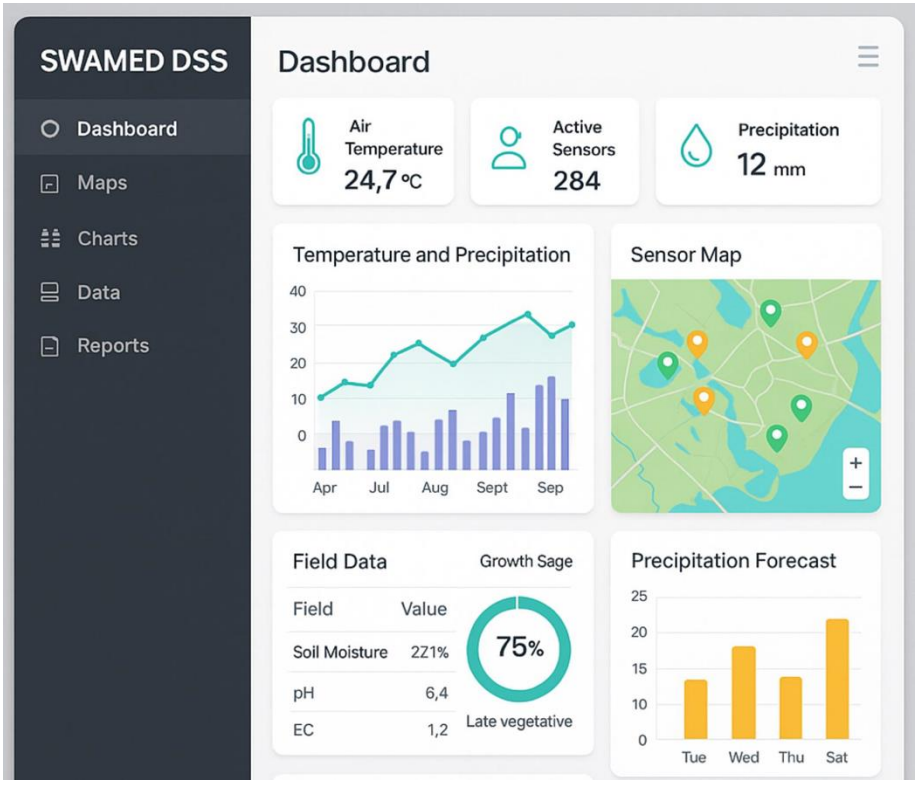
SWAMED's Decision Support System (DSS) software architecture consists of a centralised platform capable of processing continuous workflows of data. The system generates live-streaming graphs updated every 5–15 minutes, simultaneously displaying humidity levels at three different depths (10 cm, 30 cm, 60 cm), the water flow in the canals, the structural integrity of the pipes and water quality (pH, conductivity, pollutants). The software does not limit itself to recording the present; it includes predictive modules that align with 7-day weather forecasts to track soil humidity trajectories and recommend optimal irrigation volumes. Thanks to composite graphs such as the *Water Balance Graph*, the user can view rainfall, applied irrigation and evapotranspiration losses.

### The integration of sky and earth

To extend the effectiveness of the DSS beyond a single field sensor, the architecture integrates sophisticated remote-sensing data. Through satellite monitoring of vegetation cover and scheduled flights by multispectral and thermal drones, the DSS generates a *Vegetation Health Index Timeline*.

Multispectral cameras capture reflectance in key bands (Green, Red, Red Edge, NIR) to calculate the NDVI index, while thermal sensors promptly highlight temperature anomalies in the plant canopy. The software automatically correlates this aerial and satellite data with actual irrigation events, providing a basis for benchmarking performance of the various pilot sites across the four partner countries (Tunisia, Egypt, Greece, Turkey).



## TRAINING CLASSES

**Structure of the training programme**

The "Training Classes" are specifically designed to train farmers, technicians and water authority officials.

The main aim is to reduce the gap between academic research and practical application in the field, guaranteeing the long-term sustainability of technological investment. The lessons will be recorded and made permanently available on dedicated platforms.

**The 5 key teaching modules:**

- Training 1:
  Remote sensing techniques with the use of drones
  [*Faculty of Agriculture, Forestry and Natural Environment, School of Agriculture; Greece*]

- Training 2:
  Use of satellites for continuous monitoring of vegetation cover
  [*Regional Centre for Remote Sensing for North African Countries; Tunisia*]

- Training 3:
  Ground-based sensing technologies
  [*University of Campania "Luigi Vanvitelli"; Italy*]

- Training 4:
  Management of data flows and their interpretation on the DSS platform
  [*Department of Biosystem Engineering – Alanya Alaaddin Keykubat University; Türkiye*]

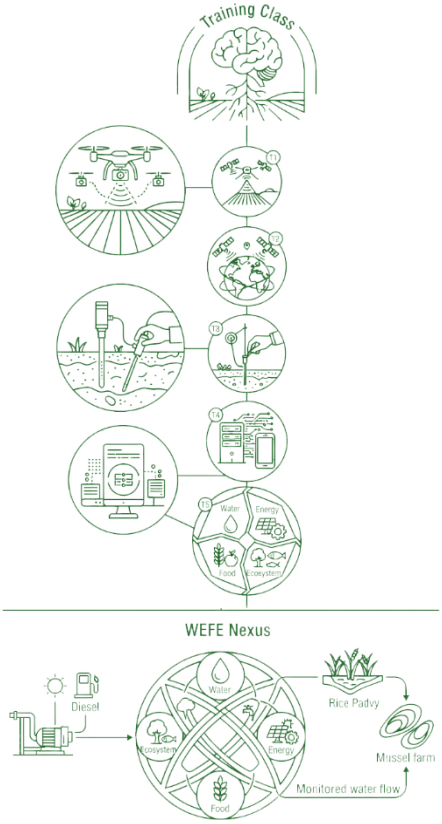
- Training 5:
  Evaluation of the approach according to the WEFE Reference Framework
  [*The British University of Egypt; Egypt*]

**The WEFE Nexus approach**

The technicians will be trained in accordance with the holistic approach of the WEFE Framework (Water – Energy – Food – Ecosystem).

This approach is based on the recognition that water, energy, agriculture and natural ecosystems are closely interlinked and can no longer be managed in separate compartments.

The training material (prepared in English and distributed in the respective local languages) explains how optimising one sector alone can compromise the security of the others. For example, in the Egyptian partner's pilot project, drop irrigation is powered by both diesel generators and solar panels, balancing the Water-Energy nexus; in the Greek partner's Axios Delta, the monitoring of rice crops helps to safeguard rice production without damaging the marine ecosystem of mussel farming.



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# SWAMED

## WHAT IS A DECISION SUPPORT SYSTEM (DSS)?

**Definition and Core components**

A Decision Support System (DSS) is an IT infrastructure that collects, organises and processes agronomic, environmental and hydrological data to assist farmers and water resource managers making strategic and timely decisions.

The pillars of a modern DSS:

- Data Input Module (Data Ingestion):
  It captures hardware data from the field (IoT sensors for humidity, conductivity and canal flow rates) and external data (weather forecasts, satellite maps, drone surveys).

- Computational Engine (Analytics):
  It calculates specific indicators (such as the water balance or NDVI trends) and detects anomalies or states of water/salinity stress.

- User Interface (Dashboard):
  It translates complex algorithms into interactive charts, colour-coded maps and mobile push notifications.

**Why is it crucial to the SWAMED project?**

Traditionally, farmers have determined irrigation volumes and timings on an empirical basis or according to fixed schedules. SWAMED's DSS introduces evidence-based planning.

**Practical examples from the pilot sites:**

- In Tunisia, the DSS monitors the water levels in on-farm storage reservoirs, helping to plan irrigation cycles during periods when the public water supply is cut off. At the same time, it prevents over-irrigation of almond trees by redirecting the water to another crop;

- In hydroponic systems, it monitors EC and pH in real time, preventing the failure of soilless crops;

- In Turkey, it helps to diversify the management of banana crops, which are supplied by different sources (the river at Mahmutlar and consortium canals at Kestel).

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SWAMED

## Interview with Prof. Ass. Dr Firat ARSLAN

*Project Manager of SWAMED for Biosystem Engineering Department - Alanya Alaaddin Keykubat Üniversitesi [TR]*

Assoc. Prof. Dr. Firat Arslan an academician serving as a faculty member and Vice Chair of the Department of Biosystems Engineering at Alanya Alaaddin Keykubat University (ALKU), Rafet Kayış Faculty of Engineering. He conducts academic research on his areas of expertise, including agricultural water management, digital agriculture, AI-powered smart irrigation systems, and Geographic Information Systems (GIS). On an international level, he serves on the board of FAO LANDNET, the land management network for Europe and Central Asia under the Food and Agriculture Organization of the United Nations. He also leads the multinational Interreg NEXT MED (SWAMED) project, which aims to combat water scarcity in the Mediterranean basin. Alongside his academic research, he contributes to the development of regional agriculture by providing field training to local farmers in Alanya on modern agricultural technologies and water-saving irrigation methods.

**Dr. Firat Arslan, what is ALKU's specific role in the development of SWAMED's DSS and in training the models?**

*As a Turkish partner specialising in agricultural engineering and data management, ALKU is leading WP4 on DSS software integration. Our role is to convert raw data streams from IoT sensors drones and satellites into predictive amounts of irrigation water applicable to local intensive crops for each country Tunisia, Greece, Egypt and in Türkiye for particularly the banana plantations in Alanya.*

**How did you approach the challenge of data interoperability in the DSS software?**

*The more the technology is improved the more we can get help from it for agricultural water management. We have developed standardised APIs capable of processing different formats simultaneously with SDI12. The most important in the project is a tool that farmers can easly apply on their irrigation scheduling. The tool will collect data from satellite images, drones, meteorological station and sensor data, and predict the irrigation tim and the amount of irrigation water. CRTEAN is the partner that will help extracting real-time satellite images to help improving our DSS system. The system will be ready to use with web and phone application by farmers with simple interfaces for them.*

**How is the WEFE approach reflected in your activities in Türkiye?**

*In Alanya, agricultural water management is very sensitive due to cultivation of tropical fruits and high number of tourism in irrigation seasons which lead managers to find better solutions for them. Water by itself, affects best-worst agricultural practice in the region. When energy is produced from dam, farmers irrigation scheduling causes more energy consuming in drip irrigation and water wells. We have also experienced farmers who use much more fertilizers than needed for banana. With our smart irrigation scheduling with DSS, we will measure soil and water quality and give advice to farmers for better and environmental friendly solutions. For now, farmers are very willing to learn new techniques and improve their cultivation. The approach, and our adaptation techniques (face to face) will be very helpful for ensuring sustainable banana production and the other crops as well, protecting the ecosystem.*

**What do you expect from the "Training Classes" aimed at local stakeholders?**

*First, the training classes are supported by local authority such as Agricultural Ministry, Agricultural Chamber and State Hydraulic Works which are very effective bodies, very well listened and respected by farmers. This helps us in quickly involving the farmers in our training classes. In the classes, we expect farmers eager to learn new technologies and open minded for our system. As we talked in our training classes, they were very curious about mobile applications by which they can easily observe all the things. We will teach them not only how to read the dashboard, but also how to trust the automatic recommendations on amount of irrigation water on time, quality checking etc. We are also excited to have meeting and talk about their concern on irrigation scheduling and water saving.*

SWAMED TÜRKİYE
@swamed_tr
swamed.tr@gmail.com

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NEXT MED

# SWAMED

*Programme Specific Objective:* 2.3 (RSO2.5) Promoting access to water and sustainable water management

Total budget

2.745.200,00 €

EU co-financing

89%

EU contribution

2.443.228,00 €

Project duration

36 months

August 2025 - July 2028

*Geographic coverage:* Italy | Tunisia | Egypt | Greece | Türkiye

## PARTNERS

*Project Coordinator*

Università degli Studi della Campania *Luigi Vanvitelli*

Alanya Alaaddin Keykubat Üniversitesi

Aristotle University of Thessaloniki

C.R.T.E.A.N

The British University in Egypt

*Associated Partners*