

Scalable deployment of IoT systems for sustainable precision olive farming in Laconia, Greece

G. Panagopoulou, I. Moutsinas, T. Theodosiadis

Pangaea R&D pc – E. Katsigra 1, PC 41335 - Larisa, Greece

Corresponding author email: info@pan-gaea.gr

**Reshaping Agriculture: Engaging IoT, 5G and AI for
a Smarter Agrifood Sector**

Semiarid Mediterranean environments suffer increasingly of:

- ❑ **Water scarcity**
- ❑ **Unbalanced distribution of water resources**
- ❑ **Excessive consumption of water by agriculture**
- ❑ **Climate variation (towards desertification of cultivated lands)**

dictating the adoption of integrated and innovative approaches

towards the development of:

- **water-saving agricultural systems** and
- **more efficient farm management tools utilising contemporary technologies**



The development of IoT systems and the associated decision support tools that forms

Interacting and Integrated Smart-Farming Decision-Support System (DSS),

Conceived Organised and Developed
by **multidiscipline research teams** of the consortium
PANGAEA R&D – GRIDNET sa in collaboration with the Network
Implementation Laboratory of Thessaly University.



- **PANGAEA R&D start-up**

Business orientation in **Technology Transfer, Research & Development Services** in the fields of **Agri-Food Industry, Computers and Informatics** valorizing innovative technological solutions. <https://pan-gaea.gr/>

- **GRIDNET sa / SpinOff** is a pioneer developer of communication and Internet technology solutions, mainly focusing on the fields of **Wireless Communications, Software-Defined Networking, Sensor Networks and Energy Management** <https://gridnet.gr/>

- **NITLAB: Network Implementation Testbed Laboratory** of University of Thessaly
More than **60 researchers, conducting multidisciplinary research**
(computer/networking engineers, agriculturists, environmentalists, ichthyologists, food scientists)

Activity in the fields of: Networking, beyond 5G, edge/cloud computing, AI, IoT (Smart Cities, Smart Agriculture, Smart Logistics, Environment), VR and others

More than 30 EU and National Grants / 8M funding (last 5 years)

Have built and maintain the **NITOS Research Infrastructure** that is a **National Research Infrastructure** and a **European ESFRI infrastructure**



The developed IoT systems infrastructure and the associated decision support tools DSS that forms interacting and integrated smart-farming decision-support systems are employed to optimize the irrigation management of tree crops

Relying on integrated IoT ecosystems designed to foster and evaluate innovative, field-based solutions that aim to improve the efficiency and sustainability of agricultural resource management:

- Energy-autonomous,
- Mesh Wireless Sensor Networks (WSN),
- Cloud Computing
- Decision-Support Systems

Providing

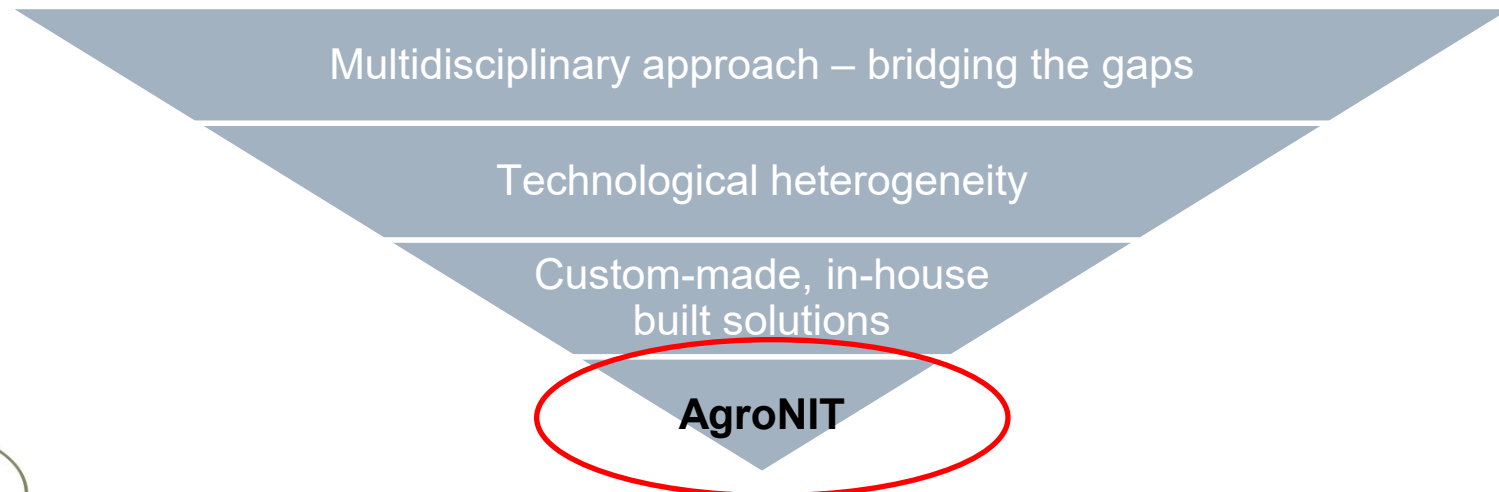
- **Real-time consultancy to farmers leveraging on distributed field data collection.**

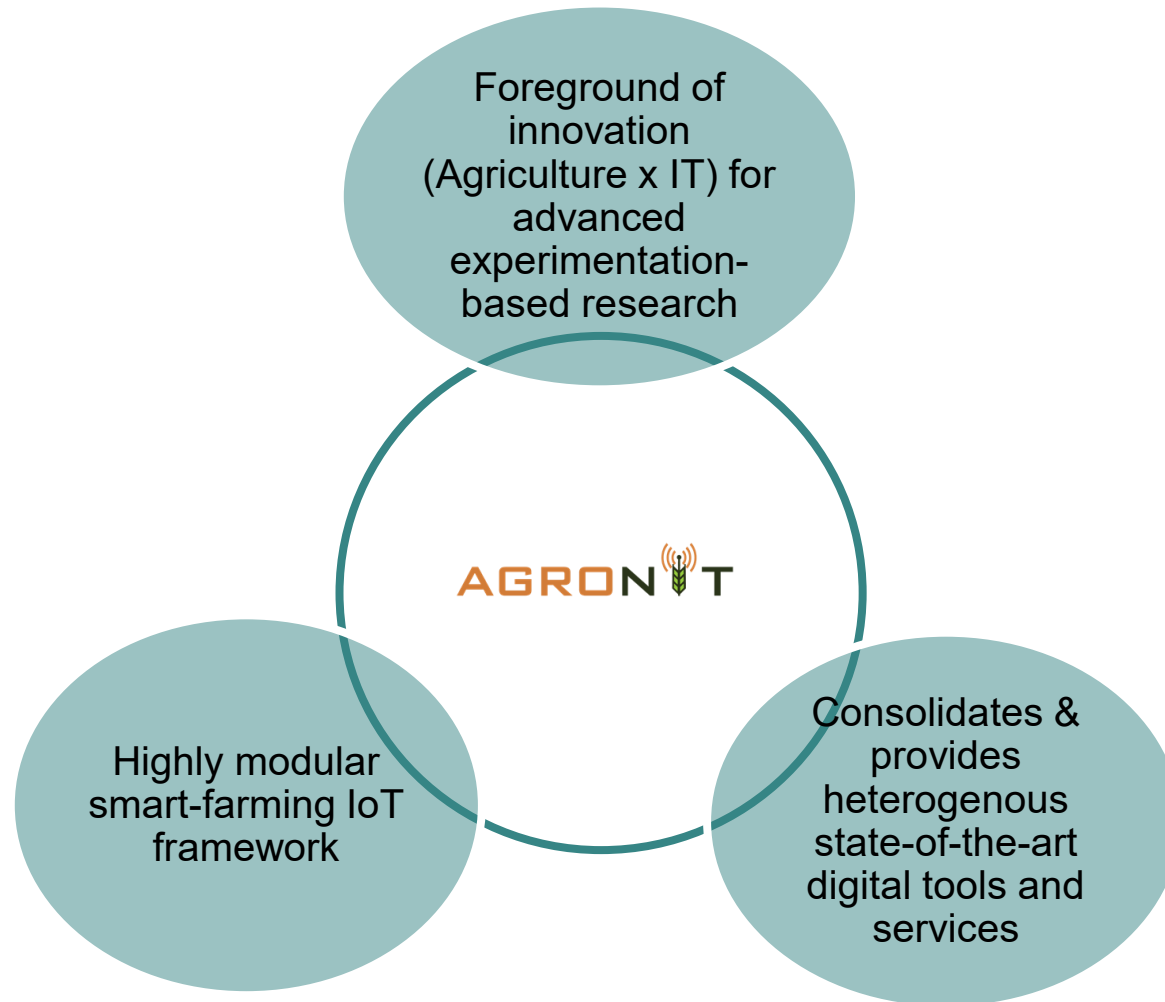


Opportunities – Challenges and Concept

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Opportunities	Challenges
Data-driven insights (DSS)	Cost
Increased efficiency / productivity	Connectivity / Energy Demands
Sustainability	(Big) Data management
Collaboration and knowledge sharing	Skills & knowledge gaps
Market demand	Resistance to change







Agrifood & Environment funded projects

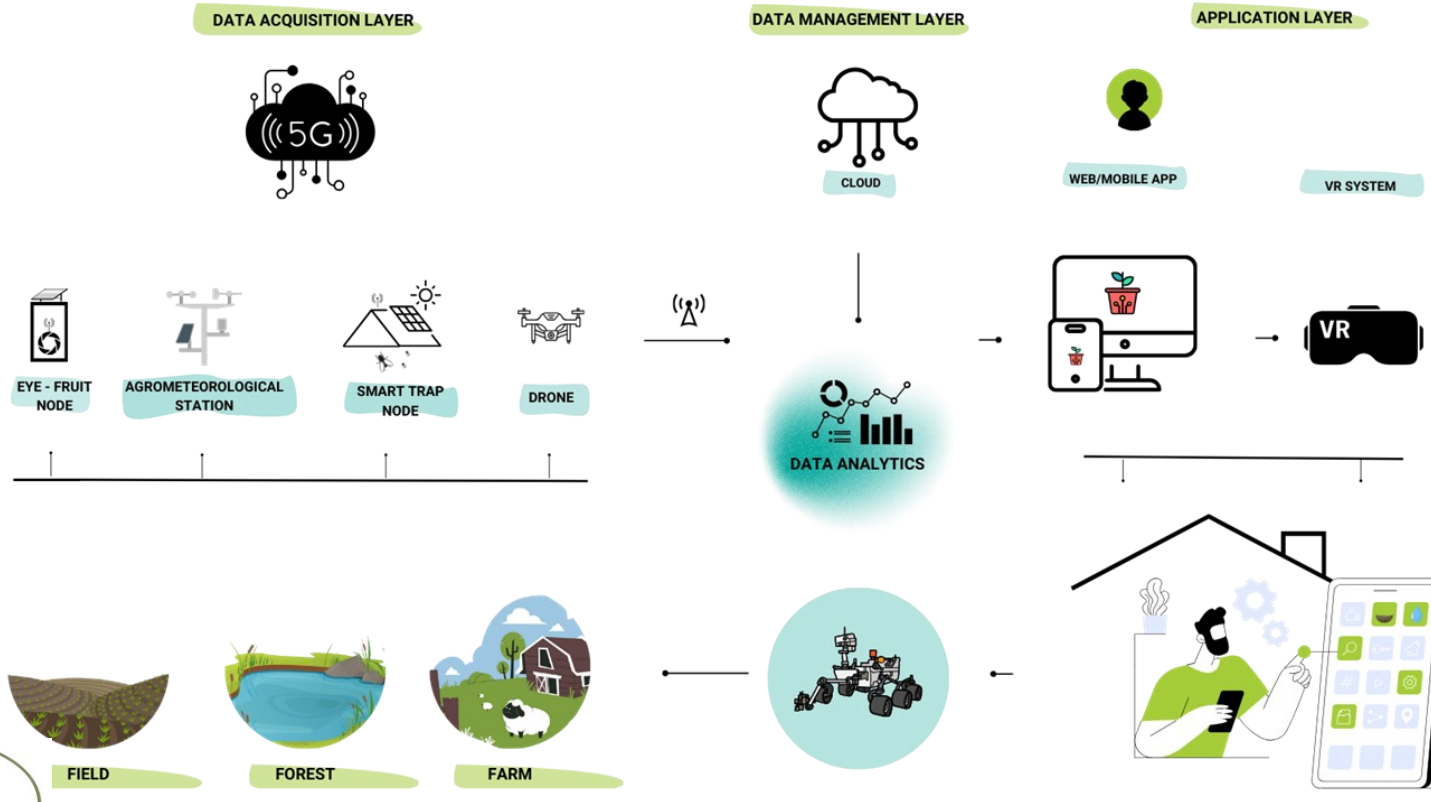
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Vertical	Projects	Objectives	Budget total	Funding Authorities
Smart Agriculture – Climate	12	<ul style="list-style-type: none"> ✓ Optimization of crop production / resource use in orchards (peach, apple, pear, cherry, olives) and extensive crops (potatoes, hemp, cotton) ✓ Crop adaptation to climate change (climate-smart agriculture) ✓ Monitoring and control of crop pests and weeds using innovative autonomous robotic spraying vehicles 	~10mil. €	EU & Partnership Agreement
Food safety	3	<ul style="list-style-type: none"> ✓ Establishment of a more resilient ecosystem for quality-labelled food supply chains by developing a holistic framework that ensures early warning systems and vulnerability risk assessment upon a strengthened data governance ✓ Monitoring and control of insanitary enemies (e.g., insects and rodents) in stored products using smart IoT-enabled electronic traps 	~6,5mil. €	
Smart Logistics	2	<ul style="list-style-type: none"> ✓ Traceability of harvested peaches from the field to the shelf ✓ Development of a digital innovative and reliable system for the efficient management of stored cotton seed 	~500k €	
Environment	2	<ul style="list-style-type: none"> ✓ Using smart traps and pheromones to control the gypsy moth ✓ Facilitate the monitoring, conservation, and management of biodiversity through this centralized system ✓ Provide up-to-date information to support policy-making and conservation efforts 	~4,5mil. €	
Aquaculture	1	<ul style="list-style-type: none"> ✓ Monitoring of fish biomass and feed allocation to promote the sustainable and resilient feed and feeding strategies 	~6mil. €	
Health	1	<ul style="list-style-type: none"> ✓ Monitoring of mosquitos in urban and rural areas to enable the timely application of control measures 	~1mil. €	



□ 4-layered architecture

- Data acquisition layer
- Data management layer
- Application layer
- Actuation/Control layer





☐ **Agro Node**

- ☐ Crop, soil, environmental conditions
- ☐ Soil water potential, Air temp. & hum., Leaf wetness



☐ **Meteo Node**

- ☐ Local climatic conditions
- ☐ Solar irradiance, Precipitation, Wind speed & direction



☐ **EyeFruit Node**

- ☐ Fruit or tree growth / phenology monitoring



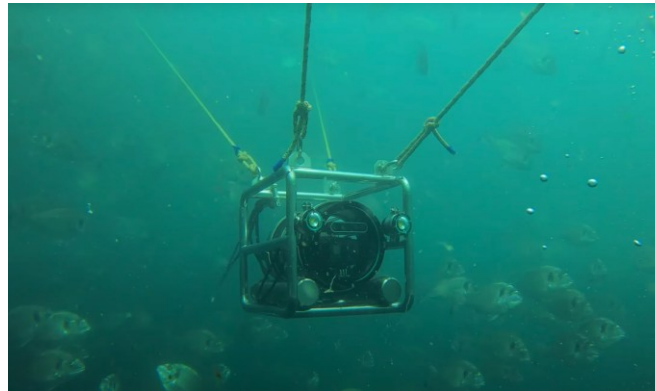
☐ **SmartTrap Node**

- ☐ Monitoring insect capturing on sticky card
- ☐ Quantification / identification of captured insects





- ❑ **Water quality sensors**
- ❑ Measurement of key water quality parameters



- ❑ **SmartFishView system**
- ❑ Fish biomass quantification
- ❑ Behavioral analysis based on fish movements
- ❑ Determination of optimal feeding to compensate the real needs

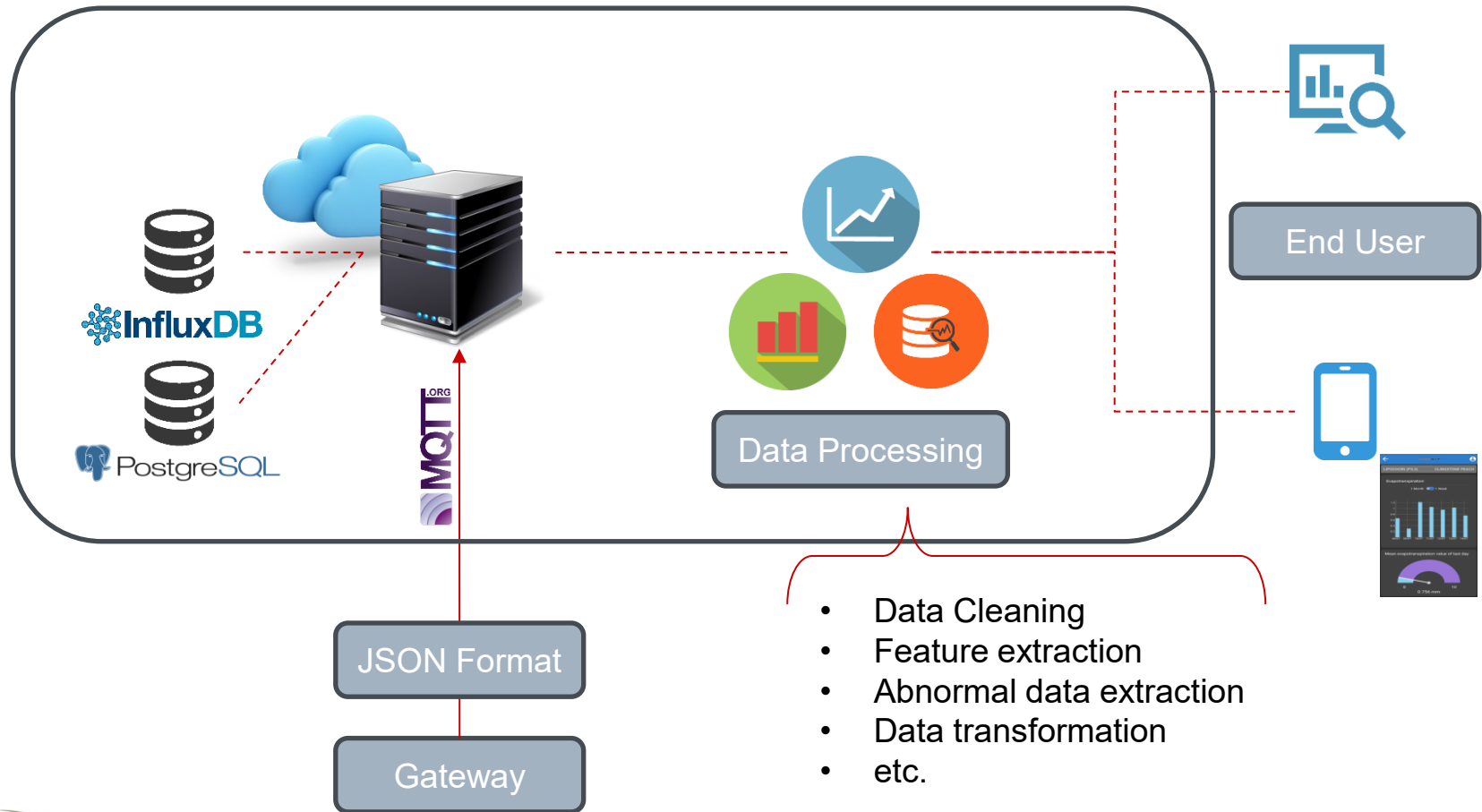


- ❑ **Control & energy system**
- ❑ Energy supply through solar panel
- ❑ Remote communication & control of monitoring system

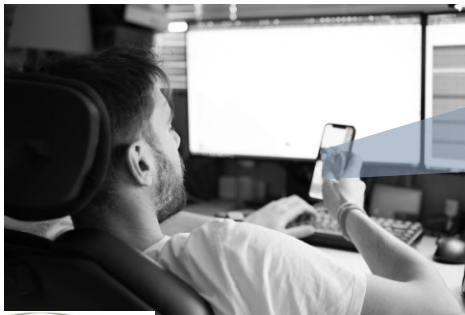
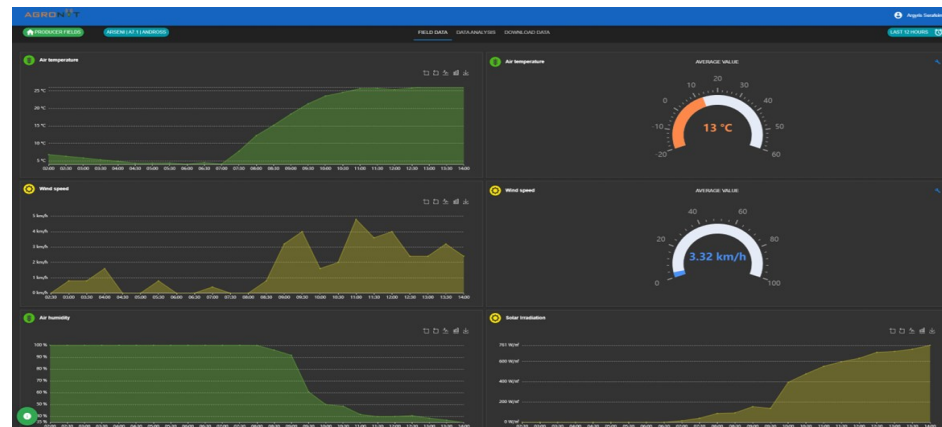
□ Deployments' map



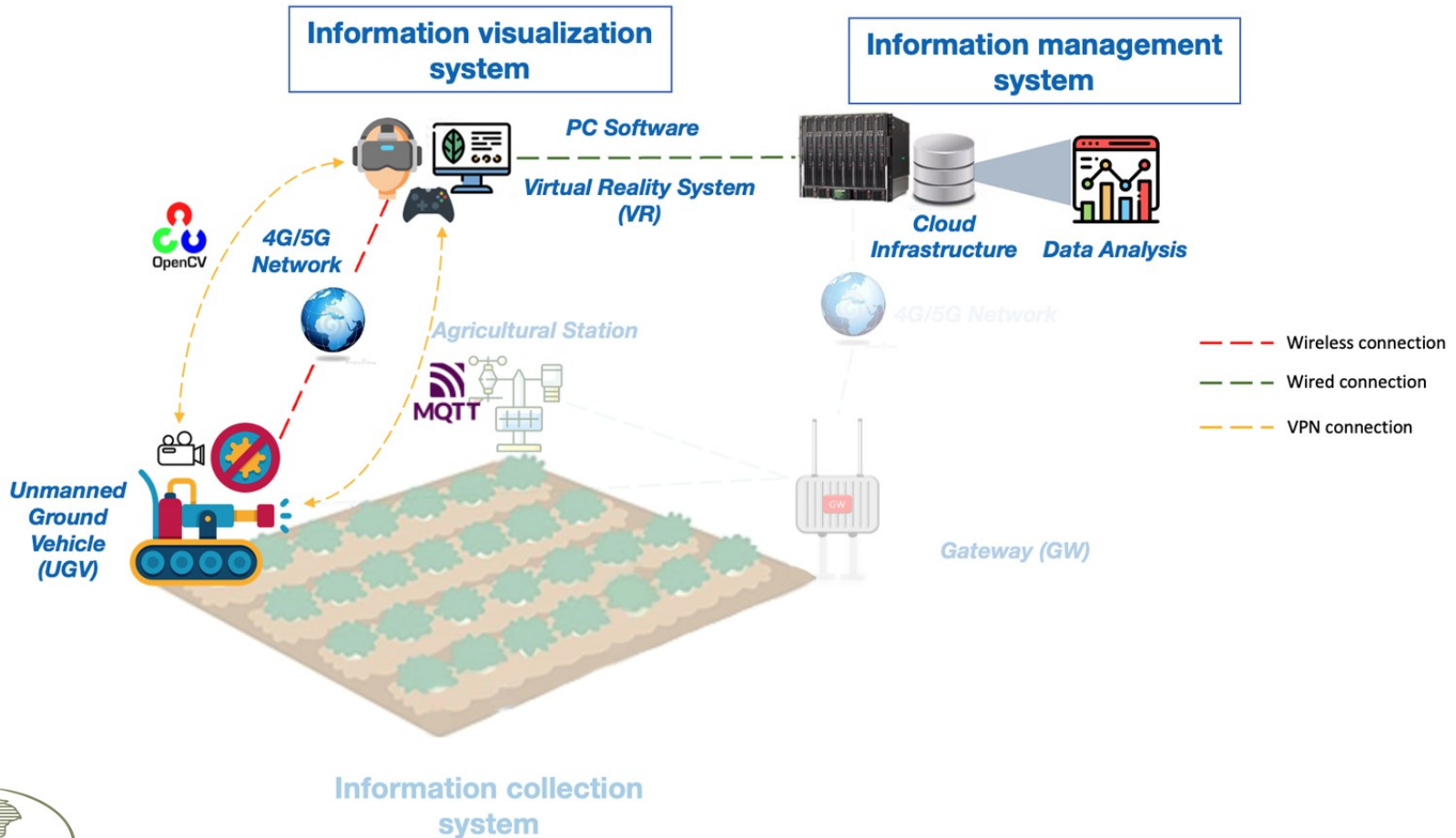
Region	Thessaly	C. Makedonia	Chalkidiki And Lakonia	Drama	Total
Crops	Apple, Pear, Cherry, Peach	Peach, Nectarines, Apricots, Pear, Kiwi	Olives	Potato	
Users	14	61	12+900	3	990
Fields	25	451	25+7500	3	8004
Hectares	~20	~200	~70/ 700	~10	~1000
Agro Nodes	19	31	8 / 50	3	111
Meteo Nodes	11	12	2 / 6	3	34
Cameras	6	8	2 / -	-	16
GW	13	24	2 / 8	3	50

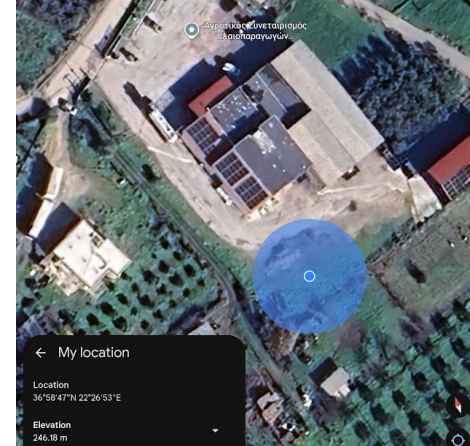


- User-friendly interface
 - Available for web and mobile applications
 - Simplifies visual presentation of information
 - Interactive UI:
 - Augmented user control with customizable graphs and heatmaps enabling user feedback and control
 - Provides deeper understanding of the crop performance by offering consolidated knowledge through interactive recommendations and alerts



□ AgroBot





Use Cases

LAKONIAN PROJECTs

Agricultural Cooperatives of Olive Producers of
Palaiopanagia & Agioi Apostoloi

Lakonia Greece

@ the southern part of continental Europe

Institutional Framework ΟΕΦ Programme is currently implemented through the Ministry of Rural Development & Food, within the framework of Reg. (EU) 2021/2115 in the olive oil and table olives or in the ΟΕΦ regime and the CAP Strategic Plan 2023/2027.



Olive Tree Crops Ag APOSTOLOI Lakonia

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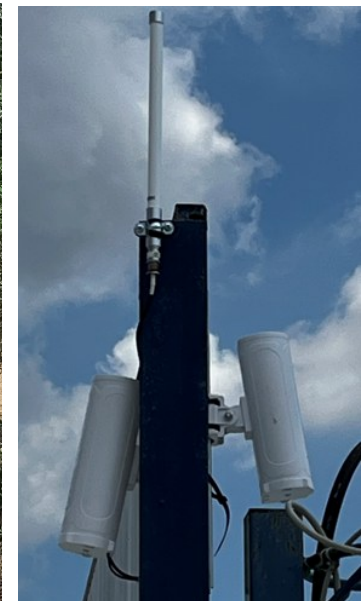


LAKONIA Project - 1st Year Wireless Sensor Network

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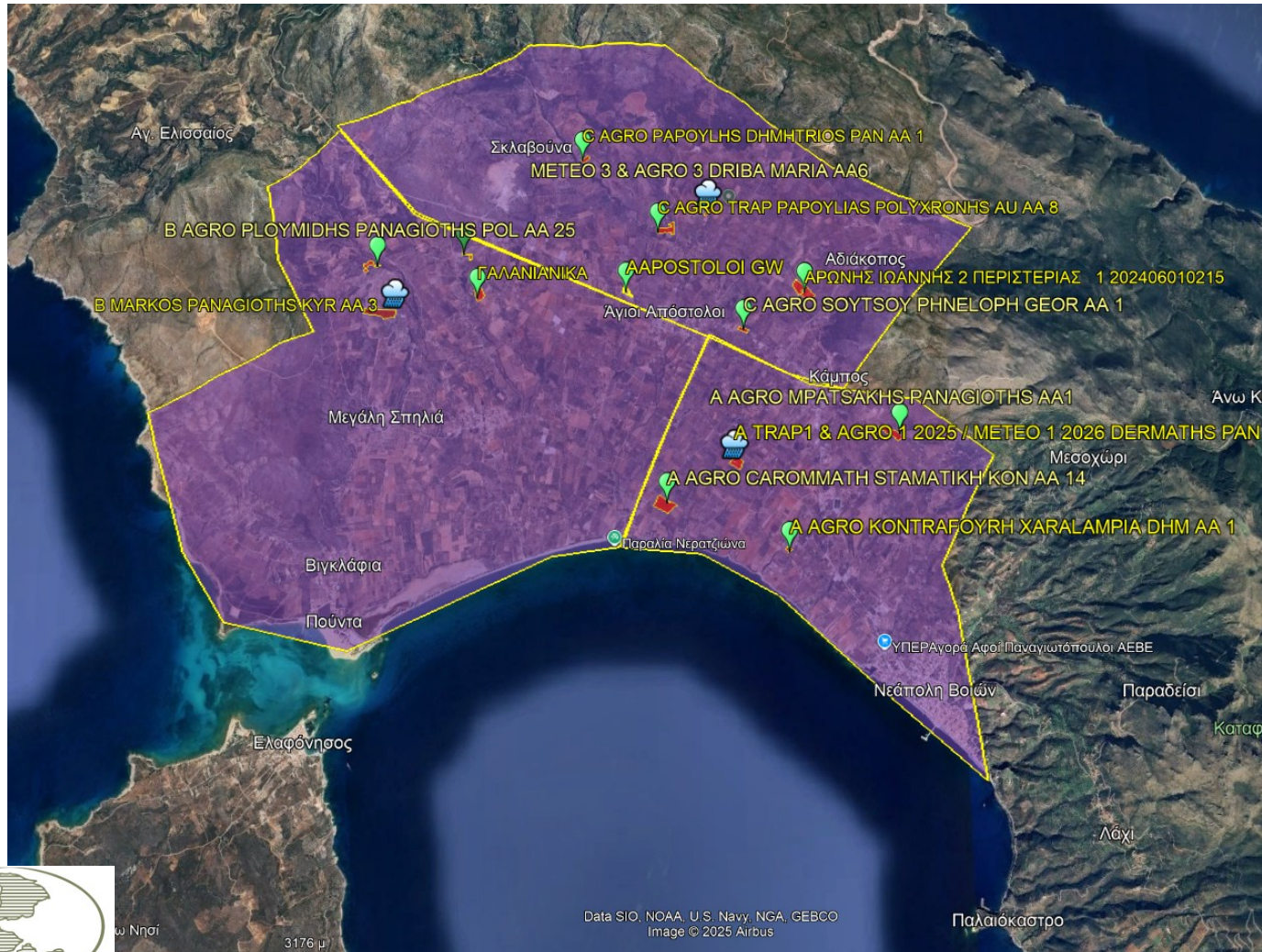
DEPLOYMENT **PALAIOPANAGIA & AG APOSTOLOI**

- **1+3 Agrometeorological Stations &**
- **13+23 Smart Electronic Insect Traps**
- **13+20 Agronode stations**
- **2+4 Communication Nodes**
- **2000+5500 Tree crops**
- **200+500 Hectares**



LAKONIA Project - 1st Year Wireless Sensor Network Deployment

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LAKONIA Project - 1st Year Objectives

- **Estimation of crop water requirements**
- **End user: farmer / consultant / researcher:**
 - i. Utilization and interaction with the specialized irrigation model
 - **Model results: depth, duration, and extent of irrigation**
 - ii. Evaluation of relevant performance indicators (**e.g., water use efficiency, cost effectiveness of water, etc.**)
 - iii. Review of irrigation management dynamically within the season

<i>Date</i>	<i>Ic (%)</i>	<i>ETc (mm)</i>	<i>Idt (mm)</i>	<i>It (min)</i>	<i>It/dose (min)</i>
27.07.21	100	24.5	28.8	495	247
03.08.21	100	25.2	29.6	508	254
10.08.21	100	21.8	25.6	439	220
17.08.21	50	19.5	11.4	196.5	98.5
24.08.21	50	18.4	10.8	185.5	92.5
31.08.21	50	21.9	12.8	111	55.5

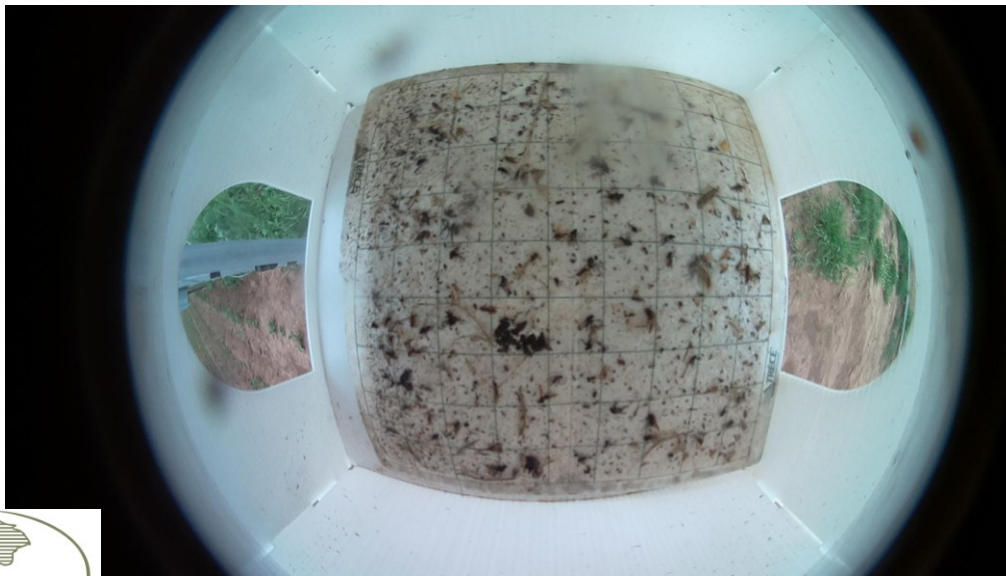
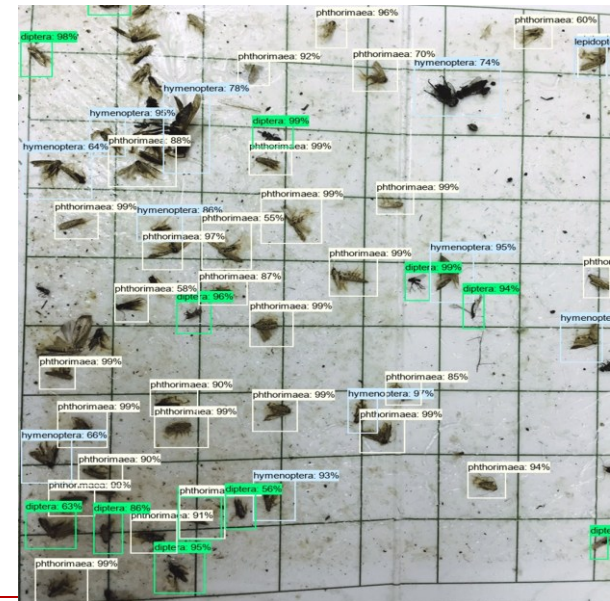
<i>Treatment</i>	<i>Irrigated (m³)</i>	<i>Savings (%)</i>	<i>Efficiency (m³/kg)</i>	<i>Cost (€)</i>
<i>Conventional</i>	500.7	—	0.22	150.2
	402.9	19.5	0.18	120.9



LAKONIA Project - 1st Year Objectives

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- ❑ Design and development of "**smart**" traps
- ❑ **Software development** for the online monitoring of traps in real time:
 - **Identification** and **quantification** of captured populations of olive tree crop
 - **Olive fruit fly (*Bactrocera oleae*) and the**
 - **Mediterranean fruit fly (*Ceratitis capitata*)** ✓
- ❑ **Automated notifications** to tackle the presence of insects through rational, timely, and targeted interventions
- ❑ Based on existing experience and background of the development team



LAKONIA Project - 1st Year: Objectives / Results

MIT LAB

- 1. Irrigation (Smart Water Management)**
- 2. Fertilization (Nutrient Management)**
- 3. Plant Protection (Integrated Pest & Disease Management)**

Conventional and model-based irrigation treatments were applied and compared to each other regarding their impact on irrigation & N-fertilization cost, as well as on crop nutrition.

The results show that model-based irrigation treatments can generate **significant water savings (up to 40%)** and **related cost-savings**, along with **N-fertilization cost-savings**.



LAKONIA Project - 1st Year Attainable results

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□ Irrigation (Smart Water Management)

- **Water savings:** Up to **30–50%** reduction in irrigation water use through soil moisture sensors, weather-based scheduling, and deficit irrigation strategies.
- **Yield impact:** Maintained or even increased yields by **10–20%** compared to traditional irrigation, due to optimized water distribution.
- **Energy savings:** Pumping energy costs reduced by **20–30%** thanks to lower water use.

□ Fertilization (Nutrient Management)

- **Fertilizer savings:** Reduction in nitrogen and phosphorus applications by **20–40%** using site-specific fertilization and leaf/soil nutrient mapping.
- **Yield and oil quality:** Yield increase of **5–15%**, with higher polyphenol content and oil stability linked to optimized nutrient balance.
- **Cost reduction:** Fertilizer input costs reduced by **25–35%**, while maintaining or improving productivity.

□ Plant Protection (Integrated Pest & Disease Management)

- **Pesticide savings:** **20–30%** reduction in pesticide applications using remote sensing, pheromone traps, and predictive models for pests like the olive fruit fly (*Bactrocera oleae*).
- **Application efficiency:** Targeted spraying (variable-rate technology) reduces pesticide drift by **40–60%**.
- **Environmental benefit:** Less chemical runoff, with significant improvement in soil and water quality indicators.



**Concluding,
integrated smart-farming decision-support systems
based on smart irrigation models treatments showed
great results cost-environmental wise, compared to
the conventional/traditional oil field treatments.**



Awards

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- **Platinum, Top Rated Award** in the category "Retail Supermarket" and **Gold Award** in the category "Quality Assurance & Hygiene Systems"





Thank you!

Contact: info@pan-gaea.gr

