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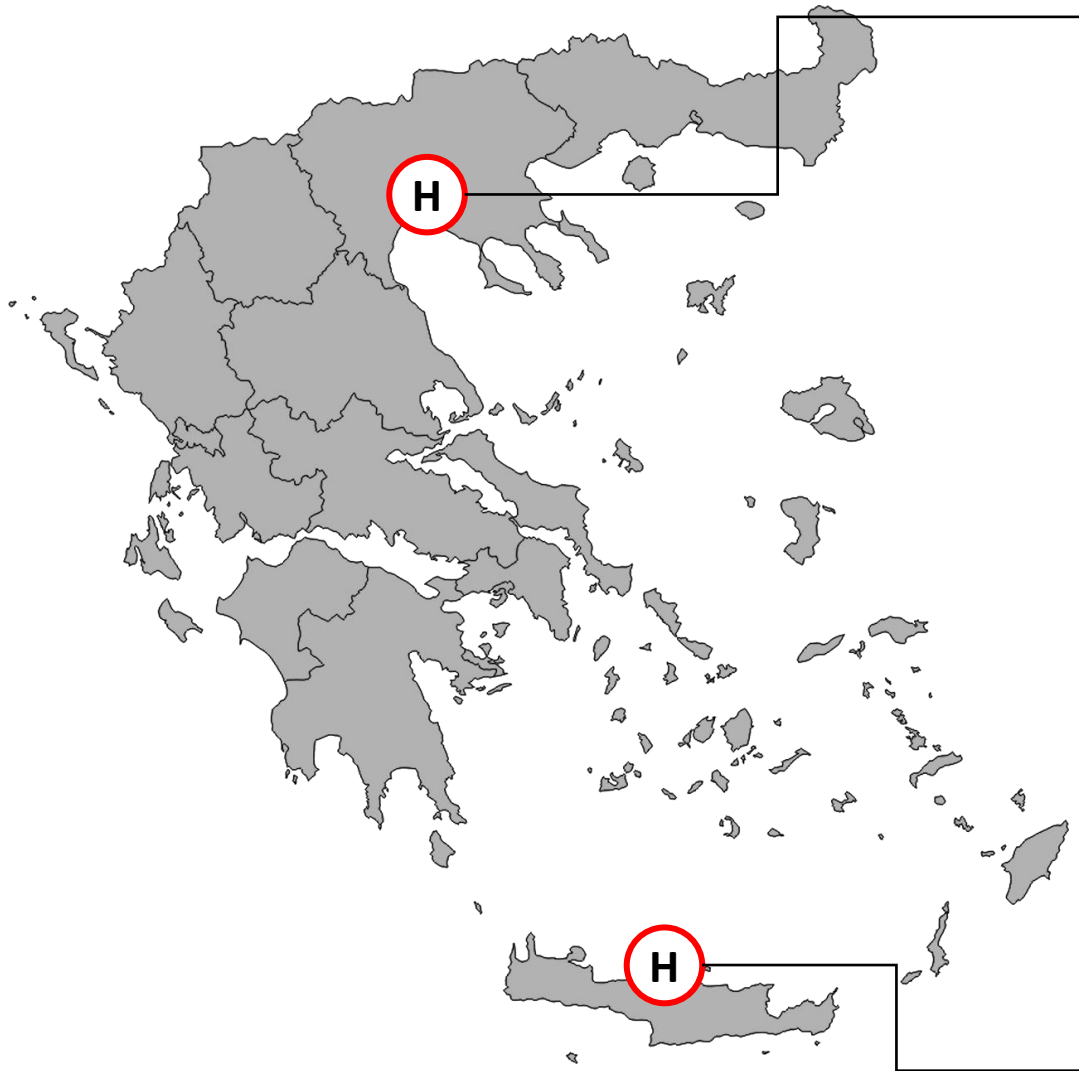
European Hospital and  
Healthcare Federation

HOPE EXCHANGE PROGRAMME - AGORA 2023  
2-4 JUNE 2023, BRUSSELS

# Climate and Environment: Challenges for Hospitals and Healthcare Services

**GREECE** 

# The hospitals of the network and the participants



## PAPAGEORGIU GENERAL HOSPITAL (THESSALONIKI)

DARREN CARROLL (IE)  
Bonsecours Hospital, Dublin



LEA BAK CHRISTENSEN (DEN)  
Aarhus University Hospital, Aarhus



STEFANO GUICCIARDI (ITA)  
Local Health Authority, Bologna



LIISI VIRGEBAU (EE)  
North Estonia Medical Centre, Tallinn

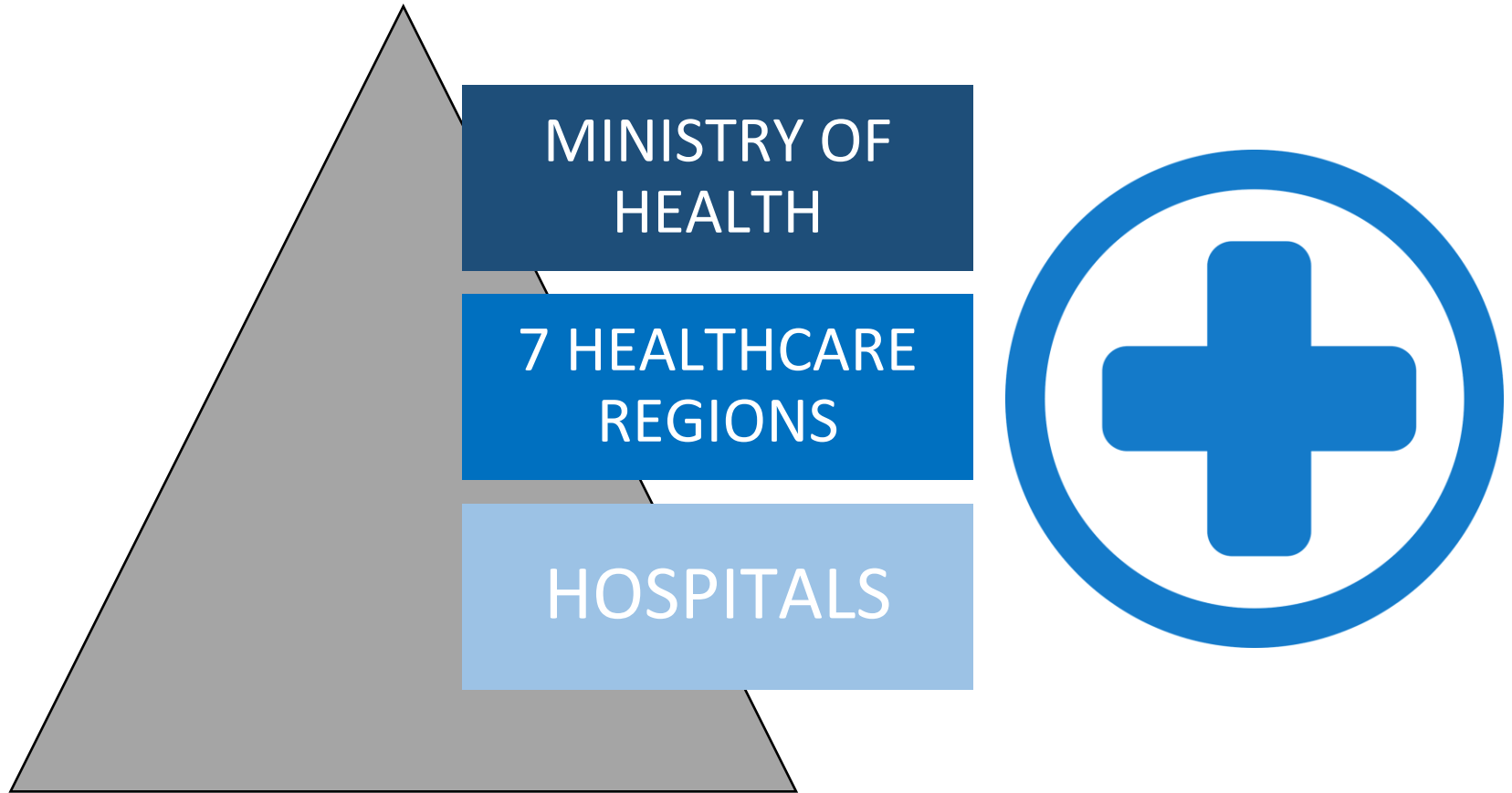


## VENIZELIO GENERAL HOSPITAL (HERAKLION)

# The Greek National Healthcare System

- **10.482.487** inhabitants (2021)
- **48,6%** male and **51,4%** female
- **80%** of territory consisting in **mountains** or **hills**
- **6.000** islands and islets, of which **227** inhabited
- **13** Administrative Regions
- **325** Municipalities
- **7** Healthcare Regions
- **9,5%** of GDP as healthcare expenditure (EU 10,9%, 2020)
- **6,2 doctors** per 1000 population (EU 4,0, 2020)
- **3,4 nurses** per 1000 population (EU 8,3, 2020)
- **65,0 healthy life years** at birth for **men** (EU 63,5, 2020)
- **66,8 healthy life years** at birth for **women** (EU 64,5, 2020)

# The Greek National Healthcare System



The Ministry of Health is the leading authority, both **supervising public** and **private** health sector. **Public hospitals** in Greece are **operated** by the Ministry of Health, while **Private hospitals** are **regulated** by the Ministry of Health.



## Venizelio General Hospital (Heraklion)

- Public Hospital of the **7th Health Region** (Crete)
- Provides **primary, secondary** and **tertiary** care
- One of the oldest hospitals in Greece, that began its operation in **1953** as a tuberculosis hospital
- Located 4 km from the center of Heraklion



# Papageorgiou General Hospital (Thessaloniki)

- A legal entity under private law, a **non-profit organization** that offers prevention, diagnosis, treatment and rehabilitation services
- Built in **1999** and equipped with private donations
- One of the two **biggest hospital** in Thessaloniki (9 hospitals overall)
- A **modern building** located in the area of N. Evkarpia 7 km away from the city center

# Climate and Environment Challenges: 3 examples of response



1. DIANYA: ON-SITE INTEGRATE MANAGEMENT OF HOSPITAL WASTEWATER



2. PHOTOCATALITIC PAINT



3. MOSQUITO CONTROL PROGRAM AND ENTOMOLOGICAL SURVAILLANCE



DIANYA

## 1. On-site integrate management of hospital wastewater

The project “**On-site integrate management of hospital wastewater**”, with the acronym “**DIANYA**” aims to develop, with competitive costs, an integrated methodology for the management of hospital wastewater that will allow:

- the **biodegradation of toxic pharmaceutical substances**;
- the **removal of multi resistant bacteria** and **organic micropollutants** contained in them;
- the **safe disposal and reuse** of the **treated wastewater**.

This methodology is piloted at the **Venizelio General Hospital of Heraklion** with the final goal to be optimized and technically and economically evaluated so that it can be applied to other hospitals in Greece and Europe.

The project is funded by the **National Action: Research-Creat-Innovate** [Operational program: “Competitiveness, Entrepreneurship & Innovation (EPAnEK) 2014-2020” (NSRF 2014- 2020), with the **co-financing of Greece and the European Union**].

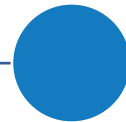




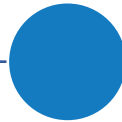
Everyday, hospital wastewater is collected and treated for major threats, but none is commonly done for:

- **pharmaceuticals and toxic by-products;**
- **viruses;**
- **antibiotics resistant genes and bacteria.**

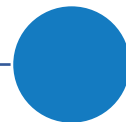
Since **conventional treatment plants aren't designed for the degradation of these elements and of emerging pollutants**, the consequences could be significant and affecting several fields.



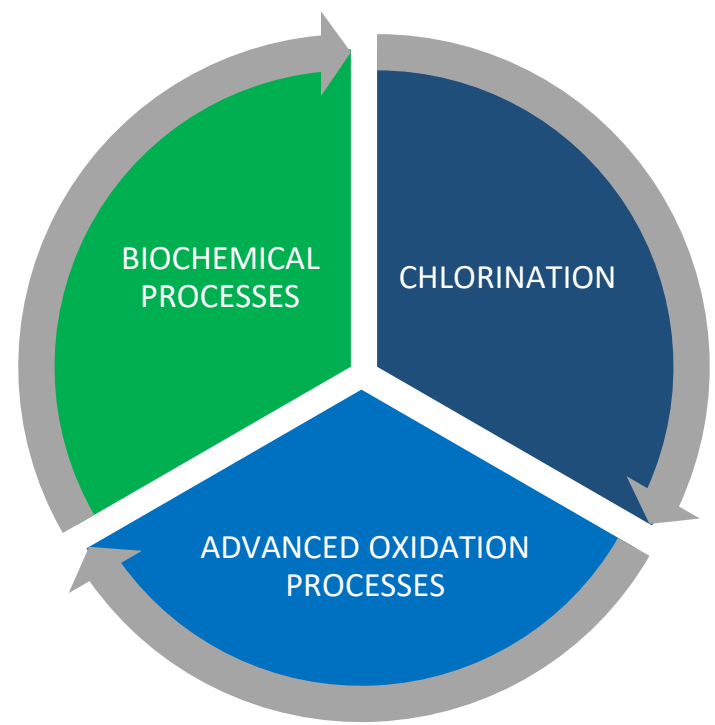
**HUMAN HEALTH, WITH INCREASE OF ANTI-MICROBIAL RESISTANT PATHOGENS**



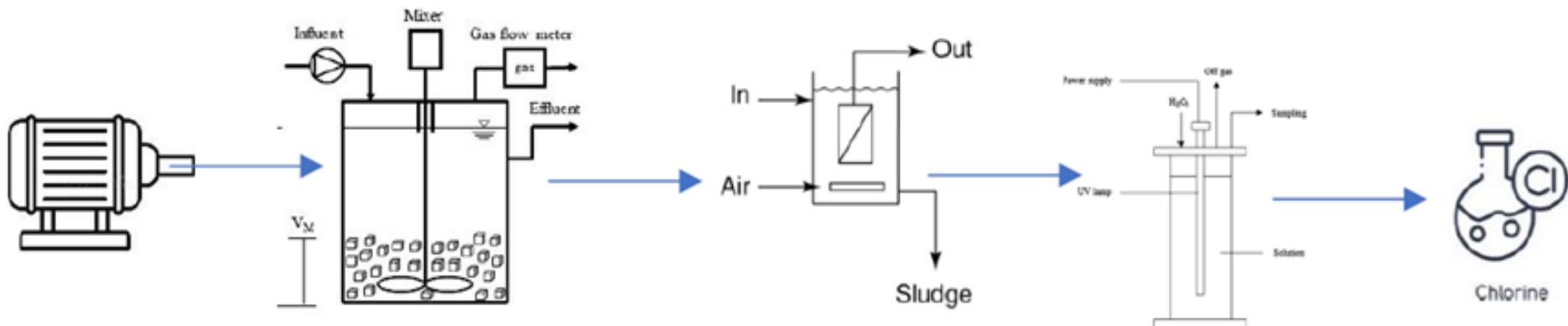
**ENVIRONMENT, WITH ECOTOXICOLOGICAL RISKS**



**PLANTS AND ANIMALS, WITH TRANSMISSION TO CROPS AND AQUATIC HABITATS**



MAIN GOAL: OVERALL REDUCTION OF **CONTAMINANTS OF EMERGING CONCERN (CECS)** THROUGH AN **HOLISTIC AND ONE HEALTH** APPROACH APPLIED TO A NEW HOSPITAL **WASTEWATER MANAGEMENT SYSTEM**





## INITIAL CONCLUSIONS

- Noticeable reduction in the value of biochemical parameters
- **Pharmaceuticals concentration** highly decreased in most of the substances
- **Successfully removal of the microbial load** (over 99% reduction)
- **Low concentrations of bacteria** in the effluent with lower risk of the spread of antibiotic-resistant bacteria
- Significant **reduction in the concentrations of resistance genes** thus a lower risk of the spread of resistant bacteria
- Experiments on **reusing the effluent water for irrigation purposes** of the green areas of the hospital



## 2. Photocatalytic paint

**Photo-Catalytic Nano Materials** is a spin-off company of the **Foundation for Research and Technology Hellas (FORTH)** based in Heraklion designed to leverage the research results of the Institute of **Electronic Structure and Laser**, and in particular a series of patents on innovative photocatalytic nano-materials (**PCN**) that degrade gaseous and liquid pollutants, purify waste, disrupt polluting and toxic odors and degrade pathogenic organisms.

The company is set to produce novel high-performance photocatalytic materials operating under the influence of solar and/or artificial (indoor) lighting, proved most effective both, on **improving indoor/outdoor air quality** and on the **disinfection of bacteria, viruses, phages**, in health-sensitive areas.

Extensive tests by independent National and International bodies have shown enhanced de-pollution functionalities and strong disinfection properties.



**FORTH**

FOUNDATION FOR RESEARCH AND TECHNOLOGY - HELLAS



We spend **90%** of our time indoors and **indoor air is 2-5 times more polluted than outdoor air.**

The two main sources of pollution are **airborne pollutants** and **airborn pathogens**, with the following annual consequences:

- **20%** European population with **asthma** or **allergies**;
- **400.000** premature deaths in EU due to air pollution;
- **4 billion €** in healthcare;
- **16 billion €** in lost workdays;
- **33.000** deaths in Europe determined by super-bugs.

The risks are especially critical for **vulnerable spaces**, such as **hospitals, schools, and elderly care facilities.**

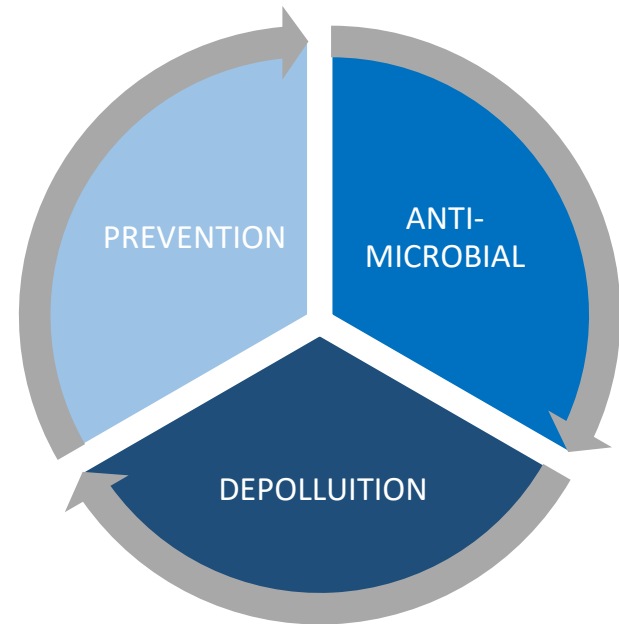


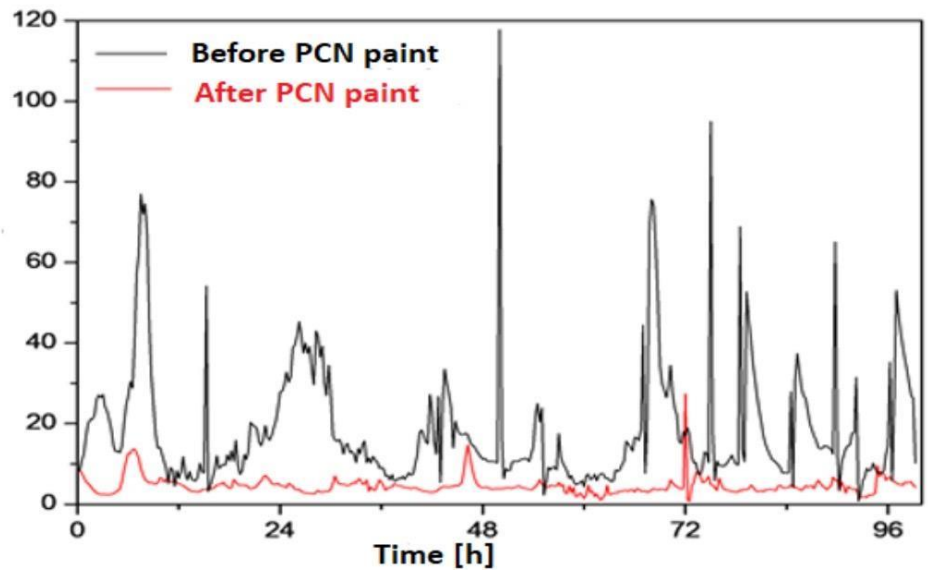


To tackle these challenges, **Photo-Catalytic Nano Materials developed a photocatalytic TiO<sub>2</sub> powder** with important effects and useful qualities:

- 85% NO<sub>x</sub> removal;
- 99.99% reduction of pathogens;
- lack of harmful by-products;
- self-cleaning material.

Compared to other existing solutions that lack of some positive effects (such as silver nanoparticles for antimicrobial paints/coatings, commercial TiO<sub>2</sub> for photocatalytic paints/coatings, or disinfectants), **this powder proved to have full preventive, anti-microbial and depolluting actions.**





Some large scale applications have already been tested, such as the **Tunnel of Stalida in Heraklion**, coated in 2014 with photocatalytic PCN for 4000 square meters or the **Greek Army Medical Center** of the cadets training camp (SEAP).

Overall, it was possible to appreciate the following results:

- **lower concentration of NOx oxides;**
- improved air quality;
- **healthier and safer environment** through the total elimination of bacteria concentration.

New applications are planned for their future.



Where can PC nano-technology be applied in a **hospital**?

- To paint **hospital indoor walls**, using wet paint;
- to paint all **metallic surfaces** within a hospital, using electrostatic paint;
- as a coating on **textiles** used within a hospital, using photocatalytic spray (i.e. curtains, doctor's coats, surgery caps etc.);
- as a coating for **furniture or devices** used within a hospital, using the photocatalytic spray (i.e. machinery, chairs, waiting rooms etc.);
- within the **air ventilation system**.

At present, a **large scale implementation is going on** at the at **PAGNI Hospital**, with the application of the high-performance photocatalytic modified TiO<sub>2</sub> powder within the **ICU**.





# Prize Winner Project EYWA



## 3. EYWA: Mosquito control program and entomological surveillance

Every year, more than **1 billion people** suffer from **vector-borne diseases** such as malaria, dengue, zika or yellow fever. These diseases are caused by viruses, bacteria and parasites transmitted via living organisms such as insects, and account for more than **17% of all infectious illnesses**.

**Globalisation** of travel and trade, **unplanned urbanisation** and environmental challenges such as **climate change** significantly contribute to their spread.

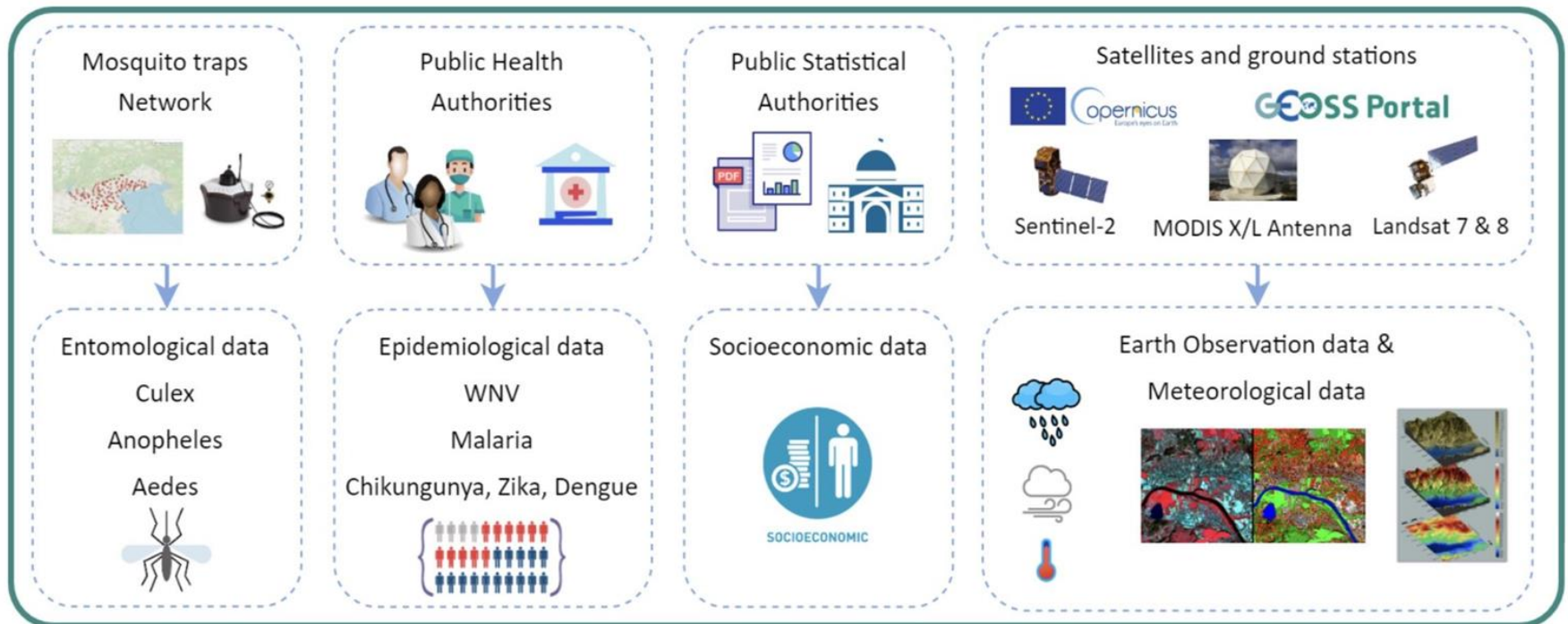
In April 2018, the European Commission launched a €5 million prize for an early warning system for a scalable, reliable and cost-effective early warning prototype system based on **Earth observation data** to forecast and monitor outbreaks of vector-borne diseases.

The winning solution, called **Early Warning System for Mosquito-borne Diseases (EYWA)**, provides an early warning capability to help prevent and mitigate the impact of infectious diseases on local, regional and global scales.

The technological novelty of EYWA lies in the efficient handling of **multiple entomological, epidemiological, Earth Observation, crowd and ancillary geospatial data**, along with dynamic and data driven models, to generate knowledge on the mosquitoes' abundance and pathogens' transmission.

Thanks to data provided by Copernicus satellites and Copernicus Core Services, EYWA reliably depicts the dynamics of mosquito habitats and breeding sites. The system also capitalises on European investments in Earth observation and cloud-based data repositories and capacities (i.e. DIAS, GEOSS, NextGEOSS).

Overall, EYWA system is the outcome of the **co-development lead by Greek research centers**, mainly the **BEYOND Centre** of EO Research and Satellite Remote Sensing of the Institute for Astronomy, Astrophysics, Space Applications and Remote Sensing (IAASARS) of the **National Observatory of Athens**, in collaboration with key core partners, the **Ecodevelopment S.A. company** specialized in mosquito control and data analytics, and the **Laboratory of Atmospheric Physics of the University of Patras** along with important European organisations from **Italy, France, Germany and Serbia**.





**The unique solution** developed by EYWA had several results:

- enhanced **mosquito surveillance** and control at various spatio-temporal scales and in different climatic zones, guiding day to day prevention and mitigation actions;
- significantly **reduced the entomological risk** with avoidance of human cases in thousands of villages where EYWA is employed (reduction of mosquito populations by approximately 50% compared to previous years);
- Implemented the **One Health** approaches by investigating arbovirus infections, while taking into account environmental and socio-economic resilience (measurable decrease of West Nile Virus infections and Neuroinvasive diseases in high-risk areas, such as 66 less villages infected in the region of Central Macedonia).

# Climate and Environment Challenges: conclusions

All the proposed examples proved to be:

- **simple** but at the same **innovative**;
- easy to **disseminate**;
- **cost-effective**;
- with a **multi-level action**.

They represent valid approaches to **locally address** the impact of **global environmental challenges**, **highlighting the role of national healthcare systems** and their potential contribution, even with limited resources.





**ΕΥΧΑΡΙΣΤΩ!**