



**EYWA**

Early Warning System  
for Mosquito Borne Diseases

Earth Observation for Epidemics  
of Vector-borne Diseases /  
EuroGEO Action Group

**EuroGEO**

EO creates  
opportunities  
for Health &  
Epidemics



# EO based Early Warning System for Mosquito-Borne Diseases

## An operational application in EU

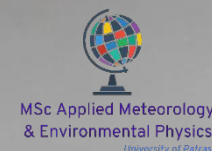
Katerina Kyratzi

EYWA Project Manager

BEYOND EO Centre

National Observatory of Athens

On behalf of the EYWA  
EuroGEO Consortium



## Mosquito-Borne Diseases in Europe An emerging threat

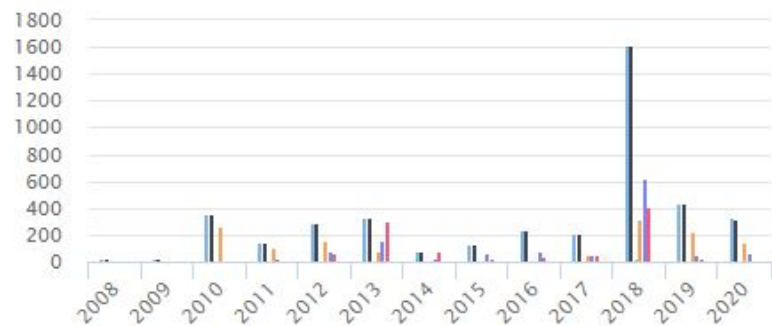
West Nile Virus: 4226

Malaria: 85246

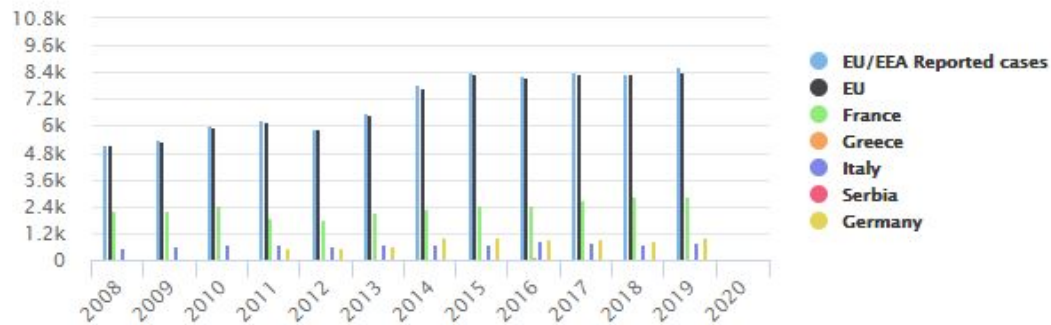
Dengue, Zika and Chikungunya: 30249

Source: ECDC, EU/EEA Reported cases 2008-2020

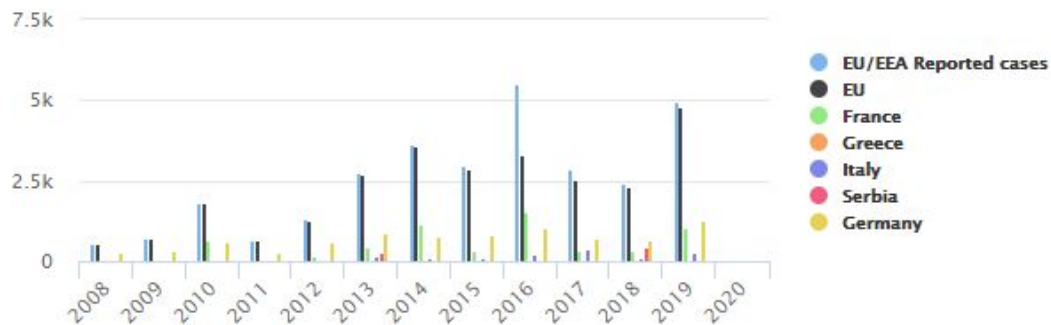
West Nile Virus reported cases (ECDC)



Malaria reported cases (ECDC)



Dengue, Zika and Chikungunya reported cases (ECDC)



### Mosquitoes and Diseases

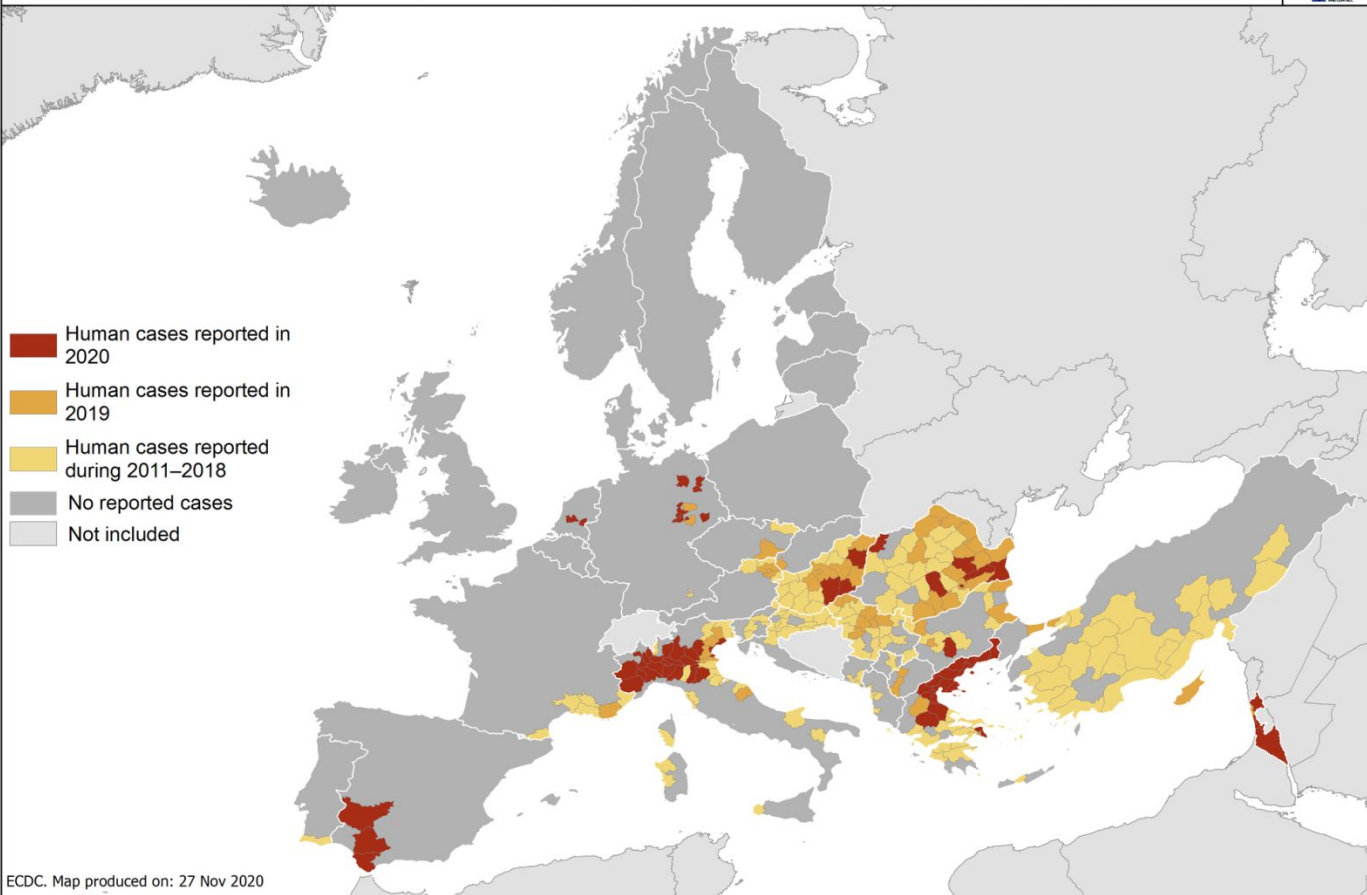
*Culex* - West Nile Virus

*Anopheles* - Malaria

*Aedes albopictus* - Dengue, Zika,  
Chikungunya

## Mosquito-Borne Diseases in Europe An emerging threat

Distribution of West Nile virus infections in humans by affected areas in the EU/EEA countries and EU neighbouring countries  
Transmission season 2020 and previous transmission seasons; latest data update 26 Nov 2020



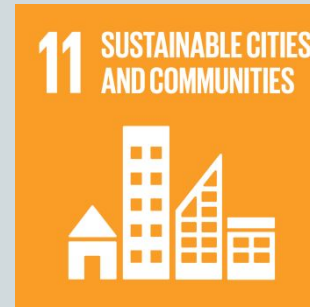
# EuroGEO

Action Group EU4EVIDENCE

(Earth Observation for Epidemics of Vector-Borne Diseases)

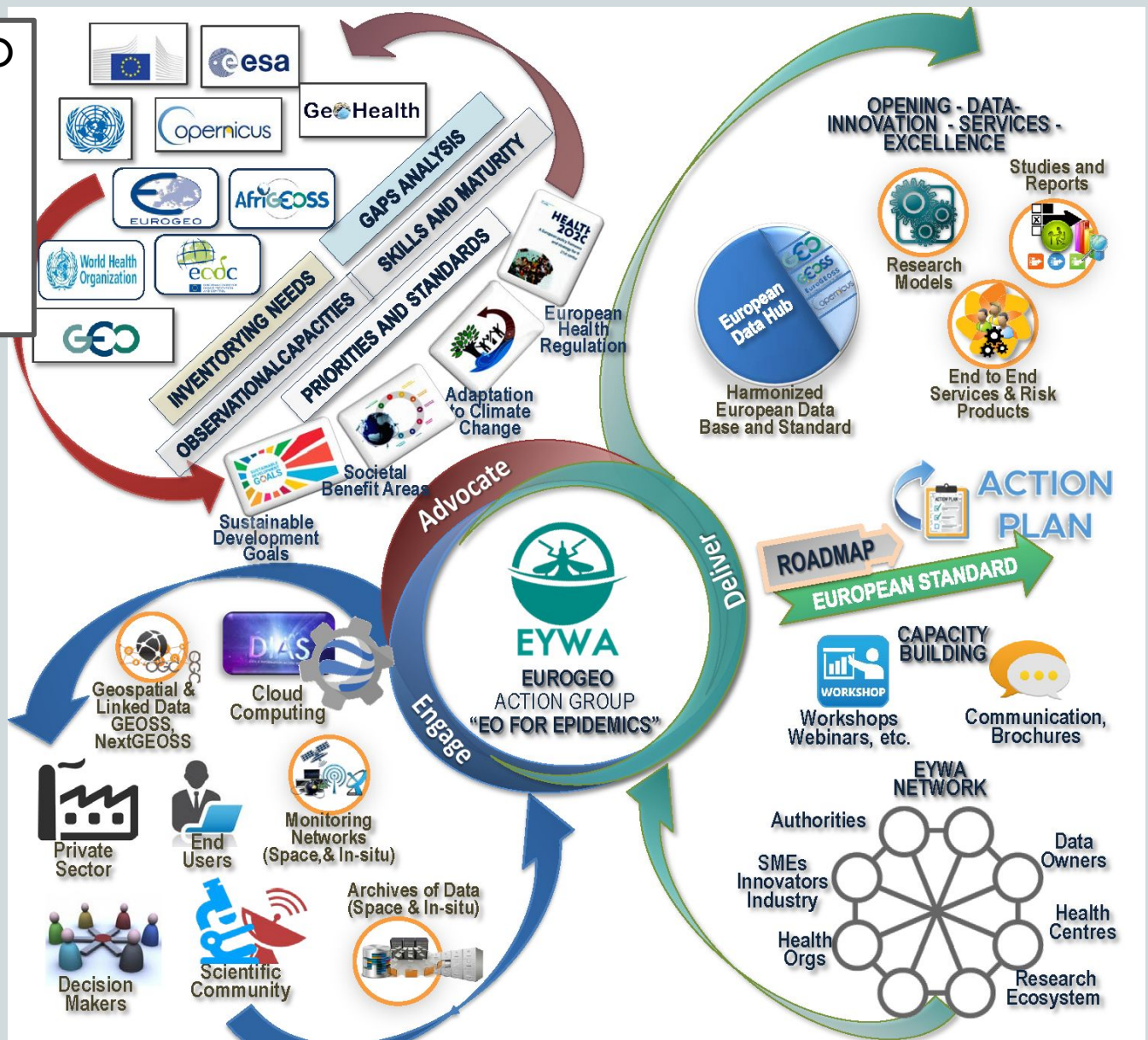
*EYWA is a vision, a network, a European and even global standard.*

*EYWA offers a scalable, reliable and sustainable early warning system, relying on Earth observation big data combined with entomological, epidemiological and socioeconomic data, to forecast and monitor Mosquito-Borne Diseases.*

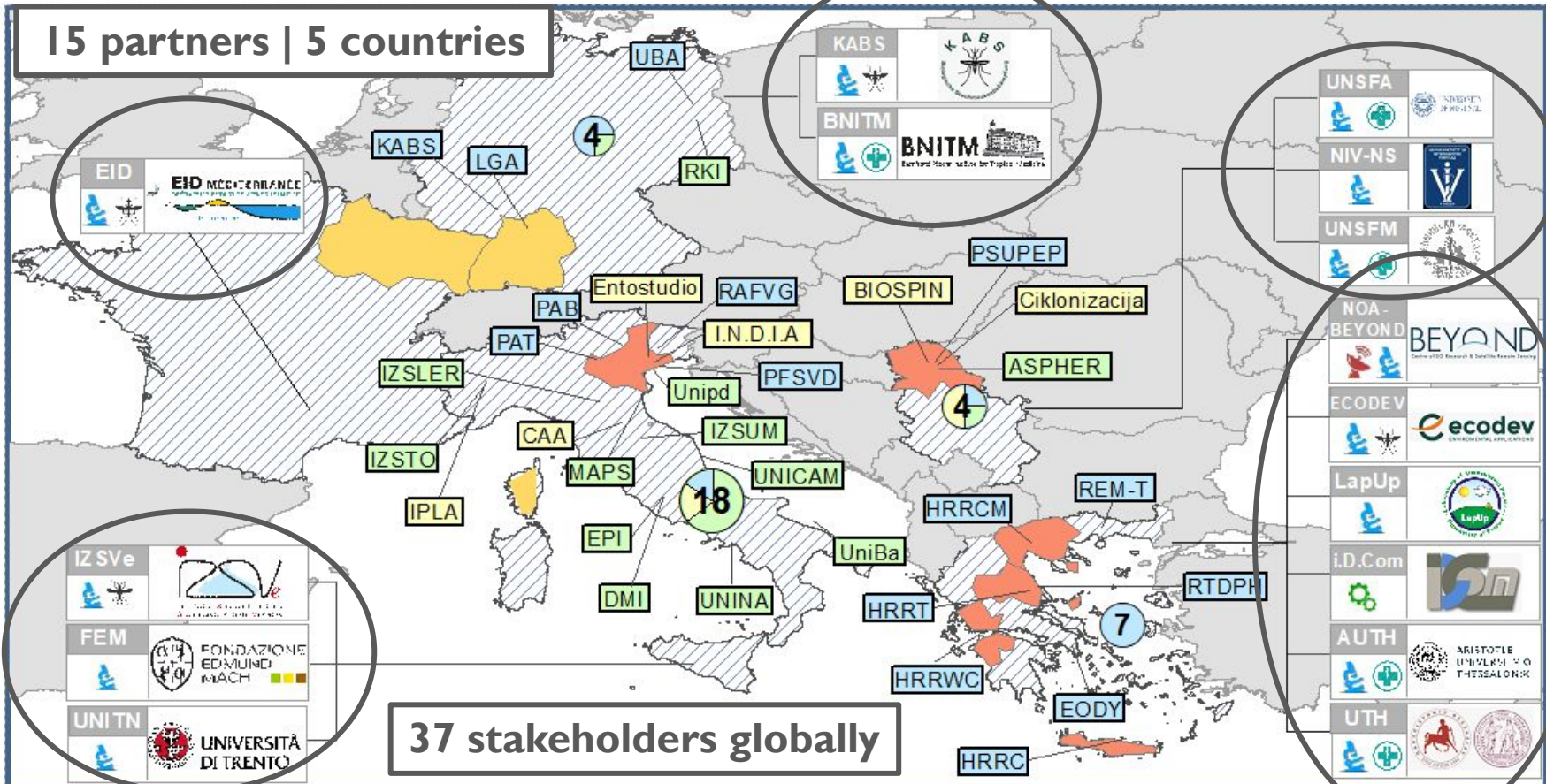




EYWA is built on the GEO triptych:  
**ADVOCATE**  
**ENGAGE**  
**DELIVER**



15 partners | 5 countries



37 stakeholders globally

**LEGEND**

**Operational Demonstration**

- 2020 TRL > 7
- 2021 TRL > 7
- New engagements
- 2021-2025

**PARTNER**

LOGO

**Organization Role**

- EARTH OBSERVATION
- SERVICE PROVIDER
- RESEARCH
- MOSQUITOES
- HEALTH

**Network of Stakeholders**

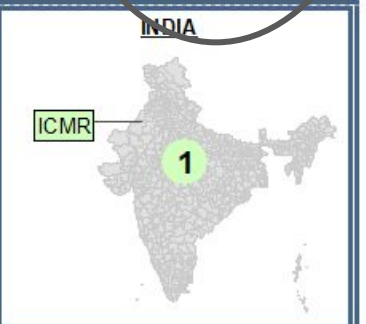
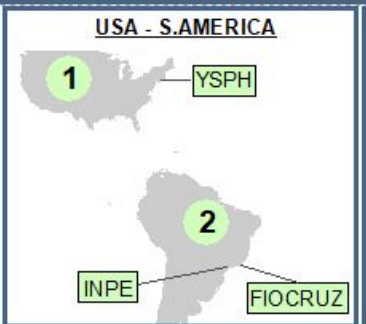
Number

- 1 - 10
- 11 - 20

Type

- RESEARCH
- GOVERNMENT
- PRIVATE SECTOR

STAKEHOLDER



UNSF A

NIV-NS

UNSF M

NOA-BEYOND

BEYOND

ECODEV

LapUp

i.D.Com

AUTH

UTH

KABS

BNITM

EID

EID PERFORMANCE

IZSVe

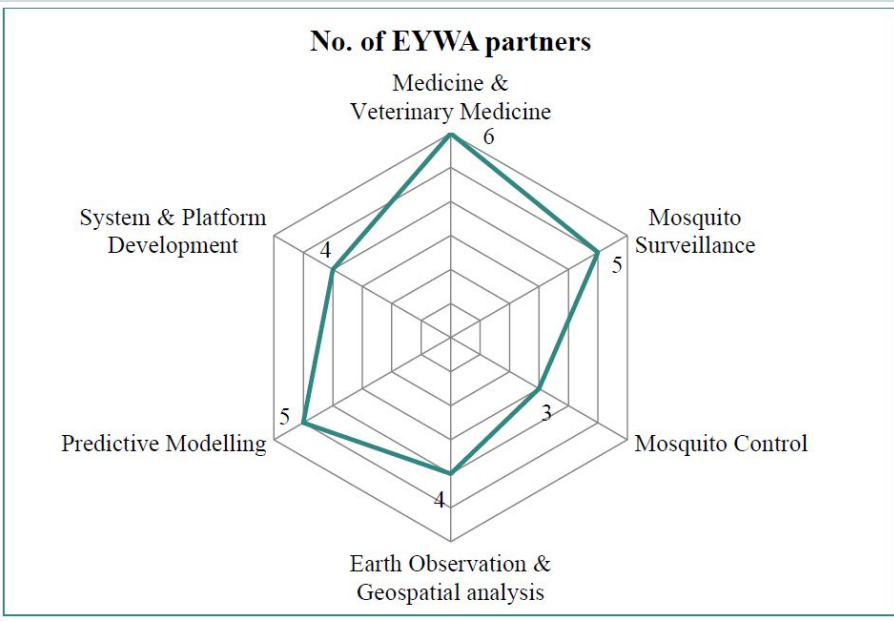
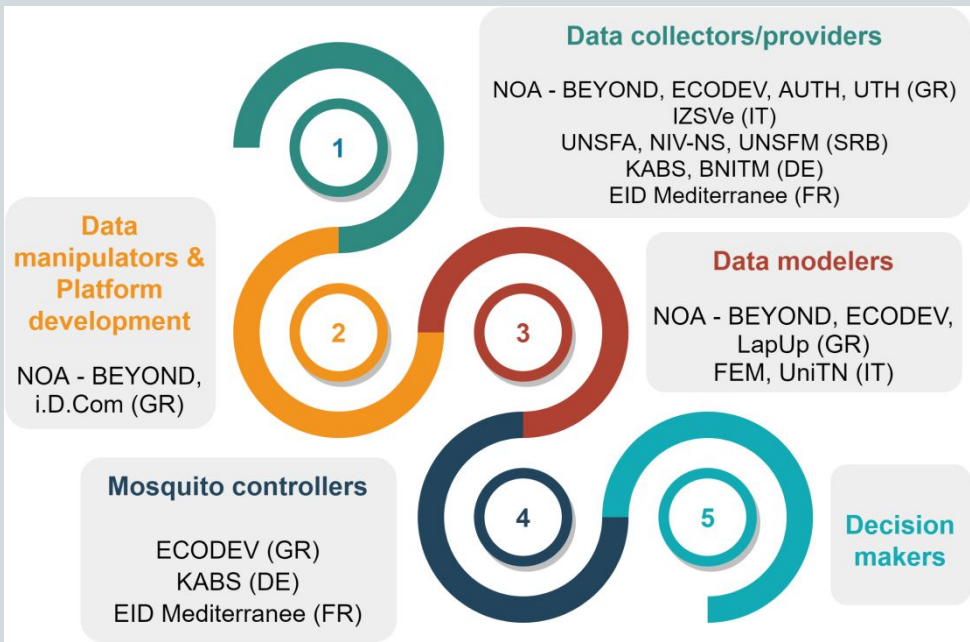
FEM

UNITN

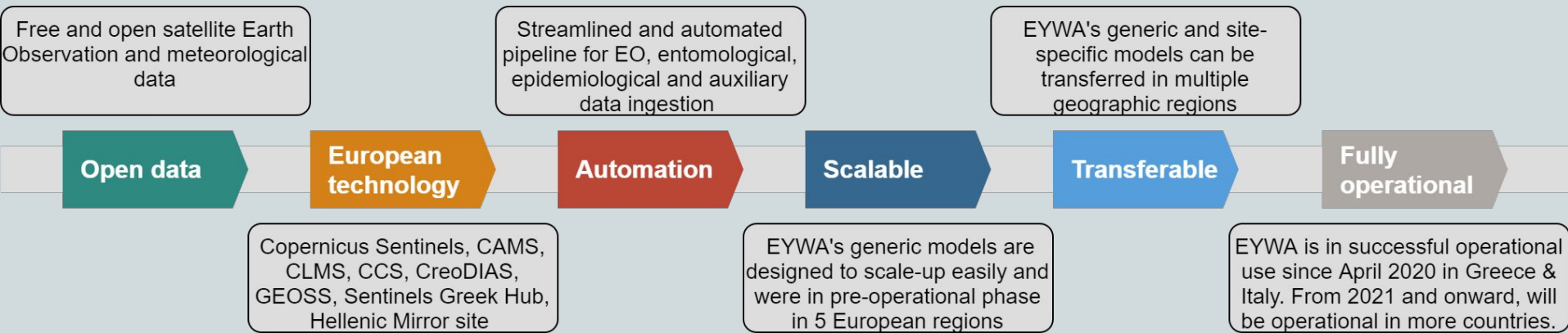
UNIVERSITA DI TRENTO

# EYWA TEAM

“Together Everyone Achieves More”



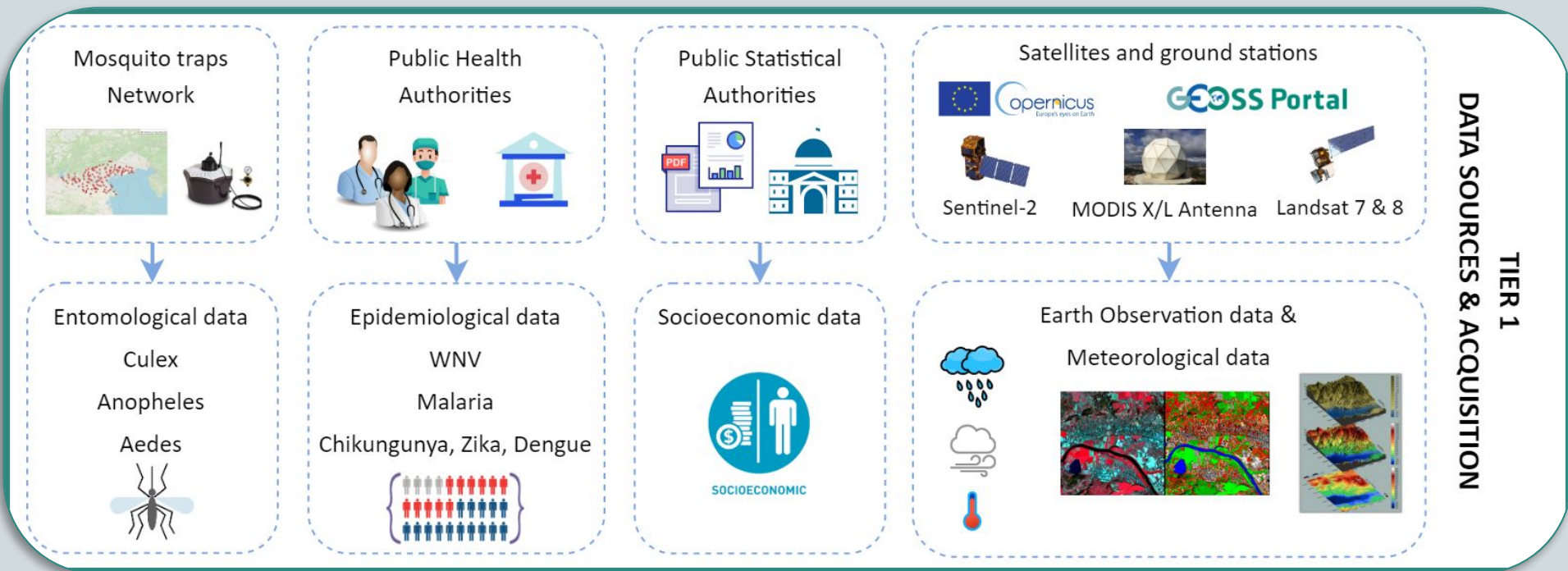
## How EYWA competes



*“EYWA is a robust and scalable Early Warning & Decision Support System that welcomes new partners from around the world to share data and transform scientific knowledge into decision-making & mosquito control actions”*



## EYWA System Architecture

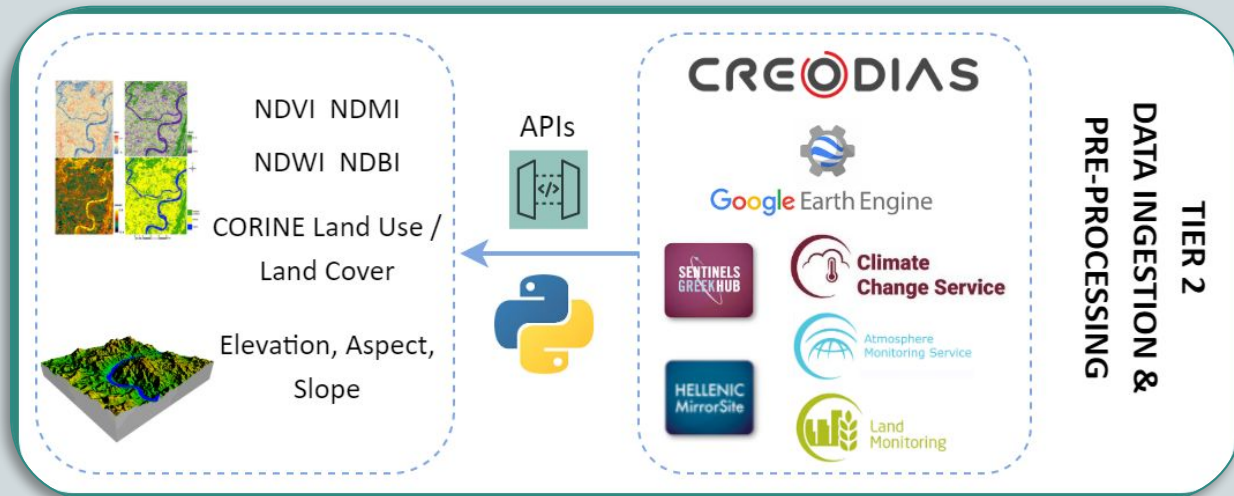


EYWA incorporates 10-years time-series of Copernicus (Sentinel-2) and other space-based data (Landsat-7 & -8, MODIS and ERA-5) in addition to in-situ entomological, epidemiological, socioeconomic and crowdsourcing data.

## EYWA System Architecture

A suite of APIs is developed and publicly available through BEYOND-NOA's GitHub profile for automatic:

- **Data Harvesting**
- **Data Pre-processing**
- **EO-based indices derivation**

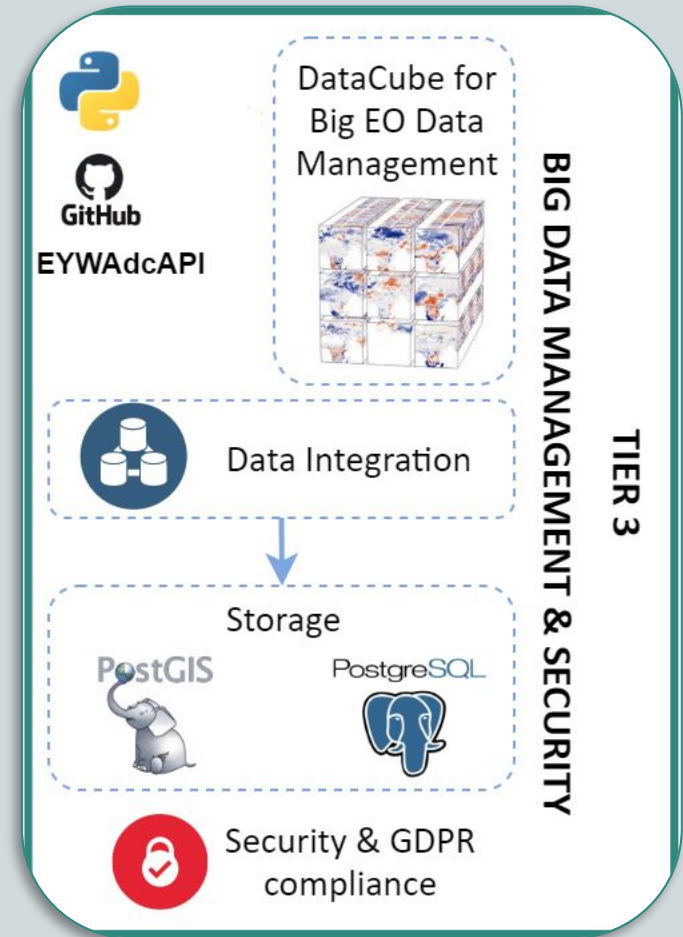


Satellite data harvesting and processing, exploiting European and non-European services:

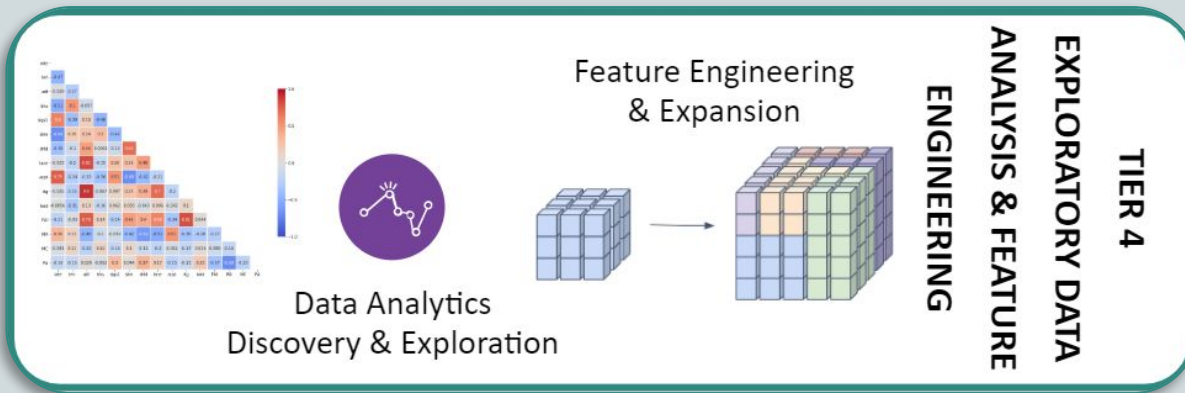
- Umbrella Sentinel Access Point of the Hellenic Mirror Site (an API that constitutes 100% EU innovation and has been developed by BEYOND-NOA in the framework of the NextGEOSS and EOPEN EU projects)
- CreoDIAS and Google Earth Engine

## EYWA System Architecture

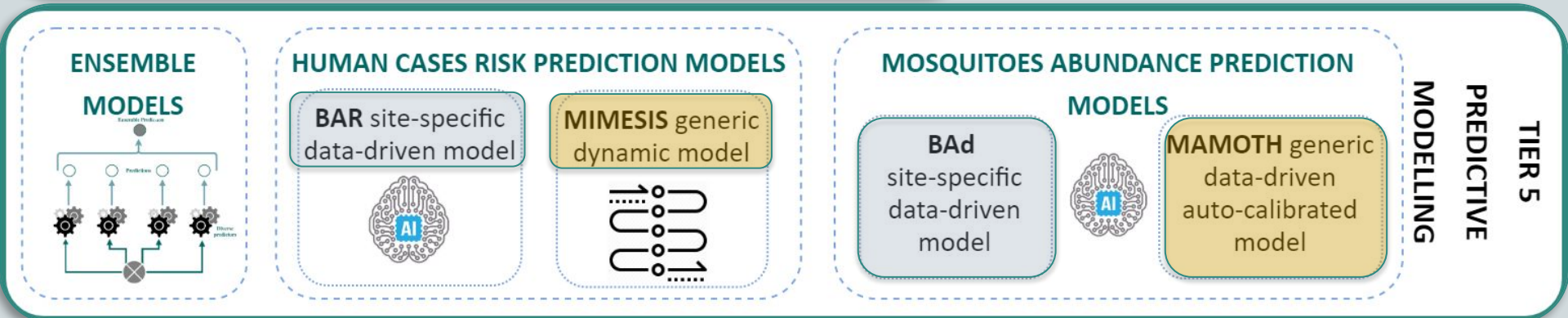
- Big Data management (**278 TB and counting**)
- Open Data Cube (ODC) technology, state-of-the-art tool for Earth Observation and other data fusion, feature engineering and data analytics
- All these processing steps are available through the dedicated Python API “**EYWAdcAPI**” at BEYOND-NOA’s GitHub profile in the epidemics repository



## EYWA System Architecture



A “mammoth” feature space of at least 10-years time-series of data for every mosquito-traps network in nine regions in Europe.



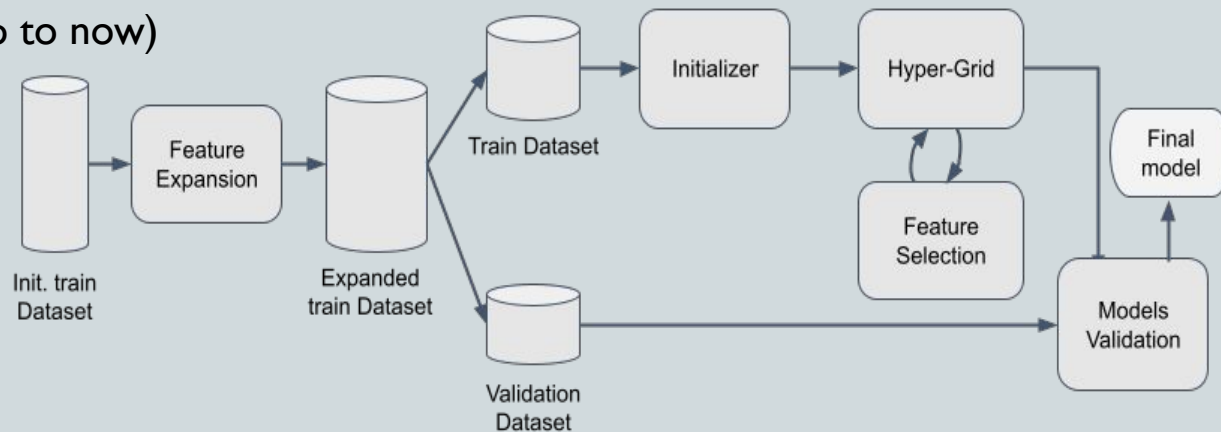
How is this plethora of independent data transformed into meaningful scientific knowledge?

EYWA has a factory of dynamic and data-driven models, learning about the dynamics of mosquitoes’ abundance and mosquito-borne diseases transmission, and providing monthly, weekly, daily predictions.

## EYWA System Architecture

### The MAMOTH model

- **MAMOTH** (**M**osquitoes **A**bandance prediction **M**odel aut**O**-calibrated from features ple**T**Hora)
- **Generic data-driven** approach relying on open **EO** data
- Automated Feature Selection:
  - **No human bias** on feature selection is injected in the model
  - **Transferable** and **replicable**
- **Knowledge expansion:** Operating under the **same architecture** and the **same mathematical principles** to different cases, offers extensive capability of comparative studies, responding to: “which characteristics seem important in one case and which on the other?”
- MAMOTH is **composed** of 32 (up to now) in-housed developed Python functions that are organized in **5 operational Modules**



## EYWA System Architecture

Mosquitoes abundance and human cases risk prediction maps & statistics



Reports for end-users



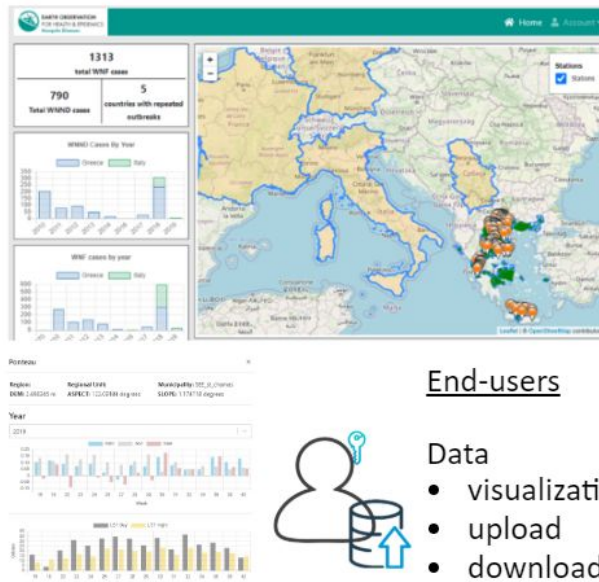
EXPLANATION

TIER 6

KNOWLEDGE REPRESENTATION &

Predictions results dissemination to the relevant Public Health Authorities through monthly reports and the EYWA Web Platform

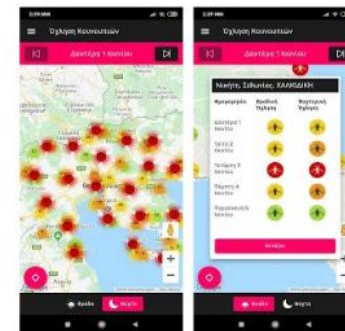
Web Platform UI



End-users

- Data
- visualization
  - upload
  - download

Mosquito Vision application



Open data sharing through the **EYWAopenAPI**



EYWA WEB SERVICES

TIER 7

## EYWA & open data sharing

# NEXTGEOSS DataHub & EYWAopenAPI

EYWA is an autonomous European Initiative, building upon the Open Innovation, Open Science and Open to the World vision for Europe.

Analysis ready 10-years' time-series of environmental, meteorological and geomorphological data for every mosquito-traps network in 10 European regions. Accessible through:

- The “EYWAopenAPI” ([http://epidemics.space.noa.gr/api\\_v2/](http://epidemics.space.noa.gr/api_v2/))
- NextGEOSS DataHub

Who is it for?



Public Health  
Professionals



Scientists



Public

## EYWA in Action

EYWA's **operational implementation in 2020** (TRL>7 ) with a demonstrated impact in:

- Greece (Regions of Central Macedonia, Thessaly, Western Greece and Crete)
- Italy (Veneto region)

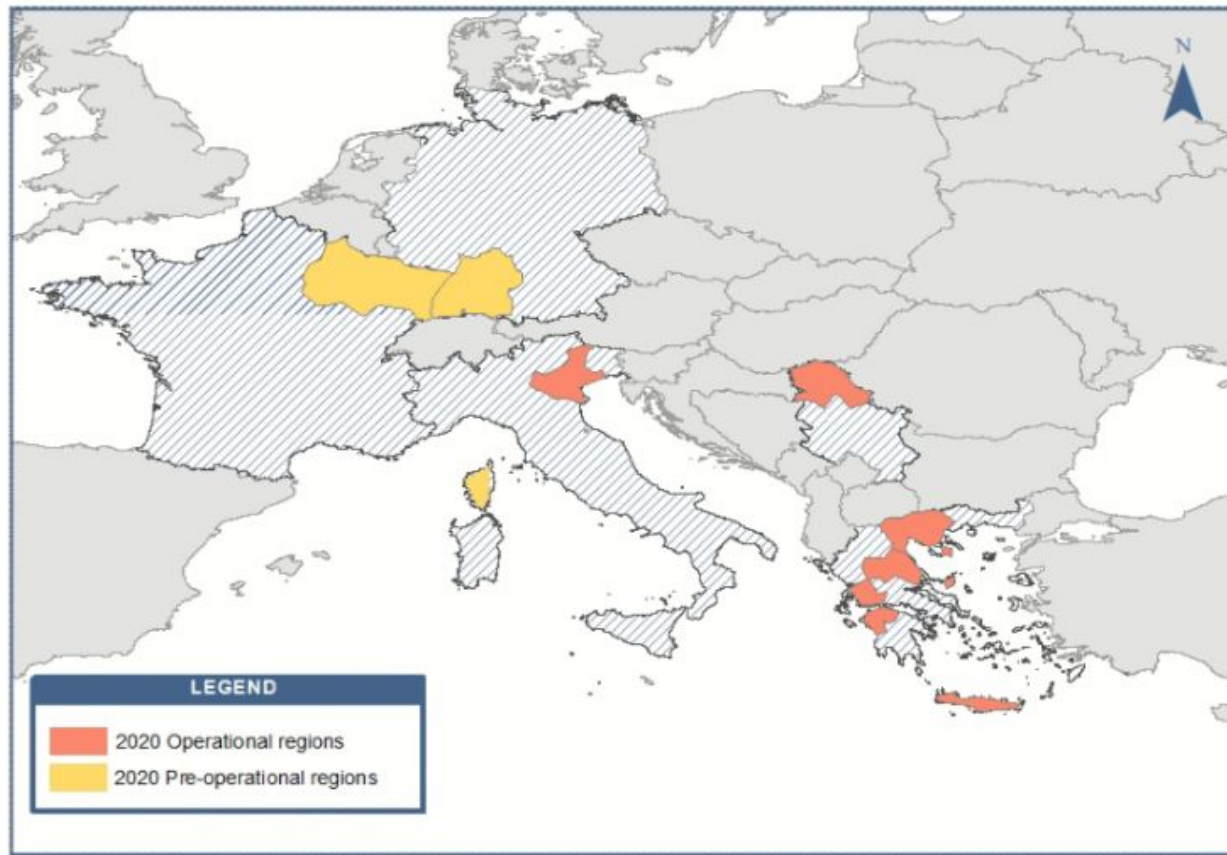
forecasting *Culex* mosquito populations and West Nile Virus outbreaks in 2020.

EYWA's **pre-operational test in 2020** for:

- *Culex* (WNV) abundance prediction in Serbia (Vojvodina region) and Germany (Baden-Württemberg region)
- *Anopheles* (Malaria) in Italy (Veneto region)
- *Aedes albopictus* (Chikungunya, Dengue, Zika) in France (Grand Est and Corsica regions)



## EYWA in Action



**EYWA is now fully operational in all these areas and started delivering results again for the 2021 mosquito season in the end of April.**

## EYWA in Action

### Reports with operational results

EYWA produces knowledge in the form of reports, statistics, validated assessments and web GIS information layers, all available to the end-users through the EYWA Web Platform.

The EYWA Reports are delivered operationally from April to October every year to the relevant Public Health Authorities and decision makers.

The monthly reports assist the authorities in organizing their mosquito control strategy and actions. Measurable performance indicators are used to evaluate the level of EYWA's effectiveness toward the protection of the engaged communities against the disease outbreak.



The reports indicate

- Up-to-date epidemiological status of the Region
- The state-of-the-art models used
- The mosquito abundance predictions for the month
- The estimated human risk

## EYWA in a nutshell

- Plethora of satellite Earth Observation data
- Entomological, epidemiological, crowdsourced, socioeconomic and auxiliary data
- State-of-the-art technological tools



Leveraging scientific knowledge and ultimately proving that EO can upend our understanding in the field of epidemics

**The pivotal role of EYWA is to become a key lever for Public Health authorities and decision makers, support preparedness and timely strategic design of the health system response actions, and raise citizens awareness on the expected risk, with a view to fight Mosquito-Borne Diseases.**

# Thank you!

## Contact us

[Kontoes@noa.gr](mailto:Kontoes@noa.gr)

(Coordinator of EuroGEO Action Group for Epidemics)  
(Lead Partner of EYWA)

Earth Observation for Epidemics  
of Vector-borne Diseases /  
EuroGEO Action Group

**EuroGEO**

## Partners

### Greece

*National Observatory of Athens (NOA) – BEYOND Centre of  
EO Research & Satellite Remote Sensing*

*Ecodevelopment S.A*

*University of Patras – Physics Department - Laboratory of  
Atmospheric Physics (LapUP)*

*Dimitrios Vallianatos (IDCOM)*

*Aristotle University of Thessaloniki*

*University of Thessaly, Medical School. Laboratory of Hygiene  
and Epidemiology*

### Italy

*Istituto Zooprofilattico Sperimentale delle Venezie (IZSVe)*

*Edmund Mach Foundation*

*University of Trento*

### Serbia

*University of “Novi Sad”, Faculty of Agriculture, Laboratory for  
Medical and Veterinary Entomology*

*Scientific Veterinary Institute “Novi Sad”*

*University of Novi Sad, Faculty of Medicine*

### Germany

*German Mosquito Control Association (KABS)*

*Bernhard Nocht Institute for Tropical Medicine*

### France

*EID Méditerranée*