EYWA
Early Warning System
for Mosquito Borne Diseases

EO creates opportunities for Health & Epidemics

EYWA: A key tool to the epidemics arsenal

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

EuroGEO

BEYOND · ecodev · FONDAZIONE EDMUND MACH · UNIVERSITÀ DI TRENTO · BNITM Bernhard Nocht Institute for Tropical Medicine · EID MÉDITERRANÉE

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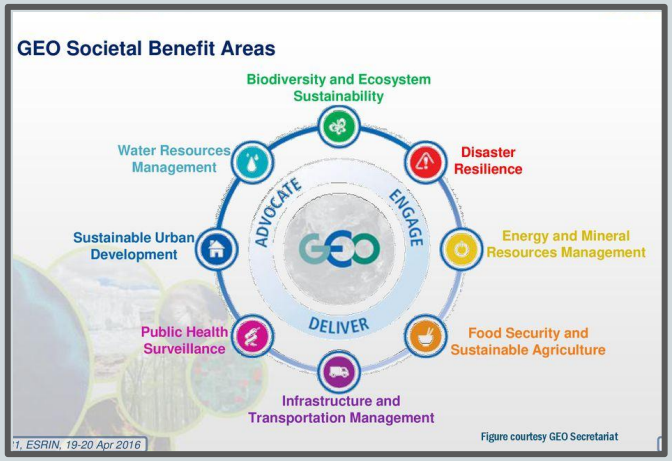
EuroGEO
Action Group "EO4EVIDence"

(Earth Observation for Epidemics of Vector-Borne Diseases)

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



EU HEALTH EMERGENCY PREPAREDNESS AND RESPONSE AUTHORITY

DG SANTE
Directorate-General for Health & Food Safety

HEALTH

SUSTAINABLE DEVELOPMENT GOALS

3 GOOD HEALTH AND WELL-BEING

11 SUSTAINABLE CITIES AND COMMUNITIES

13 CLIMATE ACTION

European Climate and Health Observatory

DG ECHO
EU Civil Protection & Humanitarian Aid Operations

Humanitarian Aid Civil Protection

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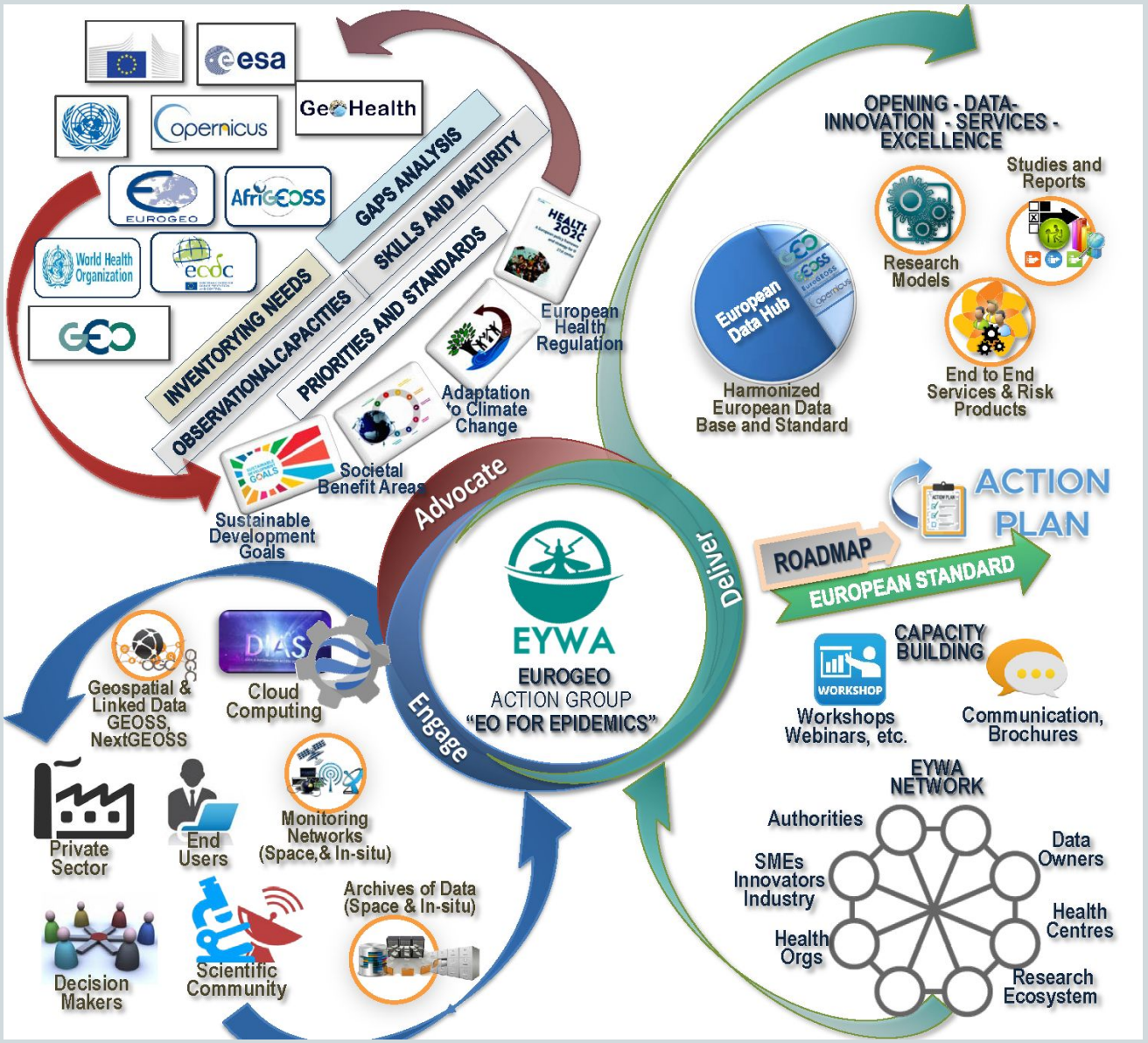
EYWA is built on the GEO triptych:

ADVOCATE
ENGAGE
DELIVER

DELIVERS

1. Digital Services
   a) Mosquito abundance
   b) Disease outbreak
2. Network of Stakeholders
3. Action Plan
   a) Service and Quality Standards
   b) Assist Policy and Regulations



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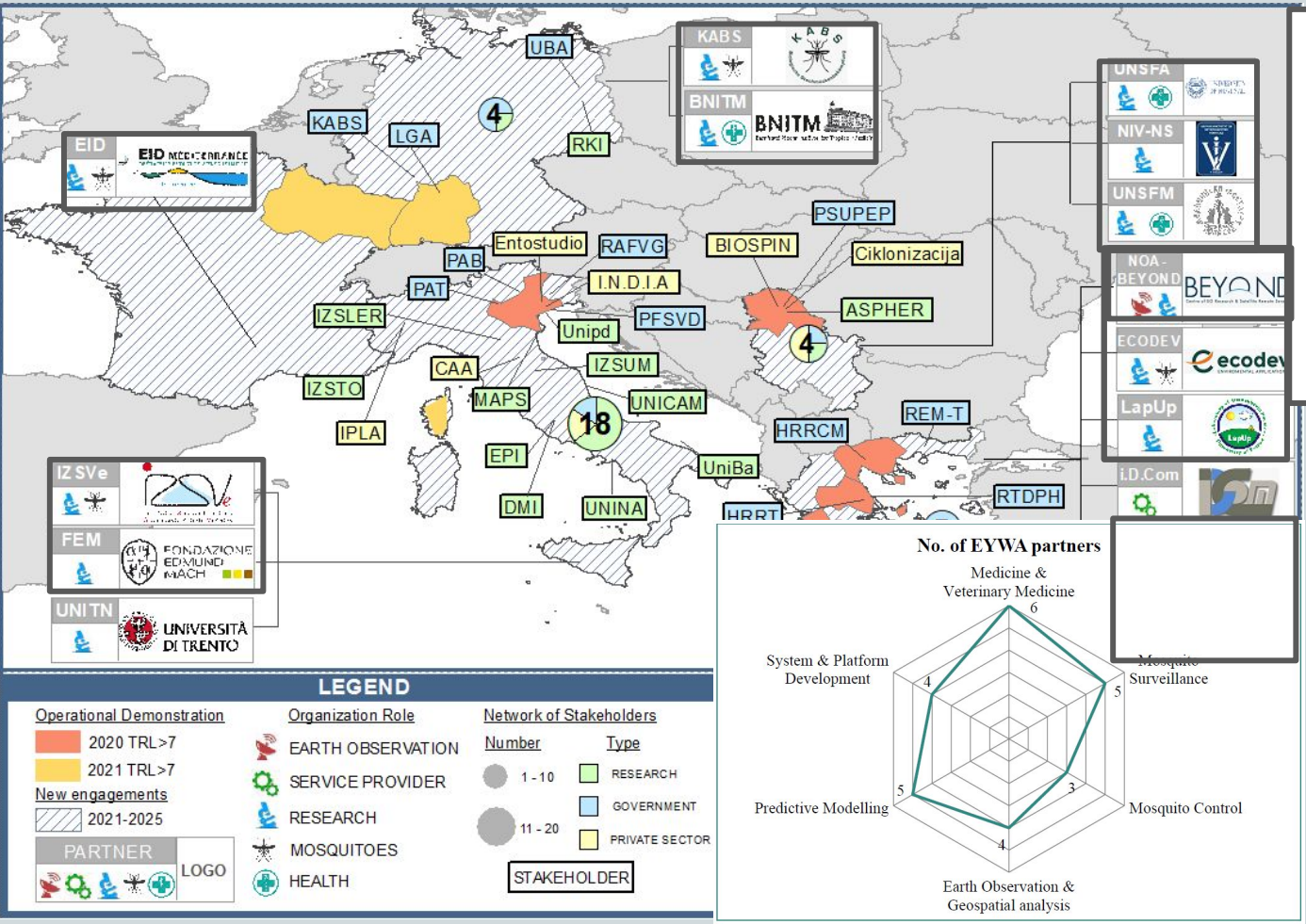

EYWA team

15 partners
5 countries (~30M citizens)

National/International Roles as Reference Entities

Data Handling, Mosquito Surveillance & Control, Medical & Veterinary Medicine from all 5 countries:
BEYOND/NOA, ECODEV, LapUp, AUTH, UTH (GR)
IZSVe, FEM (IT)
UNSFA, UNSFM, NIV-NS (SRB)
KABS, BNITM (GER)
EID-Mediterranee (FR)

BEYOND/NOA: Crosscutting role for Big Data manipulation, standardisation, harmonization & storage.

Predictive modelling:
BEYOND/NOA, ECODEV, LapUp

System, Web Platform and mobile applications development:
BEYOND/NOA, i.D.Com, ECODEV, LapUp

EYWA engages 37 stakeholders globally up to now & has received **Letters of Support** from: Germany, Italy, Serbia, Greece, USA, Brazil & India

211 publications & more than 44,450 citations

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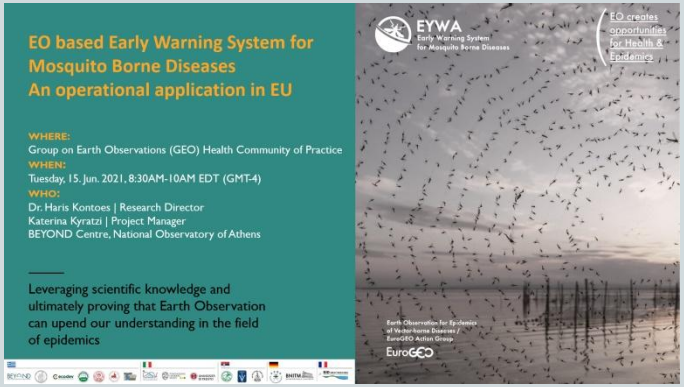
EYWA communication actions

Webinars hosted by EYWA:

- July 9th & 14th 2020 (three webinars) | European, local (Greece) and non-EU decision makers
- April 14th 2021 with more than 400 participants from around the world indicatively: Europe, USA, Mexico, Brazil, India, Azerbaijan, African countries and more, representing stakeholder groups namely: ESA, NASA, European Environment Agency, DG ECHO & DG Research & Innovation, WHO, Indian National Institute of Malaria Research, The Global Vector Hub, Nelson Mandela African institution of science & technology, National Public Health Institutes from many countries, mosquito control companies, universities and many more.

EYWA reaches out through participation in:

- GEO Health Community of Practice
- GEO & EUROGEO Symposiums
- GEO-CRADLE Initiative
- EO4GEO community



6 articles in local newspapers and magazines & TV

http://www.beyond-eocenter.eu/index.php/web-services/eywa#eywa-outreach

22 scientific publications of EYWA subcomponents and intermediate technological and research innovation **in peer reviewed journals**.

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EYWA communication actions

Openness in Partnership

EYWA shows openness, and partners and networks with key Institutions e.g. WHO, JRC, DG-ECHO, PACIFIC Disaster Center of Hawaii, Robert Koch Institute, Vector Control Research Centre (VCRC) of India, and others.

Collaboration with JRC & EC Institutions

Collaborates with officers from JRC and exchanges with the Civil Protection and Humanitarian Aid Operations (DG ECHO) Unit.

Interest has been reported to mutually develop, exploit and validate the delivered EYWA innovation concerning models and services to a broader context of pandemics.

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How EYWA competes

Open data
Free and open satellite Earth Observation and meteorological data

European technology
Copernicus Sentinels, CAMS, CLMS, CCS, CreoDIAS, GEOSS, Sentinels Greek Hub, Hellenic Mirror site

Automation
Streamlined and automated pipeline for EO, entomological, epidemiological and auxiliary data ingestion

Scalable
EYWA's generic models are designed to scale-up easily and were in pre-operational phase in 5 European regions

Transferable
EYWA's generic and site-specific models can be transferred in multiple geographic regions

Fully operational
EYWA is in successful operational use since April 2020 in Greece & Italy. From 2021 and onward, is aditionally operational in Serbia, Germany and France.

Reached the **Technology Readiness Level 8 9** in Greece, Italy, Serbia, Germany and France

"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"

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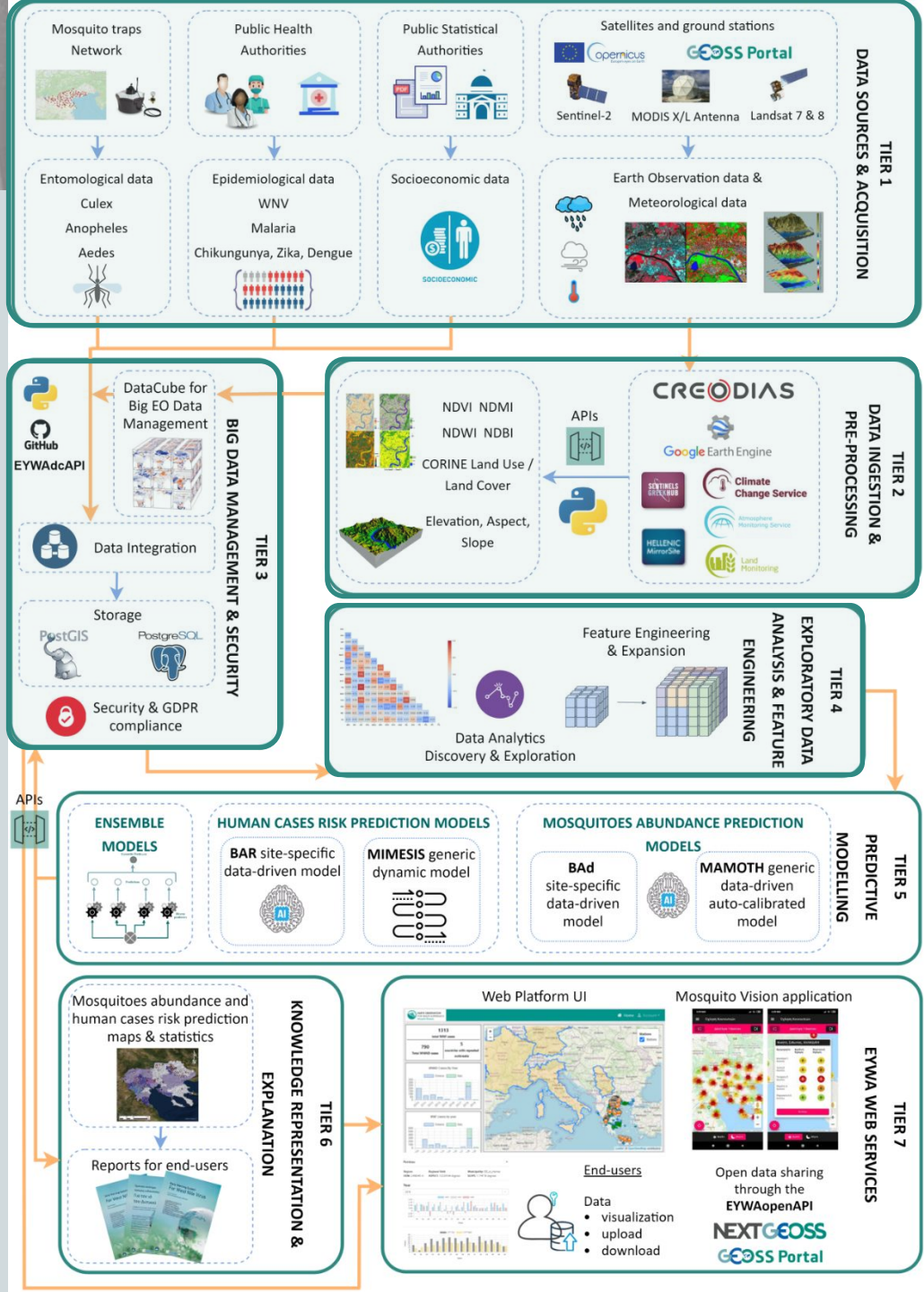
EYWA System Architecture

- Time-series of entomological, epidemiological, socio-economic, satellite Earth Observation, meteorological and geomorphological data
- A suite of APIs is developed and opened for automatic data harvesting, pre-processing and indices derivation.
- Big Data management (~300 TB and counting)
- Open Data Cube (ODC) technology
- Pre-processing scripts open and available through the "EYWAdcAPI" at [BEYOND-NOA's GitHub](#) profile in the [epidemics repository](#)
- A "mammoth" feature space of at least 10-years time-series of data for every mosquito-traps network in ten regions in Europe.

Data Opened
APIs Available in GitHub



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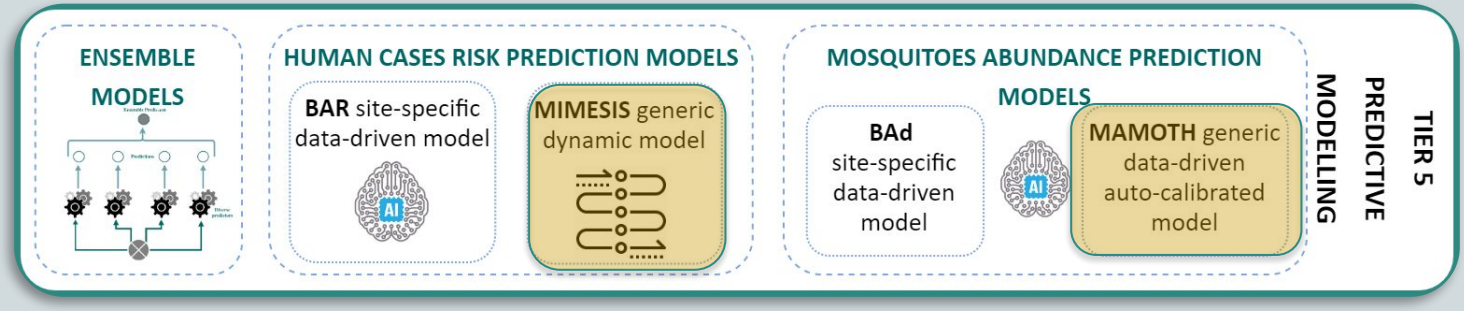
EYWA state-of-the-art Models

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.



MAMOTH(NOA)

- Data-driven ML (Gradient Boosting) model
- Auto-calibrated, generic, applicable to all landscapes
- Trap and off-trap level

MIMESIS(Uni of Patras)

- Climate-dependent epidemiological model(deterministic) operating in an ensemble (probabilistic) framework.
- Spatial-temporal scale: municipality, seasonal
- Climate forcing: ECMWF seasonal forecasts issued every month, hence MIMESIS forecasts are updated on a monthly basis.
- Model Outputs include infected mosquitoes, mosquito abundance, infected humans, risk, week of infection.

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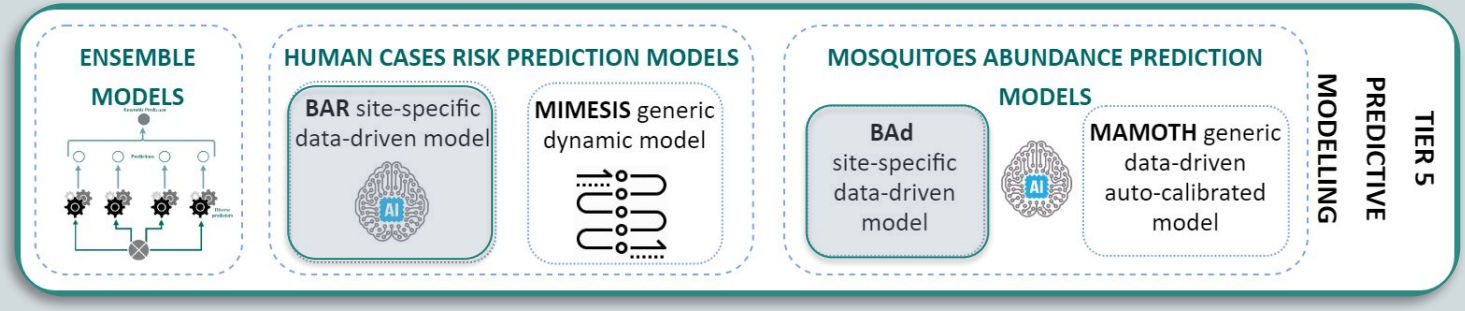

BAd(ECODEV)

- ❑ Data-driven ML (Neural Network) model
- ❑ High resolution, Site-specific
- ❑ Settlement level

BAR(ECODEV)

- ❑ Data-driven (Neural Network) model
- ❑ High resolution, Site-specific
- ❑ Settlement level

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EYWA 2021 Operational Statistics

2 years of evolution

Entomological data collected

- Greece
  - In a network of 178 mosquito traps, there was a total of 1642 samplings performed, resulting in more than 130K mosquitoes collected.
  - From the above samplings there were 48 cases of WNV detected.
- Italy
  - Culex: a network of 190 traps, 1035 samplings, collecting more than 88K mosquitoes collected.
  - Anopheles: 187 traps, 441 samplings, collecting more than 600 mosquitoes collected.
- Germany
  - Culex: 56 traps, 570 samplings, collecting more than 57K mosquitoes collected.

BAd/BAR stats

- BAd operational in Western Greece prefecture in 331 settlements (325 in 2020), in Thessaly in 217 settlements (no model operational in 2020), Crete in 833 settlements (820 in 2020) and in Central Macedonia in 1022 settlements (1040 settlements in 2020)
- BAR operational in Central Macedonia for a second year.

MAMOTH stats

- Predictions expanded to 4 countries (France, Germany, Italy, Serbia) from Italy in 2020.
- Predictions for 3 mosquito genus (Culex, Aedes, Anopheles)
- Two different approaches:
  - With entomological data: Second year of operations, TRL 8
  - Without entomological data: First year of experimental application, TRL 7

 2.675 predictions into total for all sites and all months

MIMESIS stats

- Continued operation for a second year in Italy and Greece, providing risk analysis for 5 different regions.

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EYWA 2021 Operational Statistics

Real world statistics from a wide range of regions.

MAMOTH(NOA) Operational Accuracy

On total 2.675 prediction points in six months operational period:

- With entomological:
  - mean error = 1.59
  - error ≤ 3 = 90.1 %
  - fail to Predict = 6.7 %
- Without entomological:
  - mean error = 2.26
  - error ≤ 3 = 72.4 %
  - fail to Predict = 42.1 %

	May	June	July	August	Sept	Oct	Total
Culex Italy	110	70	116	94	115	98	603
Culex Germany	85	51	45	102	55	95	433
Culex Serbia	123	123	122	123	37	122	650
Culex France	19	18	15	18	18	19	107
Aedes France	107	106	41	101	26	107	488
Anopheles Italy	93	106	129	28	27	11	394
Total	537	474	468	466	278	452	**2675**

*Predictions with using entomological data
*Predictions without using entomological data

BAd/BAR(ECODEV) model stats

Predictions for four regions in Greece:

- BAd model Mean Absolute Error = 1.55 mosquito classes (vs 3 in 2020)
- BAR model ROC_AUC = 93%, with Recall 44.5% (vs 51% in 2020, decrease due to fewer cases of WNV in 2021)

MIMESIS(Uni of Patras) model stats

- Average probability of detection exceeds 0.7

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EYWA System Architecture

TIER 6 KNOWLEDGE REPRESENTATION & EXPLANATION

Mosquitoes abundance and human cases risk prediction maps & statistics

Reports for end-users

TIER 7 EYWA WEB SERVICES

Web Platform UI

Mosquito Vision application

End-users

Data
- visualization
- upload
- download

Open data sharing through the **EYWAopenAPI**

NEXTGEOSS

GEOSS Portal

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

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

Thank you!

15 Partners | 5 Countries

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

Contact us

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