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Citizen science to investigate and control disease-carrying mosquitoes

A. Richter-Boix & Frederic Bartumeus

CSIC Consejo Superior de Investigaciones Científicas | CEAB exploring aquatic ecosystems

1st Symposium on Research and Innovation for the Control of Vectors of Emerging Arboviruses

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Why citizen science: the ubiquity of smartphones as an opportunity for mosquito surveillance

Citizens as sensors monitoring the presence and activity of mosquitoes in real-time with their personal observations. A supporting factor for citizens as sensors is the the high mobile phone penetration (67% of the world's population).

Citizen science encourage individuals to collect information on mosquitoes in their communities.

This also becomes a tool to raise the citizen awareness of mosquitoes and arboviruses.

- Scalability
- Real-time
- Flexibility
- Integrative (communities)
- Transparency
- Cost-effective
- Big data
- Scientific standards

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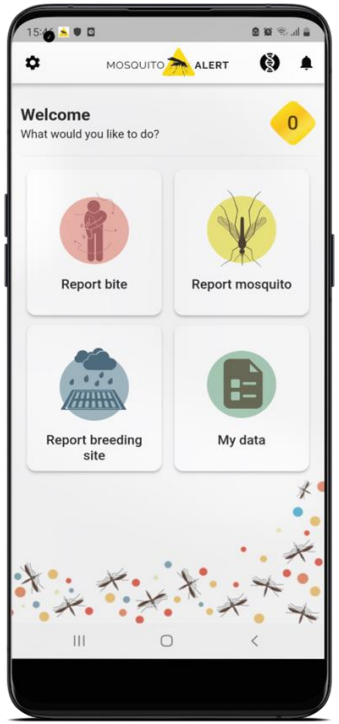
The Mosquito Alert app (data collection)



Google Play Store (Android)
Apple Store (iOS)

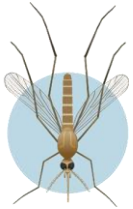
20 languages

Ae. albopictus

Ae. aegypti

Ae. japonicus

Ae. koreicus



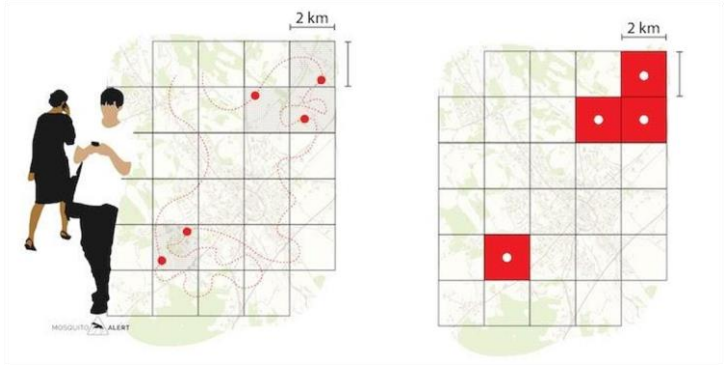
Culex pipiens

Report bite

Breeding sites

Collect samples

Notification system to communicate with participants



Background tracking system to estimate the sampling effort in a given area and time. Essential information to model the data.

The Mosquito Alert ecosystem

App Mosquito Alert

Citizens

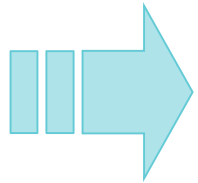
Technology development (Digital EntoLab, app, notification system, visualization of results)

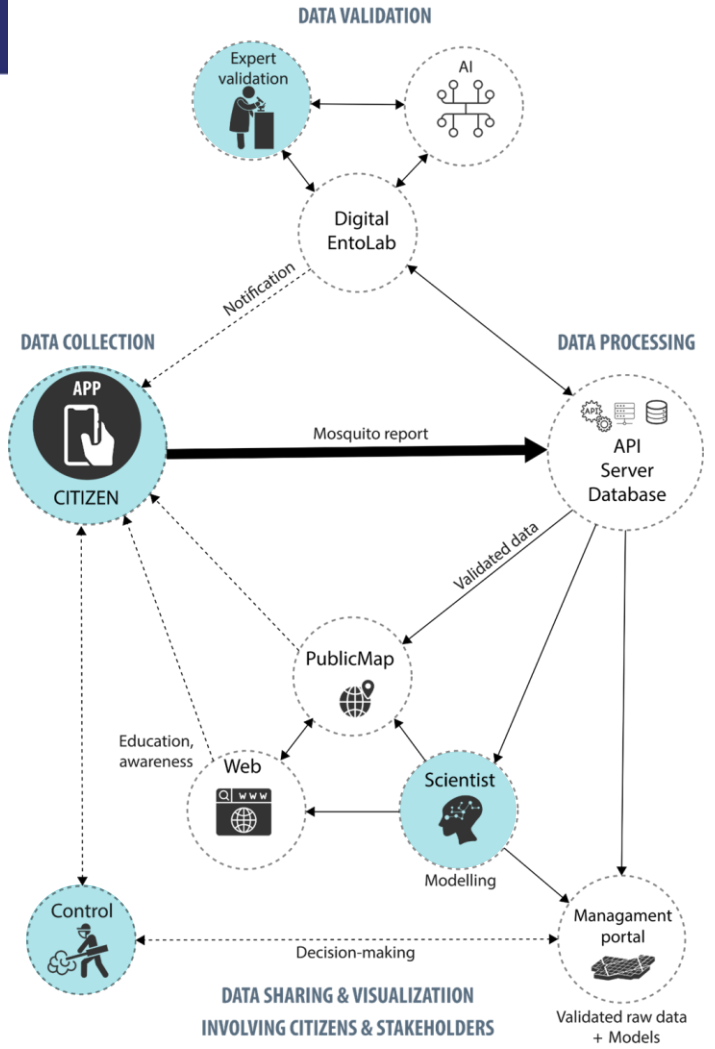
Experts in entomology, ecology, sociology, mathematics, computer science. Development of ecological and epidemiological models

Development of Artificial Intelligence that helps in the validation of mosquito reports

Communication channels (web, social networks, press releases, notifications)

Educational program for high schools





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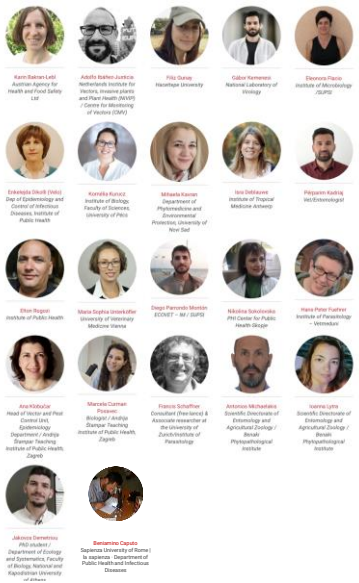
European Digital Entomology Network

MOSQUITO ALERT
Digital Entomology Network

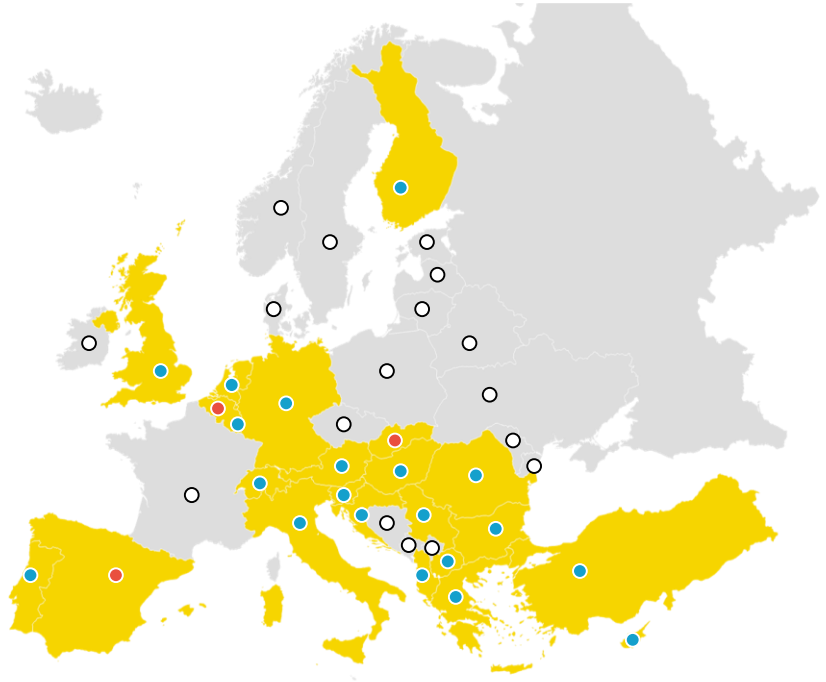
20 National Supervisor
62 Experts

* Validate mosquito reports
* Give feedback to participants
* Translation of the notifications
* Translation of the app
* Disseminate the project

AIM COST
EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY



Countries with National Supervisor & Experts



- Country with assigned National Supervisor (NS) (20)
- Country with experts but not NS (3)
- Country without experts and NS

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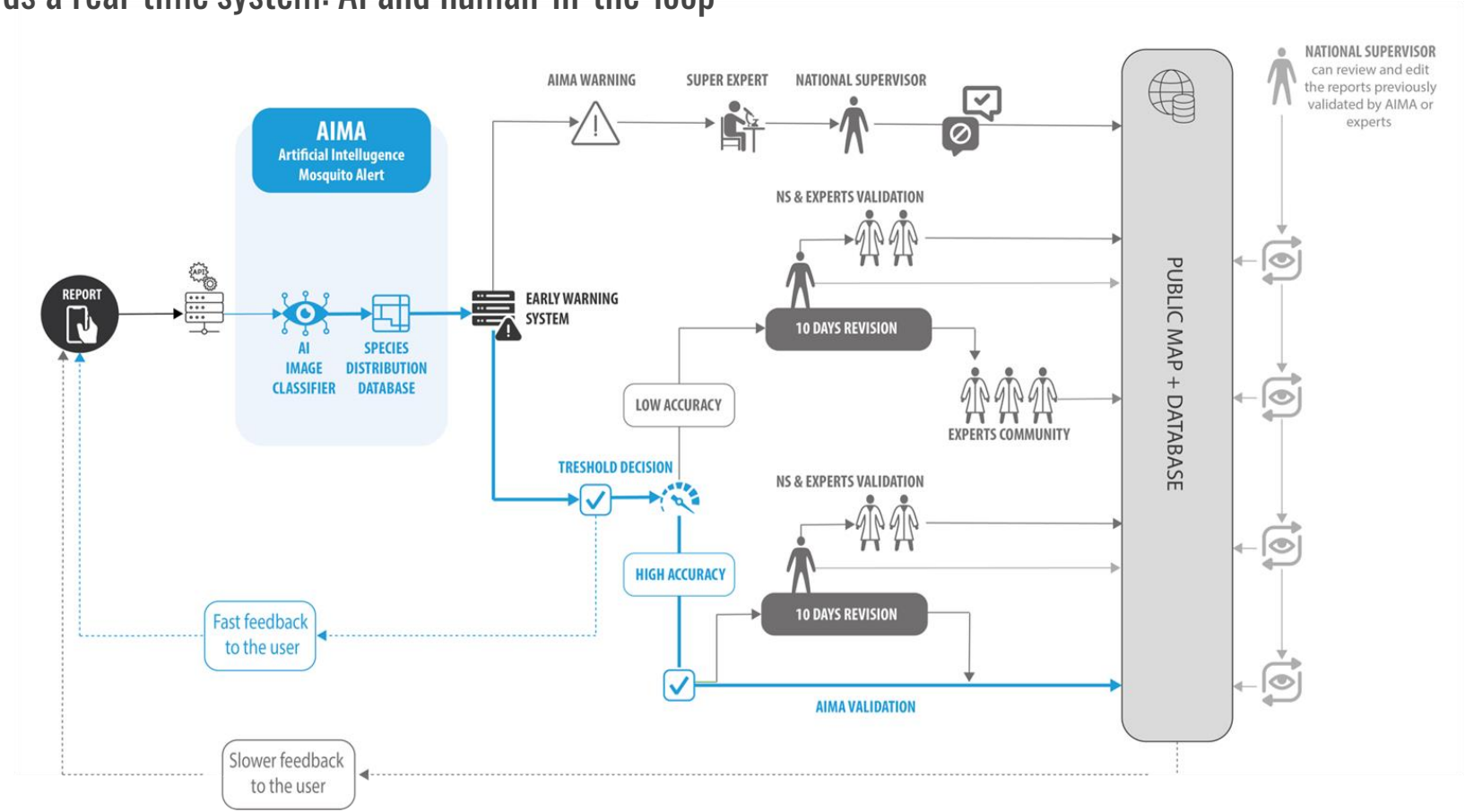
Towards a real-time system: AI and human-in-the-loop



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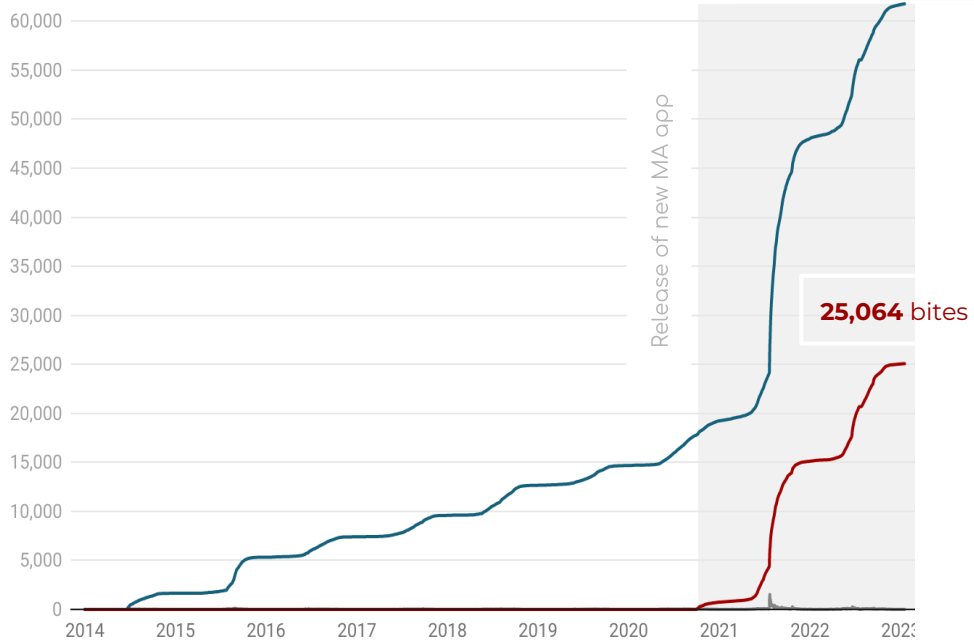
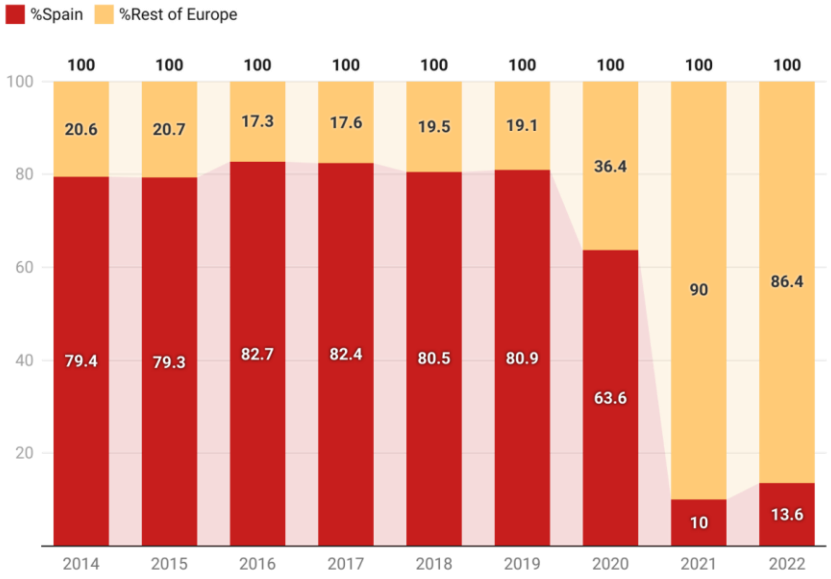
Surveillance with citizen science becomes European in 2020



Evolution of the percentage of mosquito reports from Spain and the rest of Europe. In 2021 and 2022 a greater number of countries contribute to the total of reports.



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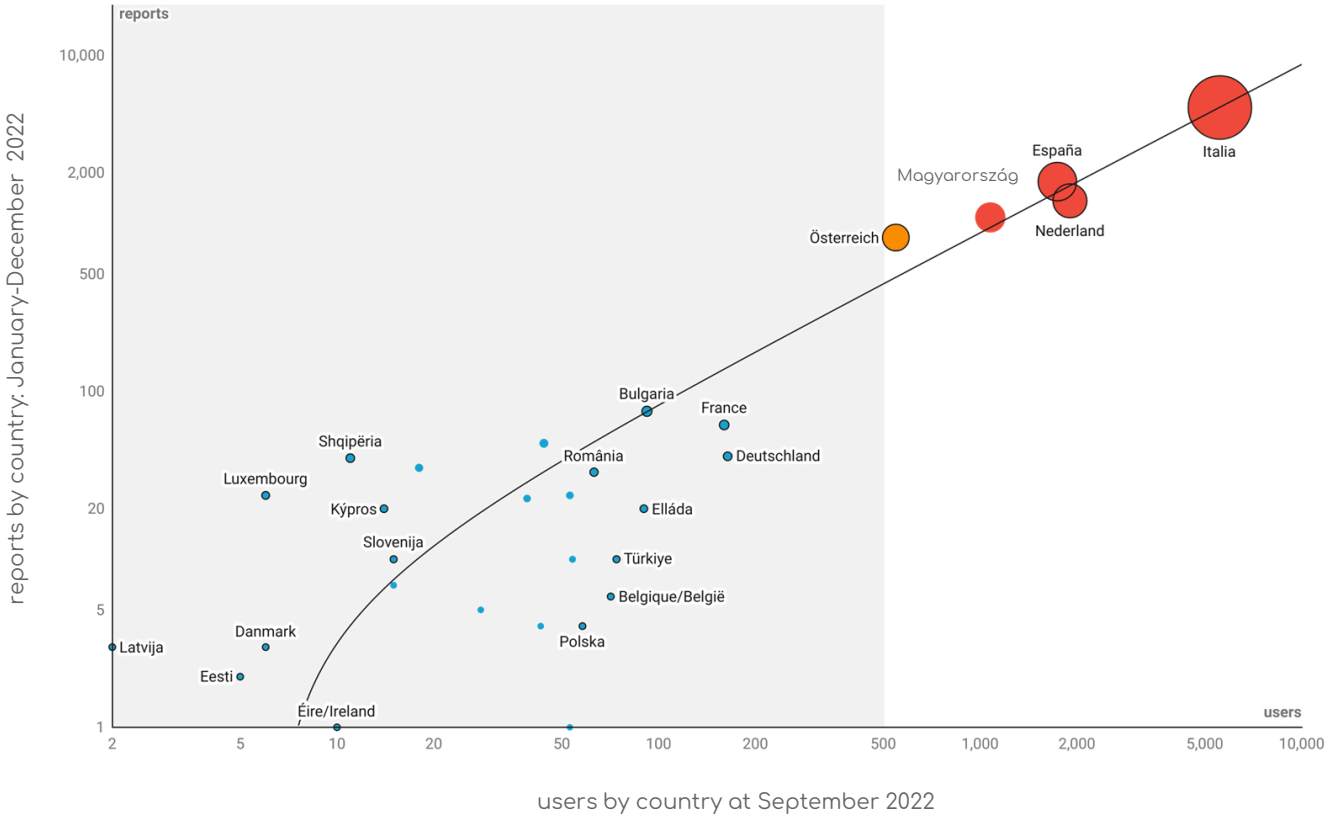
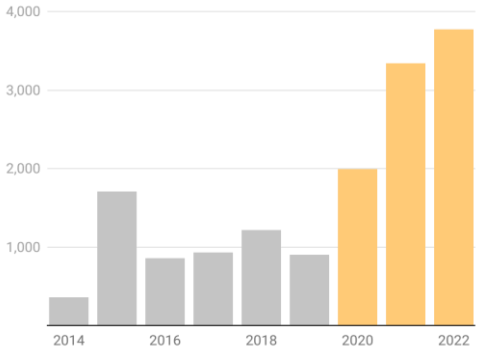
The greater the number of users, the greater the number of reports: 2022



Number of *Aedes* invasive mosquitoes reports by year



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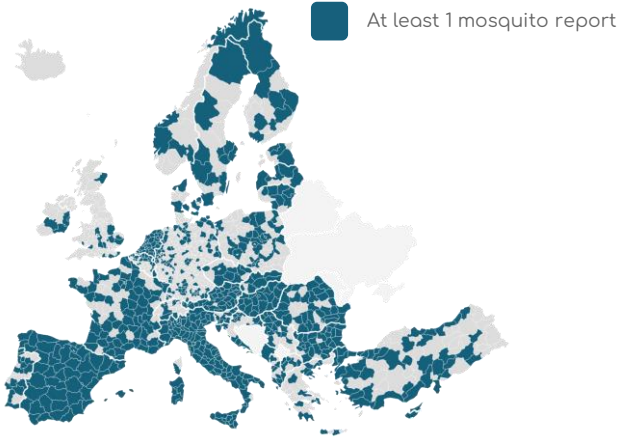
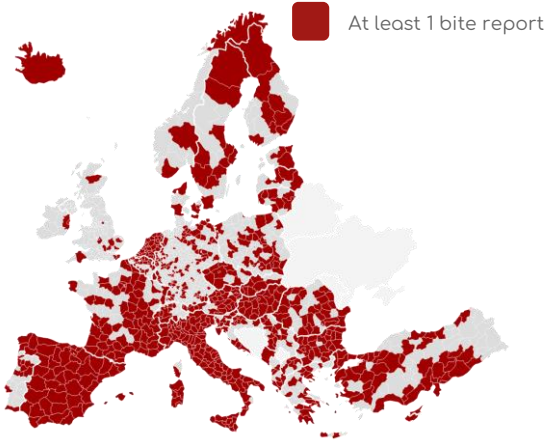
SPATIAL COVERAGE 2020 - 2022

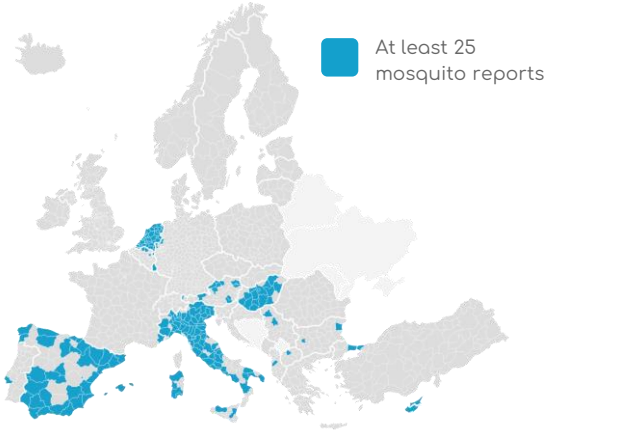
NUTs 3 in which at least one mosquito or bite report has been received during this period.

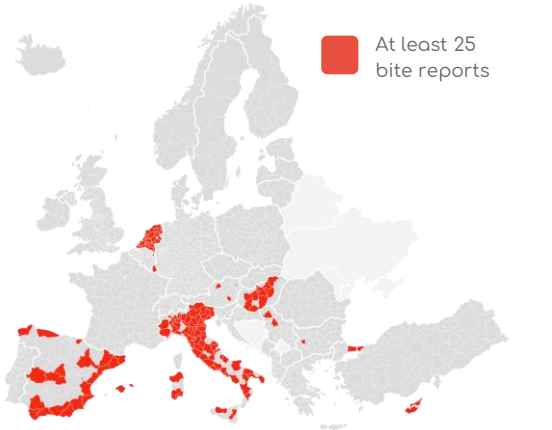
- 5,670 municipalities 1 mosquito report
- 4,144 municipalities 1 bite report

NUTs 3 in which there has been a greater participation. In these geographic units, at least 25 reports of mosquitoes or bites have been received.









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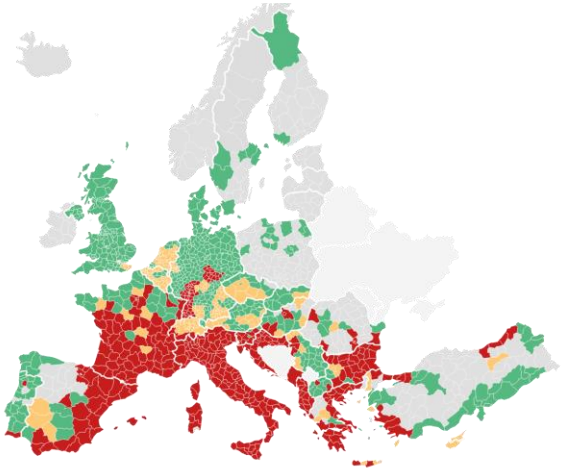
DETECTION OF *Aedes albopictus* WITH CITIZEN SCIENCE AT NUT3 LEVEL

AIMSurv (AIM-COST)
Citizen science (2020-2022)

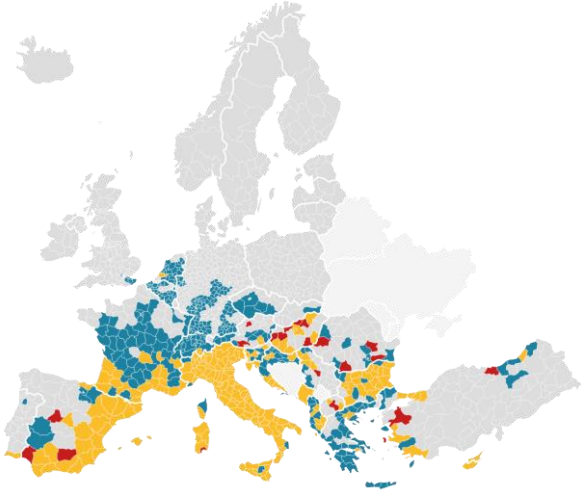
Detection with MA (AIM-COST)

ECDC
Modified from ECDC March 2022 + Cyprus



Established
Introduced
Absent

Spatial coincidences between AIMSurv citizen science and ECDC



Only MA
ECDC + MA
ECDC

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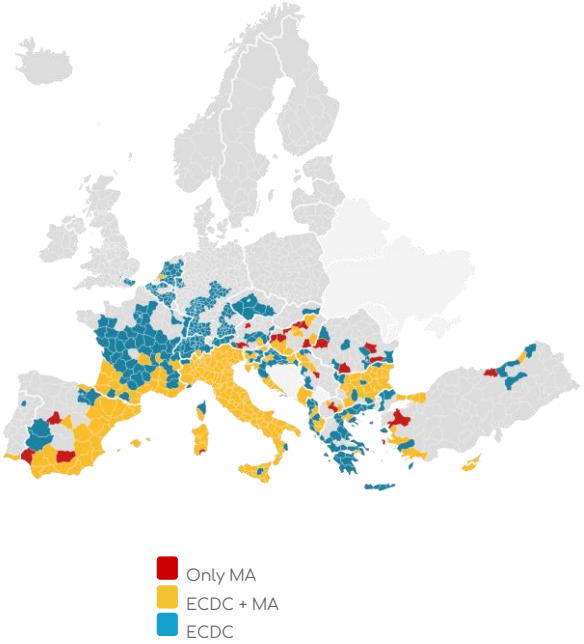
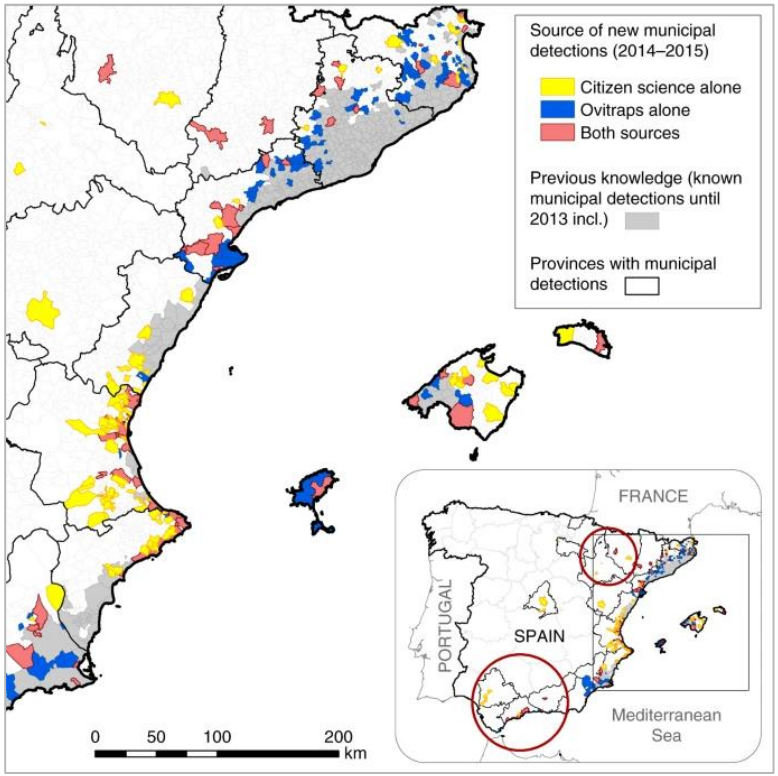
CITIZEN SCIENCE DETECTION TEND TO BE FARTHER FROM THE KNOWN INVASION AREAS THAN TRADITIONAL SURVEILLANCE METHODS DETECTIONS

Spatial coincidences between AIMSurv citizen science and ECDC





nature COMMUNICATIONS

ARTICLE

DOI: 10.1038/s41467-017-00914-9 OPEN

Citizen science provides a reliable and scalable tool to track disease-carrying mosquitoes

John R.B. Palmer[1,2,3], Aitana Oltra[1,3], Francisco Collantes[4], Juan Antonio Delgado[4], Javier Lucientes[5], Sarah Delacour[5], Mikel Bengoa[5], Roger Eritja[3] & Frederic Bartumeus[1,3,6]

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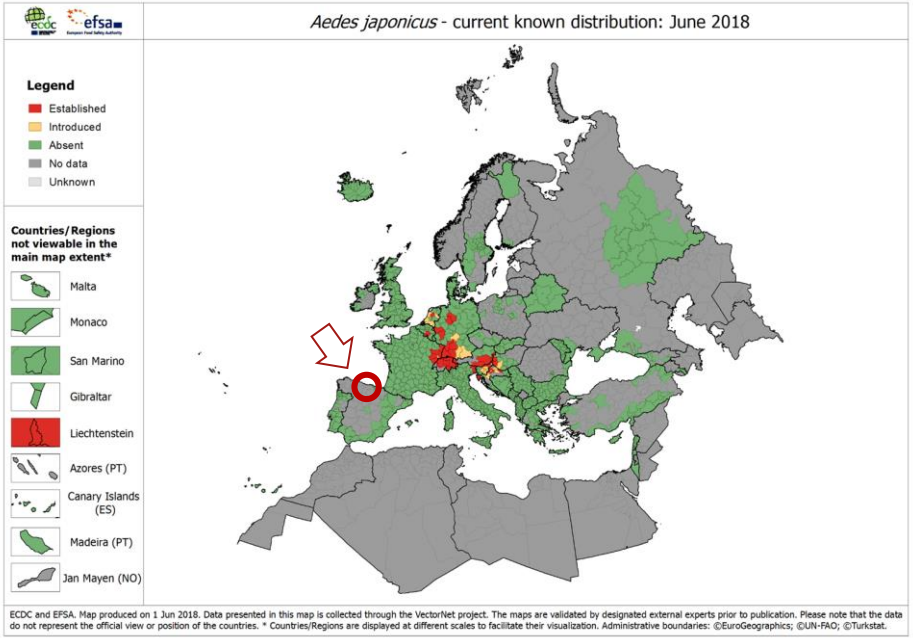
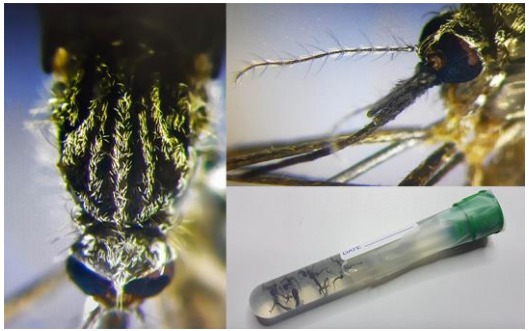
CITIZEN SCIENCE EARLY DETECTION OF INVASIVE SPECIES IN UNEXPECTED LOCATIONS



At **earlier June 2018** Mosquito Alert received a photo of a suspicious mosquito resembling *Aedes japonicus* from the north of Spain. Field inspections corroborated the presence of *Aedes japonicus* in Asturias (Spain)




Parasites & Vectors
RESEARCH
Open Access
First detection of *Aedes japonicus* in Spain: an unexpected finding triggered by citizen science


Parasites & Vectors
RESEARCH
Open Access
At the tip of an iceberg: citizen science and active surveillance collaborating to broaden the known distribution of *Aedes japonicus* in Spain

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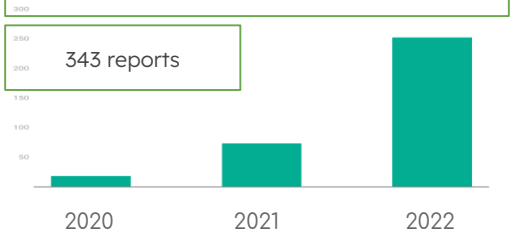
DETECTION OF *Aedes japonicus* & *Aedes koreicus* WITH CITIZEN SCIENCE AT NUT3 LEVEL

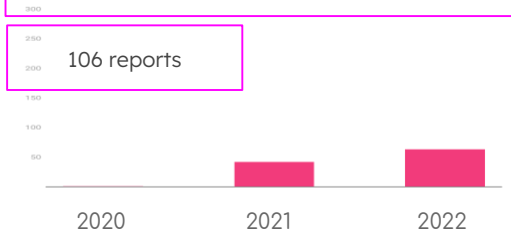
Aedes japonicus (2020-22)

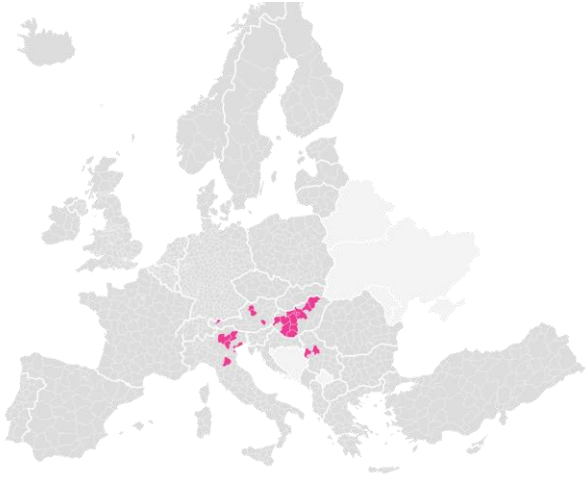
343 reports



complex *japonicus/koreicus* (2020-22)

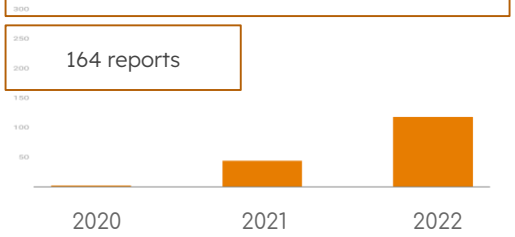
106 reports





Aedes koreicus (2020-22)

164 reports



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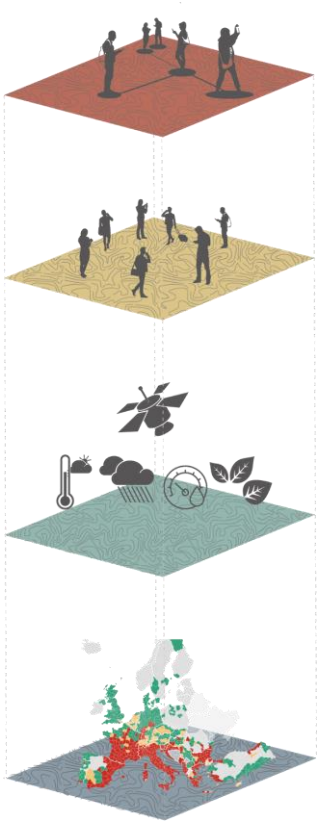
ENCOUNTER PROBABILITY OF MOSQUITO SPECIES (MONTHLY UPDATED)

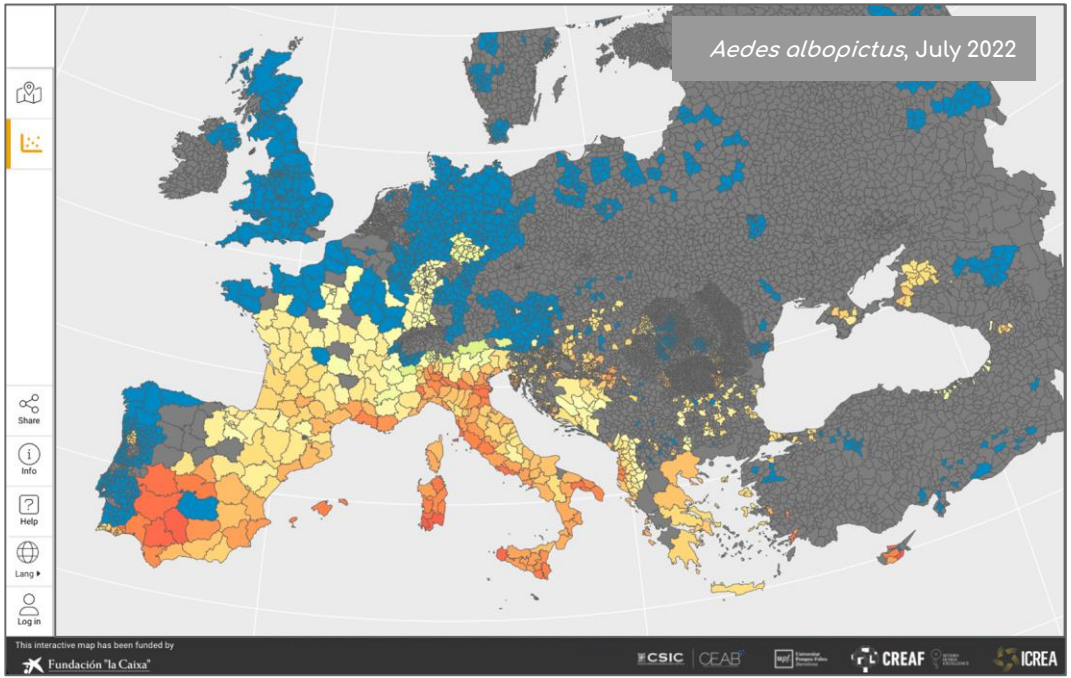


Mosquito species reports

Sampling effort and algorithmic bias (app changes)

ERA5 variables: temperature, precipitation, relative humidity, leaf area index

Species known range (ECDC + citizen science)



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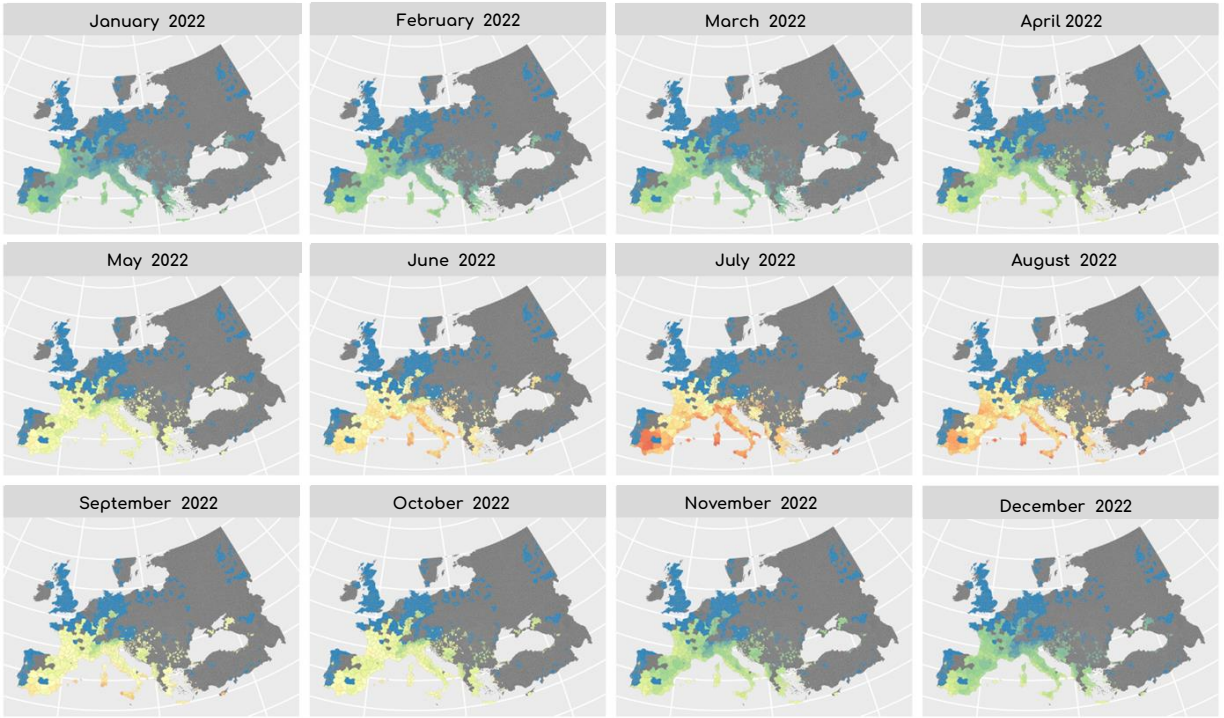
ENCOUNTER PROBABILITY OF MOSQUITO SPECIES (MONTHLY UPDATED)

Aedes albopictus, Monthly 2022



Probability of encountering tiger mosquito in a given month during 2022.

The probabilities are estimated on the species known range, citizen science data controlled for sampling effort, and ERA5 variables (temperature, precipitation, relative humidity, and leaf area index)

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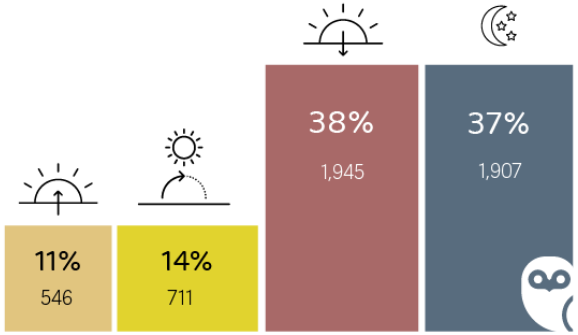
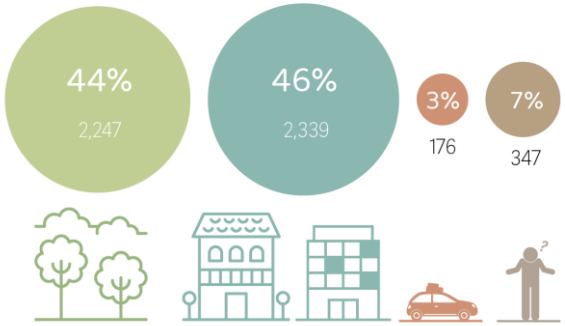
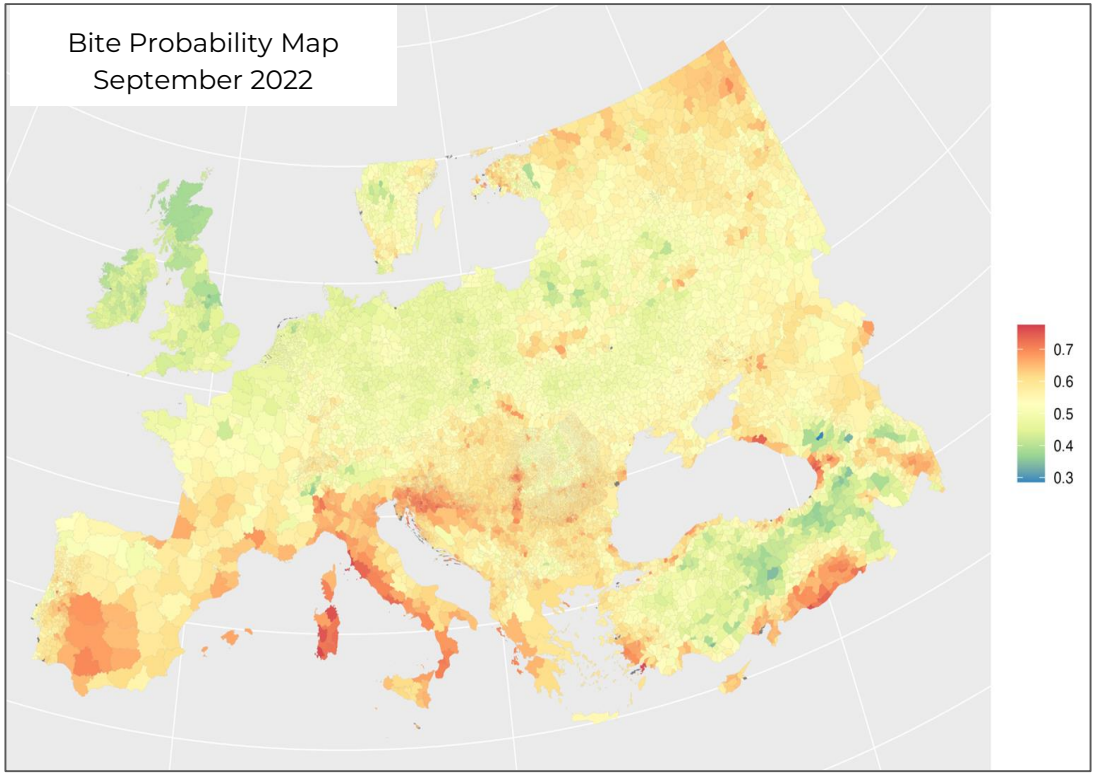
NUISANCE/BITES: WHEN, HOW AND AT WHAT TIME?

Human-mosquito interaction in July 2022
Time of the day and place of the interaction







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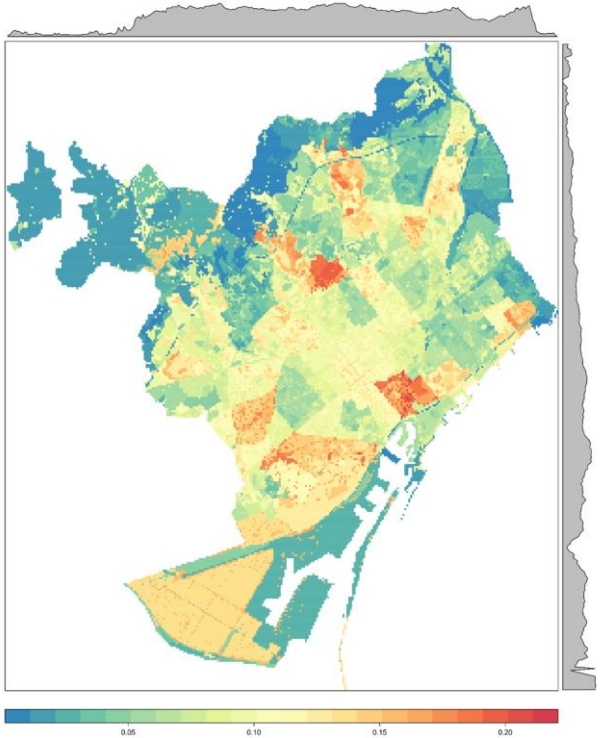
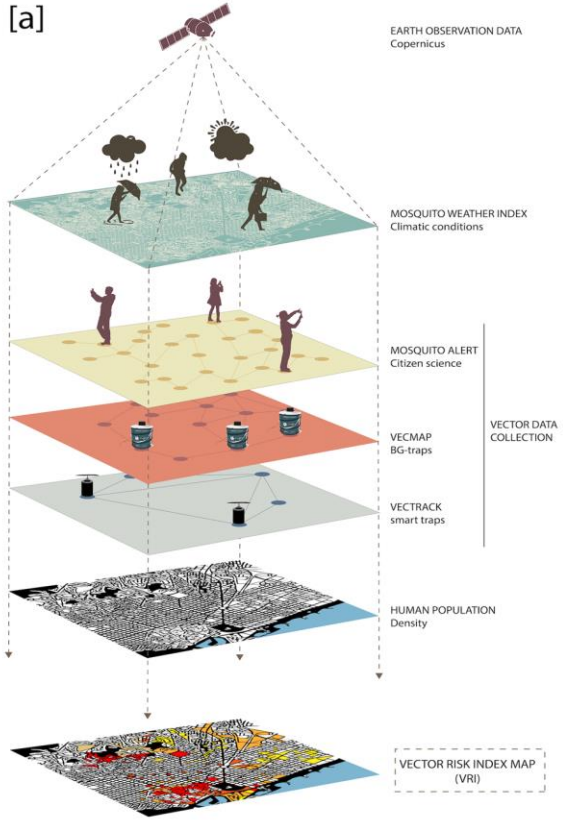
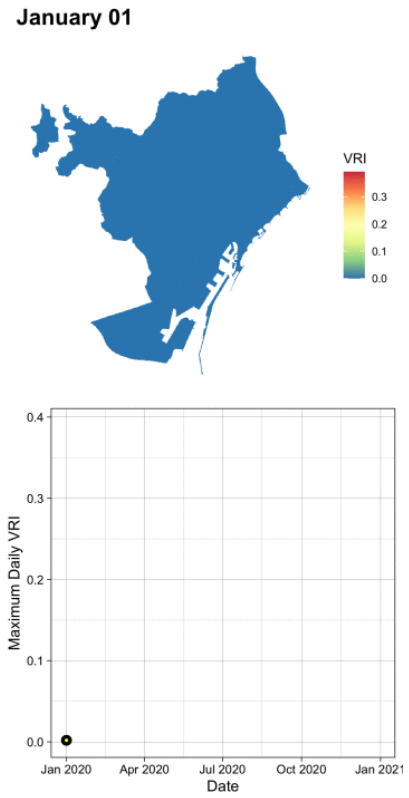
"SMART" CITY: MULTI-SOURCE MODEL ESTIMATES AND FORECATS OF MOSQUITO EXPOSURE







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MOSQUITO ALERT

MOSQUITO ALERT is a citizen science project coordinated by: