Defining Ecoregions and Prototyping on EO-based Vector-borne Disease Surveillance System for North Africa (PROVNA)

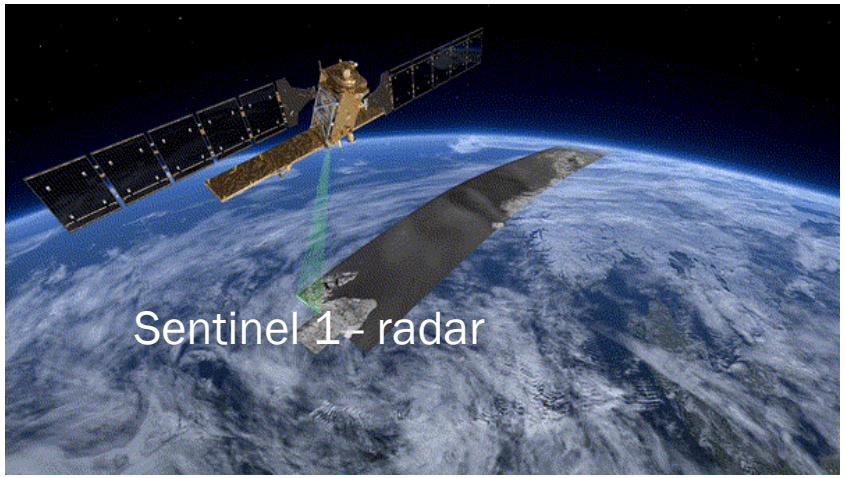
- IZS-Teramo - WOAH Collaborating Center for Epidemiology
- WOAH Office North Africa in Tunis

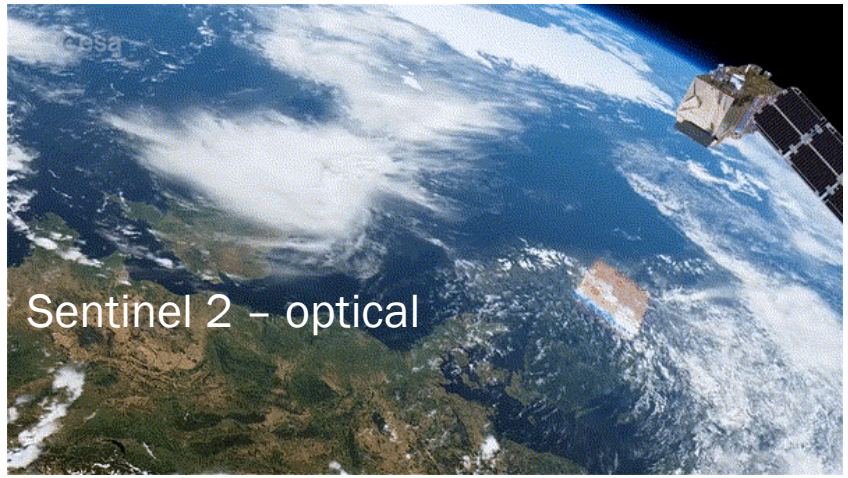
Laura AMATO

MediLabSecure Final Meeting – 13 June 2024

Earth Observation

→ Dense time series of data (with frequent passages of satellites) over large and inaccessible geographical areas





EO provides:

- **Accurate** geo-locations for contiguous target areas;
- **Objective** and consistent measurements on a large variety of spatial resolutions;
- **Repeated** coverage, enabling detection of changes in features and/or their condition

Ecoregions and ecoregionalization

Ecoregions have been defined as areas “within which there are associations of interacting biotic and abiotic features”.

Ecoregionalization is the process through which a territory is classified into **similar areas** according to specific **environmental** and **climatic** factors.

The climate and the environment strongly influence the presence and distribution of vectors responsible for significant human and animal diseases worldwide.

→ It is then useful to develop a map of similar eco-climatic regions adopting a **data-driven spatial clustering approach** using recent and detailed spatial data on climatic and environmental factors.

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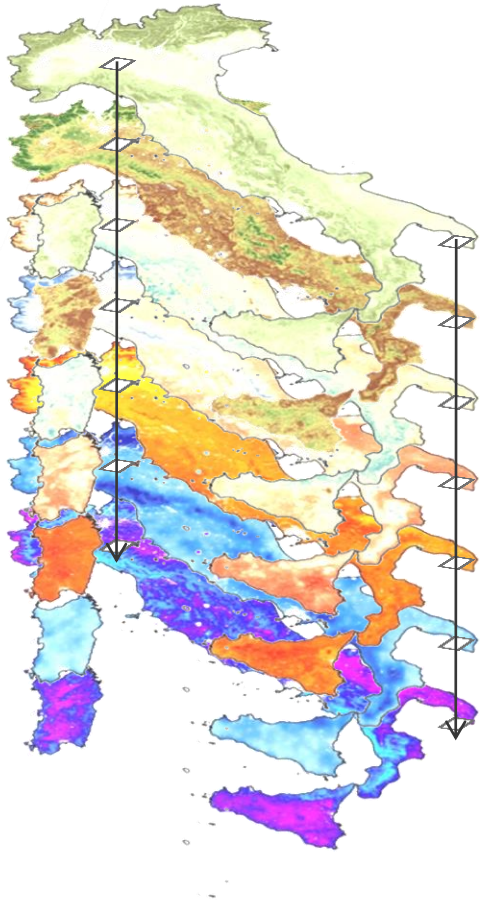
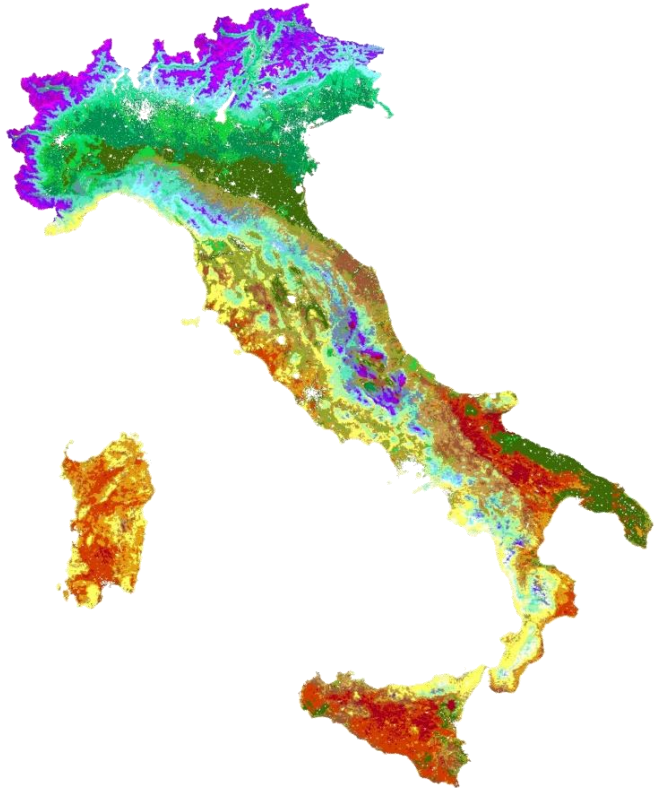
Ecoregions

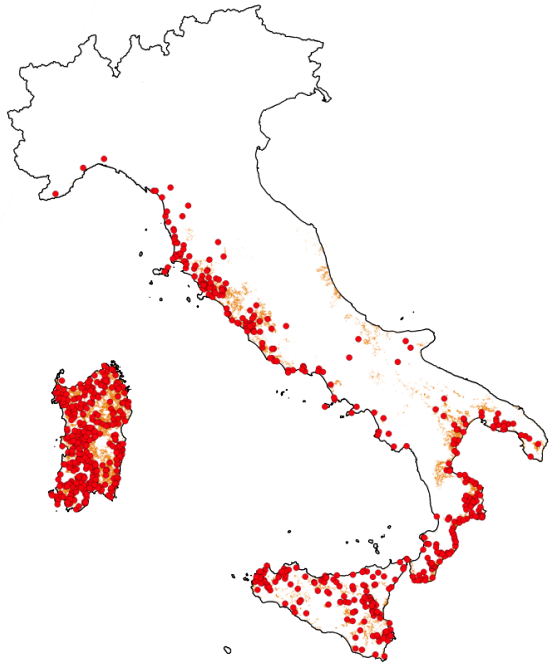




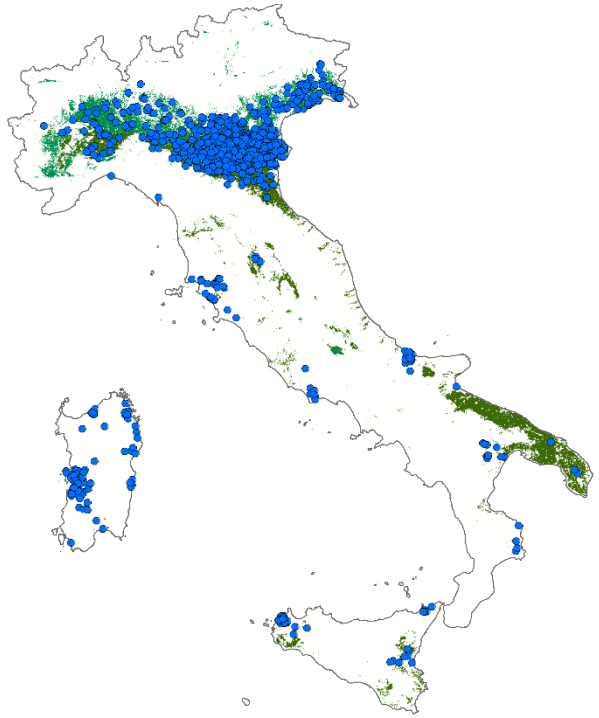
Ippoliti et al. 2019, PLoS ONE, https://doi.org/10.1371/journal.pone.0219072

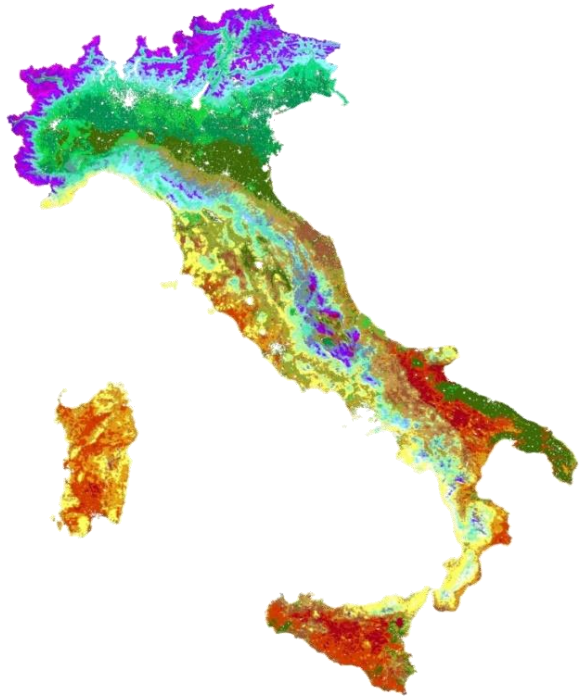
Ecoregions

C. imicola



WNV circulation





Compared the resulting ecoregion maps with two datasets related to Bluetongue vectors and West Nile Disease (WND) outbreaks in Italy.

Ippoliti et al. 2019, PLoS ONE, https://doi.org/10.1371/journal.pone.0219072

PROVNA – Objectives

- To **define the "ecoregions" of the North African territory** (Mauritania, Morocco, Algeria, Tunisia, Libya and Egypt), characterized by distinct environmental and climatic factors, **on the assumption that similar areas** (in space and / or time) **are subject to similar diseases** (especially vector-borne diseases);

- To build a **customised prototype application** (PROVNA) in the North Africa region for monitoring vector-borne diseases

What for

PROVNA will support North African Veterinary Services with:

- Risk based surveillance
- Early warning systems
- Assessment of risks of VBD introduction and persistence

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Study area

Target disease

The disease selected for the project is
Rift Valley Fever (RVF)

Among the vector borne diseases, RVF is one of the most important zoonoses currently present in countries bordering Europe and has potential for globalization.

The distribution of specific RVF vectors and other potential vectors is largely unknown. Therefore if the virus is introduced into RVF free areas, suitable environmental conditions can trigger a new transmission cycle or sustained endemicity.

Project phases

26/04/2022

Phase 1. Definition of the requirements

Activity 1.1: literature review
Activity 1.2: definition of EO data
Activity 1.3: definition of system architecture and statistical analysis

Phase 2: EO data preparation

Activity 2.1: Data retrieval
Activity 2.2: Manipulation and processing of EO data

Phase 3: Statistical model/analyses

Activity 3.1: Super SOM (Unsupervised Neural Network)

Phase 4: Ecoregion map evaluation/validation/application and prototype development

Activity 4.1: disease data/risk areas and ecoregions comparison
Activity 4.2: Web Based Prototype Application Development

Phase 5: Communication and dissemination

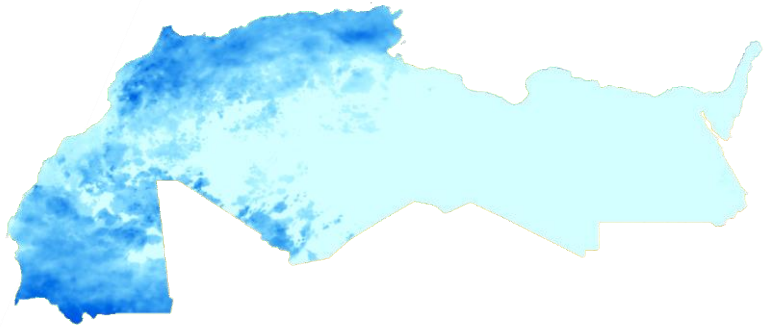
31/06/2024

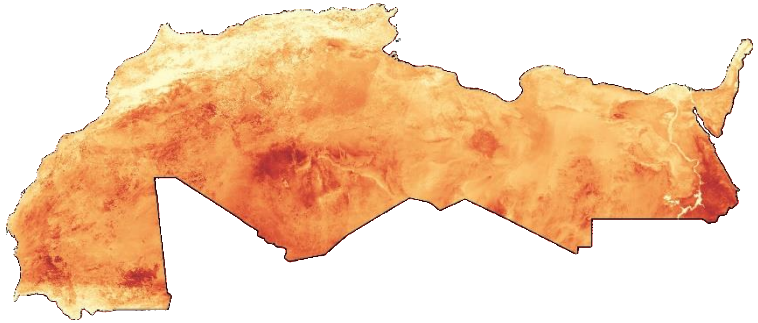
ECOREGIONALIZATION in North Africa

Selected Earth Observation data (2018-2022)

Rainfall

250 mt spatial resolution
16 days temporal resolution

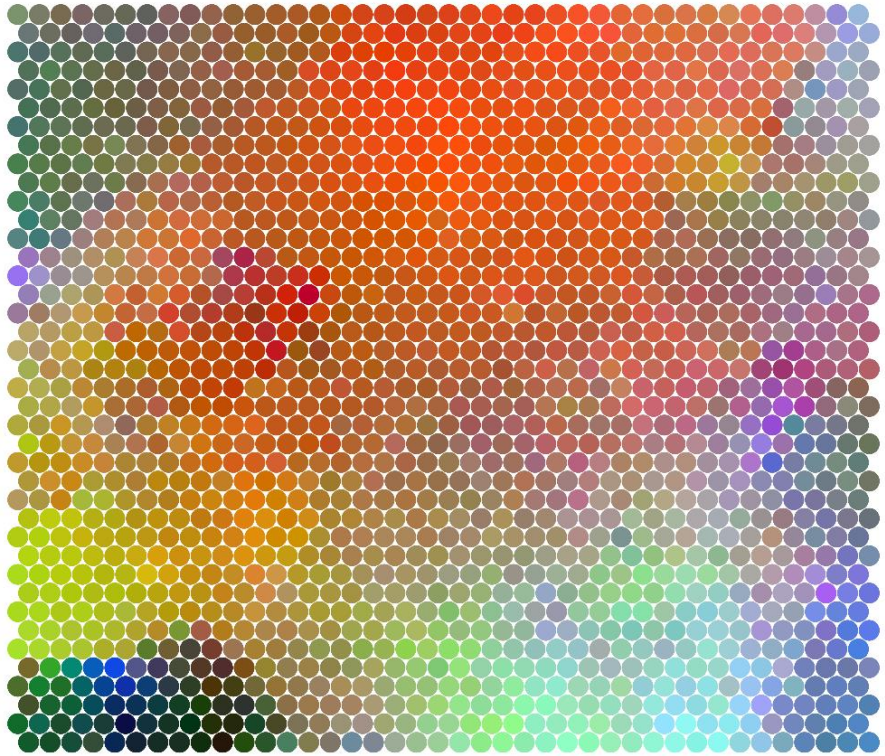


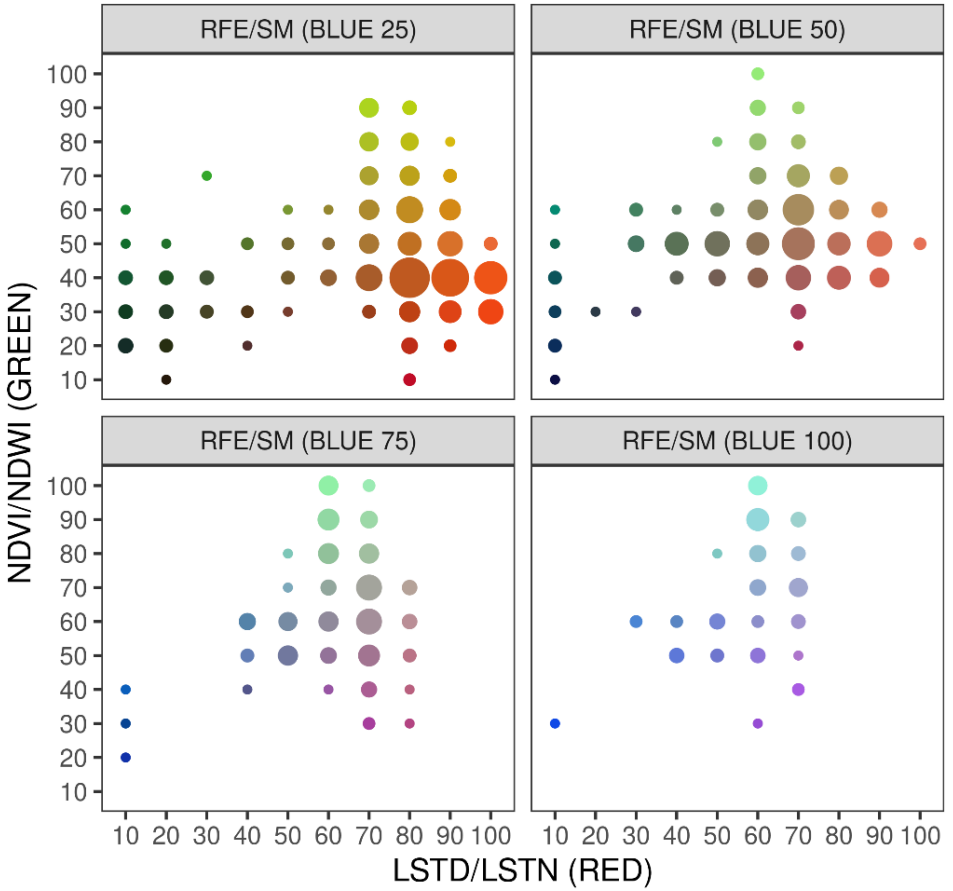


- Land Surface Temperature Day and Night - LSTD and LSTN,
- Normalised Difference Vegetation Index - NDVI,
- Soil Moisture - SM,
- Normalised Difference Water Index - NDWI,
- Rainfall - RF

- Collected
- Aggregated
- Standardised at a seasonal/year level

Self Organizing Maps (SOM)– Model result



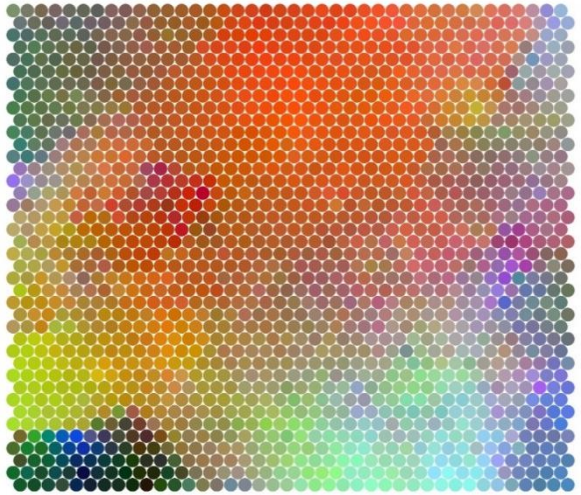


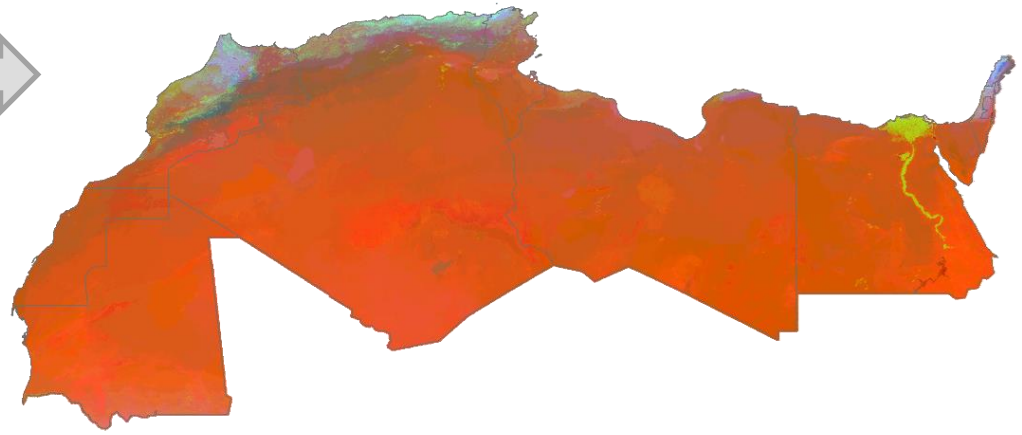
Self Organizing Maps – Model result (left) and colors' meaning for the underlying variables (right)

ECOREGIONALIZATION in North Africa

- The study area has been classified into ecoregions, defined as zones "*within which there are similar ecological and climatic areas with interacting biotic and abiotic features*".

- The results of the SOM were applied to obtain a usable and interpretable topology-preserving map.





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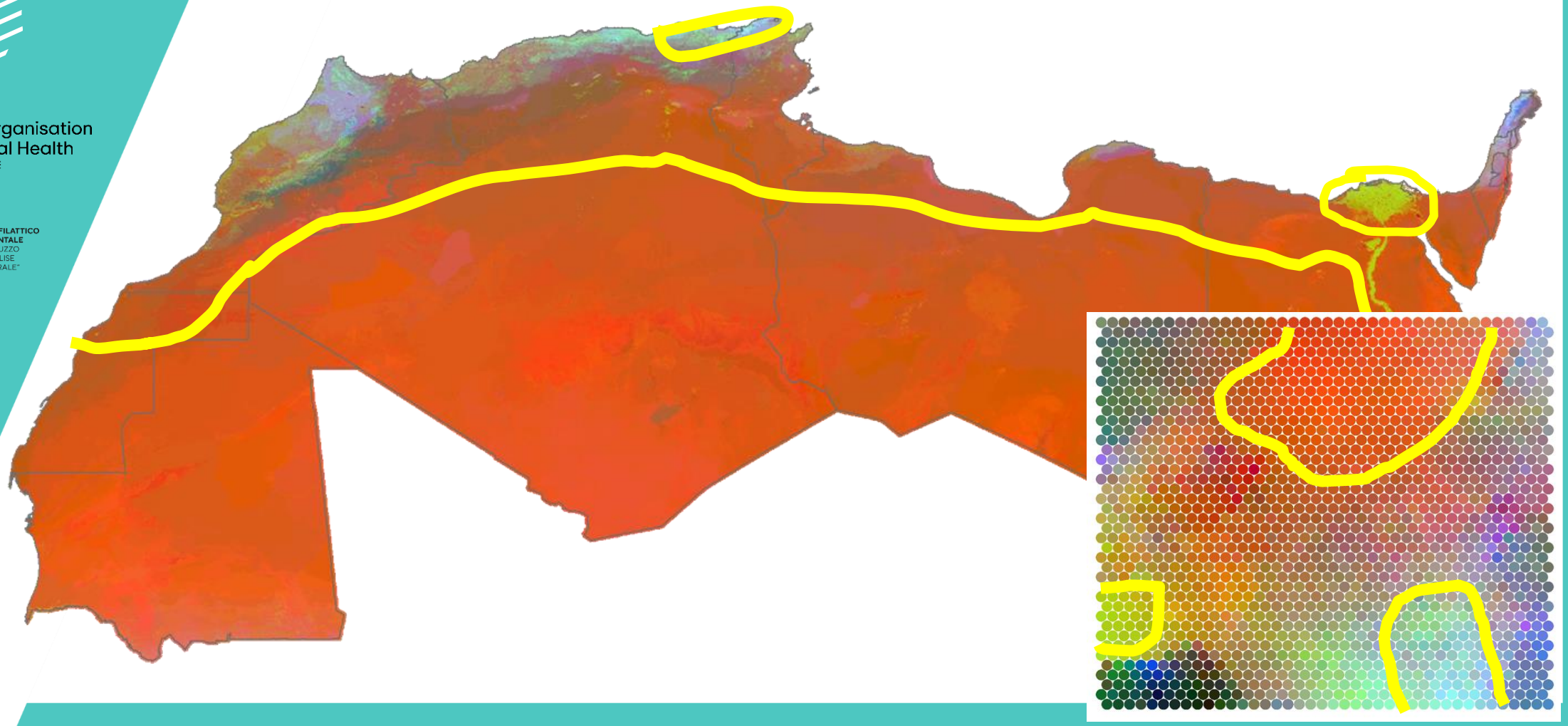
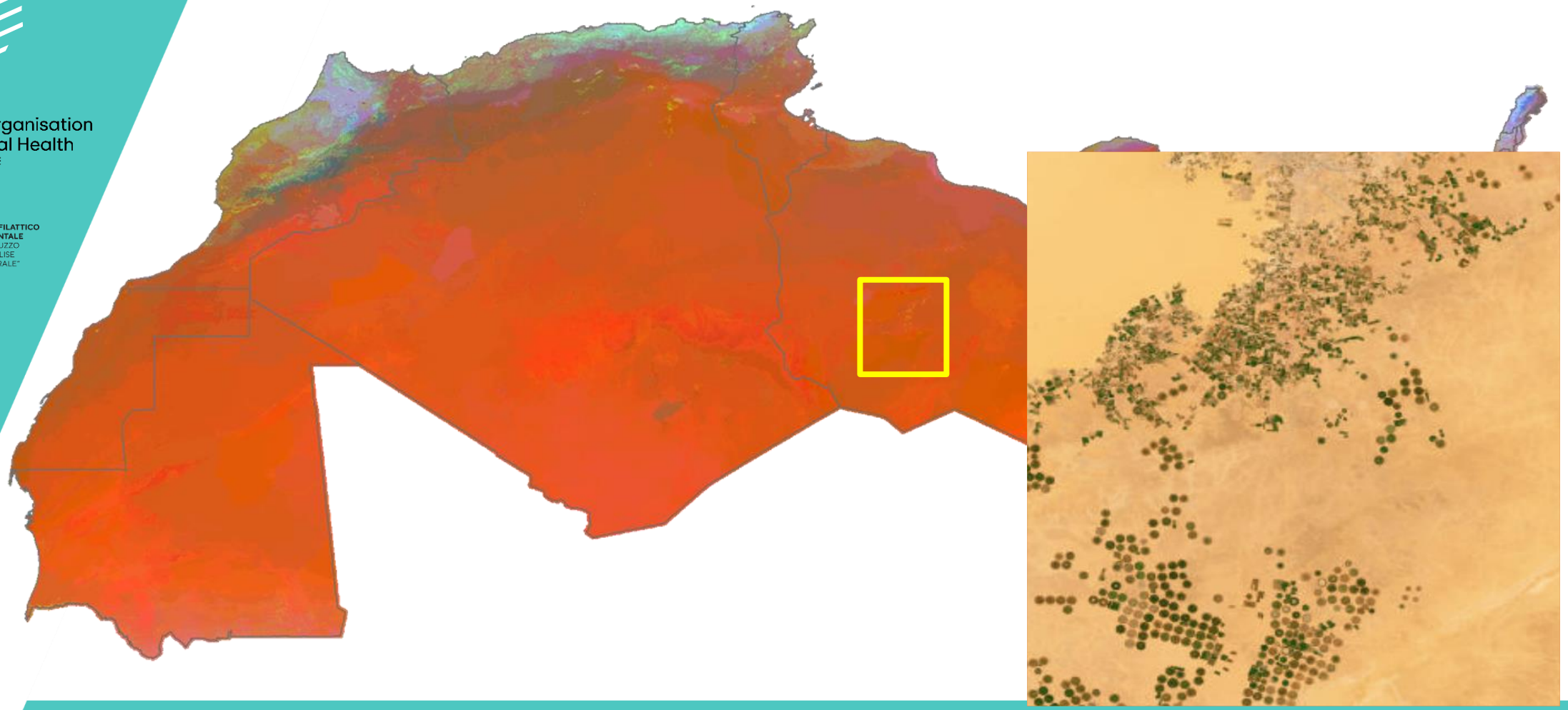
ECOREGIONALIZATION in North Africa



ECOREGIONALIZATION in North Africa



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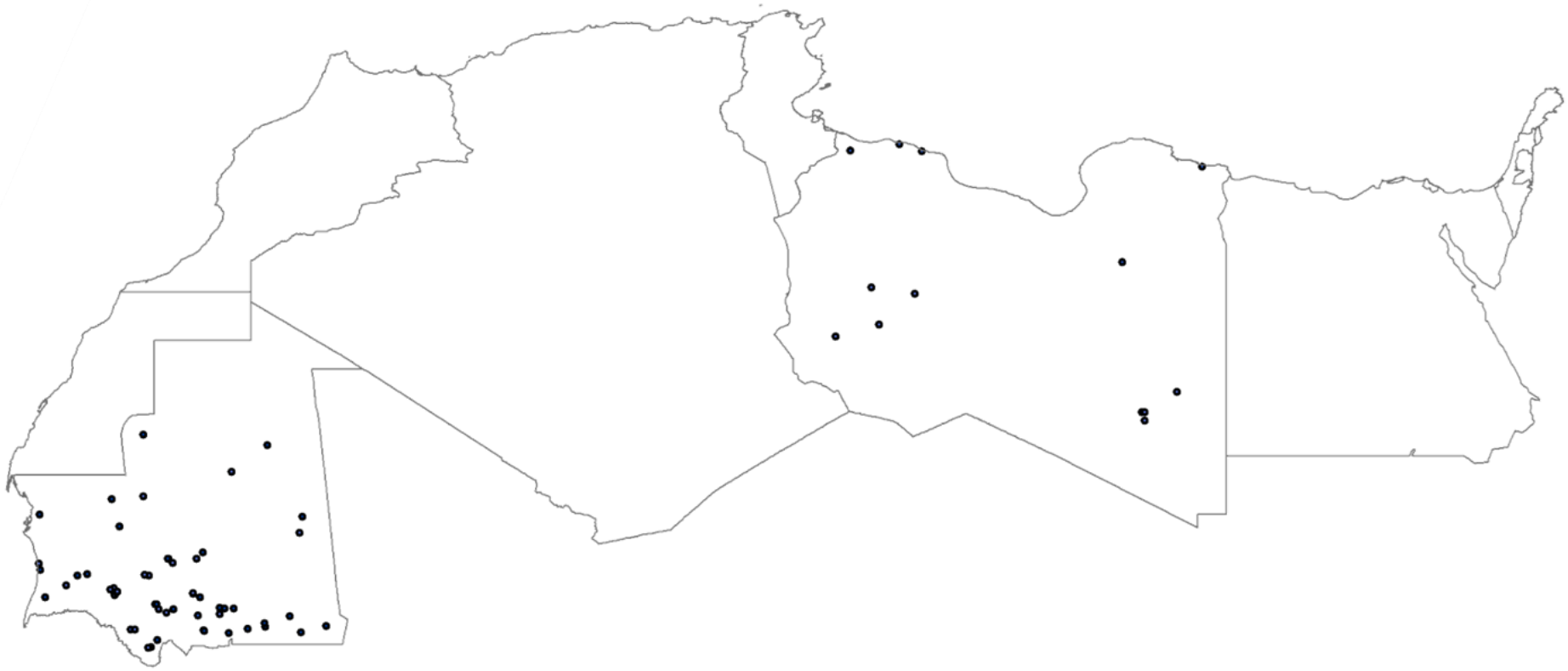
APPLICATION of ECOREGIONS in North Africa

RVF outbreaks 2018-2022
(WOAH, FAO, WHO)



Preliminary outcomes

Preliminary outcomes have been shared with the national competent authorities:

- **Surveillance activities** carried out by the countries have been discussed during two webinars.
- Bilateral meetings are in progress, two hours each, investigating and **discussing the ecoregions** of specific countries with their representatives.
- A **face-to-face workshop** is planned for early July.

What next for ECOREGIONS in North Africa

1. To be fully investigated, we should better define the level of similarity/difference between ecoregions with the help of Countries

2. Integrate field data for vector-borne diseases to better test and compare with, where possible

3. PROVNA phase 2

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Conclusion

Through the application of **innovative approaches** in the use and analysis of EO data, PROVNA can provide relevant **support to the Veterinary Services in implementing and/or improving risk-based targeted surveillance of VBDs**, optimising financial and human resources through strategic planning.

→ WOAH's approach to a **common regional strategy for vector-borne and transboundary animal disease** control would also be fulfilled.

PROVNA phase 2

Given the work done, it is now crucial to combine the decision-making tools based on eco-regionalization with data from in-field surveillance.

This step is essential to strengthen the capacity of the National Veterinary Authorities to effectively **monitor, predict, prepare for and respond to diseases.**

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Thank you

Questions?

IZS-Teramo

- Annamaria Conte
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- Carla Ippoliti
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- Valentina Zenobio
- Paolo Calistri
- Alessandro Ripani

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- Rachid Bouguedour
- Chadia Wannous