



Toward an integrated approach to address LSLA processes

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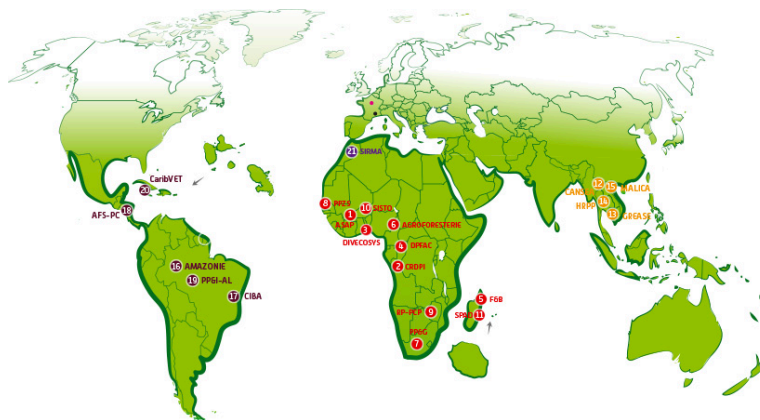


4th Open Science Meeting of the Global Land Programme
April 24-26, 2019 | Bern, Switzerland

● CIRAD



The French agricultural research and international cooperation organization working for the sustainable development of tropical and Mediterranean regions.



Research and training platforms in partnership worldwide (<http://www.cirad.fr/en>)

● TETIS



Territories, Environment, Remote Sensing & Spatial Information

A Joint Research Unit, with teams from:



• Large Scale Land Acquisitions

- **Large Scale Land Acquisitions (LSLAs)** by private companies or states have seen a sudden increase in recent years
 - increase in demand for biofuel
 - increase in food demand
- Questions about **production models, people's rights, resource governance**
- Root of **conflicts** with local populations

Global scale LSLA-related initiatives exist...

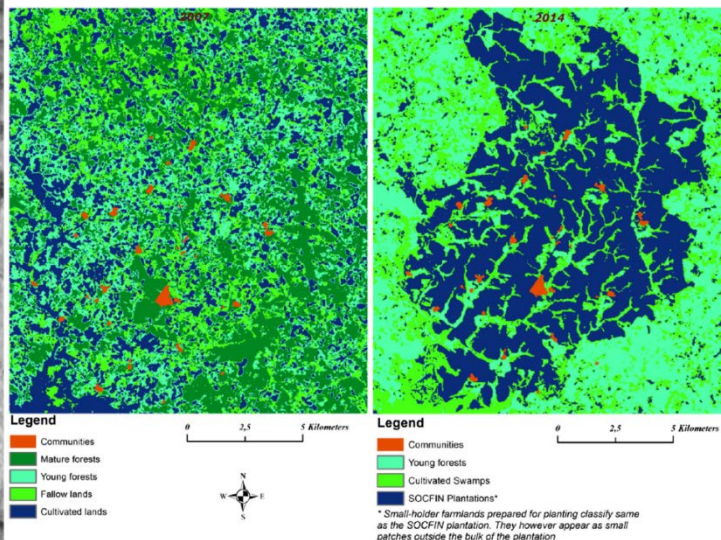


...but their data is often based on sources which may be incomplete or strongly biased (press articles, government data, individual contributions, scientific publications).

• LSLA in literature

Remote Sensing approaches

- Some specific **case studies** at local scale (focusing on impacts)
- Studies at larger scale on **land conversion** (Brazil, China) but not specifically on LSLA
- Or **focused on a given process** (e.g. Deforestation for agriculture)
- **Less studies on the specific process of LSLA**
- **Lack of Data Mining/Machine Learning** approaches specifically dealing with LSLAs



Yengoh et al., 2016

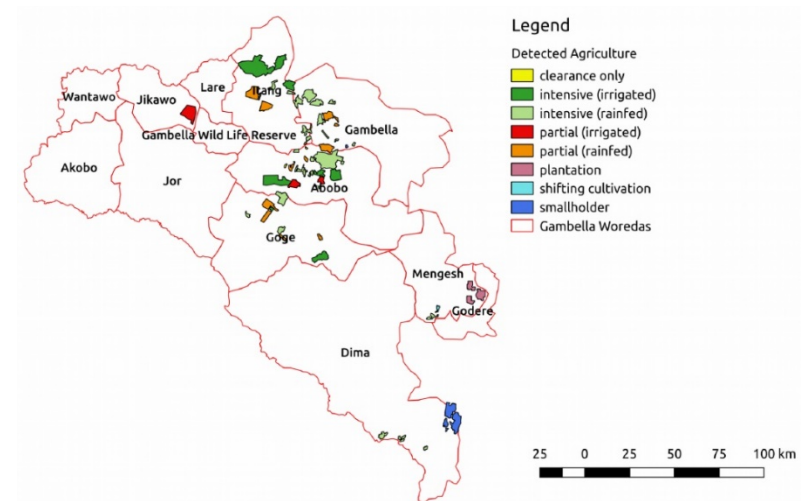


Figure 5. Map of detected agricultural production areas, grouped by estimated type, based on the analysis of 2015-6 Sentinel-1 and Sentinel-2 image composites.

Lemoine et al., 2017

• Ongoing challenges regarding LSLA

How to detect LSLAs at country scale ?

- What are the **different types** of LSLA ?
- How to **automatically detect** LSLA presence ?
- How to **follow LSLA dynamics** through time?



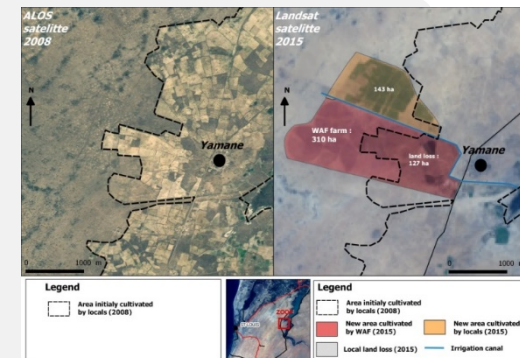
How to characterize detected LSLAs ?

- What are the **spatial footprints** ?
- How to **determine agricultural type**?
- How to **follow investment productivity**?



How to assess their impacts on the territory ?

- What are **the neighboring effects**?
- What are the **consequences of LSLA on rural development**?
- How to measure their **environmental impact**?



• VISAGE Project (2019-2021)

« Towards the detection and characterization of Large Scale Land Acquisitions for agro-industry with multisource satellite remote sensing in Senegal »



SENEGALESE INSTITUTE FOR
AGRICULTURAL RESEARCH



TETIS & AIDA RESEARCH
TEAMS

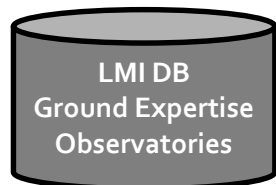


LAND MATRIX INITIATIVE

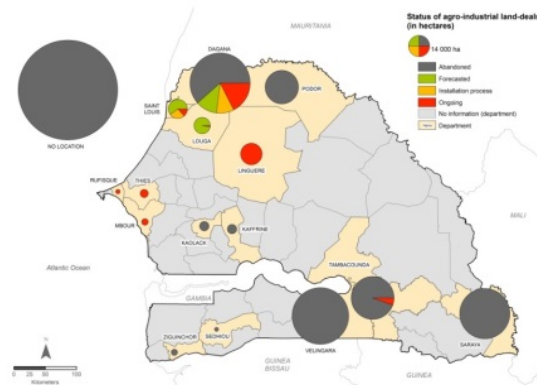
AN INTEGRATED APPROACH:

- **MULTISOURCE** and **MULTISCALE**
- From **DETECTION** at national scale to **CHARACTERIZATION** at local scale
- With a focus on the **IMPACTS** of LSLA on physical and socio-economic environment
- **INTEGRATING** Remote Sensing, Data Science and Spatial Modeling techniques

• Case study: LSLAs in Senegal



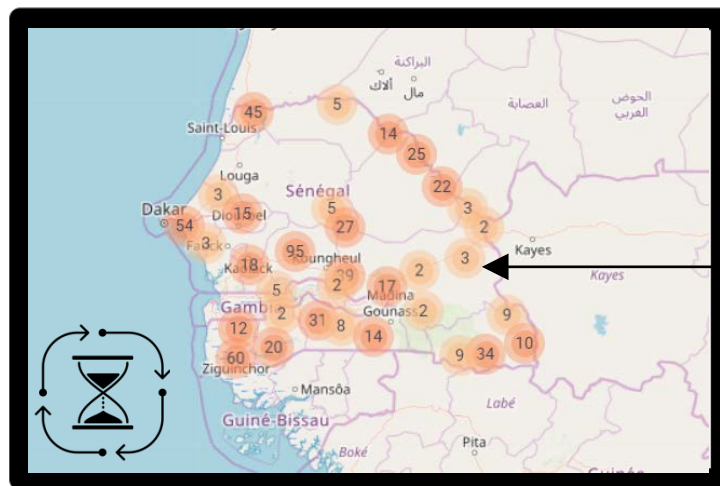
Need to overcome **weak representation** of deals



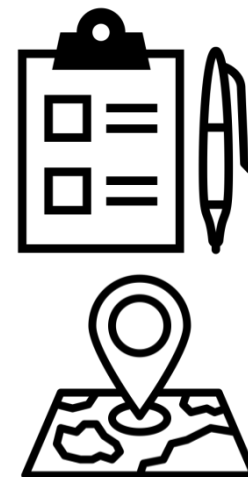
2019 National Data Campaign

Work in progress in
all 45 departments

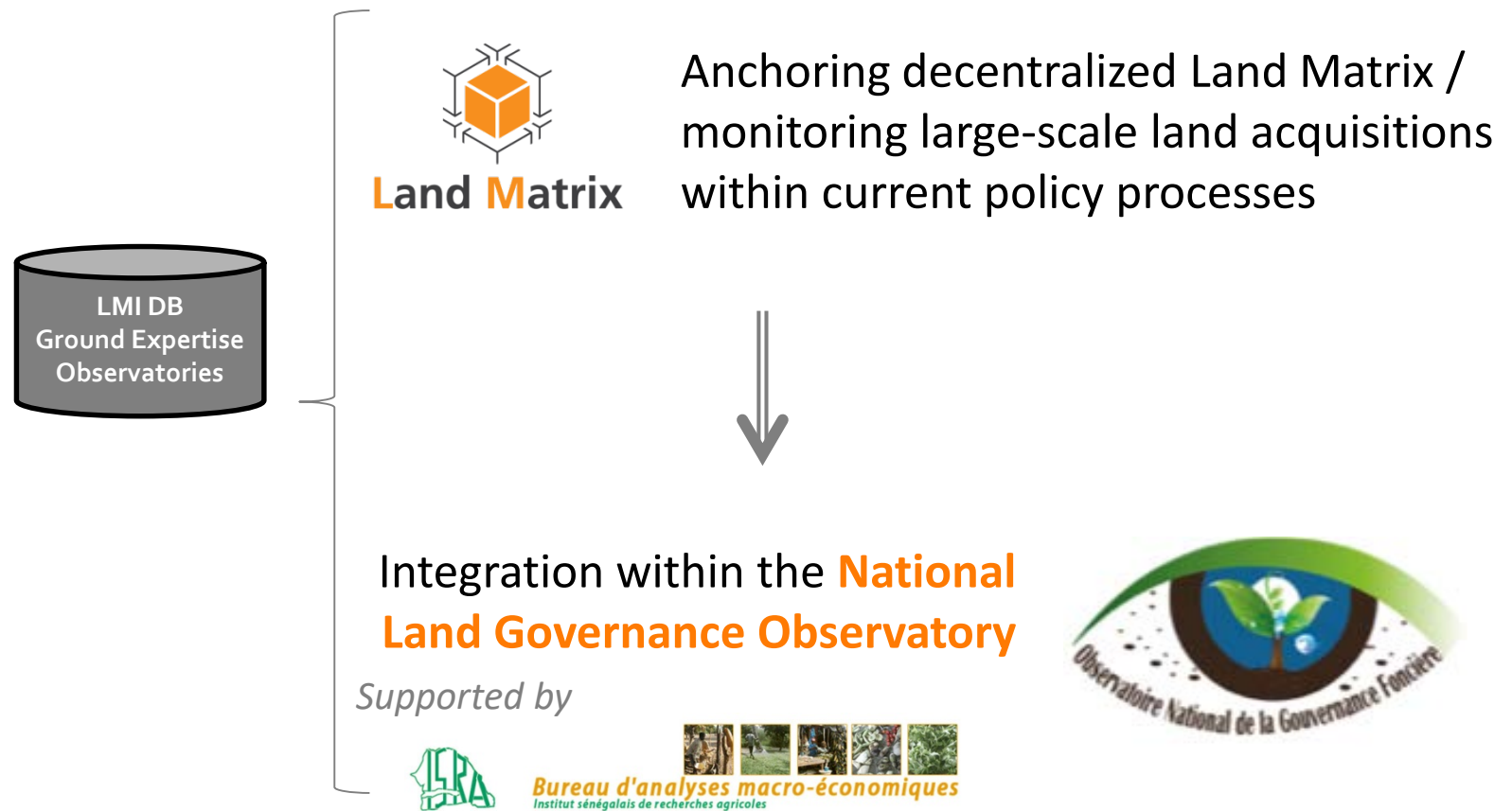
Until now,
> **600 land deals**
identified



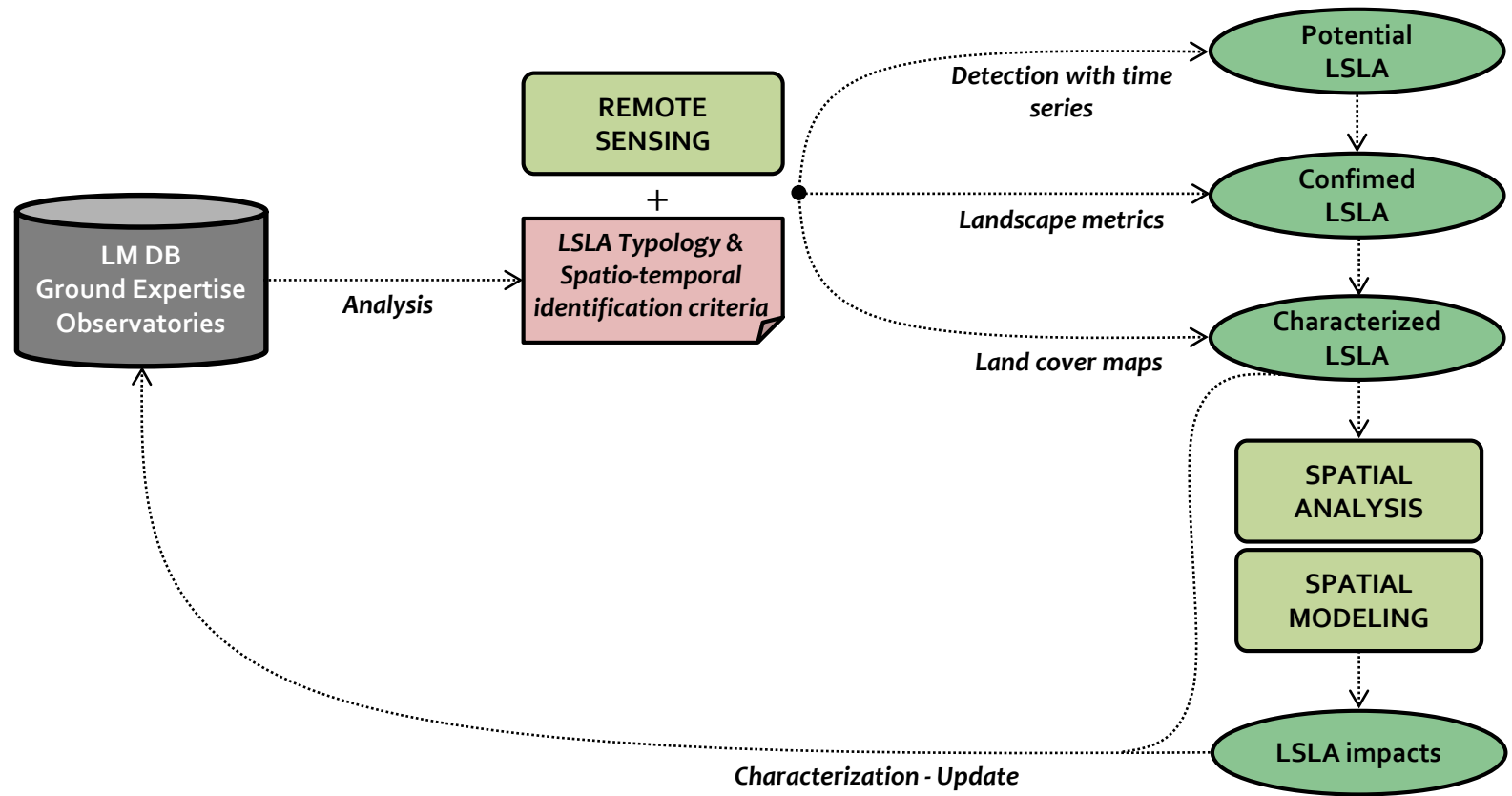
LAND DEALS



• Case study: LSLAs in Senegal



• Project Framework



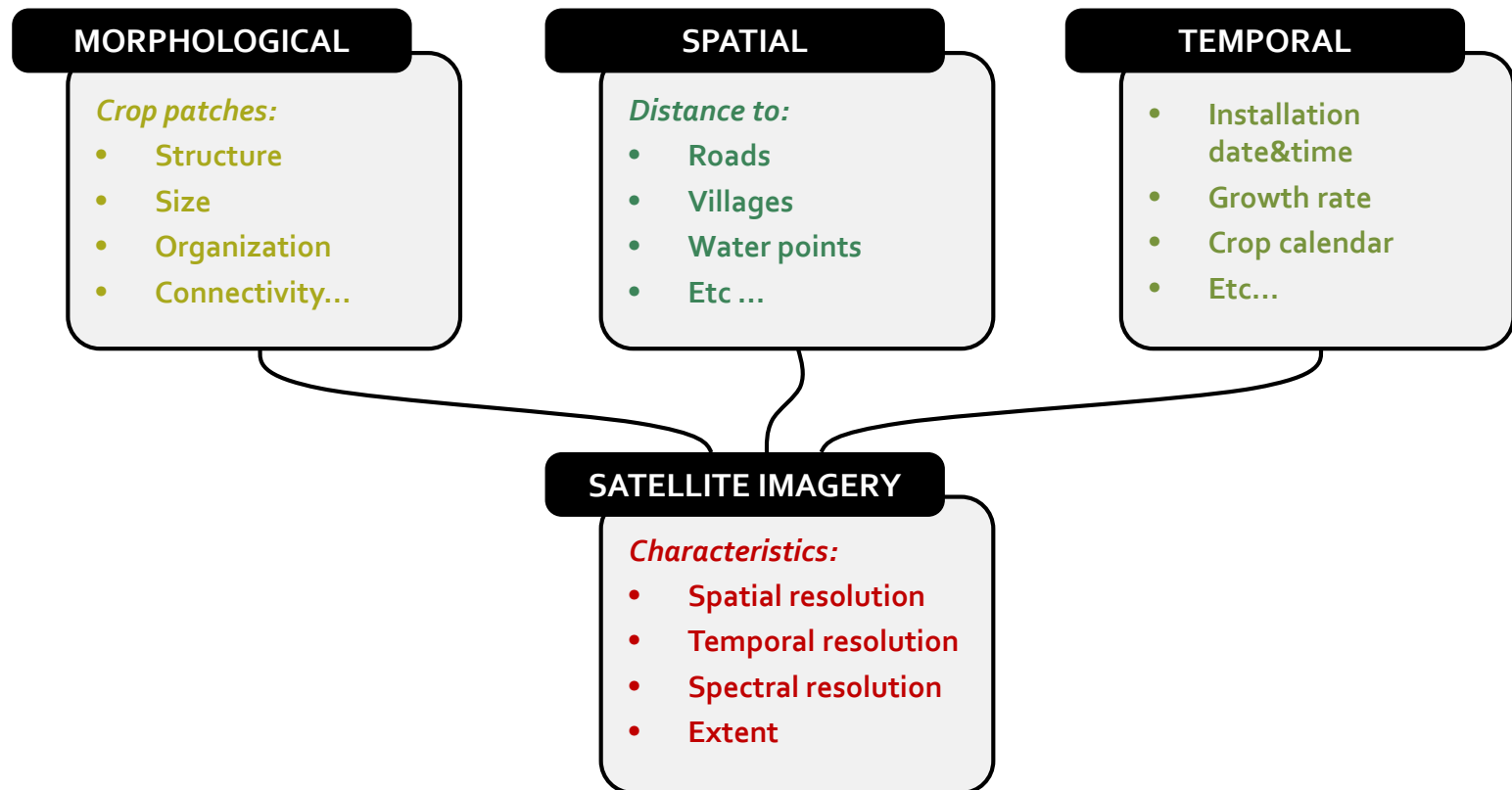
A black and white photograph of a terraced rice field in a mountainous region. The terraces are filled with water, reflecting the sky. In the background, there are traditional houses and a small bridge.



• VISAGE Project

TASK 1. Definition of spatio-temporal criteria for the discrimination of agro-industries

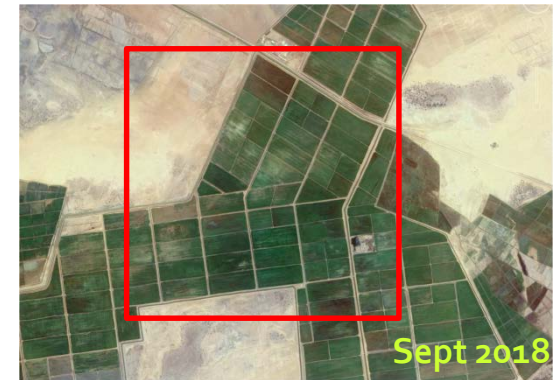
Typology based on spatio-temporal indicators



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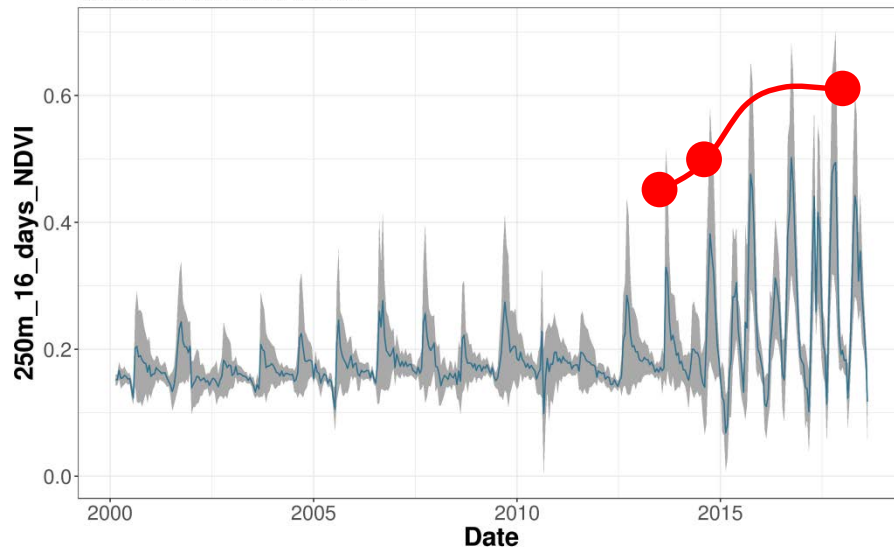
TASK 2. Detection of potential zones of LSLA for agro-industry using MODIS time series

First detection filter from MODIS 250m NDVI historic time series at 16 days frequency



Background images: Google Earth

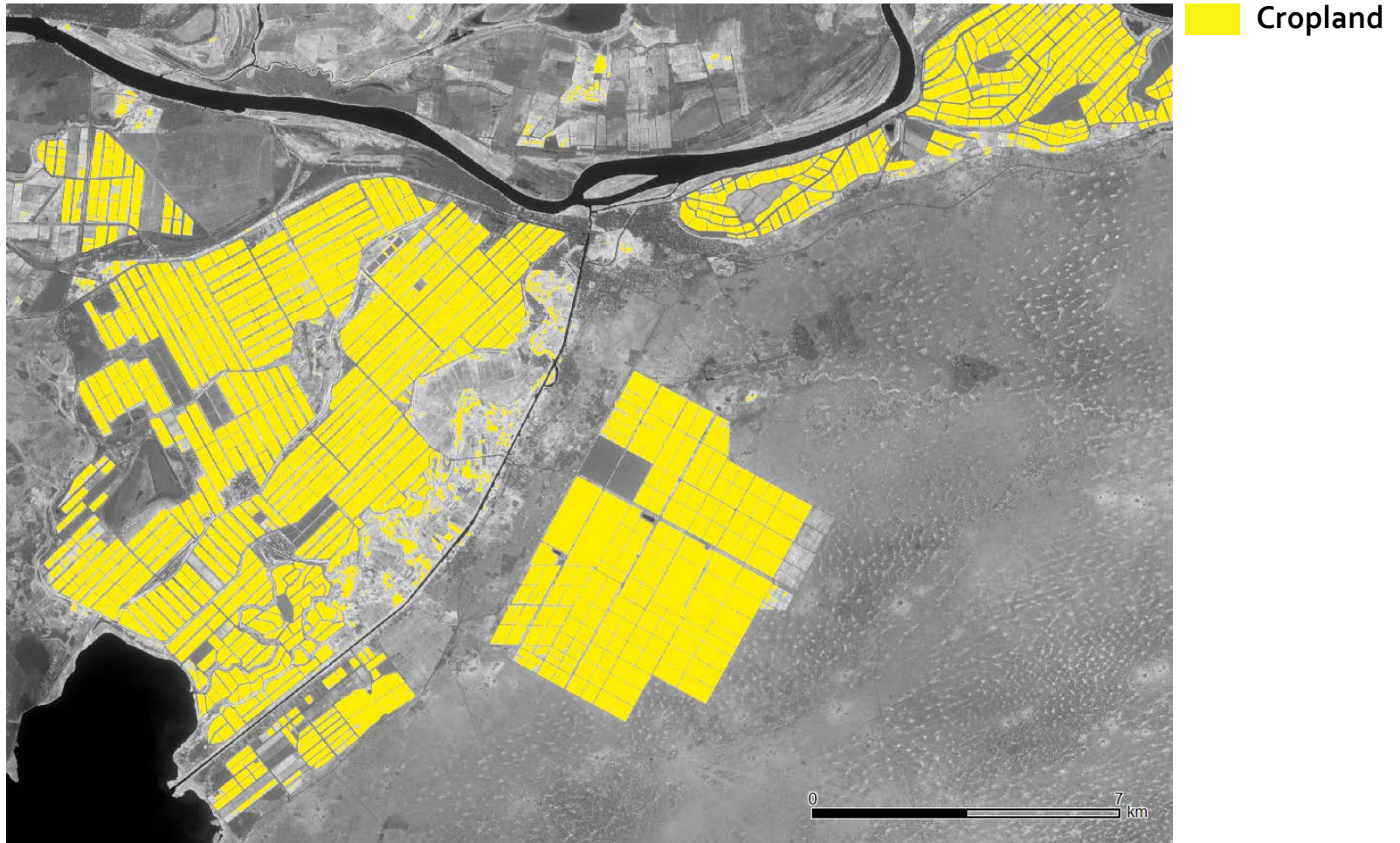
Subset Mean and 68% CI



Such time series can be used to detect changes in land use that can be attributed to the development of agroindustry

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TASK 3. Confirmation of the presence of an LSLA for Agro-industry with landscape metrics from Sentinel-2 or Landsat-8 data

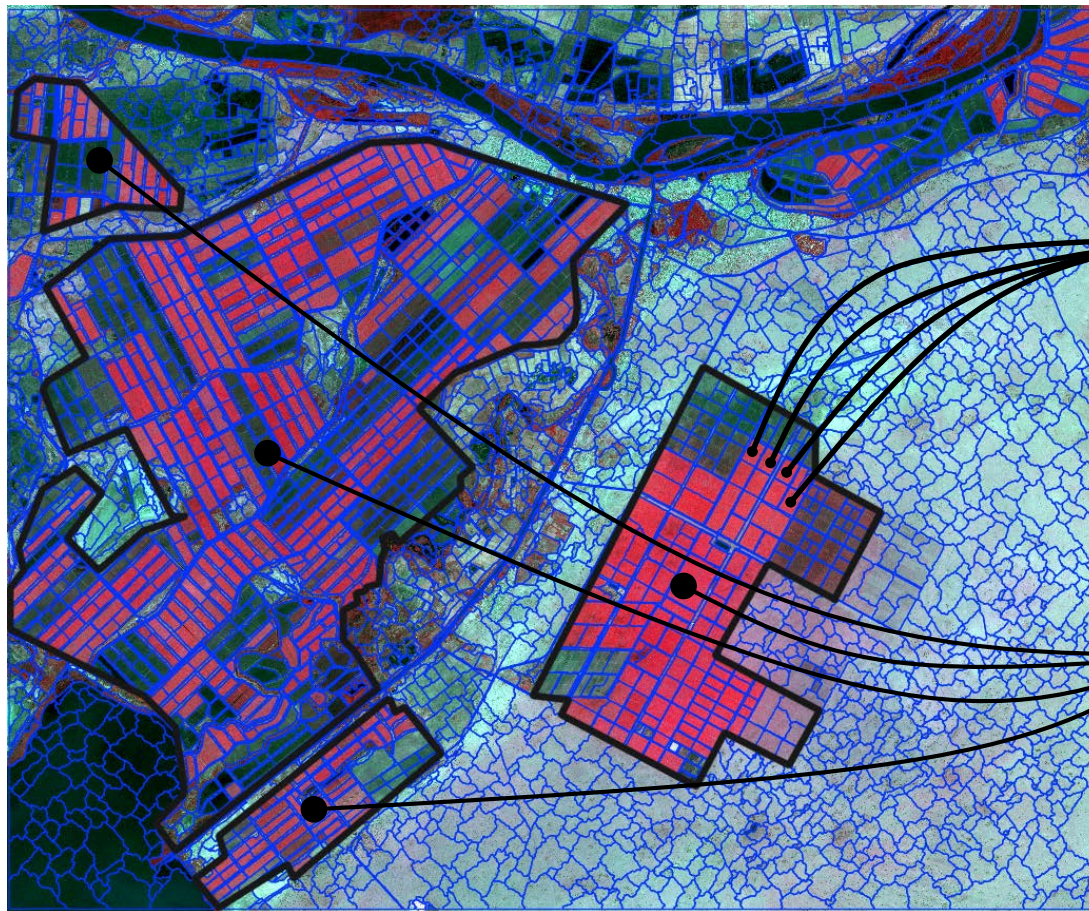


Sentinel 2 image acquired on September 15, 2017

• VISAGE Project

TASK 4. Detailed characterization of identified agro-industries

Production of various indicators describing the agro-industry



Spot 6 image acquired on February 06, 2017

At field scale:

- Start up date
- Area
- Crop type...

At farm scale:

- Start up date
- Intensification
- Total area
- Infrastructures...



Validation - Update

• VISAGE Project

TASK 5. Impacts on the physical and socio-economic environment



Border effects:

- New roads
- New infrastructures
- New villages
- Reorganization of cropland
- Disappearance of land uses
- ...

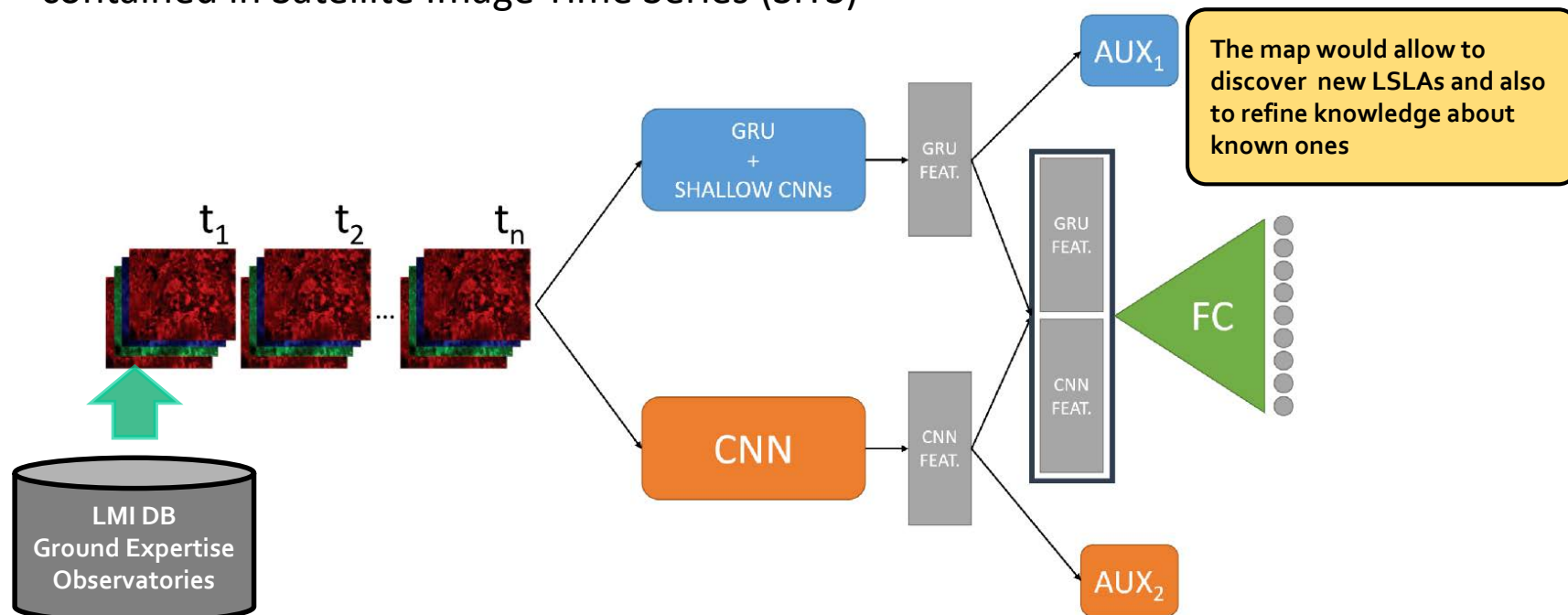


Using **spatial analysis** and **geographic information systems**

Machine learning approaches for the LSLA analysis

Data Science approaches (e.g., **Data Mining** and **Machine Learning** techniques) can be used to address LSLA dynamics by:

- Improve detection and characterization process, i.e., by the use of **Deep Learning** architectures able to exploit spatial and temporal information contained in Satellite Image Time Series (SITS)

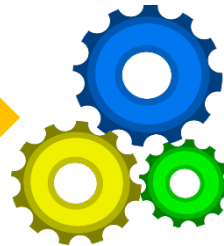


R. Interdonato et al.: "DuPLO: A DUAL view Point deep Learning architecture for time series classification". (2018)

• Machine learning approaches for the LSLA analysis

Data Science approaches (e.g., **Data Mining** and **Machine Learning** techniques) can be used to address LSLA dynamics by:

- Use **Text Mining** and **Network Analysis** techniques to extract additional information from heterogeneous sources, e.g.:
 - Public available sources (newspapers, websites, social media)
 - Data issued by investigative journalism (paradise papers, panama papers)



LSLAs
detection/characterization
/analysis

• And Spatial Modeling?

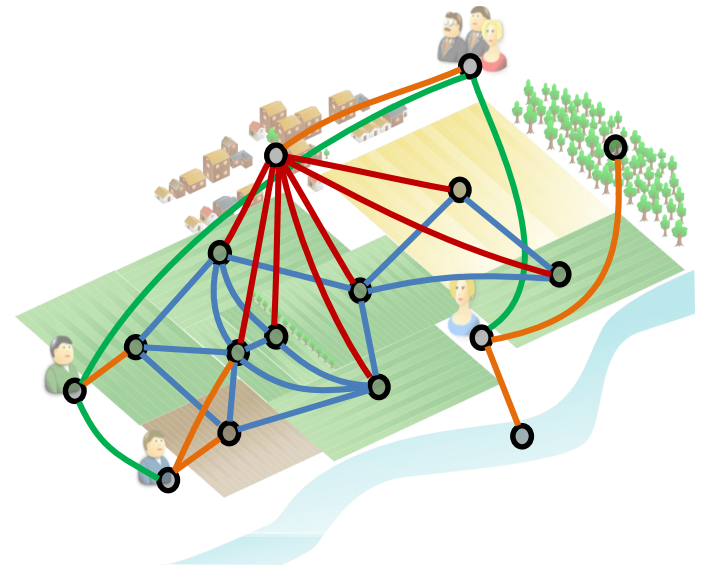
OBJECTIVES

- **Better discriminate** the objects detected by remote sensing (or data mining) according to their interactions with other elements of the territory (use of spatio-temporal expert rules)
- Analyse and **model the LSLA processes and impacts through space and time**



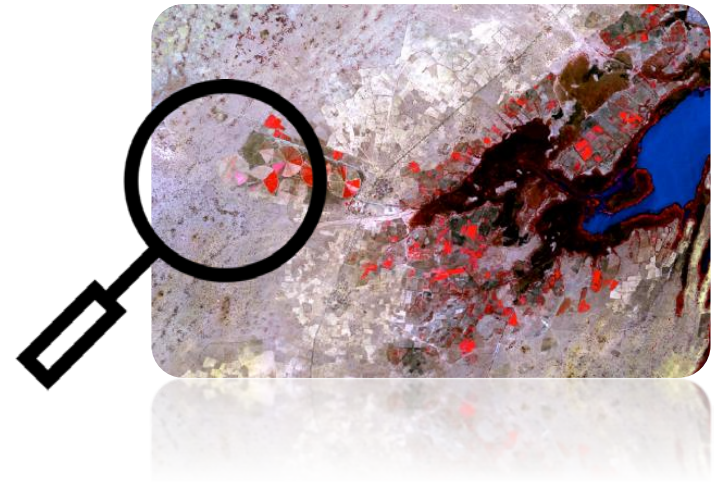
Ocelet is a Domain Specific programming language for:

- manipulating *entities* in *relation*
- using *interaction graphs*
- building *scenario* and running simulations




Degenne P., Lo Seen D., 2016, Ocelet: Simulating processes of landscape changes using interaction graphs, SoftwareX, 5:89-955

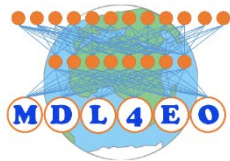
Thank you!



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<https://mdl4eo.irstea.fr>



MACLEAN: MACHine Learning for EArth
ObservationN (workshop @ECML/PKDD2019)