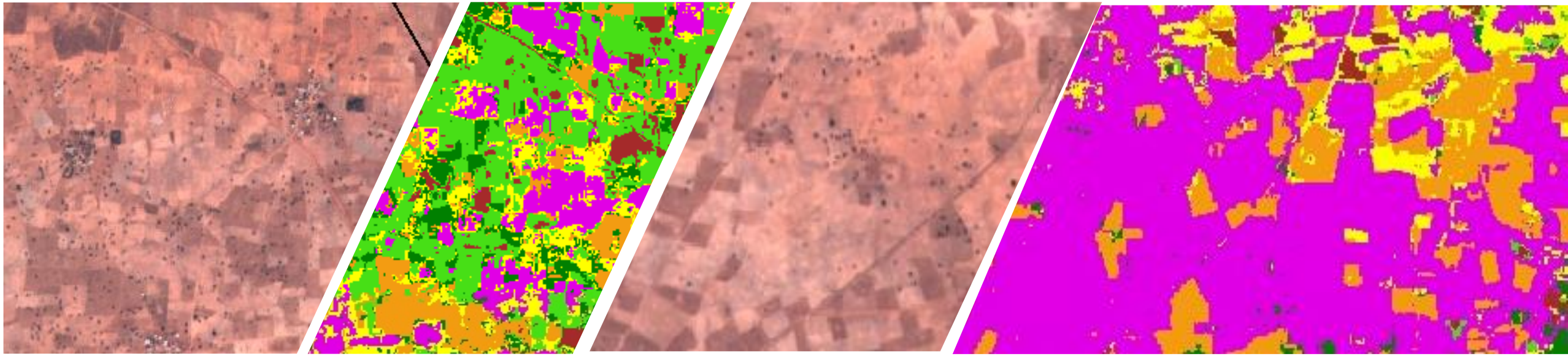
Food and Agriculture Organization of the United Nations

SUSTAINABLE DEVELOPMENT GOALS

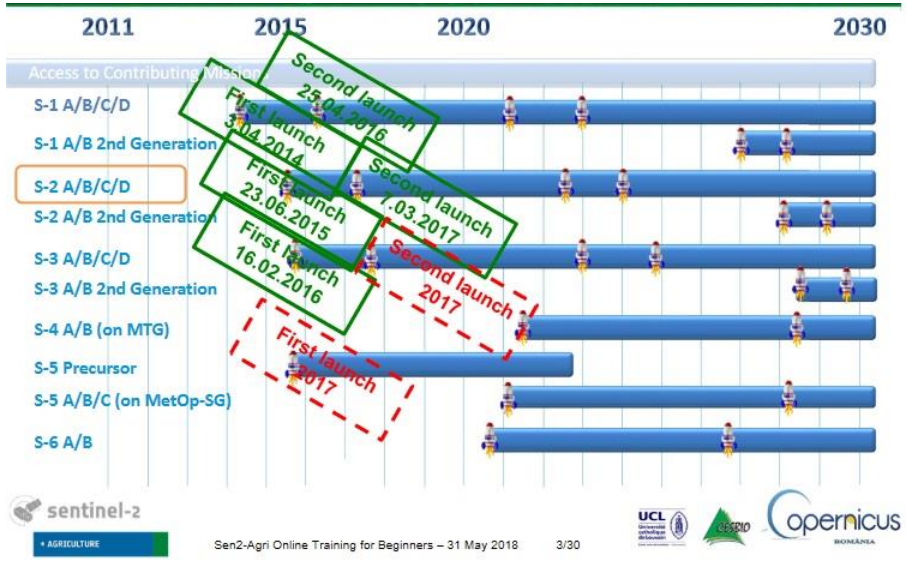
UN Big Data Regional Hub for Africa



EO-STAT CROP MAPPER FOR CROP TYPE MAPPING IN SENEGAL

Presenter: Vivian Ondieki
EO data scientist OCS,FAO

Project Overview



- **Big data ERA , improved computation capacity,rise of ML**
- **Challenges:**
  - Low availability of quality insitu data
  - Need for expertise for RS &Big data handling

- **Main Objective** is to support countries' capacity to consistently collect agricultural statistics through integrated earth observation data, physical modeling, and ground truth data collection

- Development and testing of data frugal algorithms (e.g. Dynamic Time Warping, transfer learning)

Impact:

- Support accurate reporting and decision-making for enhancing food security monitoring and natural resources management

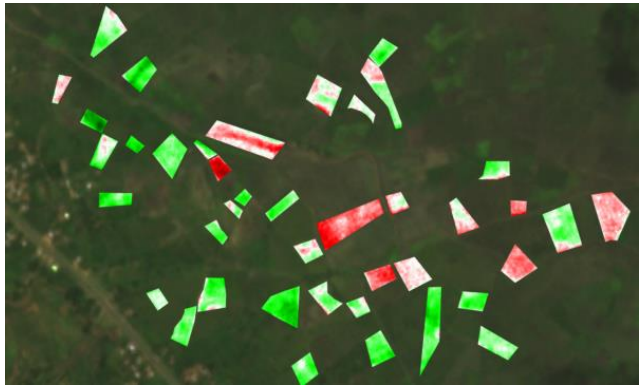
aws Google Earth Engine Microsoft Azure

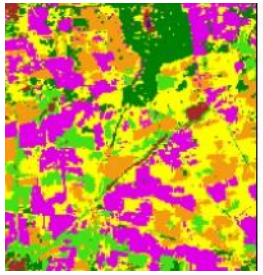
sentinelhub ONDA CREODIAS

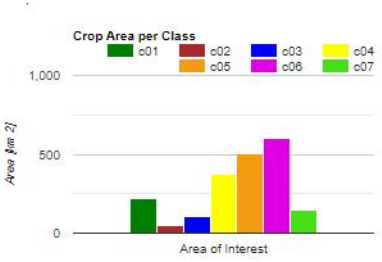
Digital Earth AFRICA

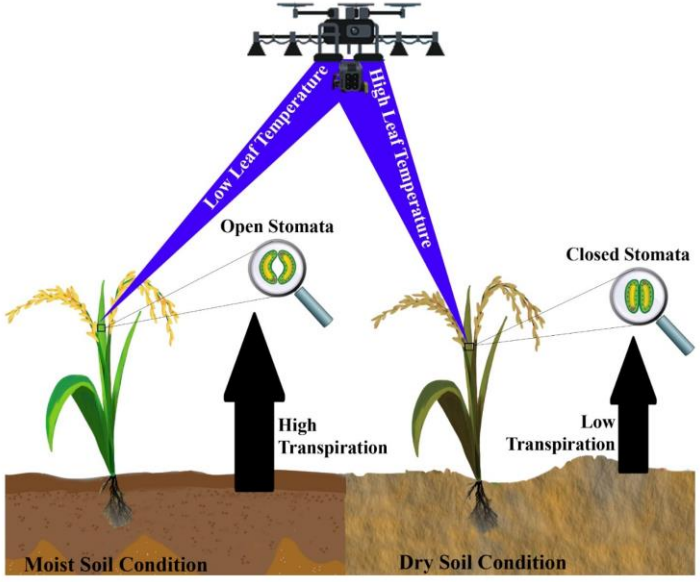
UN Big Data Regional Hub for Africa EO-STAT

Importance of crop type mapping









UNBigData Regional Hub for Africa EO-STAT

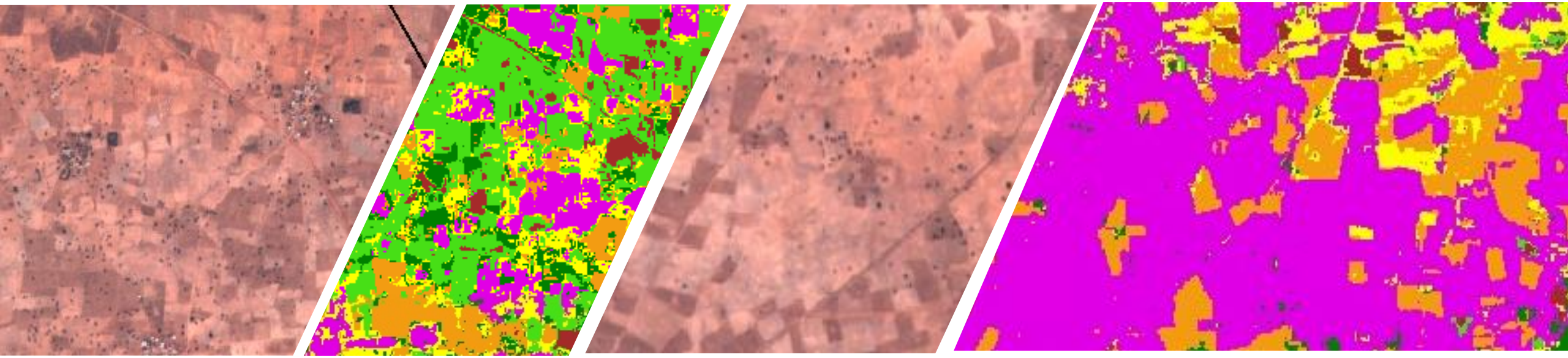
Reason for Action

Training Goal:

- *Understand the EO-STAT crop mapper methodology*
- *Enable the participants to be acquainted with EO-STAT crop mapping tool (no coding required).*
  - *Set up study area,*
  - *Define crop calendars*
  - *Load insitu samples and perform QA/QC*
  - *Run supervised classifier*
  - User-friendly exploration of crop type data through Google Earth Engine tools.

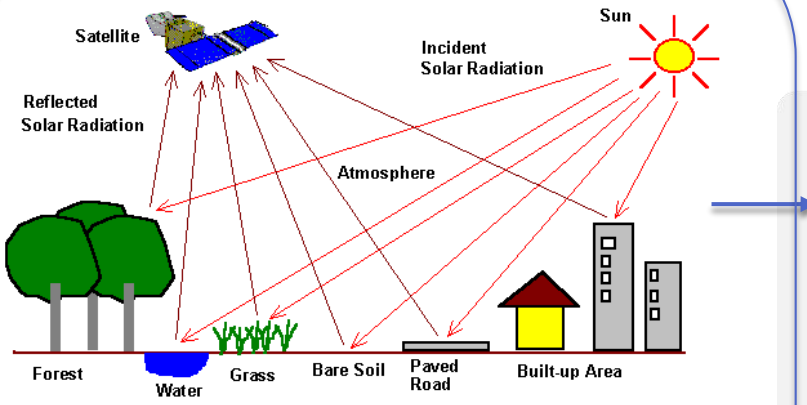
UNBigData Regional Hub for Africa EO-STAT

EO-STAT CROP MAPPER METHODOLOGY

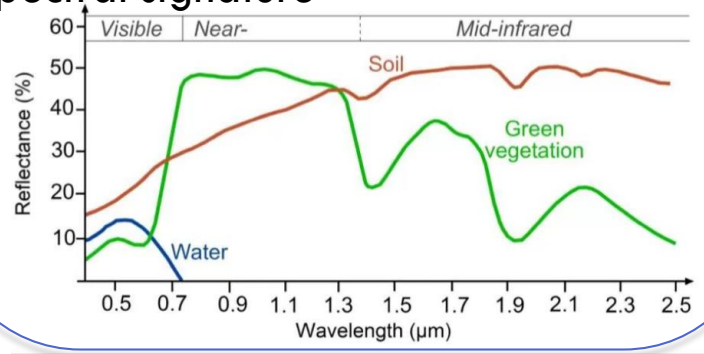


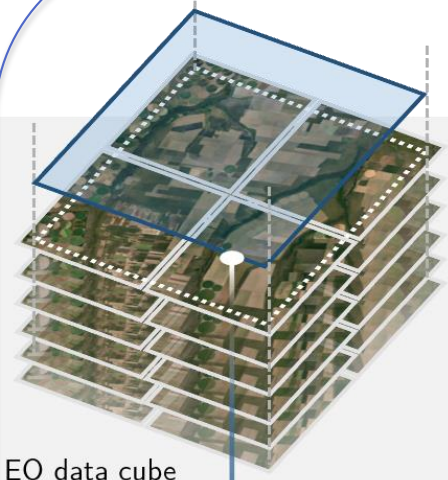
UNBigData Regional Hub for Africa EO-STAT

Supervised classification



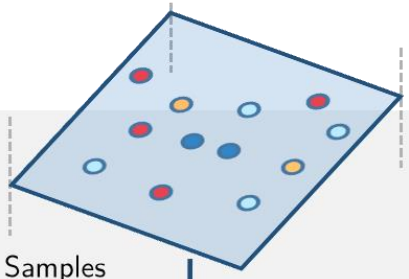
Spectral signature



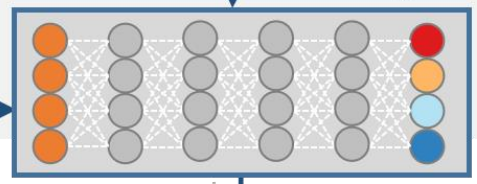


EO data cube

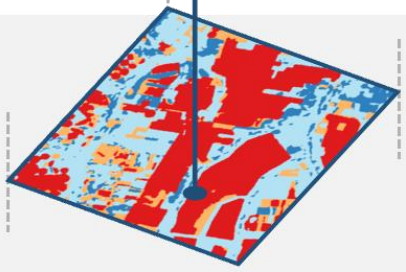
Satellite image time series



Samples



Training



Crop type map

Field data collection

Validation

UNBig Data Regional Hub for Africa

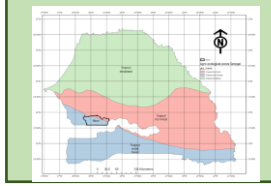
EO-STAT

Step 1 : Define AOI and load insitu data

Load region/samples

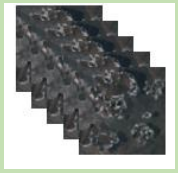
1

- Load crop library
- Load AEZ
- Load districts

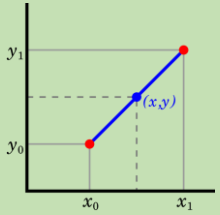


2 Acquisition of SITS at specific season

Cloud masking – S2 cloudless



Interpolation

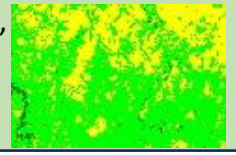


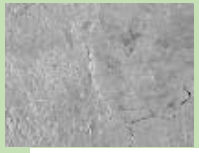
Linear interpolation

Harmonic model

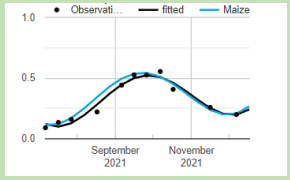
Feature selection

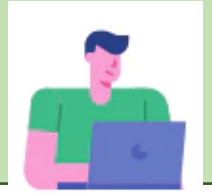
S2 BANDS - 'B2', 'B3', 'B11', 'B12', 'ndvi'
S1 – VV, VH

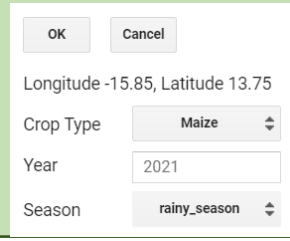




3 Sample selection/ verification

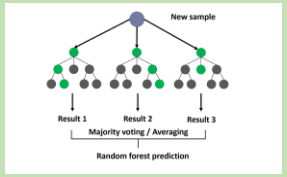


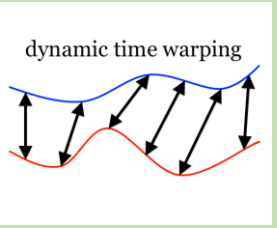


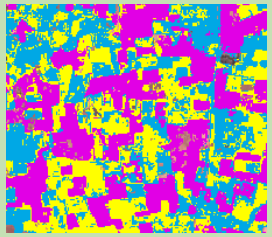


4 Crop type map Generation

- Select number of samples for classification
- Agricultural season
- Sensors
- Algorithm





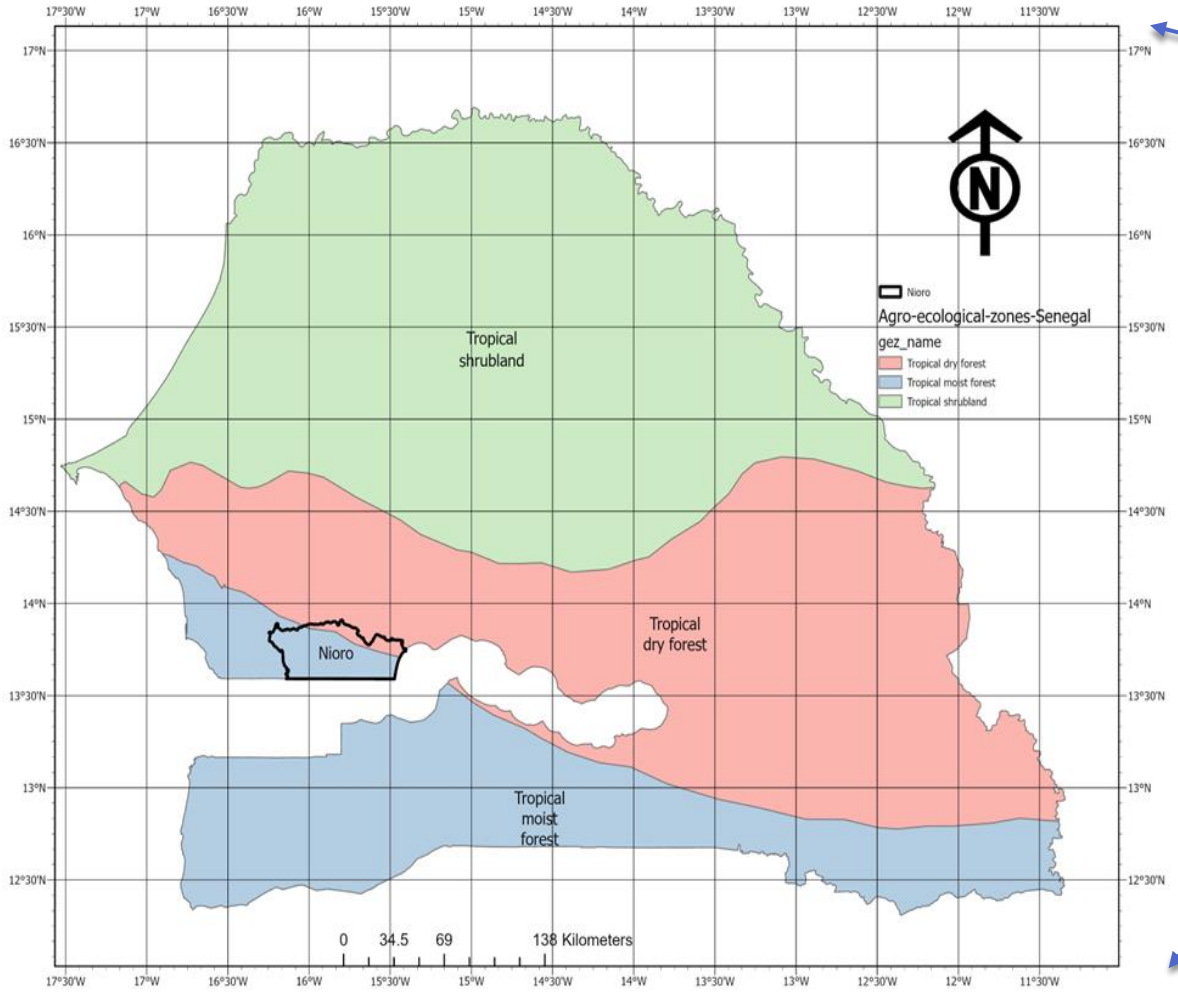


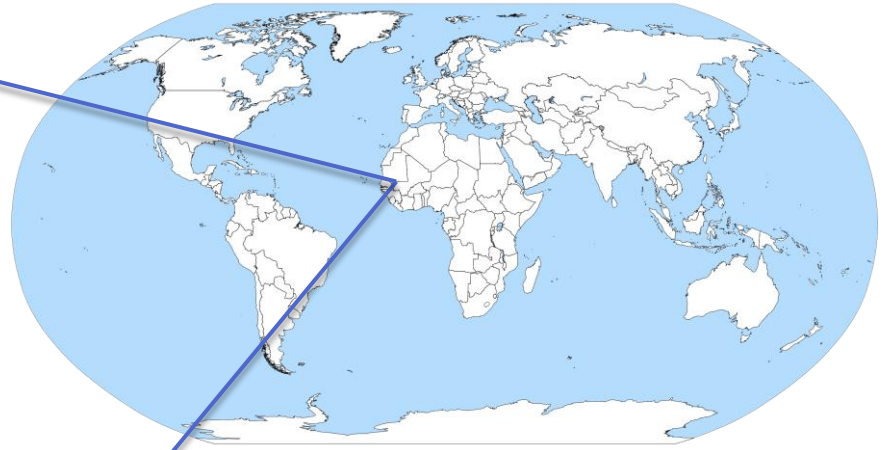
Validation, Visualize & Download map 5

UNBig Data Regional Hub for Africa EO-STAT

1

Define area of interest





Administrative units

Districts

Agro-ecological zones

Country

UNBig Data Regional Hub for Africa

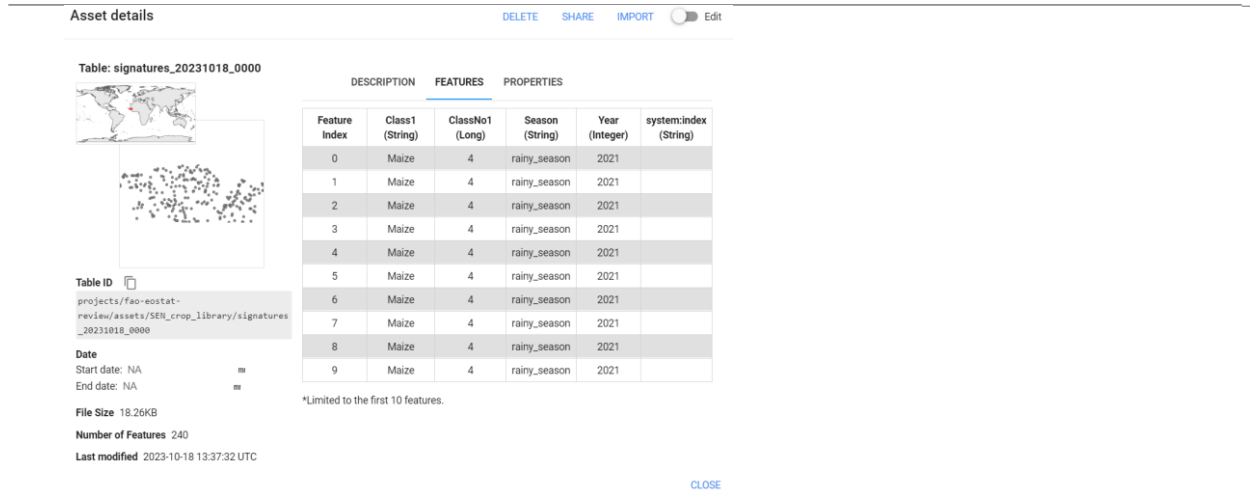
EO-STAT

1

Loading the insitu data

- Crop data
  - Formatting:
    - attribute types
    - attribute names
  - Four attributes must be indicated:
    - Crop name
    - Crop ID
    - Year
    - Period

Attribute	Column Name	Type	Description	Remark
Crop Name	*Class1*	String	Crop type class attribute	The crop names are case sensitive. E.g., do not use "Wheat" and "wheat" for the same crop type.
Crop ID	*ClassNo1*	Number	Crop type ID attribute	Unique ID associated to every Crop Name. Only numbers between 1 and 50 are permitted.
Year	*Year*	Number	Year of observation	
Period	*Season*	String	Validity period of observation	Use one of the following: • *"rainy_season"* • *"dry_season"* • *"rainy_season&dry_season"*

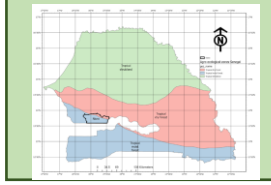


Step 2: QA/QC of insitu points

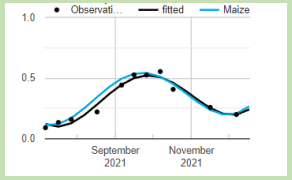
Load region/samples

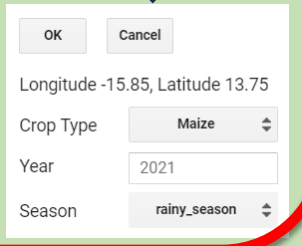
1

- Load crop library
- Load AEZ
- Load districts



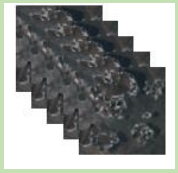
2 Sample selection/ verification



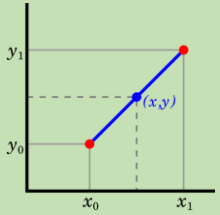


3 Acquisition of SITS at specific season

Cloud masking – S2 cloudless



Interpolation

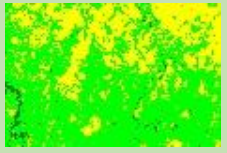


Linear interpolation

Harmonic model

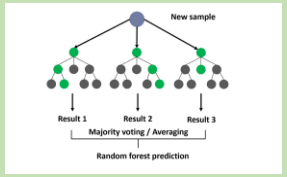
Feature selection

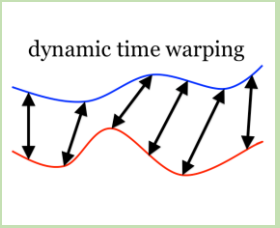
S2 BANDS - 'B2', 'B3', 'B11', 'B12', 'ndvi'
S1 – VV, VH

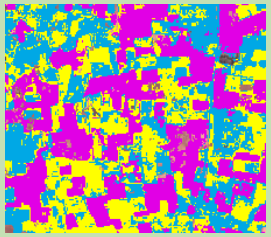


4 Crop type map Generation

- Select number of samples for classification
- Agricultural season
- Sensors
- Algorithm





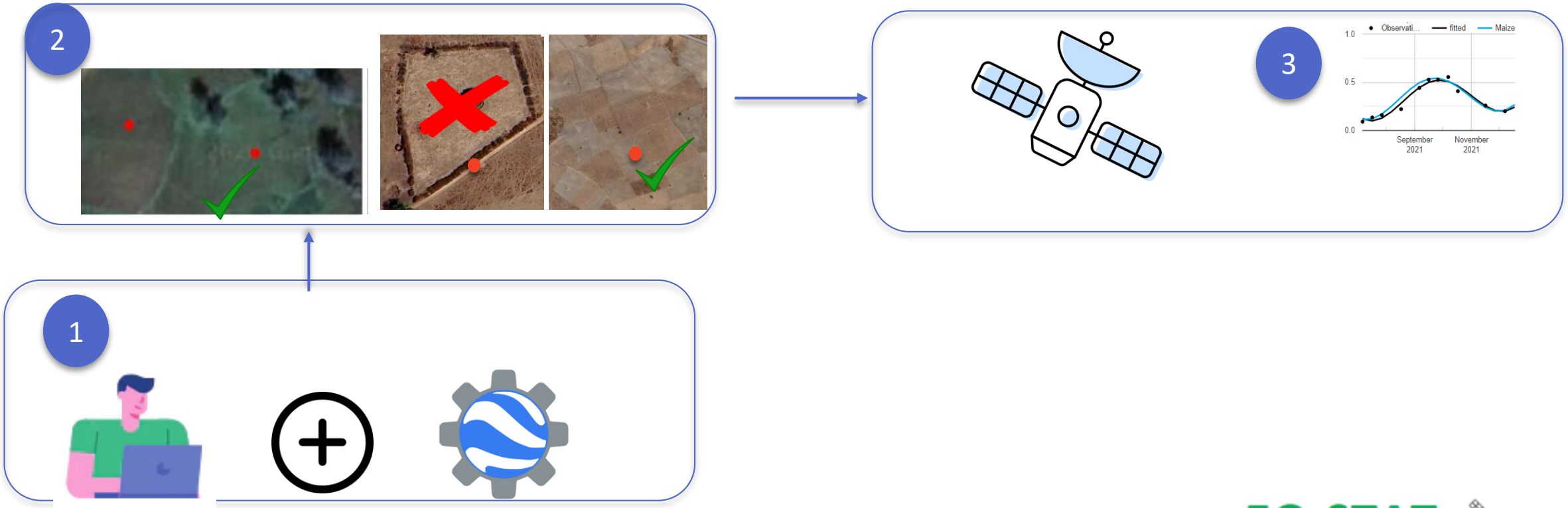


Validation, Visualize & Download map 5

UNBig Data Regional Hub for Africa EO-STAT

2

Insitu data QA/QC on eo-stat tool



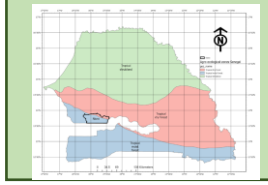
UNBigData Regional Hub for Africa EO-STAT

Step 3: Satellite image preparation

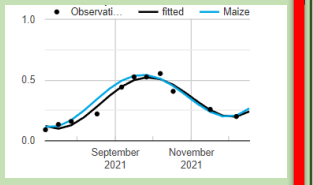
Load region/samples

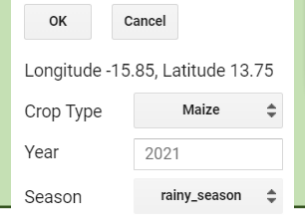
1

- Load crop library
- Load AEZ
- Load districts



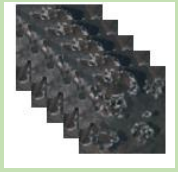
2 Sample selection/ verification



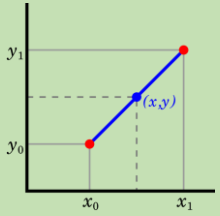


3 Acquisition of SITS at specific season

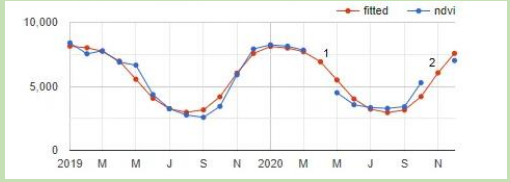
Cloud masking – S2 cloudless



Interpolation



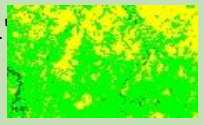
Linear interpolation



Harmonic model

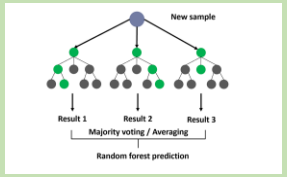
Feature selection

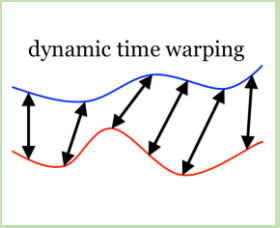
S2 BANDS - 'B2', 'B3', 'B11'
'B12', 'ndvi'
S1 – VV, VH

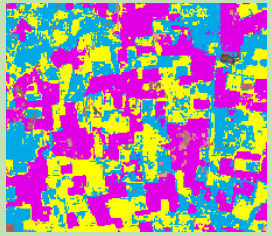


4 Crop type map Generation

- Select number of samples for classification
- Agricultural season
- Sensors
- Algorithm







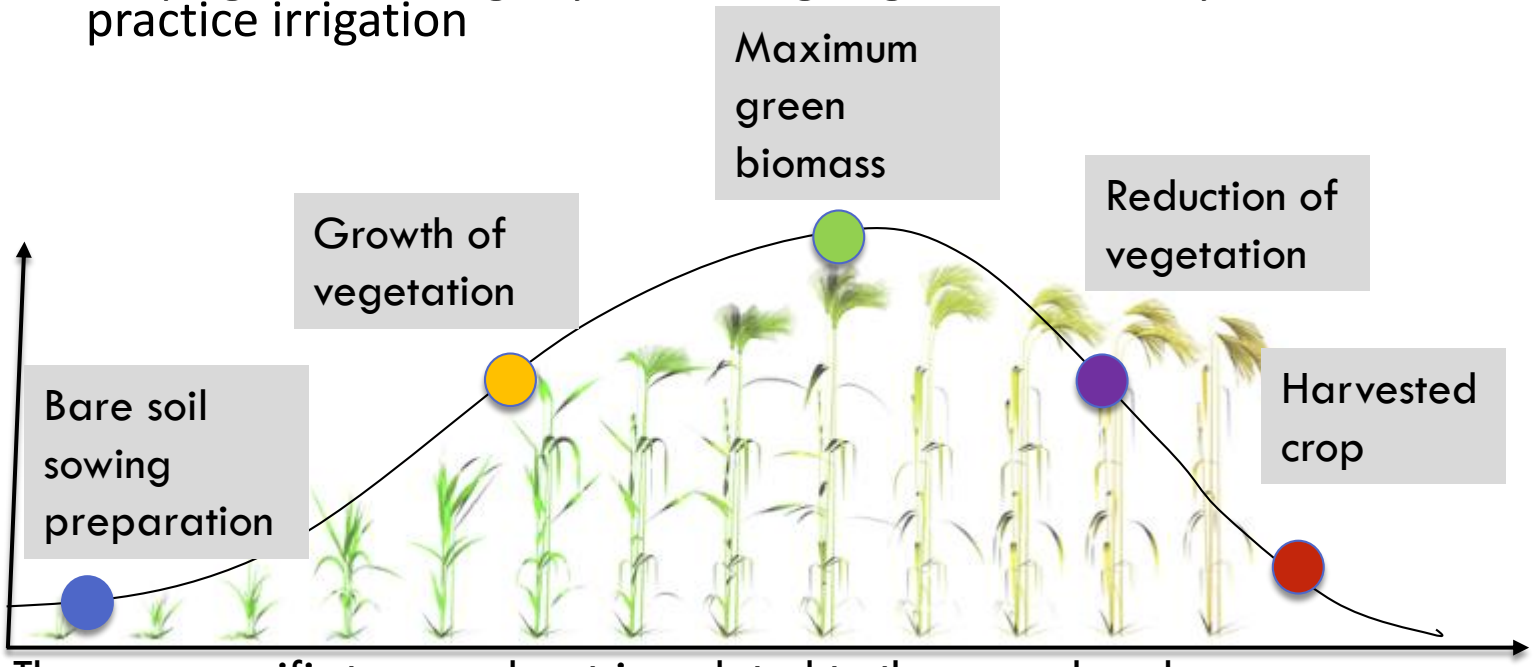
Validation, Visualize & Download map 5

UNBig Data Regional Hub for Africa EO-STAT

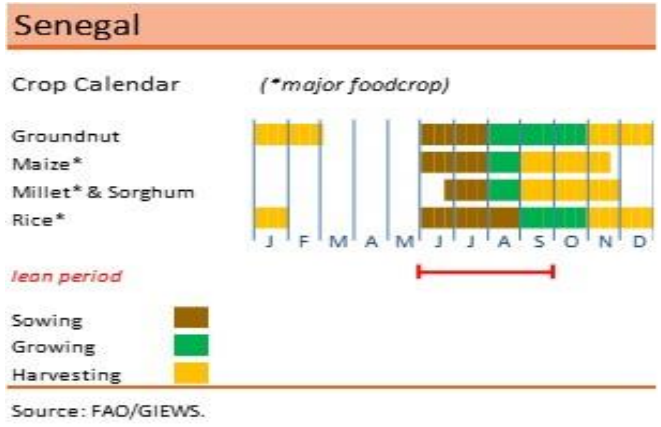
3

Select crop seasons

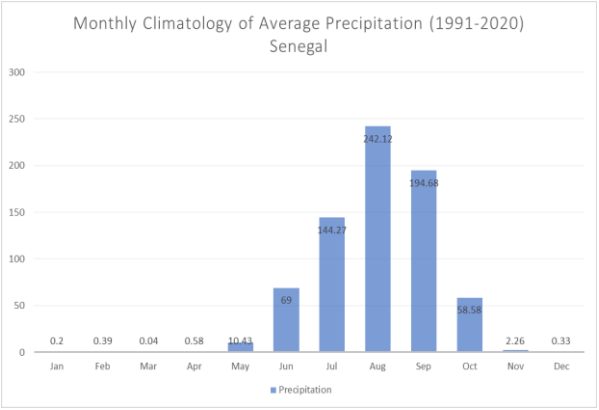
- Seasons used include:
  - Rainy season - lies between June to November
  - Dry season - January to May
- Most farmers grow crops during rainy season
- Crops grown during dry season eg vegetables mainly practice irrigation



The crop-specific temporal metrics related to the crop phenology will be extracted



Senegal crop calendar (source: FAO)



Average monthly rainfall (1991-2020) (source Worldbank)

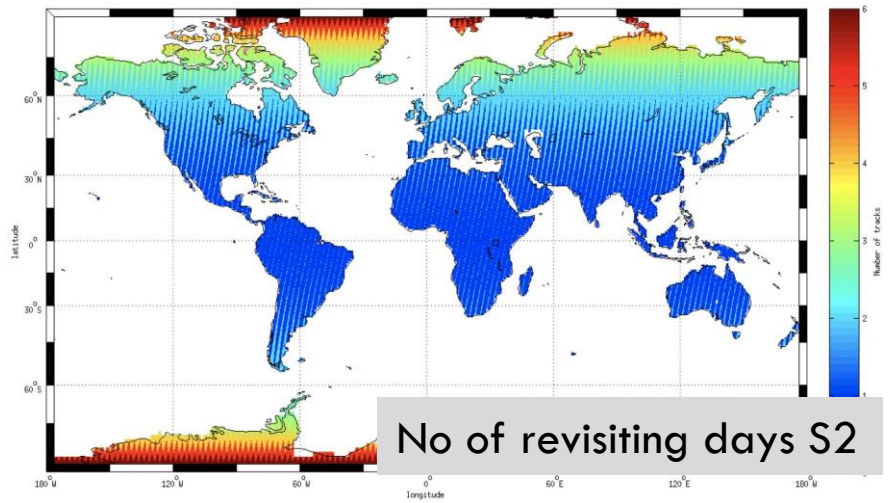
3

Sensors

The following sensors are used in EO-stat Senegal tool

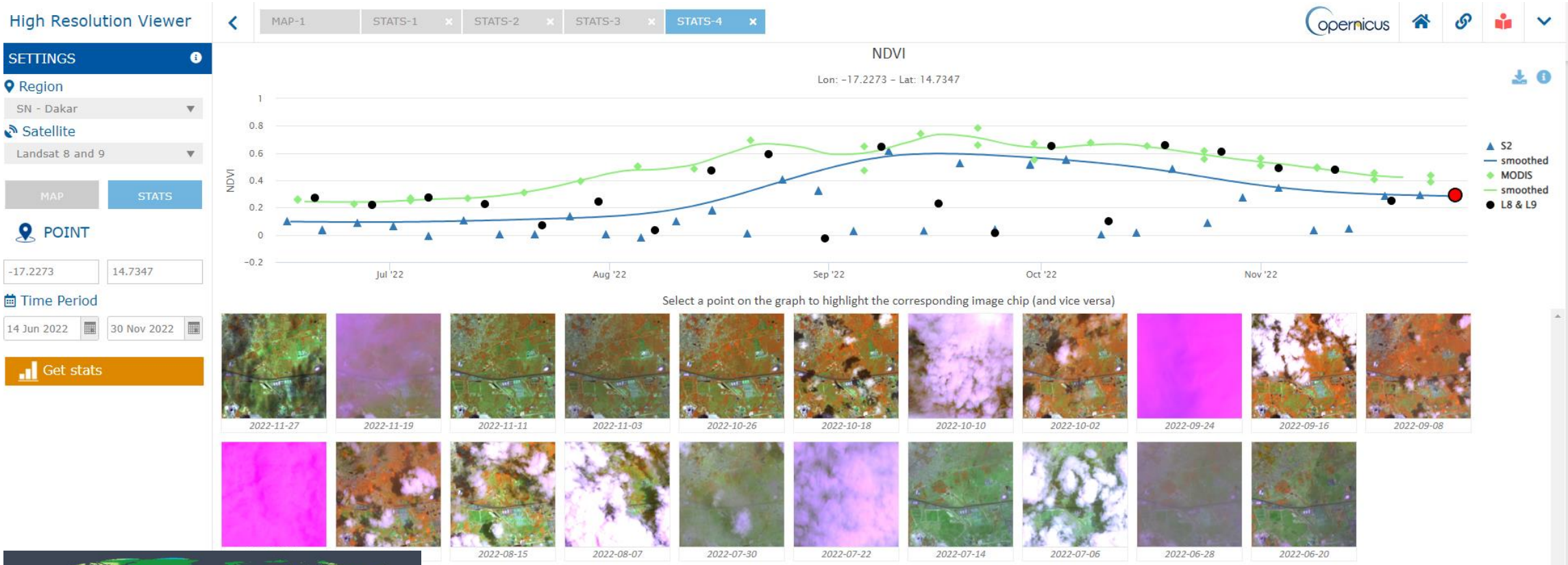
- Sentinel-1 and Sentinel-2
- Sentinel-2

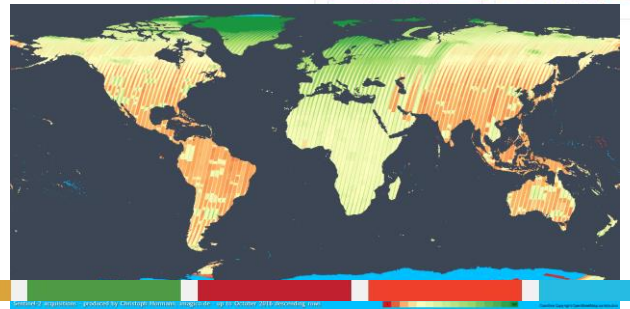
Sentinel 1	Sentinel 2
❑ Type : Radar	❑ Type: Optical
❑ Temporal resolution: one image every 6 days	❑ Temporal resolution: one image every 5 days
❑ Spatial resolution: 10m	❑ Spatial resolution : 10m
❑ Used bands: VV, VH	❑ Used bands : Green, Blue, SWIR1,SWIR2,NDVI



No of revisiting days S2

Atmospheric pertubations



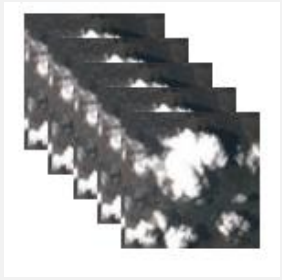


https://agricultural-production-hotspots.ec.europa.eu/hresolution/?region=271

UNBigData Regional Hub for Africa EO-STAT

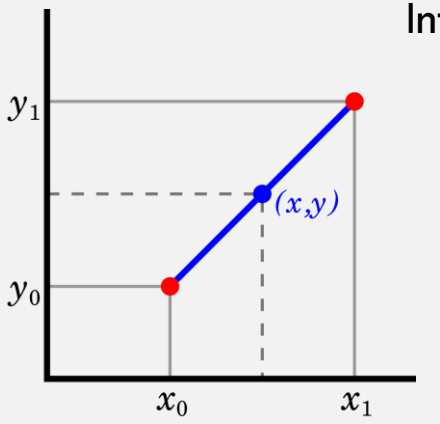
3

Satellite image processing

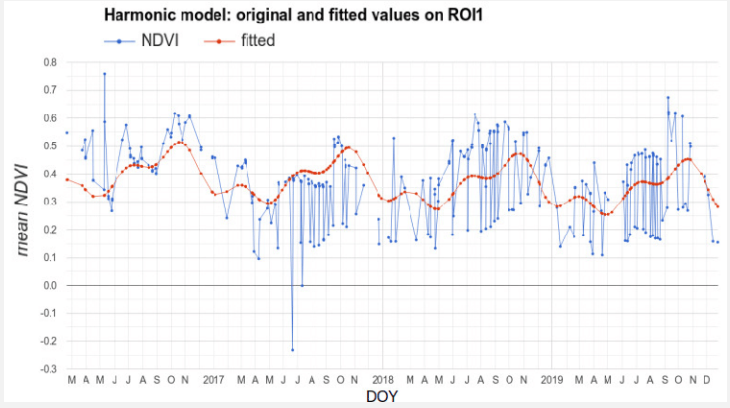


S2 cloudless

Interpolation

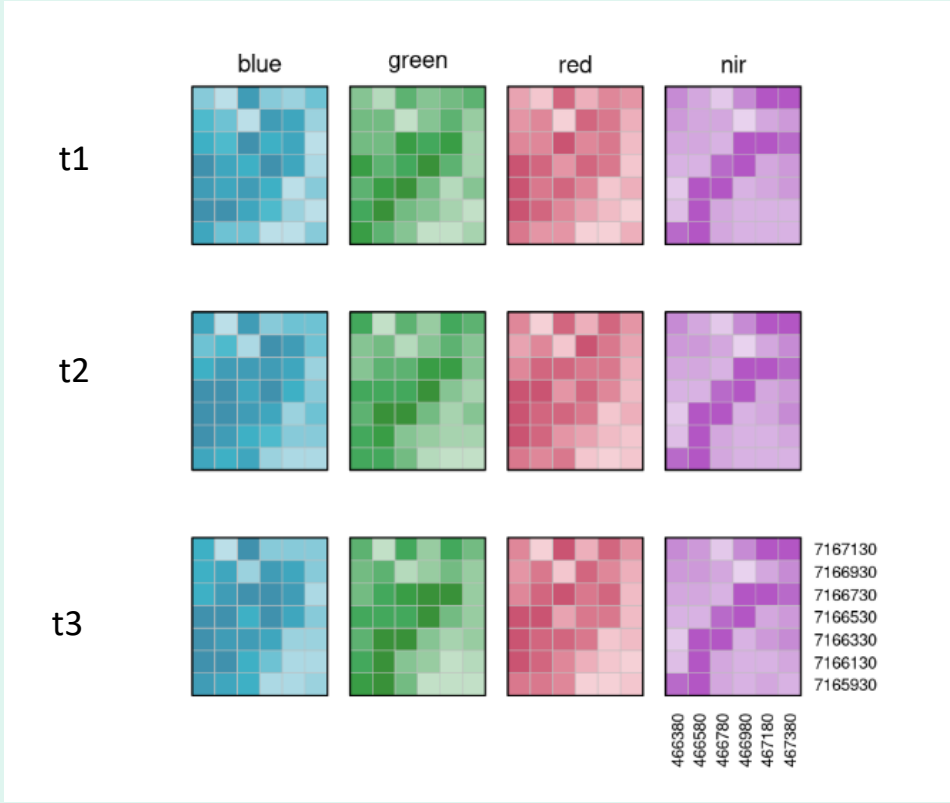


Linear Interpolation



Harmonic Model

Data cube generated for specific growing season



UNBig Data Regional Hub for Africa

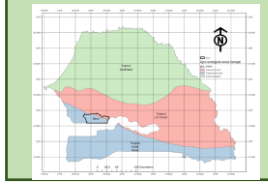
EO-STAT

Step 4: Crop map generation

Load region/samples

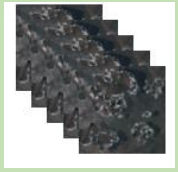
1

- Load crop library
- Load AEZ
- Load districts

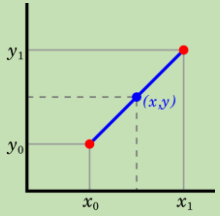


2 Acquisition of SITS at specific season

Cloud masking – S2 cloudless



Interpolation

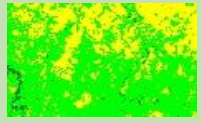


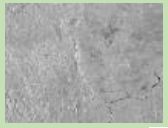
Linear interpolation

Harmonic model

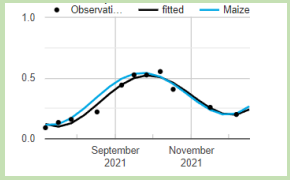
Feature selection

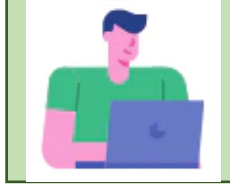
S2 BANDS - 'B2', 'B3', 'B11', 'B12', 'ndvi'
S1 – VV, VH

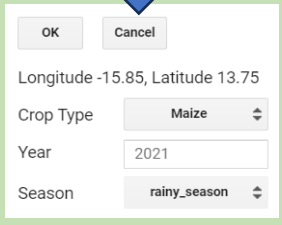




3 Sample selection/ verification

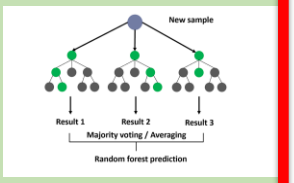


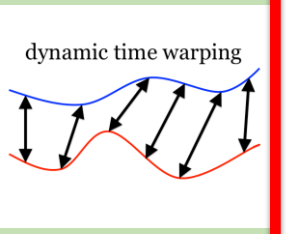


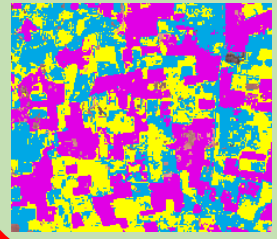


4 Crop type map Generation

- Select number of samples for classification
- Agricultural season
- Sensors
- Algorithm







Validation, Visualize & Download map 5

UNBigData Regional Hub for Africa

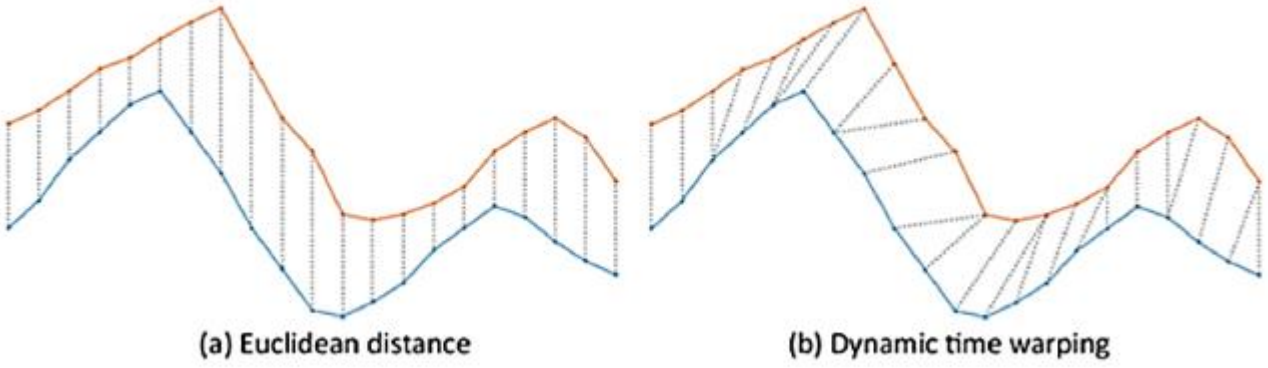
EO-STAT

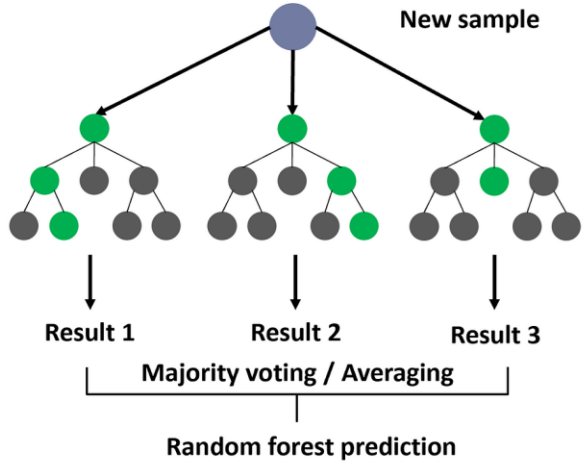
4

Crop type classification algorithms

Three methods of classification are available

- Time-constrained Dynamic Time Warping (Maus, Camara, et al., 2016, Desimone Lorenzo et al., 2022).
- Random Forest supervised classification (Gorelick et al., 2017).



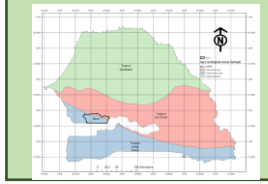


Step 5: Accuracy assessment & Visualization of results

Load region/samples

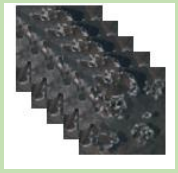
1

- Load crop library
- Load AEZ
- Load districts

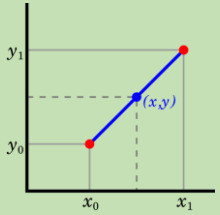


2 Acquisition of SITS at specific season

Cloud masking – S2 cloudless



Interpolation

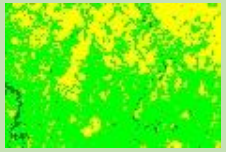


Linear interpolation

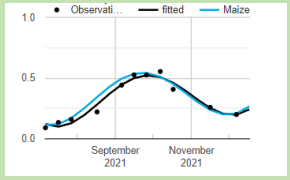
Harmonic model

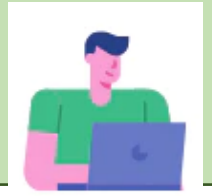
Feature selection

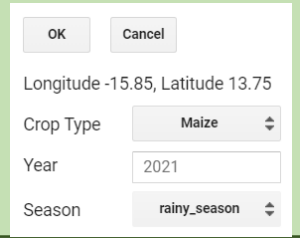
S2 BANDS - 'B2', 'B3', 'B11', 'B12', 'ndvi'
S1 – VV, VH



3 Sample selection/ verification

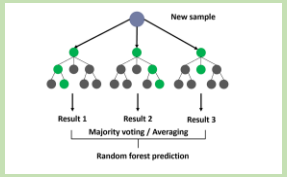


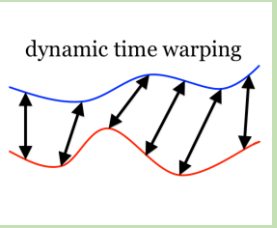


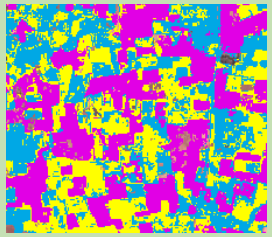


4 Crop type map Generation

- Select number of samples for classification
- Agricultural season
- Sensors
- Algorithm







Validation, Visualize & Download map 5

UNBigData Regional Hub for Africa EO-STAT

5

Accuracy Assessment

The tool provides four types of accuracy metrics:

- Overall accuracy
- Cohen's kappa index
- Producer's accuracy per class
- Users' accuracy per class

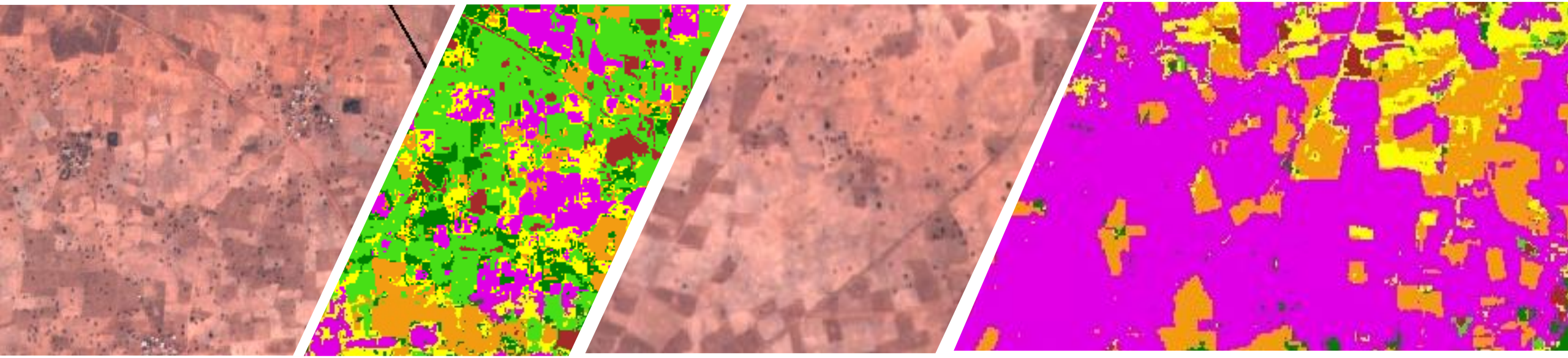
$$OA = \frac{TP + TN}{TP + TN + FP + FN}$$

Value of Kappa	Level of Agreement	% of Data that are Reliable
0–.20	None	0–4%
.21–.39	Minimal	4–15%
.40–.59	Weak	15–35%
.60–.79	Moderate	35–63%
.80–.90	Strong	64–81%
Above.90	Almost Perfect	82–100%

Confusion matrix

		Predicted condition	
	Total population = P + N	Positive (PP)	Negative (PN)
Actual condition	Positive (P)	True positive (TP)	False negative (FN)
	Negative (N)	False positive (FP)	True negative (TN)

EO-STAT CROP MAPPER COMPONENTS

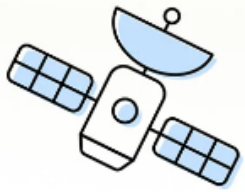


UNBigData Regional Hub for Africa EO-STAT

Eo-stat crop mapper components

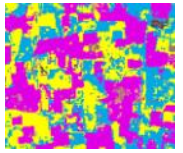
Admin tool

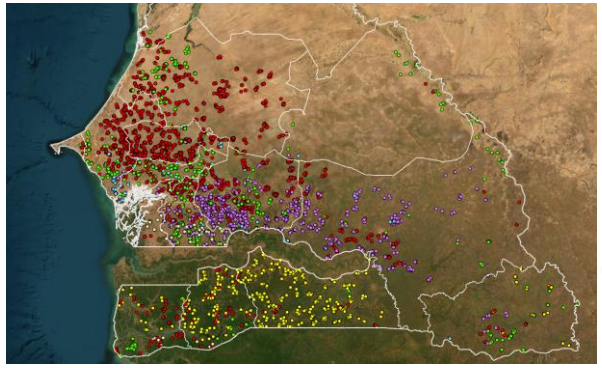
- administrator tool for trusted users to perform back-end tasks



End user tool

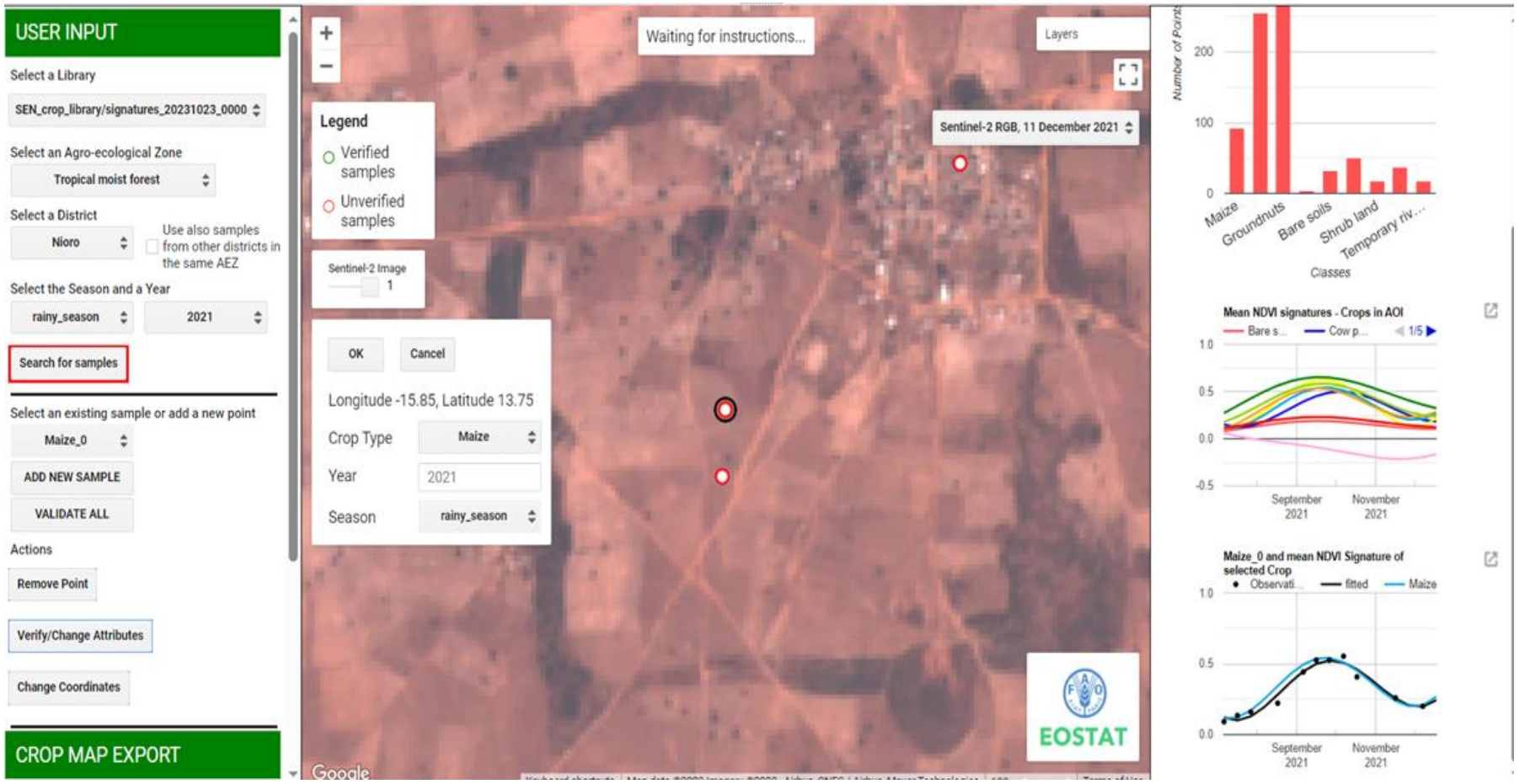
- the end-user tool for viewing, analyzing, and downloading earth observations (EO) derived crop maps.



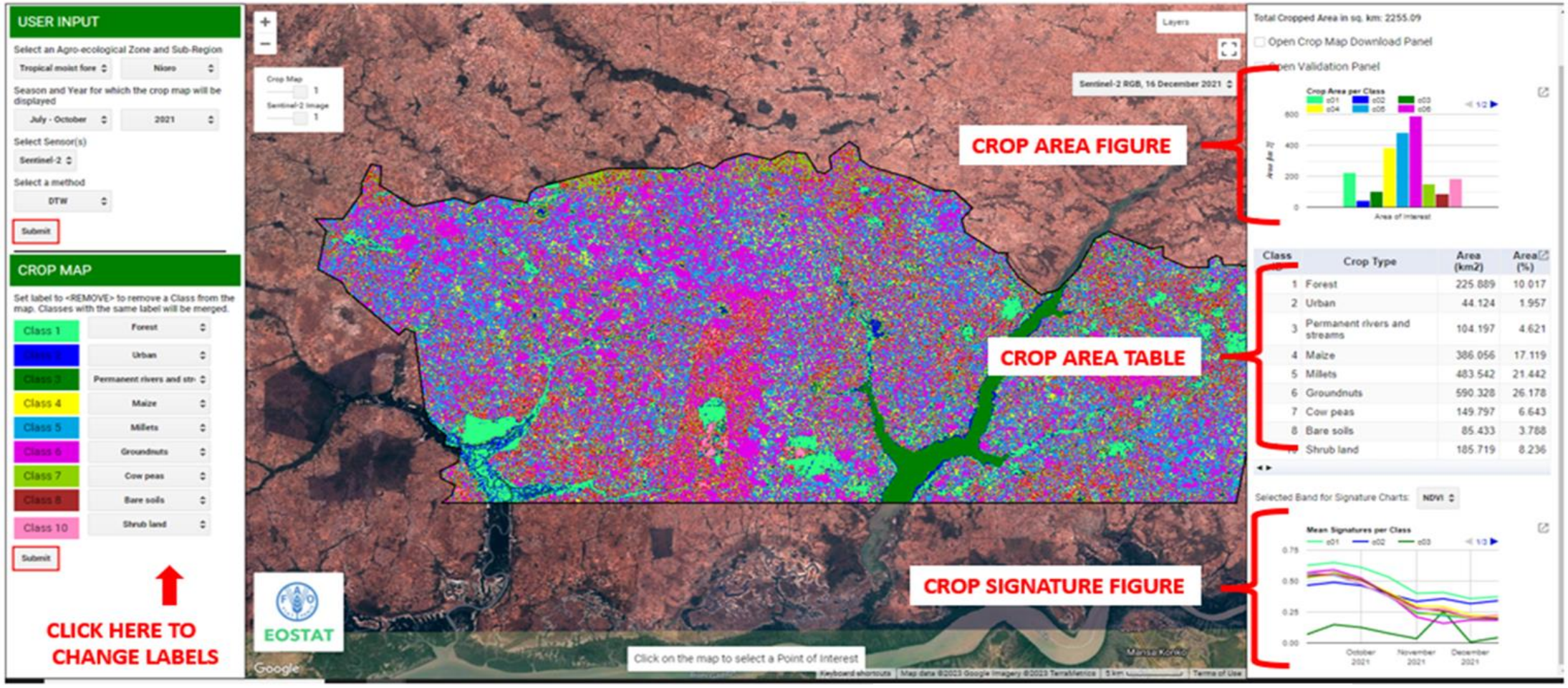


Crop library
Asset folders

Adminstrator tool



End user Tool

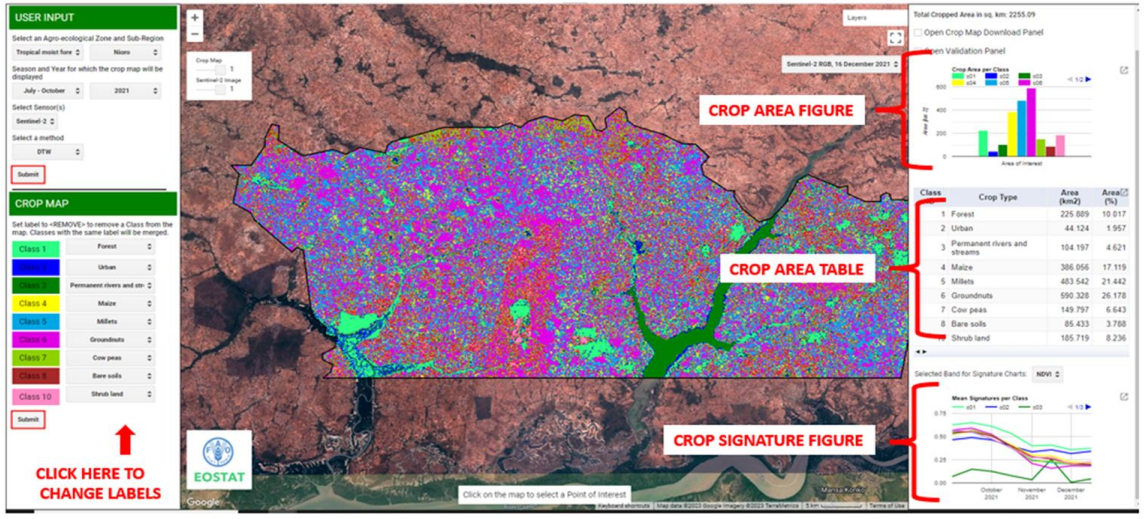


https://ocsgeospatial.users.earthengine.app/view/eostat-senegal

UNBigData Regional Hub for Africa

EO-STAT

App architecture



User provided inputs

Feed results back to GEE App Interface

UNBigData Regional Hub for Africa EO-STAT

ANY QUESTIONS?

https://www.fao.org/in-action/eostat

https://ecastats.uneca.org/regionalhub/

Scan me!

UN Big Data Regional Hub for Africa

EO-STAT