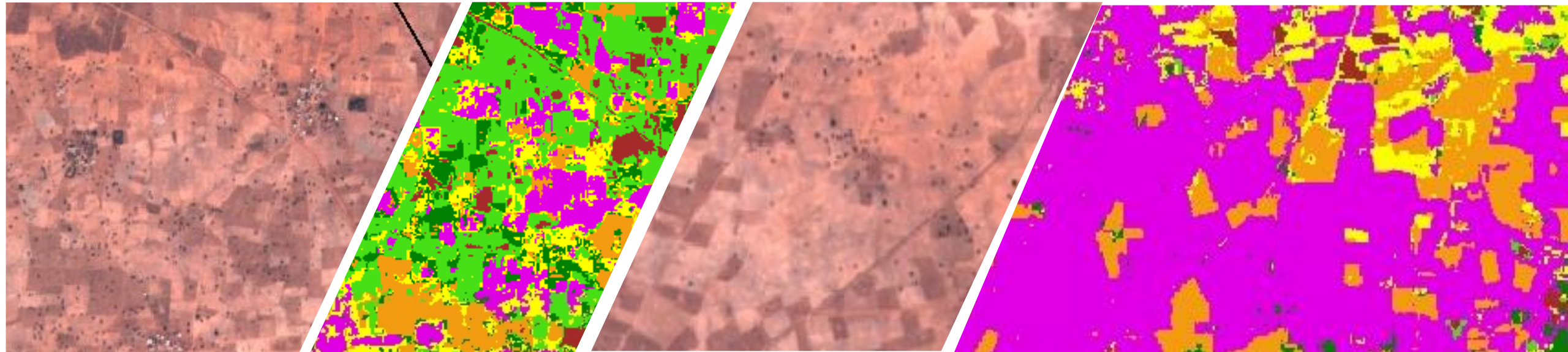




Food and Agriculture
Organization of the
United Nations



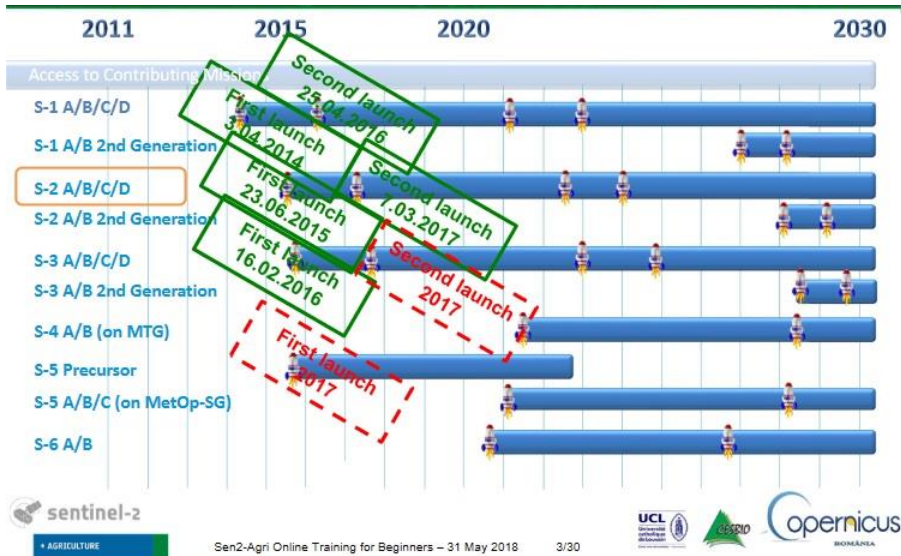
 UN Big Data Regional Hub for Africa



EO-STAT CROP MAPPER FOR CROP TYPE MAPPING IN SENEGAL

Presenter: Vivian Ondieki
EO data scientist OCS,FAO

Project Overview



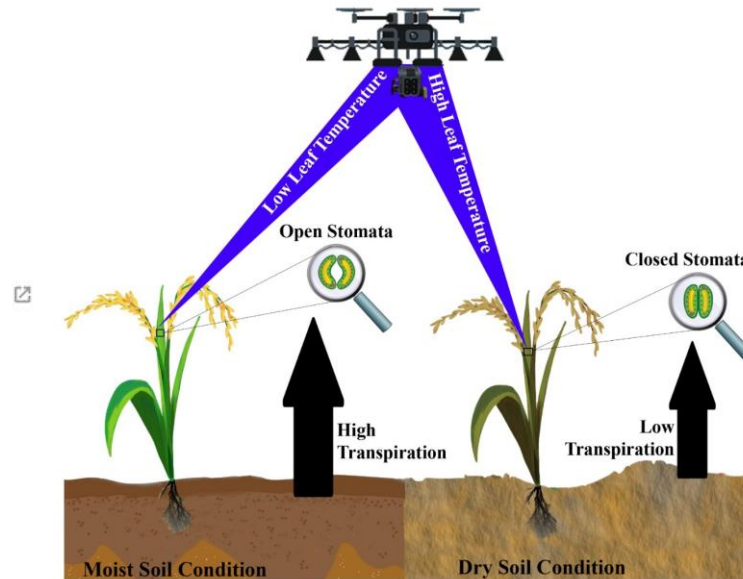
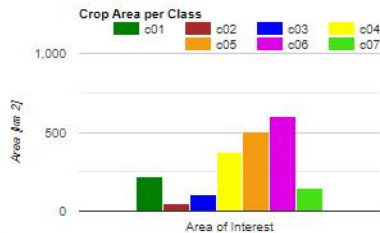
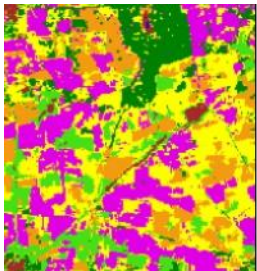
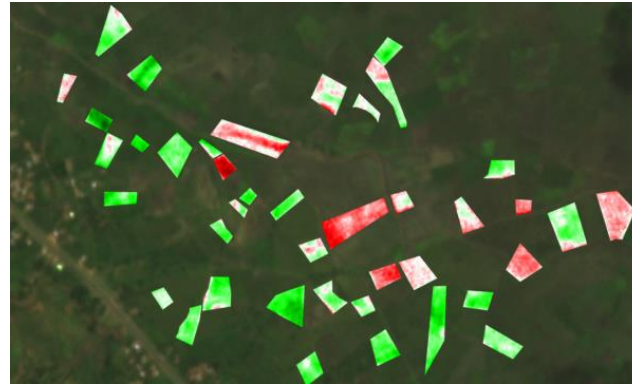
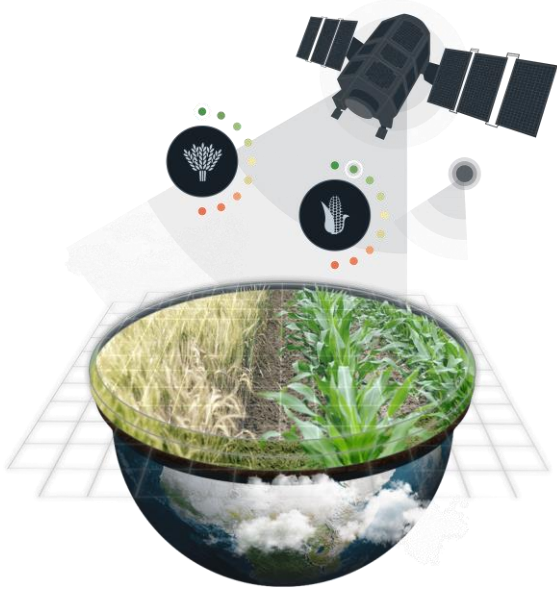
- **Big data ERA , improved computation capacity, rise of ML**
- **Challenges:**
 - Low availability of quality insitu data
 - Need for expertise for RS & Big data handling
- **Main Objective** is to support countries' capacity to consistently collect agricultural statistics through integrated earth 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



Importance of crop type mapping



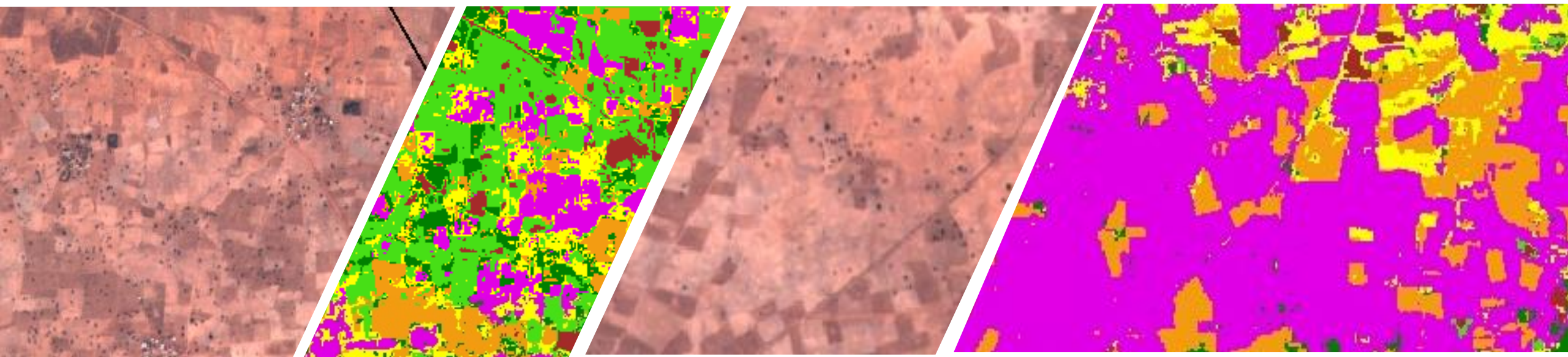
Reason for Action

Training Goal:

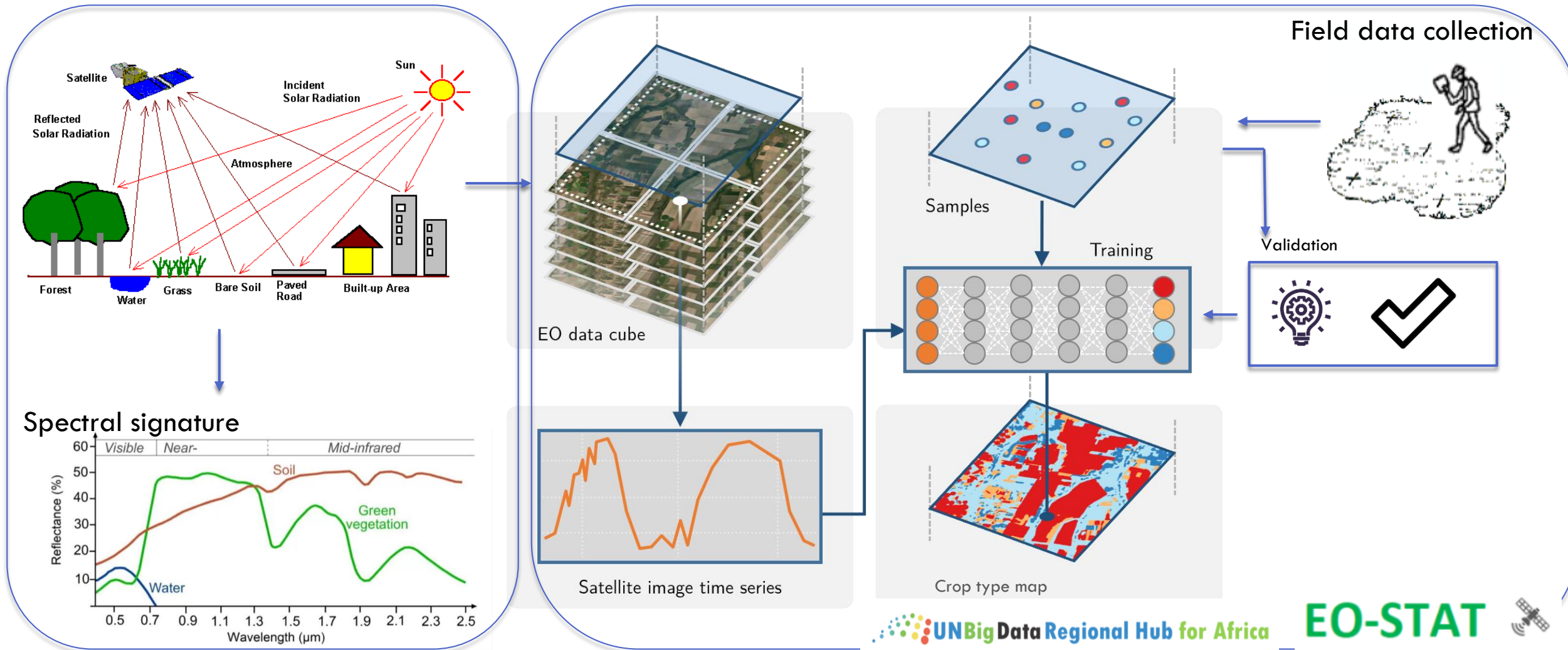
- *Understand the EO-STAT crop mapper methodology*
- *Enable the participants to be acquainted with EO-STAT crop mapping tool (no coding required).*
 - *Set up study area,*
 - *Define crop calendars*
 - *Load insitu samples and perform QA/QC*
 - *Run supervised classifier*
 - *User-friendly exploration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



EO-STAT CROP MAPPER METHODOLOGY



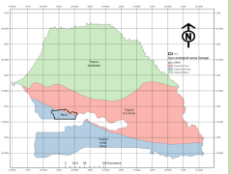

Supervised classification



Step 1 : Define AOI and load insitu data


Load region/samples

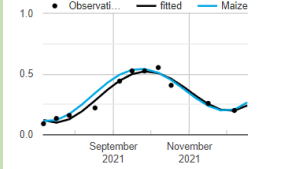
- Load crop library
- Load AEZ
- Load districts





1

Sample selection/ verification







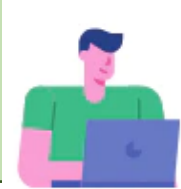
OK
Cancel

Longitude -15.85, Latitude 13.75


Crop Type Maize

Year 2021


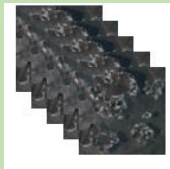
Season rainy_season



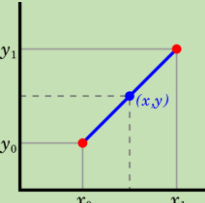
Acquisition of SITS at specific season



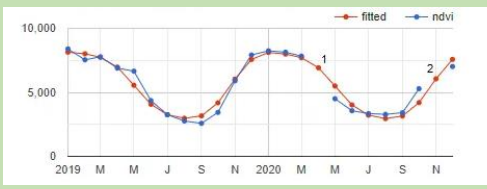
Cloud masking – S2 cloudless

Interpolation



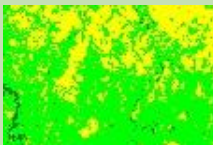

Linear interpolation



Harmonic model

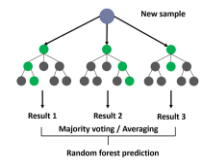
Feature selection

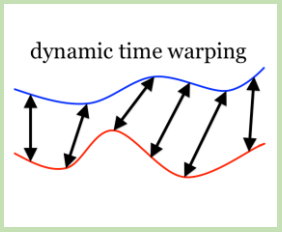
S2 BANDS - 'B2', 'B3', 'B11', 'B12', 'ndvi'
S1 – VV, VH

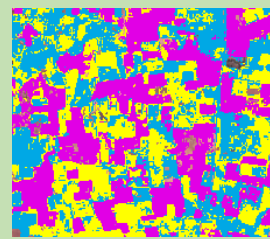



Crop type map Generation


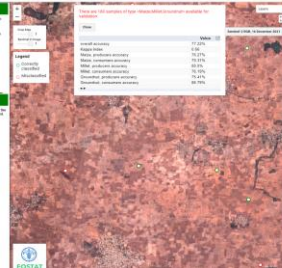

- Select number of samples for classification
- Agricultural season
- Sensors
- Algorithm





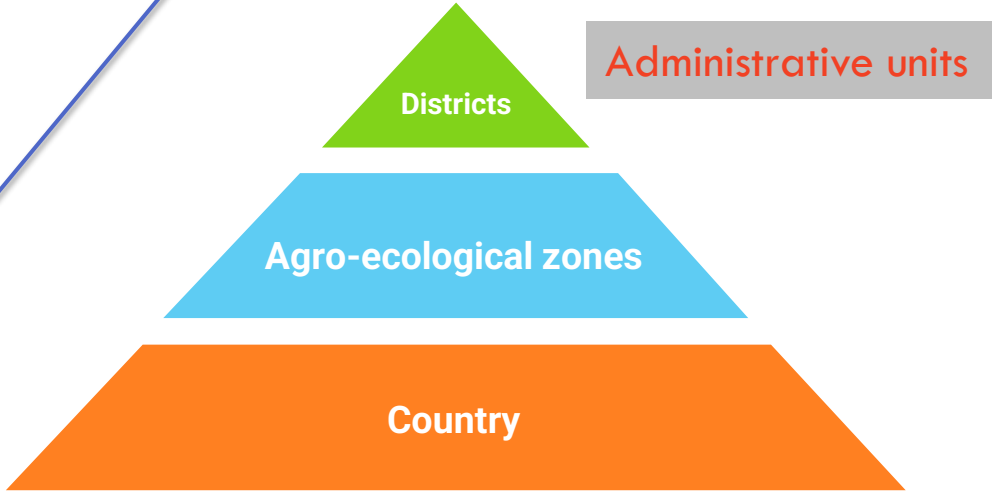
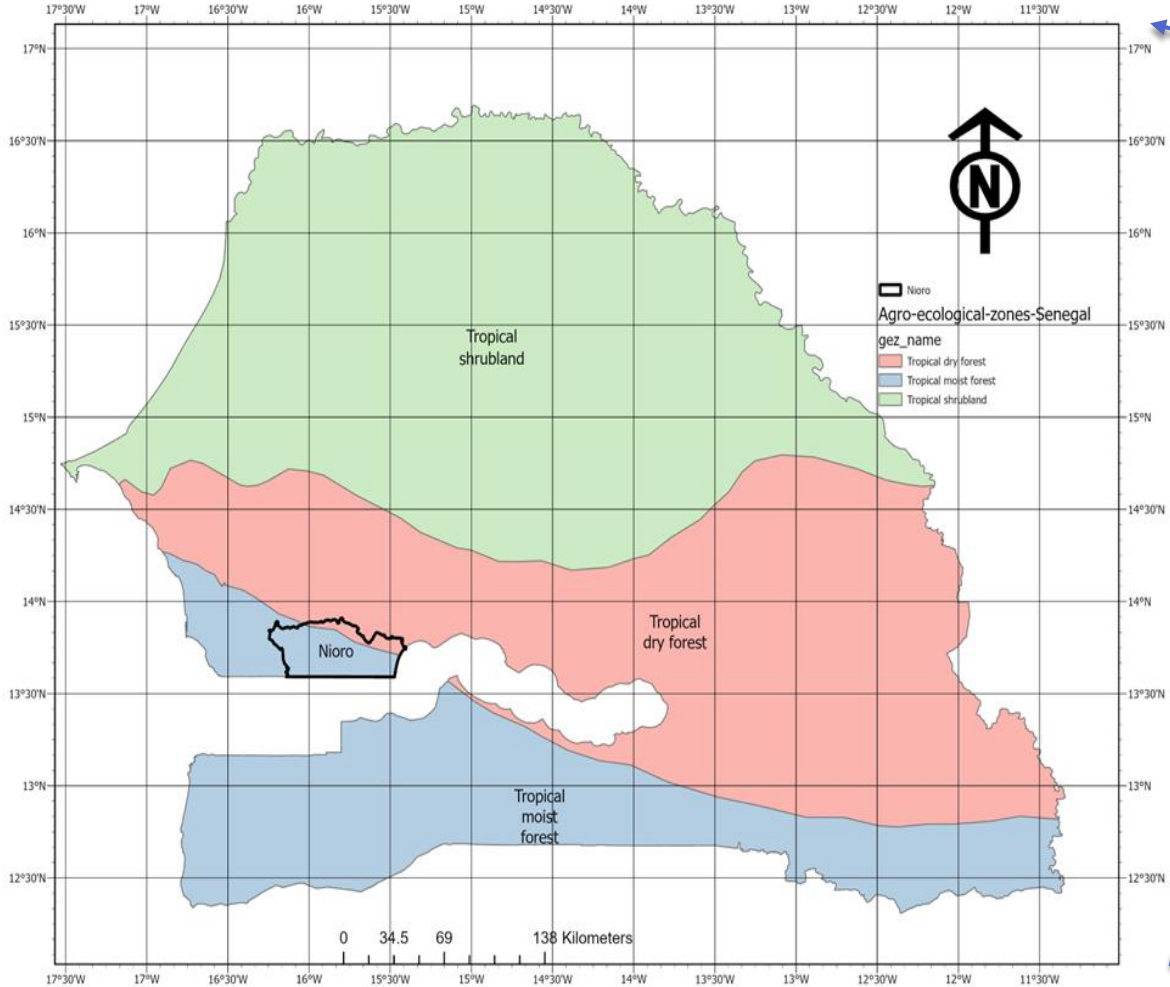


Validation, Visualize & Download map

Validation, Visualize & Download map

Define area of interest



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	<i>Class1</i>	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	<i>ClassNo1</i>	Number	Crop type ID attribute	Unique ID associated to every Crop Name. Only numbers between 1 and 50 are permitted.
Year	<i>Year</i>	Number	Year of observation	
Period	<i>Season</i>	String	Validity period of observation	Use one of the following: <ul style="list-style-type: none"> • <u>"rainy_season"</u> • <u>"dry_season"</u> • <u>"rainy_season&dry_season"</u>

Asset details DELETE SHARE IMPORT Edit

Table: signatures_20231018_0000



Table ID

Date
Start date: NA
End date: NA

File Size 18.26KB

Number of Features 240

Last modified 2023-10-18 13:37:32 UTC

DESCRIPTION		FEATURES		PROPERTIES	
Feature Index	Class1 (String)	ClassNo1 (Long)	Season (String)	Year (Integer)	system:index (String)
0	Maize	4	rainy_season	2021	
1	Maize	4	rainy_season	2021	
2	Maize	4	rainy_season	2021	
3	Maize	4	rainy_season	2021	
4	Maize	4	rainy_season	2021	
5	Maize	4	rainy_season	2021	
6	Maize	4	rainy_season	2021	
7	Maize	4	rainy_season	2021	
8	Maize	4	rainy_season	2021	
9	Maize	4	rainy_season	2021	


*Limited to the first 10 features.

CLOSE

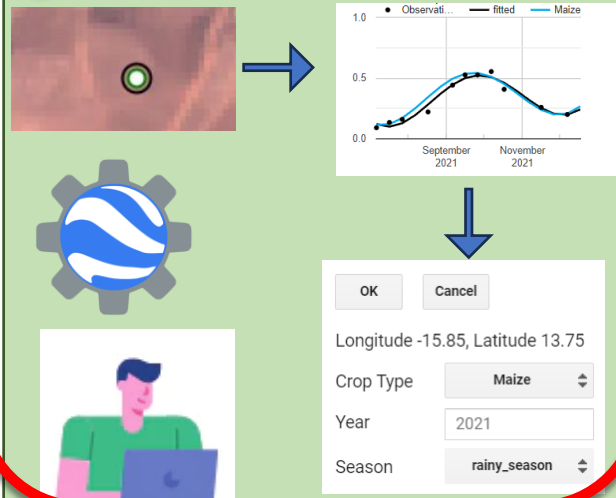
Step 2: QA/QC of insitu points

1 Load region/samples

- Load crop library
- Load AEZ
- Load districts



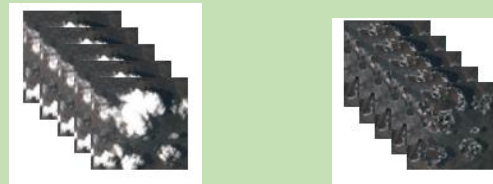
2 Sample selection/verification



3 Acquisition of SITS at specific season

↓

Cloud masking – S2 cloudless



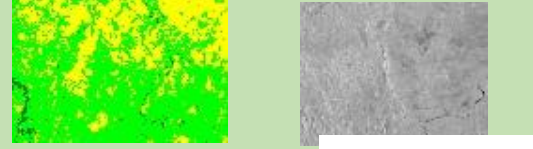
Interpolation



Linear interpolation Harmonic model

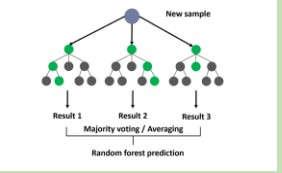
Feature selection

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

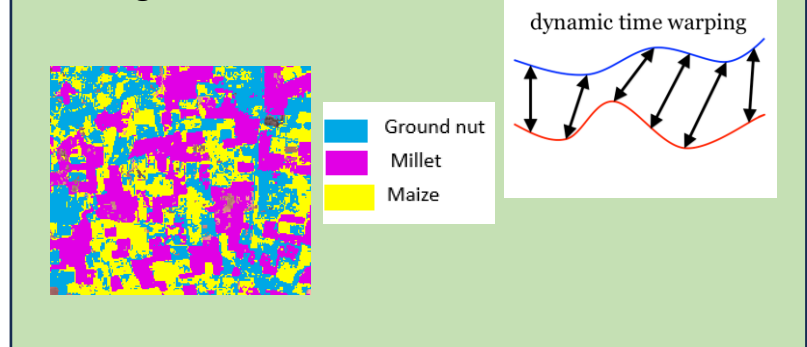


4 Crop type map Generation

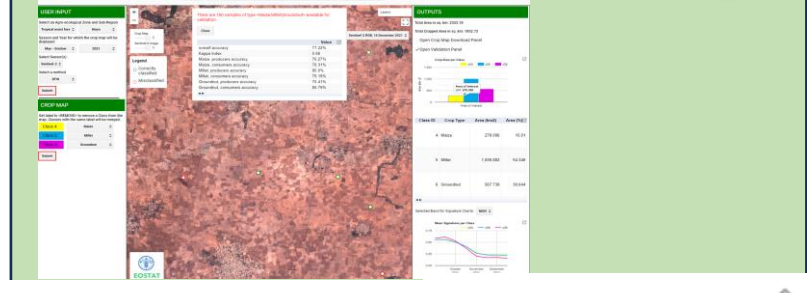
- Select number of samples for classification
- Agricultural season
- Sensors
- Algorithm



dynamic time warping

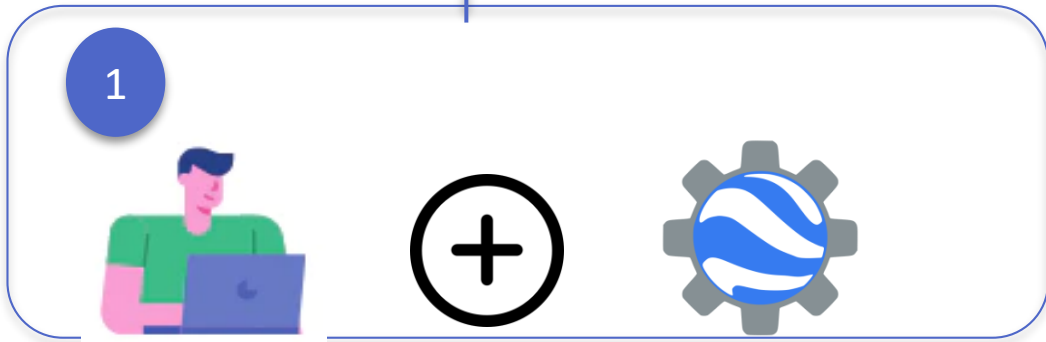
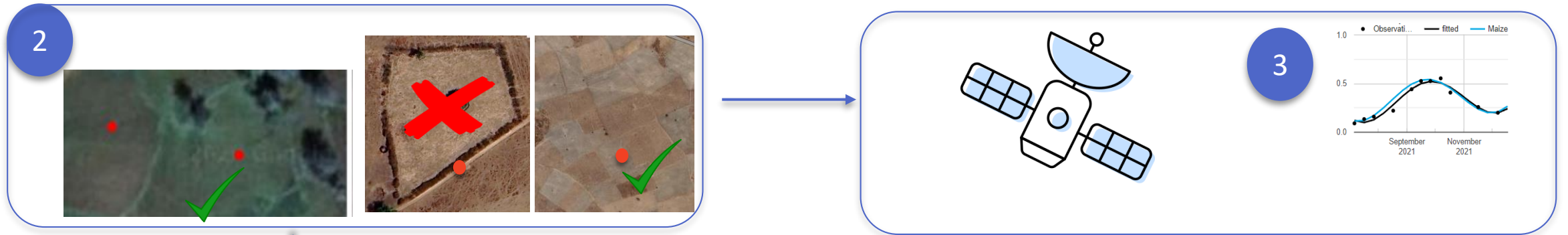


Validation, Visualize & Download map 5



2


In situ data QA/QC on eo-stat tool



Step 3: Satellite image preparation

1 Load region/samples


- Load crop library
- Load AEZ
- Load districts



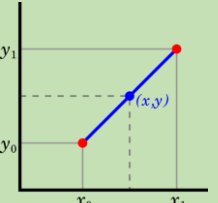
3 Acquisition of SITS at specific season

↓

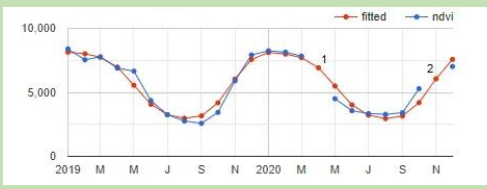
Cloud masking – S2 cloudless



Interpolation



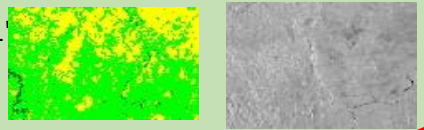
Linear interpolation



Harmonic model

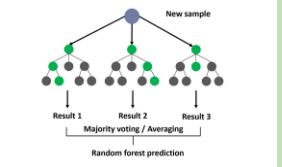
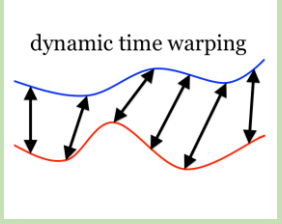
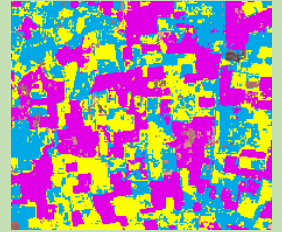
Feature selection

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




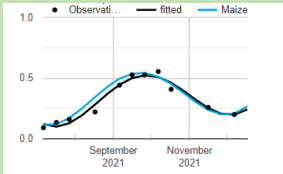

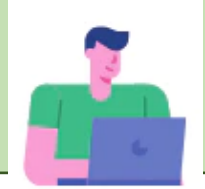
4 Crop type map Generation

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

Ground nut
Millet
Maize

2 Sample selection/ verification

OK Cancel

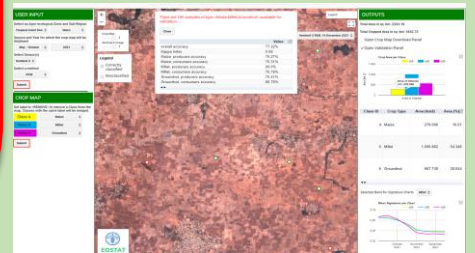
Longitude -15.85, Latitude 13.75

Crop Type

Year

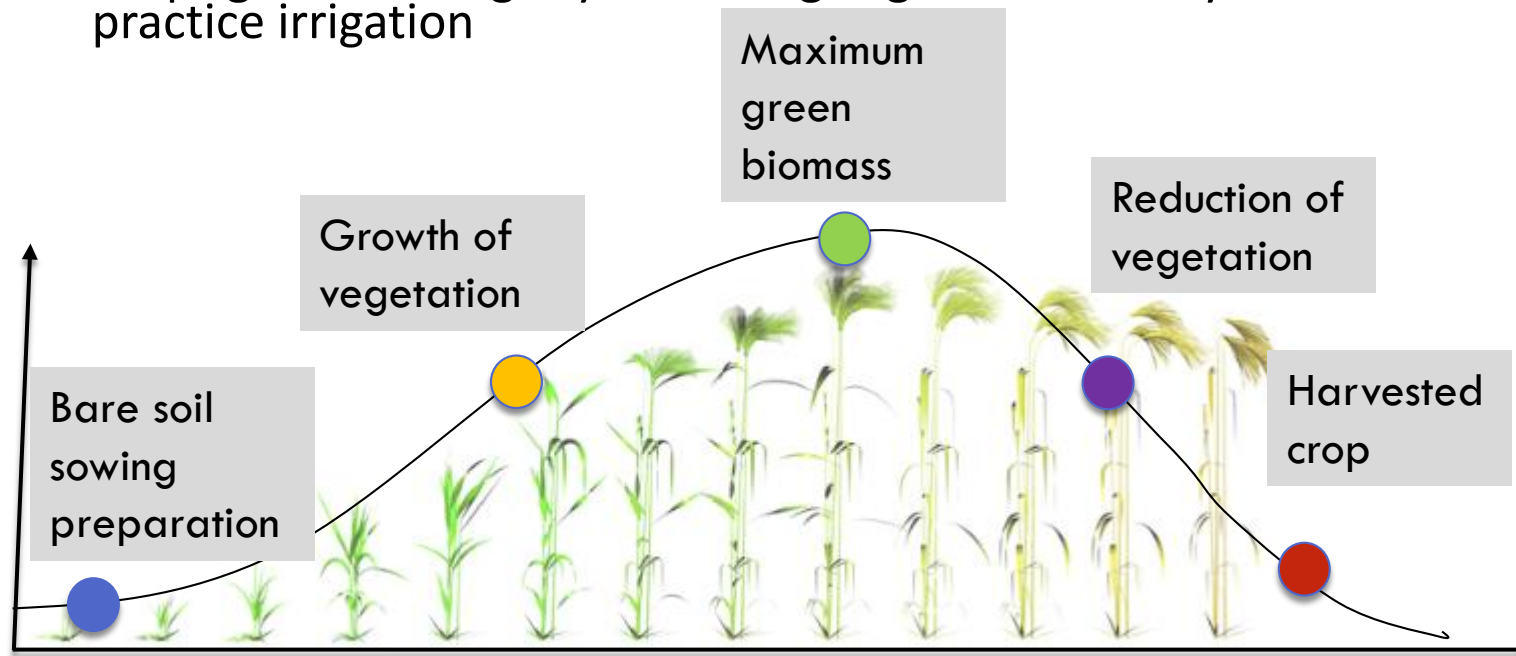
Season

5 Validation, Visualize & Download map

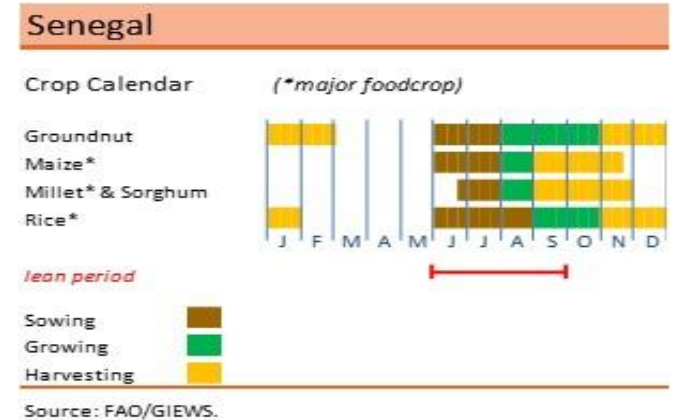


Select crop seasons

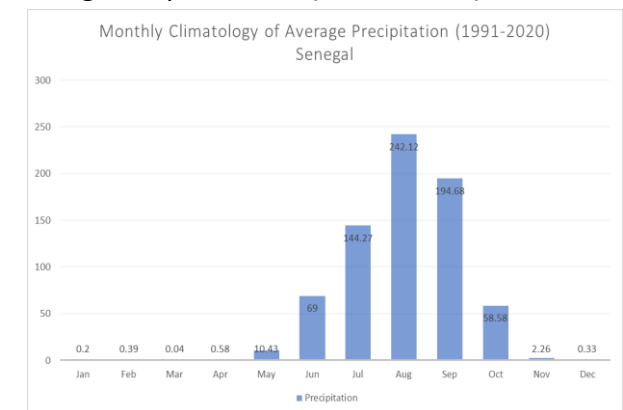
- Seasons used include:
 - Rainy season - lies between June to November
 - Dry season - January to May
- Most farmers grow crops during rainy season
- Crops grown during dry season eg vegetables mainly practice irrigation



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)

The following sensors are used in EO-stat Senegal tool

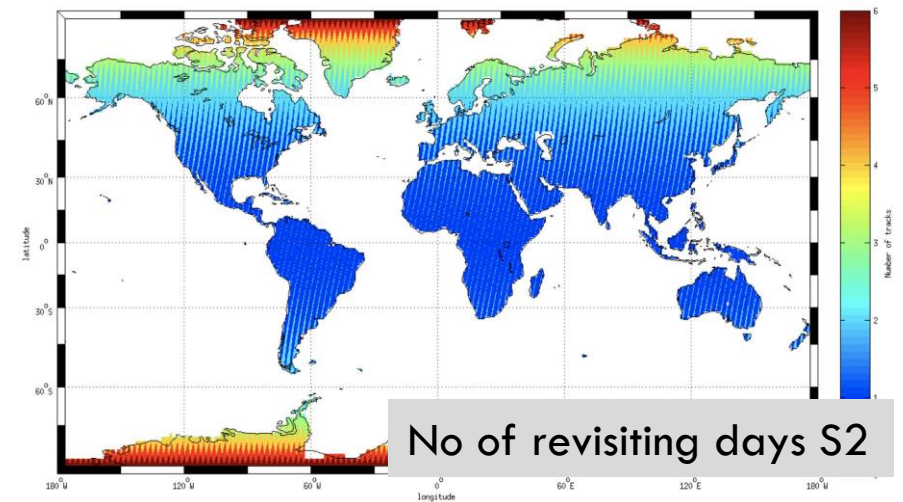
- Sentinel-1 and Sentinel-2
- Sentinel-2

Sentinel 1

- Type : Radar
- Temporal resolution: one image every 6 days
- Spatial resolution: 10m
- Used bands: VV, VH

Sentinel 2

- Type: Optical
- Temporal resolution: one image every 5 days
- Spatial resolution : 10m
- Used bands : Green, Blue, SWIR1,SWIR2,NDVI



Atmospheric perturbations

High Resolution Viewer

SETTINGS

Region

SN - Dakar

Satellite

Landsat 8 and 9

MAP STATS

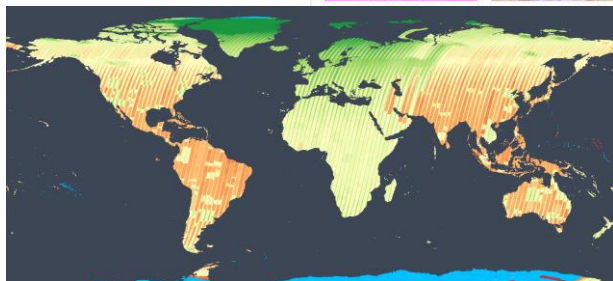
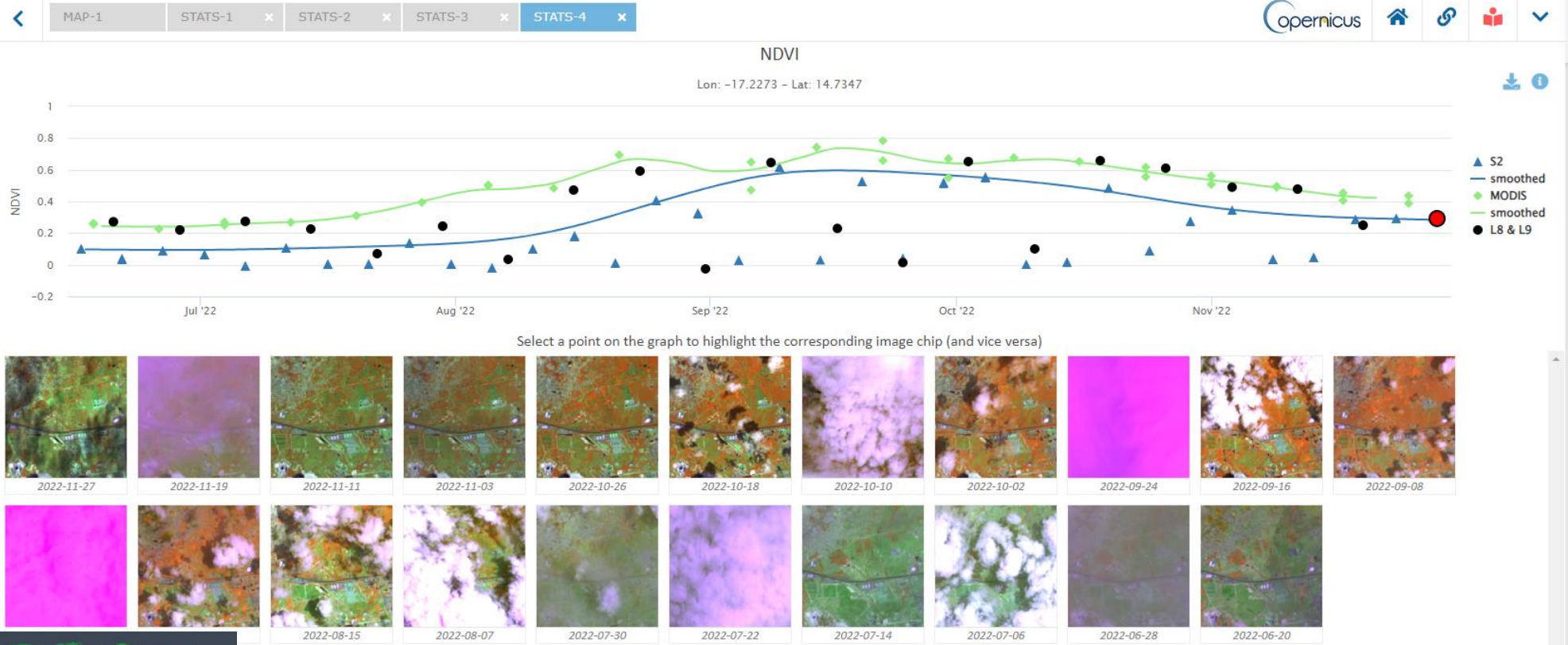
POINT

-17.2273 14.7347

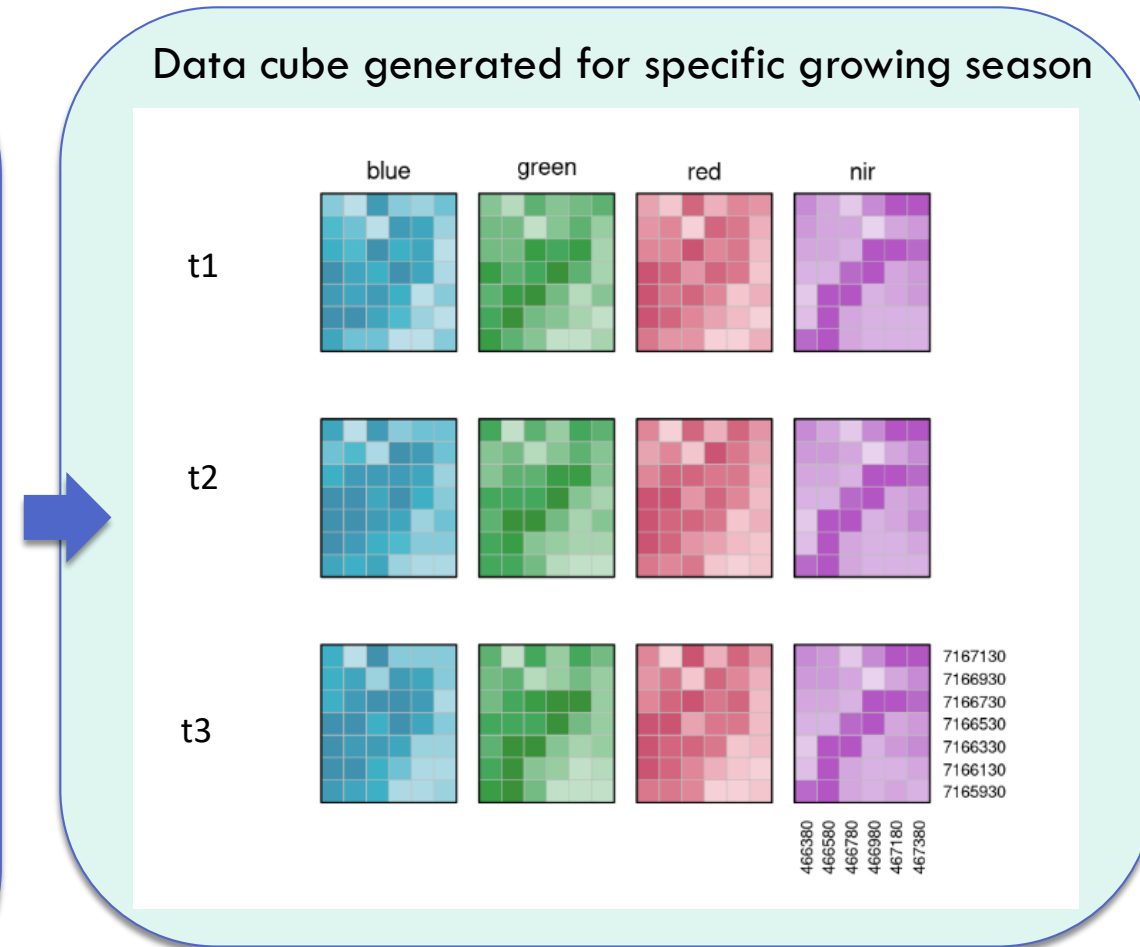
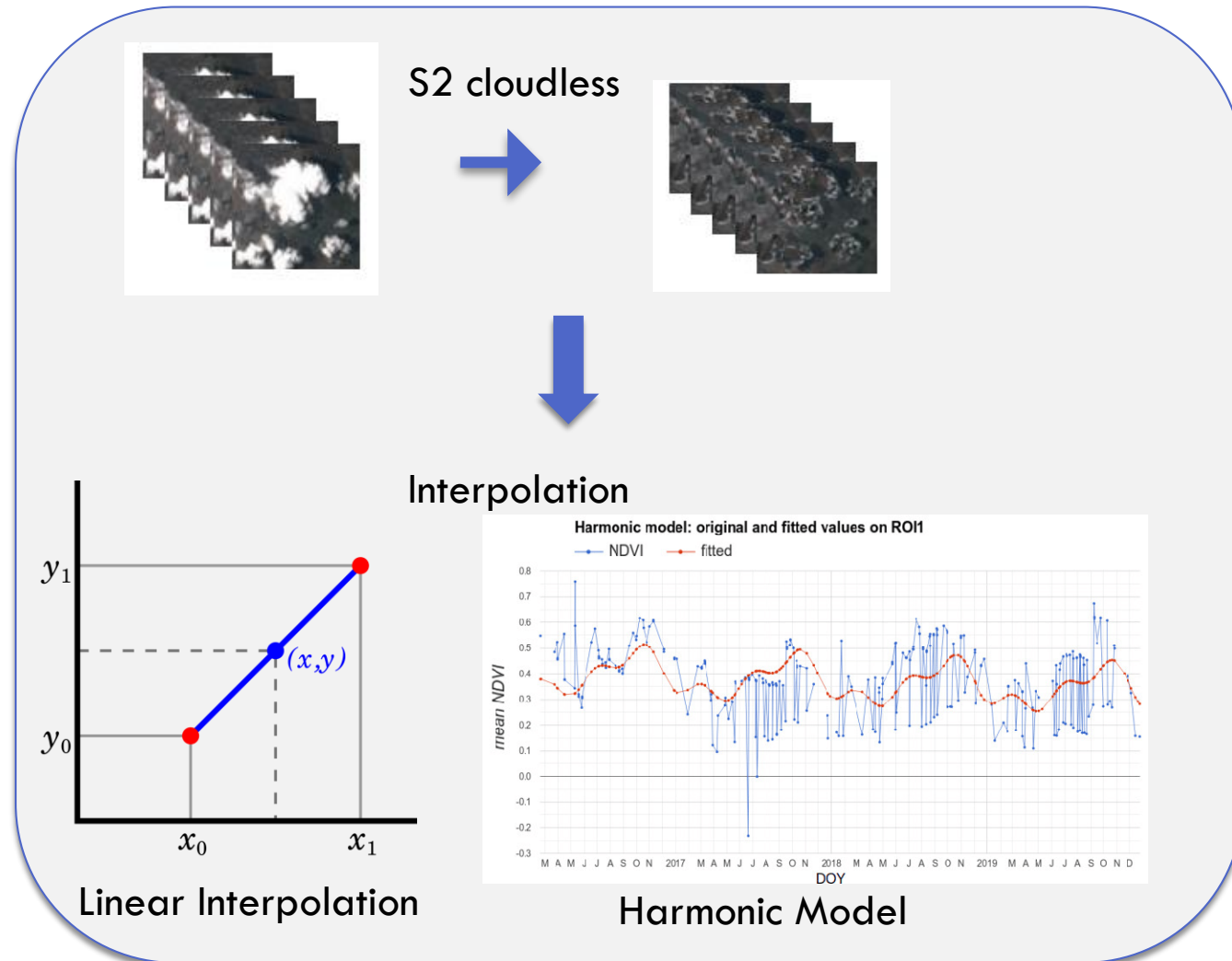
Time Period

14 Jun 2022 30 Nov 2022

Get stats




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




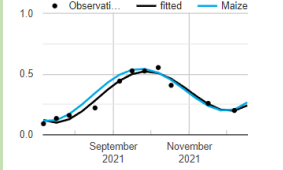
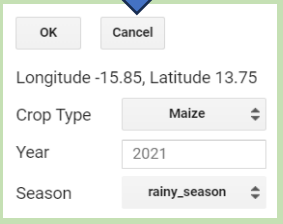
Step 4: Crop map generation

1 Load region/samples

- Load crop library
- Load AEZ
- Load districts




3 Sample selection/ verification

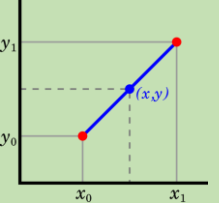
2 Acquisition of SITS at specific season

Cloud masking – S2 cloudless




Interpolation

Linear interpolation




Harmonic model



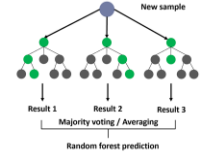
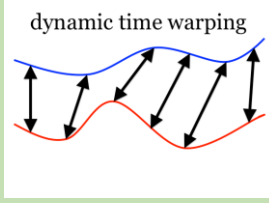
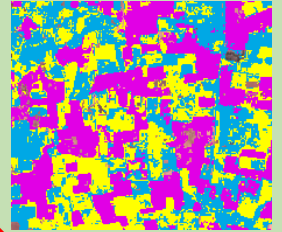
Feature selection

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




4 Crop type map Generation

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

5 Validation, Visualize & Download map

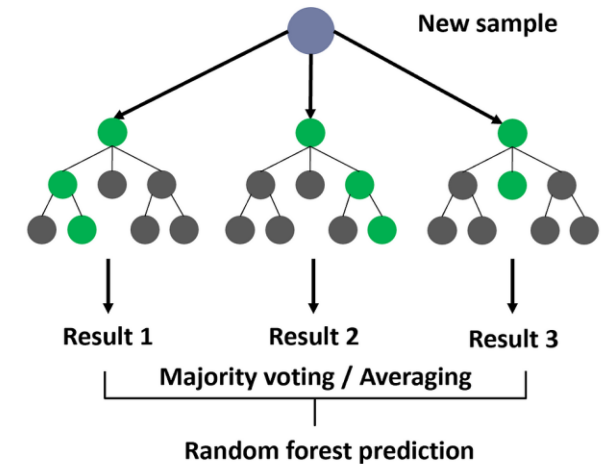
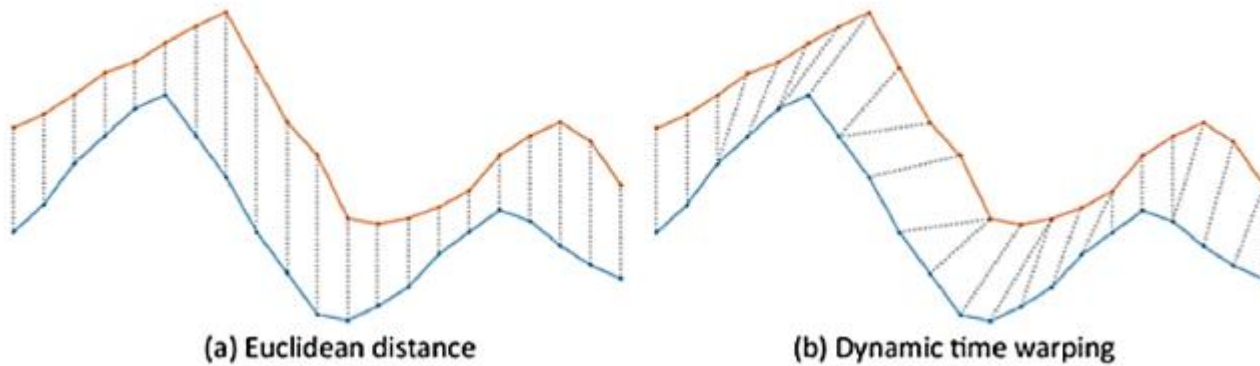




Crop type classification algorithms

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).




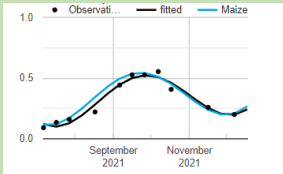
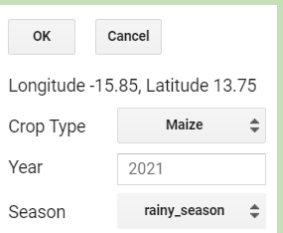
Step 5: Accuracy assessment & Visualization of results

1 Load region/samples

- Load crop library
- Load AEZ
- Load districts

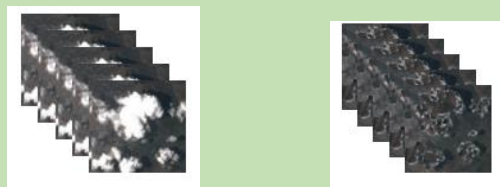


3 Sample selection/ verification

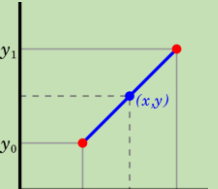
2 Acquisition of SITS at specific season

Cloud masking – S2 cloudless




Interpolation

Linear interpolation

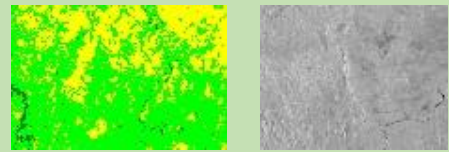


Harmonic model



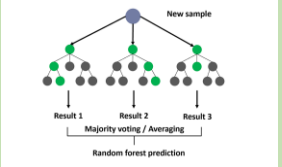
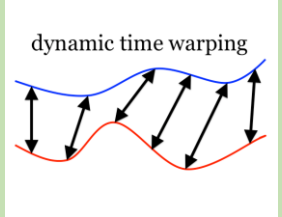
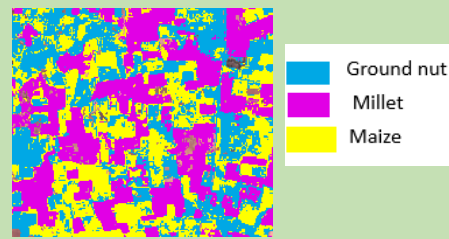
Feature selection

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




4 Crop type map Generation

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

5 Validation, Visualize & Download map



The tool provides four types of accuracy metrics:

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

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%

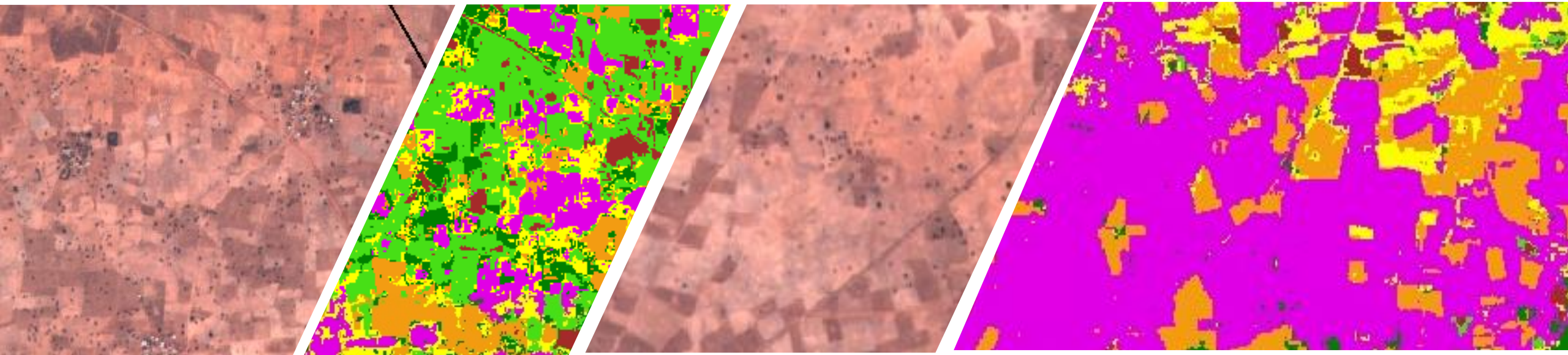
OA

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

Confusion matrix

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

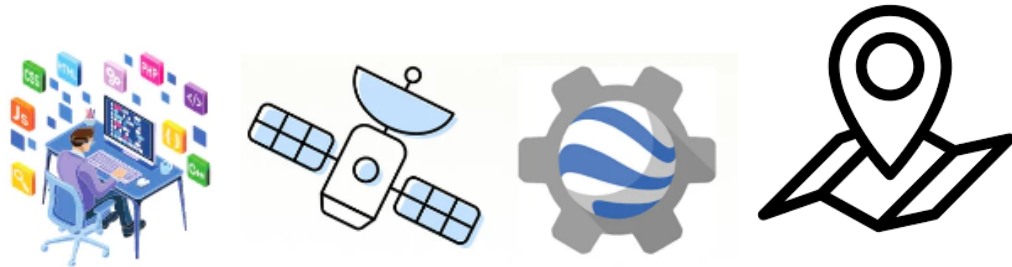
EO-STAT CROP MAPPER COMPONENTS



Eo-stat crop mapper components

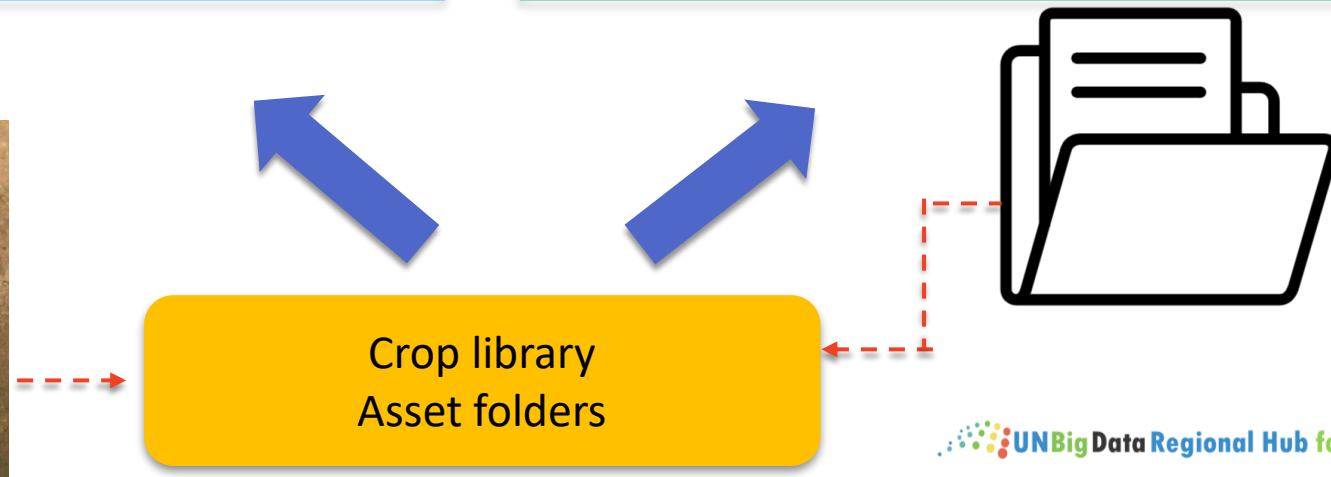
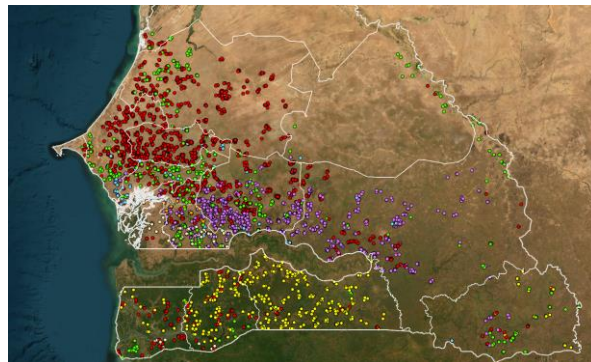
Admin tool

- 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.



Administrator tool

The screenshot displays the EO-STAT Administrator tool interface, which is used for crop mapping and analysis. The interface is divided into several sections:

- USER INPUT:** A sidebar on the left containing dropdown menus for 'Select a Library' (SEN_crop_library/signatures_20231023_0000), 'Select an Agro-ecological Zone' (Tropical moist forest), 'Select a District' (Nioro), and 'Select the Season and a Year' (rainy_season, 2021). It also features a 'Search for samples' button and a section for 'Select an existing sample or add a new point' with options for 'Maize_0', 'ADD NEW SAMPLE', and 'VALIDATE ALL'. At the bottom of this sidebar are 'Actions' like 'Remove Point', 'Verify/Change Attributes', and 'Change Coordinates', and a 'CROP MAP EXPORT' button.
- Map:** A central satellite map showing a rural landscape. A red dot indicates a selected sample point. A legend identifies 'Verified samples' (green circle) and 'Unverified samples' (red circle). A 'Sentinel-2 RGB, 11 December 2021' label is visible above the point. A 'Waiting for instructions...' message is at the top of the map area. The 'EOSTAT' logo is in the bottom right corner of the map.
- Charts:** On the right side, there are two charts. The top chart is a bar graph titled 'Number of Points' showing the count for various land cover classes: Maize (~90), Groundnuts (~250), Bare soils (~10), Shrub land (~40), and Temporary riv... (~10). The bottom chart is a line graph titled 'Mean NDVI signatures - Crops in AOI' showing NDVI values from September 2021 to November 2021 for 'Bare s...' (red) and 'Cow p...' (blue). Below it is another line graph titled 'Maize_0 and mean NDVI Signature of selected Crop' showing 'Observati...' (black dots), 'fitted' (black line), and 'Maize' (blue line) NDVI signatures over the same period.

End user Tool

USER INPUT

Select an Agro-ecological Zone and Sub-Region
 Tropical moist fore | Niara

Season and Year for which the crop map will be displayed
 July - October | 2021

Select Sensor(s)
 Sentinel-2

Select a method
 DTW

Submit

CROP MAP

Set label to «REMOVE» to remove a Class from the map. Classes with the same label will be merged.

Class 1	Forest
Class 2	Urban
Class 3	Permanent rivers and str.
Class 4	Maize
Class 5	Millets
Class 6	Groundnuts
Class 7	Cow peas
Class 8	Bare soils
Class 10	Shrub land

Submit

↑
CLICK HERE TO CHANGE LABELS

Layers

Sentinel-2 RGB, 16 December 2021

Crop Map: 1
Sentinel-2 Image: 1

Click on the map to select a Point of Interest

Total Cropped Area in sq. km: 2255.09

Open Crop Map Download Panel

Open Validation Panel

Crop Area per Class

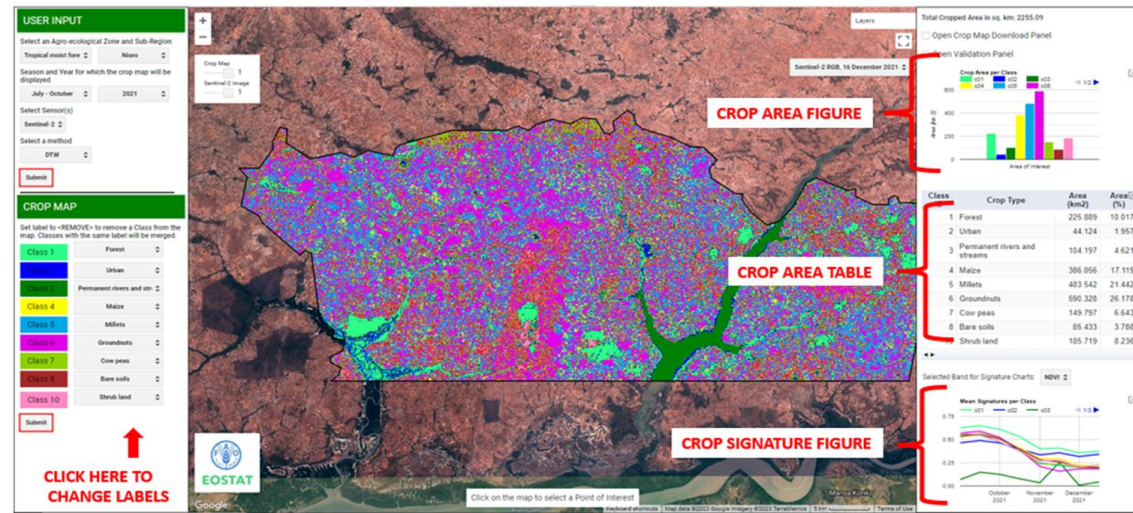
Class	Crop Type	Area (km2)	Area (%)
1	Forest	225.089	10.017
2	Urban	44.124	1.957
3	Permanent rivers and streams	104.197	4.621
4	Maize	386.056	17.119
5	Millets	483.542	21.442
6	Groundnuts	590.328	26.178
7	Cow peas	149.797	6.643
8	Bare soils	85.433	3.768
10	Shrub land	185.719	8.236

Selected Band for Signature Charts: NDVI

Mean Signatures per Class



App architecture



User provided inputs

Feed results back to GEE App Interface



ANY QUESTIONS?

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

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



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