First results to detect deforestation using Surface Water Ocean Topography (SWOT) observations : case of the Pacific Coast of Ecuador

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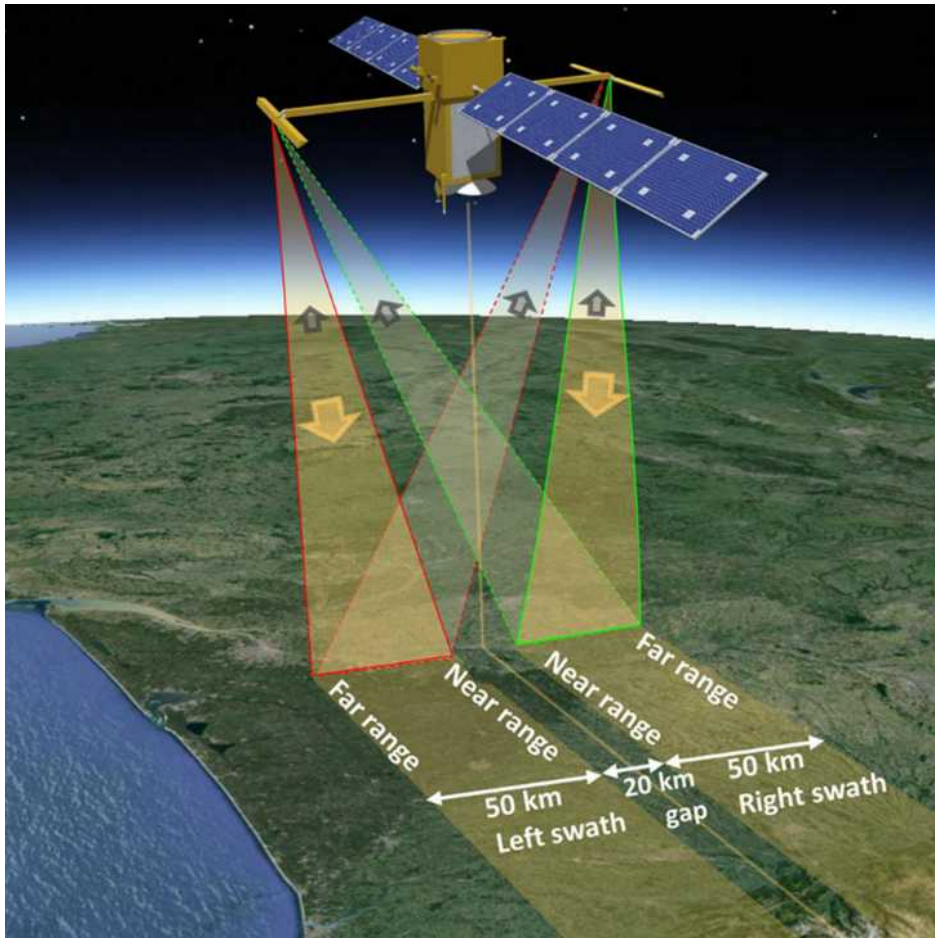
INTRODUCTION

Significant breakthrough in radar remote sensing of terrestrial and ocean water surfaces



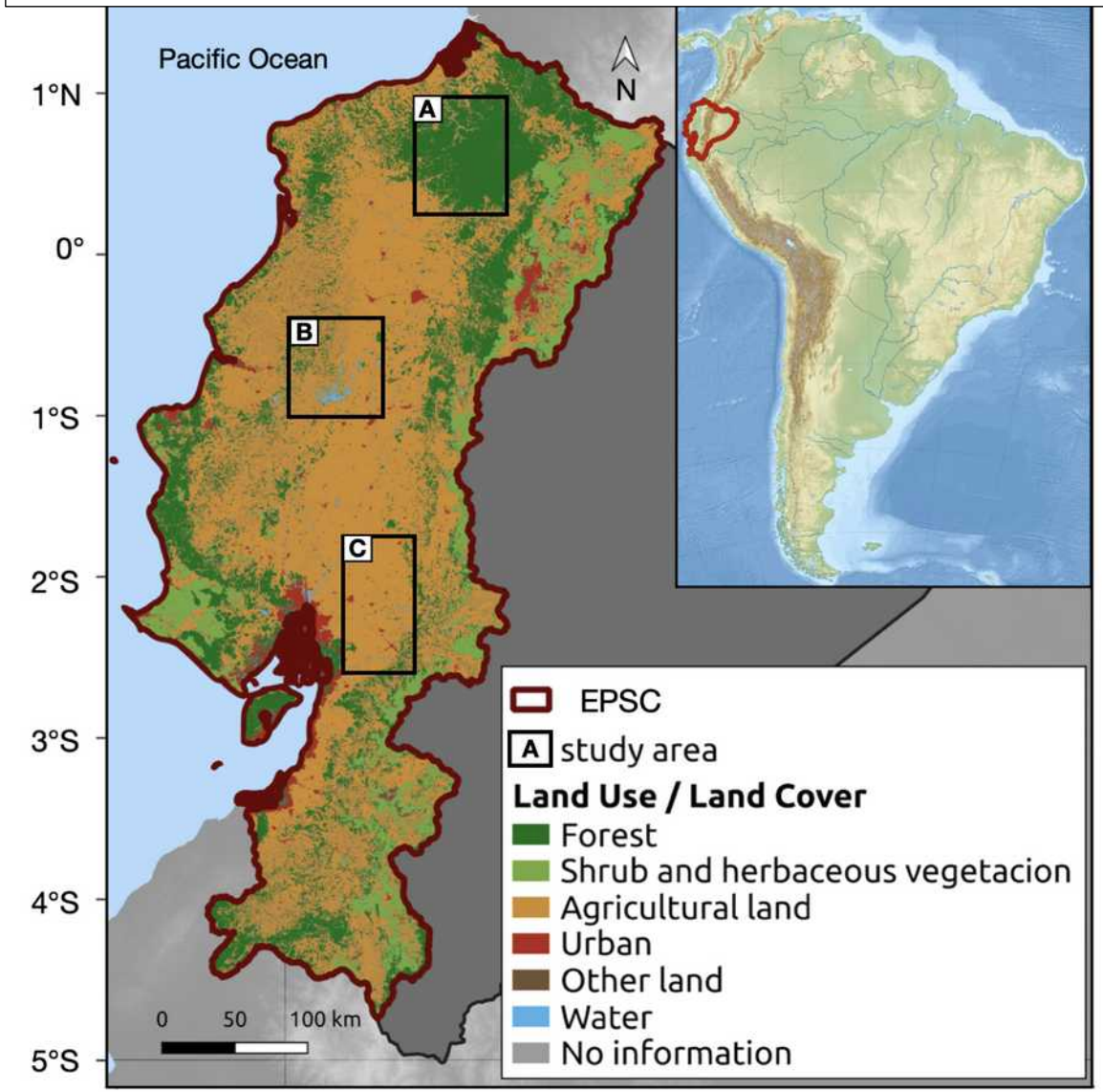
SWOT mission launched in 2022
International collaboration

Advanced technology : Ka-band Radar Interferometer (KaRIn)

Scientific advances : overcomes the limitations of traditional altimetry missions at nadir
Limits : increased data dispersion over steep gradients and densely vegetated areas (Normandin et al., 2024)

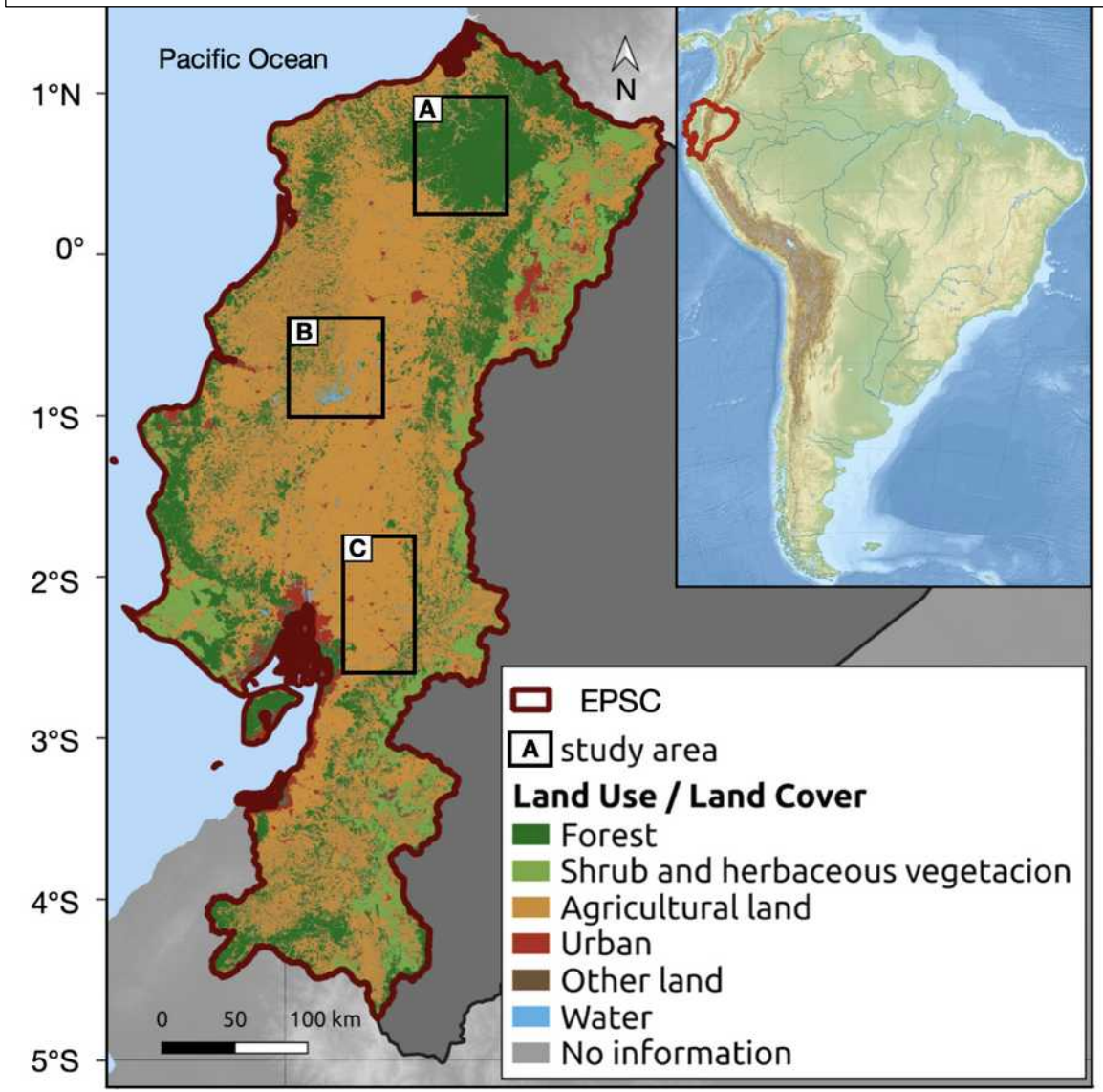
New applications : innovative application of SWOT to monitor deforestation

STUDY AREA : the Pacific Coast of Ecuador



Zone A : in the north with the rain-fed bioclimate is home to tropical rainforests

STUDY AREA : the Pacific Coast of Ecuador



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Zone B : in the middle with a less humid climate with seasonal tropical forest and a more marked anthropic influence.

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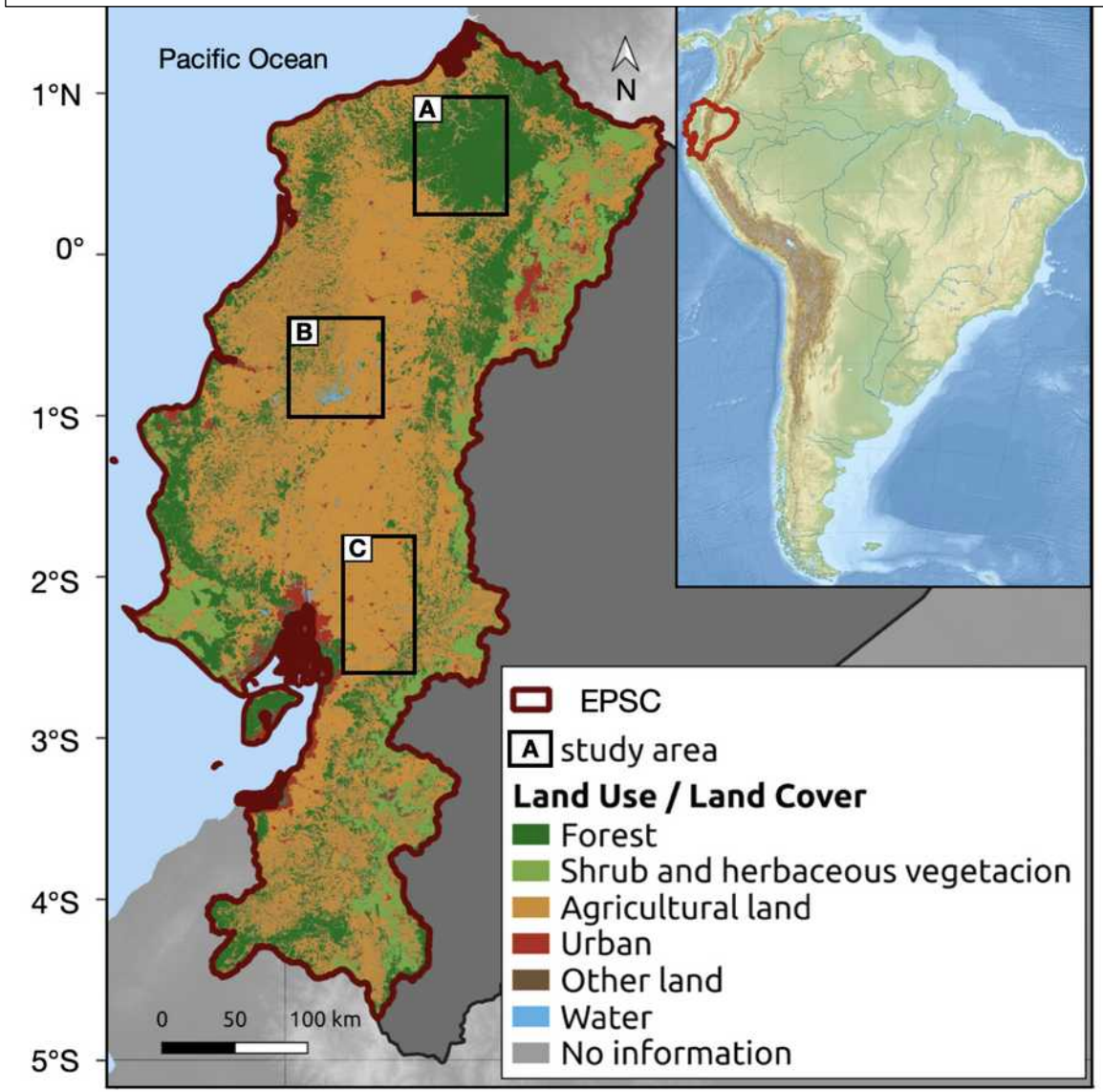

Zone A : in the north with the rain-fed bioclimate is home to tropical rainforests

Zone B : in the middle with a less humid climate with seasonal tropical forest and a more marked anthropic influence.

Zone C : further south, which has been largely anthropized and contains most of the country's cultivated land.

DATASETS

SWOT gridded data
Level 2 High-Resolution Raster product (L2_HR_Raster)

- Spatial resolution : 100m
- Temporal resolution : 21 days
- Variables :
  - Backscatter coefficient (Sigma0)
- Quality layers : Values of 0, 1, 2 and 3 indicate good, suspect, degraded and bad measurement, respectively.

In this study, we analyzed the data available for the **year 2024**.

Reference LULC maps produced by the Ecuadorian Ministry of the Environment

- Spatial resolution : 30m
- LULC maps are available for 1990, 2000, 2008, 2014, 2016, 2018, 2020 and 2022.
- Landsat images and corrected by field data

The three steps of the methodology

STEP 1
SWOT Data Processing (Filtering)

STEP 2
Classification of SWOT data into 4 classes with machine learning model (SVM)

STEP 3
Comparison of SWOT classification with Ministry data : Confusion matrix

METHOD AND RESULTS

STEP 1 : SWOT Data Processing (Filtering)

Two filters are applied

- Filter out pixels of poor quality : All pixels with a quality index greater than or equal to 2 (degraded and bad measurement) are removed.

- Filter out noise : All isolated pixel groups of less than three pixels are removed.

METHOD AND RESULTS

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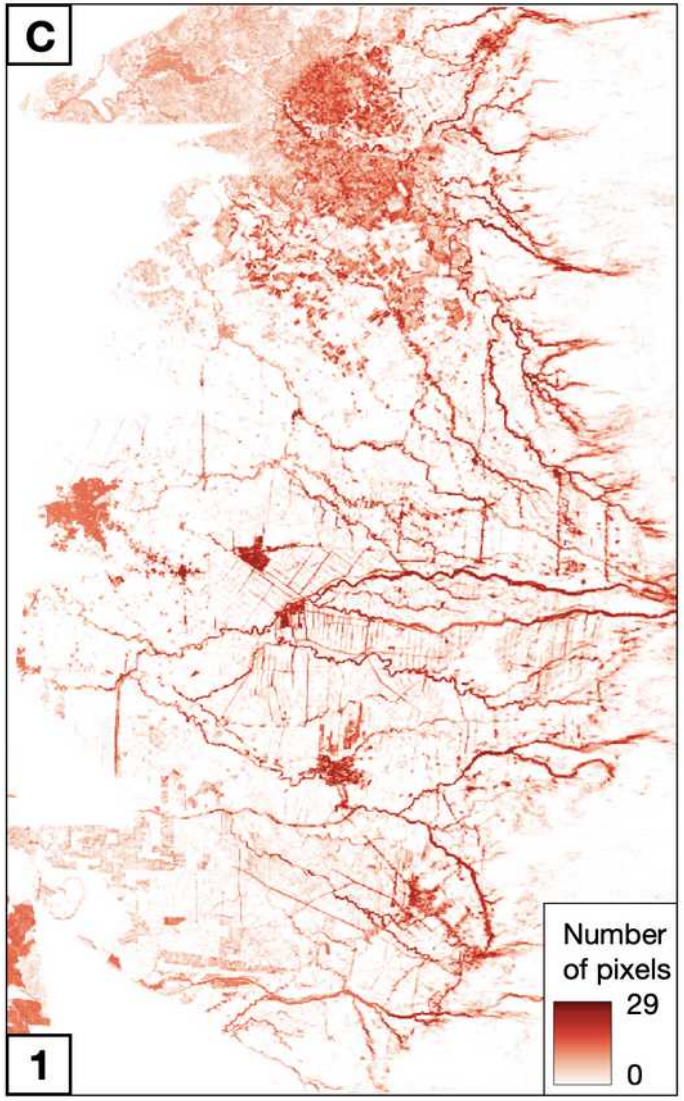
- calculate the number of occurrences of each pixel on all rasters (for the year 2024) : Layer 1



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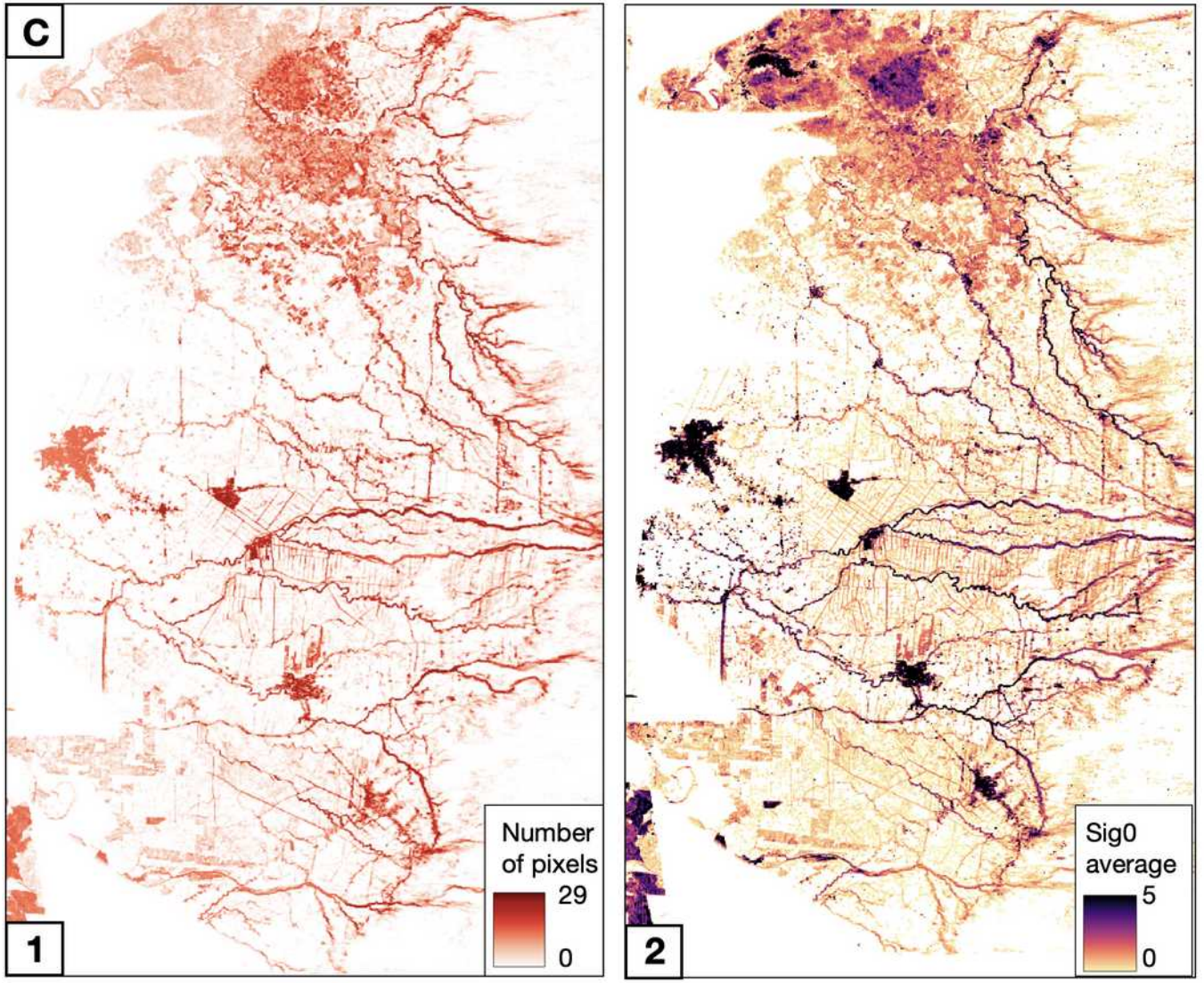
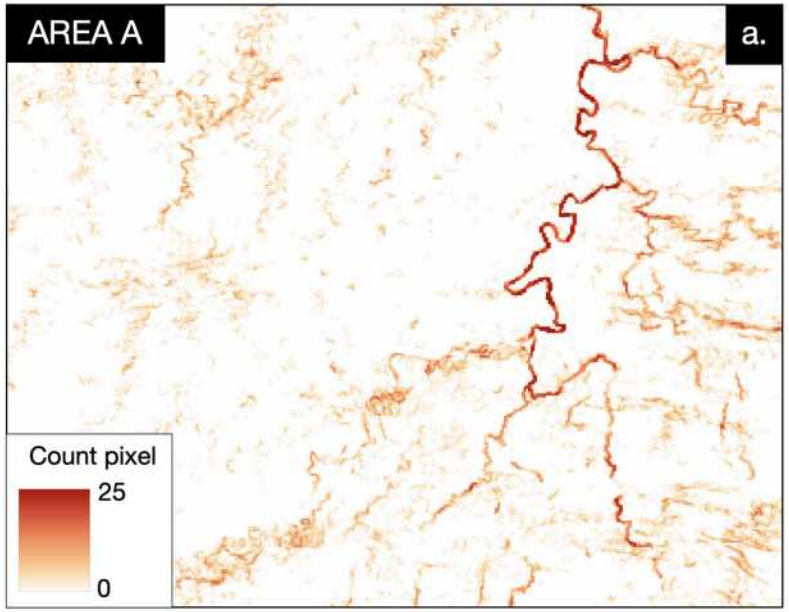
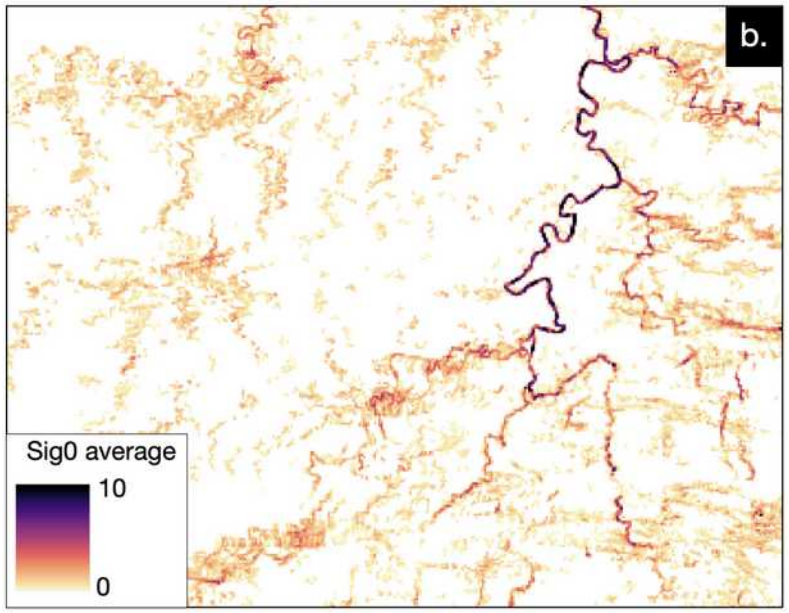
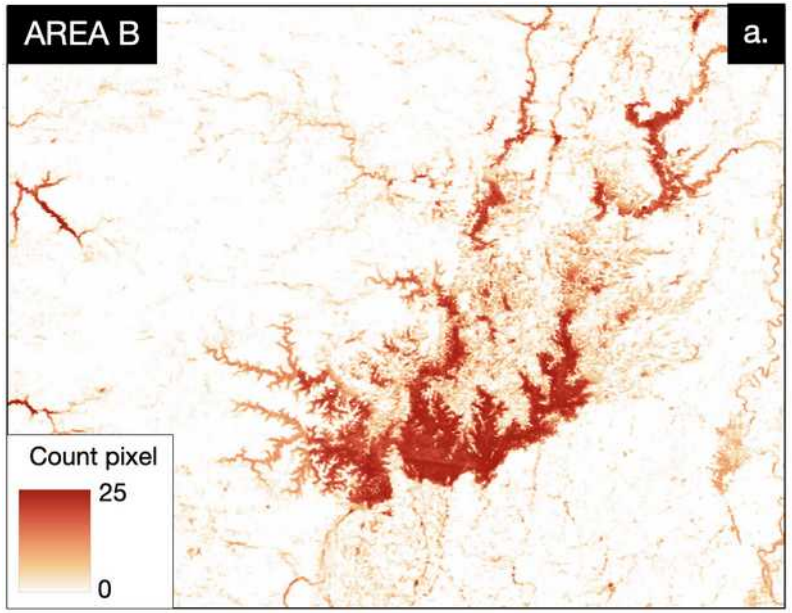
- Calculate the average of sigma0 for each pixel : Layer 2

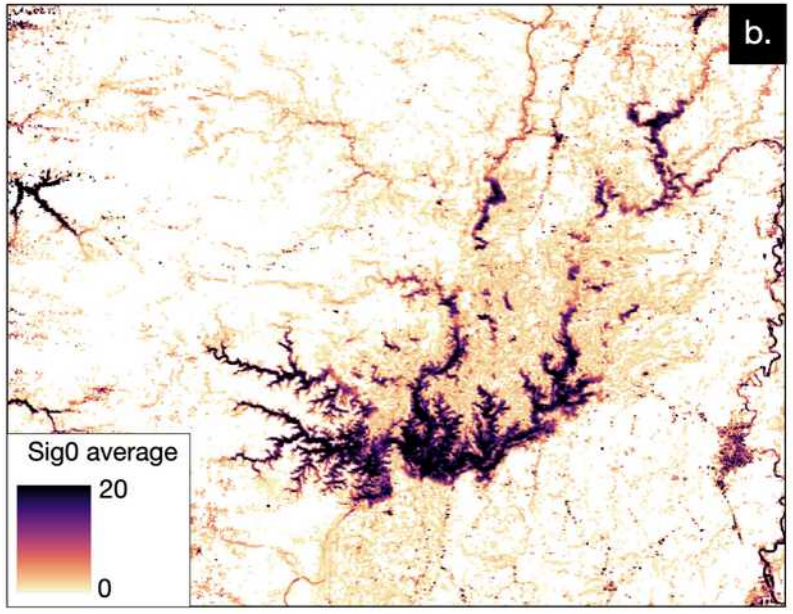


METHOD AND RESULTS





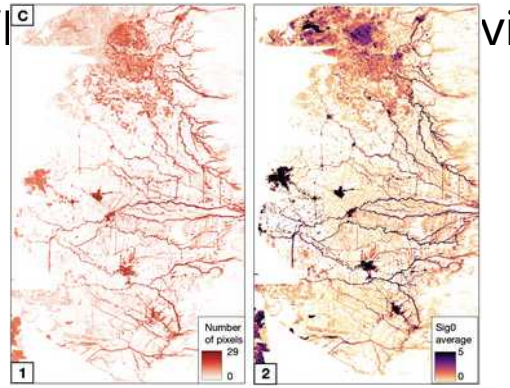




METHOD AND RESULTS

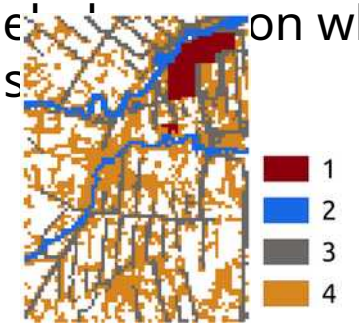
STEP 2 : Classification of SWOT data into 4 classes with machine learning model (SVM)

- At the SVM step, we combine the previous layers



- Small hand-labeled region on which the SVM will learn to classify :

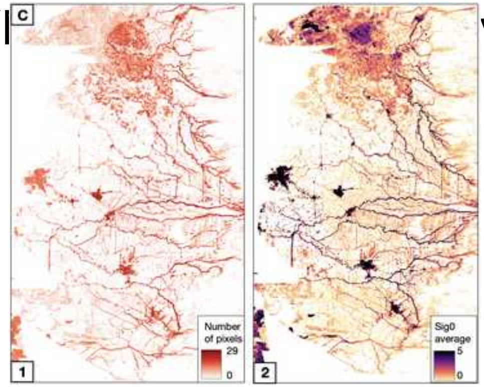
1. City
2. River
3. Road
4. Cropland



METHOD AND RESULTS

STEP 2 : Classification of SWOT data into 4 classes with machine learning model (SVM)

- At the SVI vious layers



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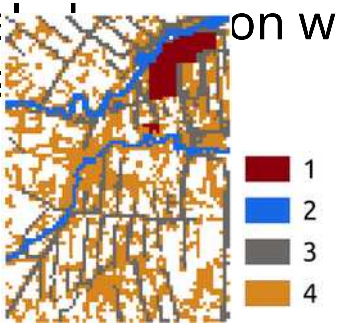
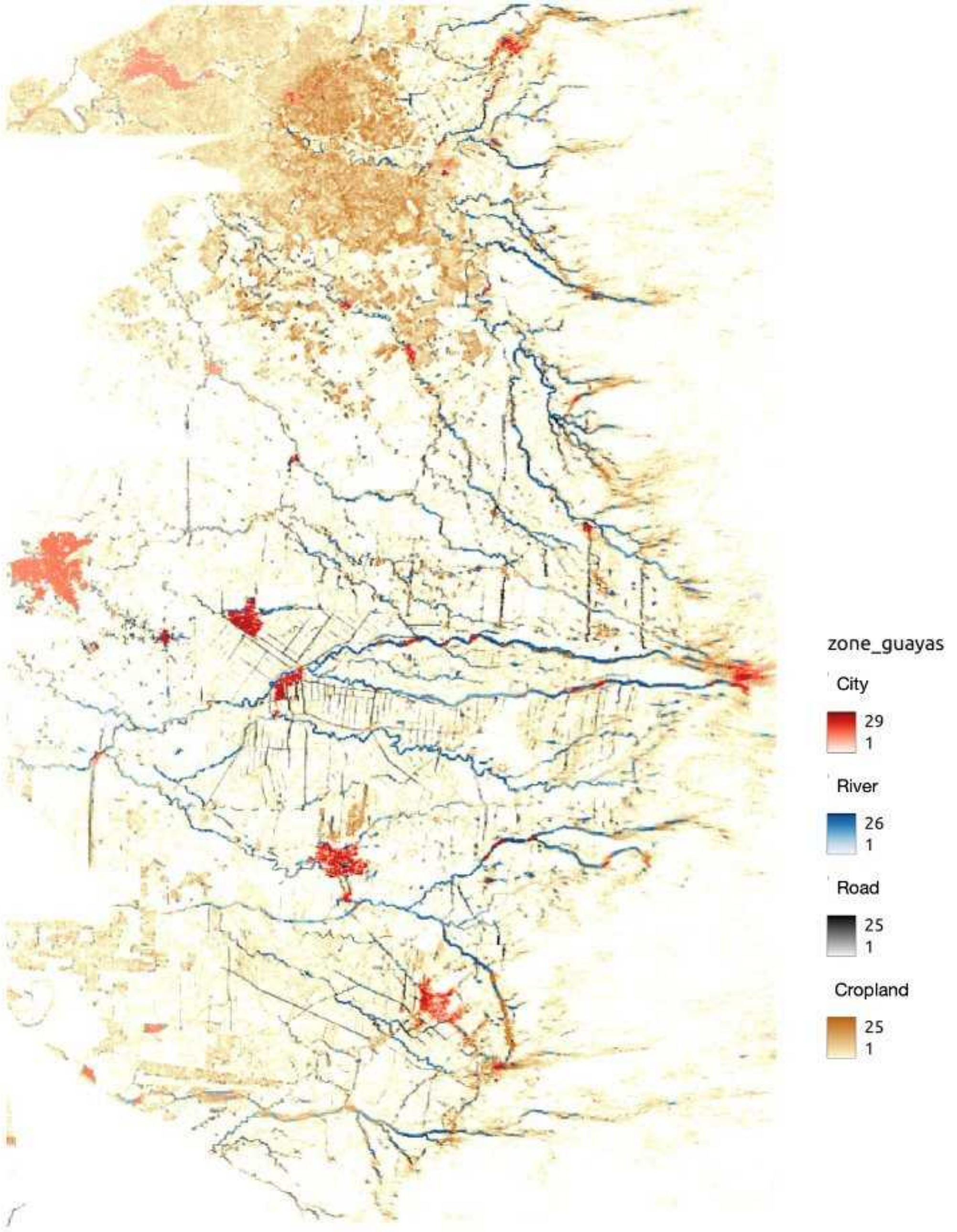
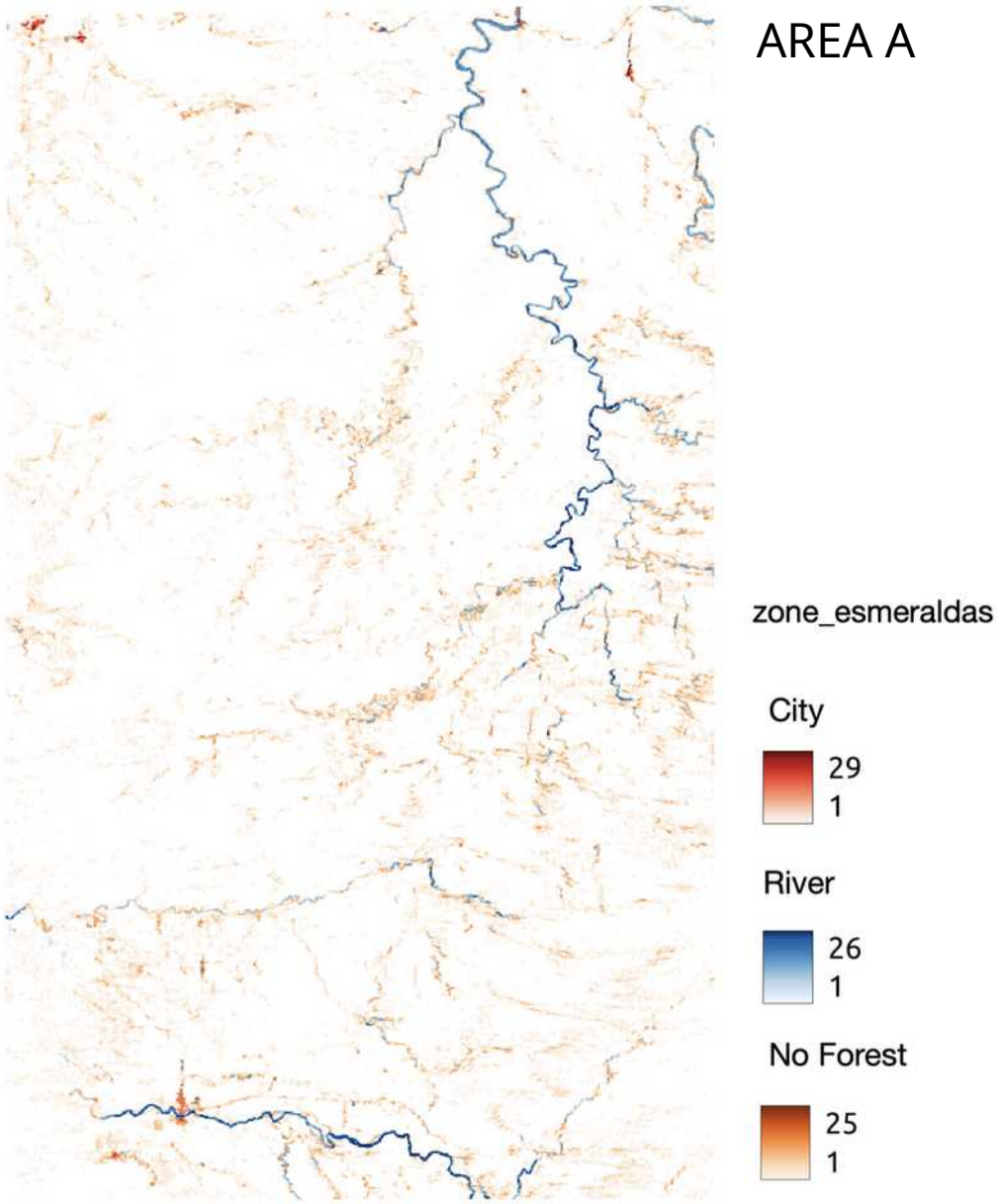


- Automatic classification across the entire study area

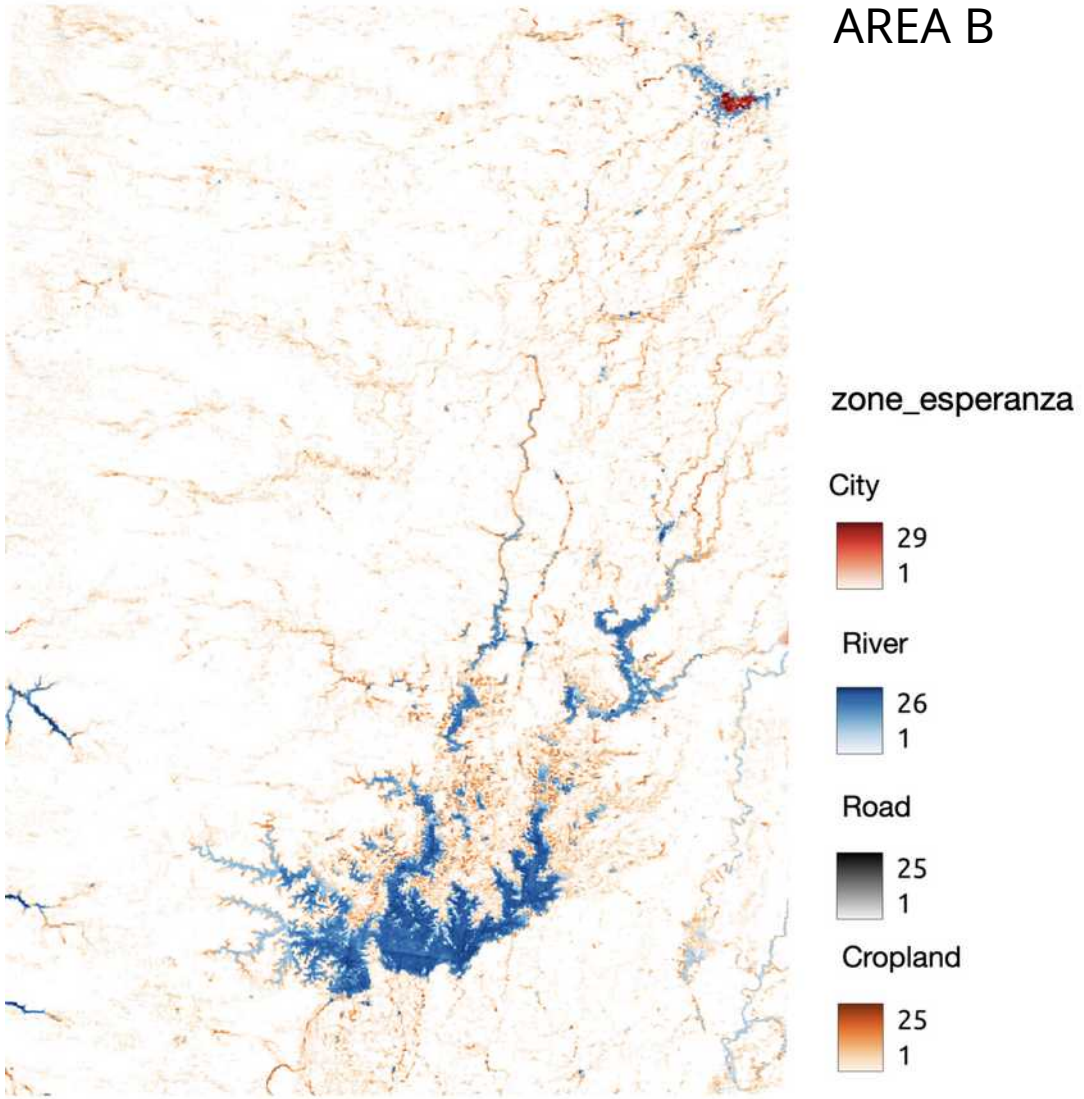


METHOD AND RESULTS

AREA A



AREA B



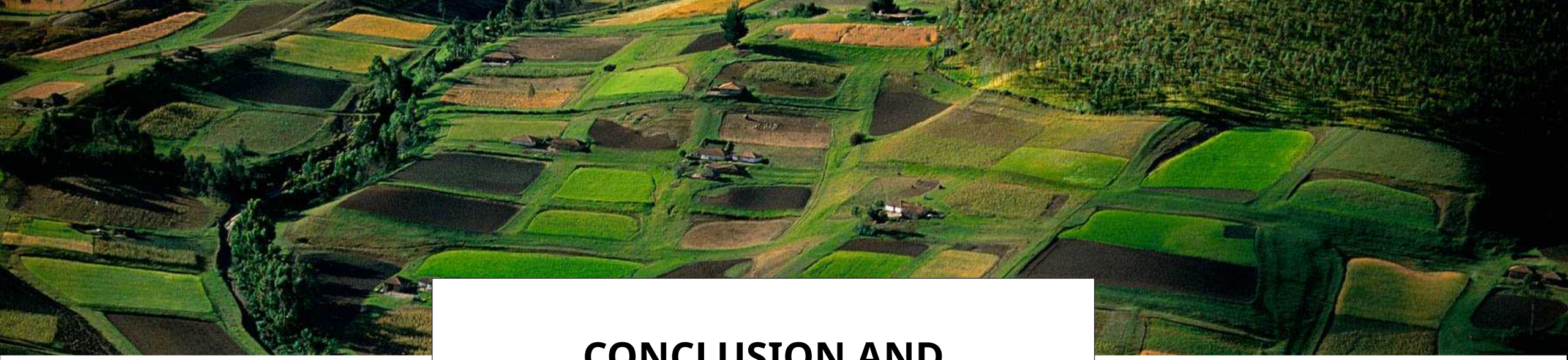
METHOD AND RESULTS

STEP 3 : Comparison of SWOT classification with Ministry data : Confusion matrix

Metrics (AREA A)	
Accuracy	0.89
Precision	0.94
Recall	0.89
Specificity	0.78
F1-score	0.91
MCC	0.44

Metrics (AREA B)	
Accuracy	0.91
Precision	0.92
Recall	0.91
Specificity	0.81
F1-score	0.91
MCC	0.63

Metrics (AREA C)	
Accuracy	0.87
Precision	0.93
Recall	0.87
Specificity	0.66
F1-score	0.89
MCC	0.34



CONCLUSION AND PERSPECTIVES

<u>Contribution</u> :

Innovative use of SWOT : SWOT's ability to provide information on recent forms of deforestation - along existing communication routes with the opening up of deforestation fronts.

<u>Limits and objectives</u> :

- Size of rivers
- Complicated detections under forest cover
- Objective : comparison with GFC change maps (Hansen et al., 2013) and CuSum output results (Ygorra et al., 2021)

Thank you for you attention