

# CERRADATA-4MM: A MULTIMODAL DATASET ON THE CERRADO BIOME

PhD Student

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Advisers

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# Introduction



## Phytopysiognomies of the *Cerrado* biome



Forest  
Formation



Savanna  
Formation



Grasslands

Teoneto (2014)

# Introduction



## Cerrado biome

- It covers 22% of the Brazilian territory
- Wide biodiversity of fauna and phytophysiology
- It has undergone changes in its landscapes due to the expansion of agriculture fields

## Challenge

- Land use and land cover (LULC) is a challenge for itself
- Supervised deep learning models for semantic segmentation rely on large labeled datasets
- Among deep learning models and learning approaches, multi-task learning has shown enhanced performance for LULC classification

# Biome Cerrado Dataset



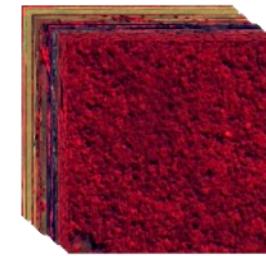
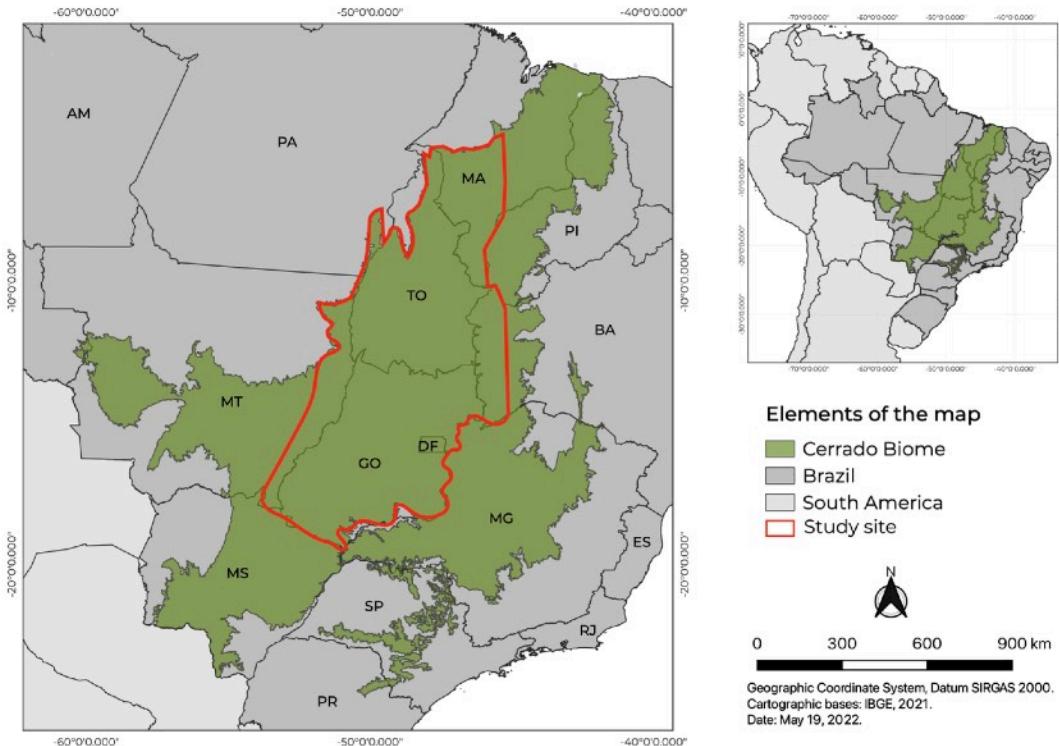
CERRA  
DATA  
4MM

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DATA  
4MM

## Multimodal biome Cerrado dataset

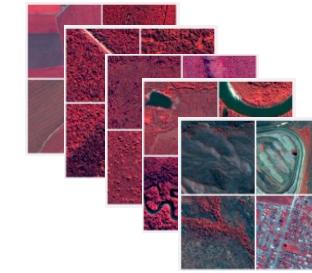
It is the very first multimodal  
benchmark dataset on the *Cerrado*  
biome designed for semantic  
segmentation task

# The previous versions



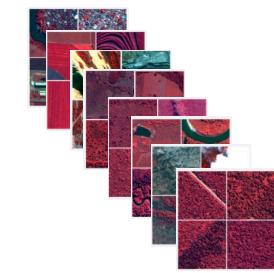
CerraData-1

- Unlabeled dataset
- 2,45 million of samples



CerraData-2

- 50,000 labeled samples
- For scene classification
- 5 classes of land use and land cover

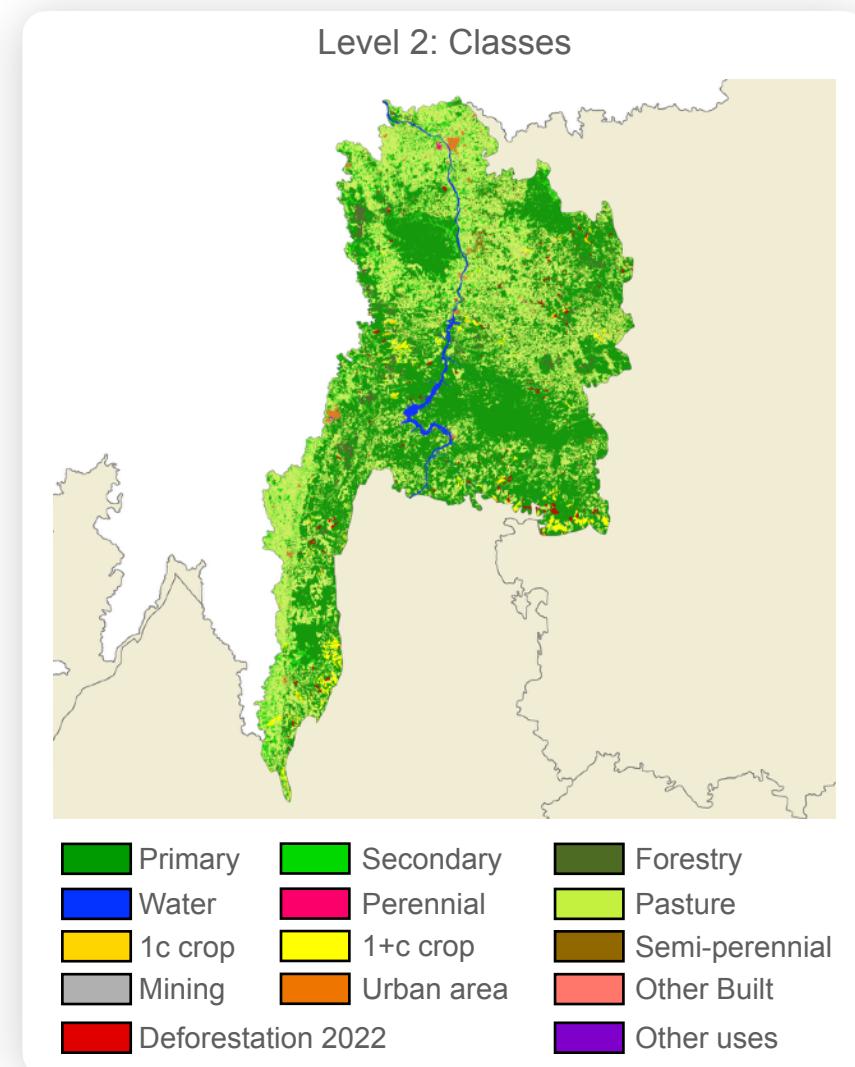
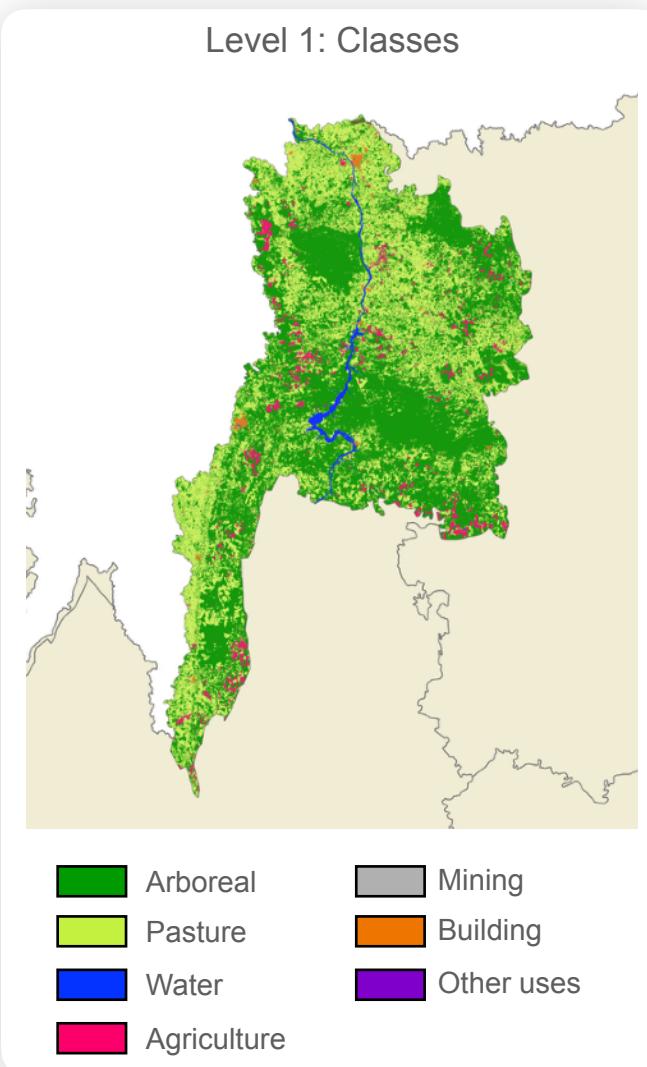
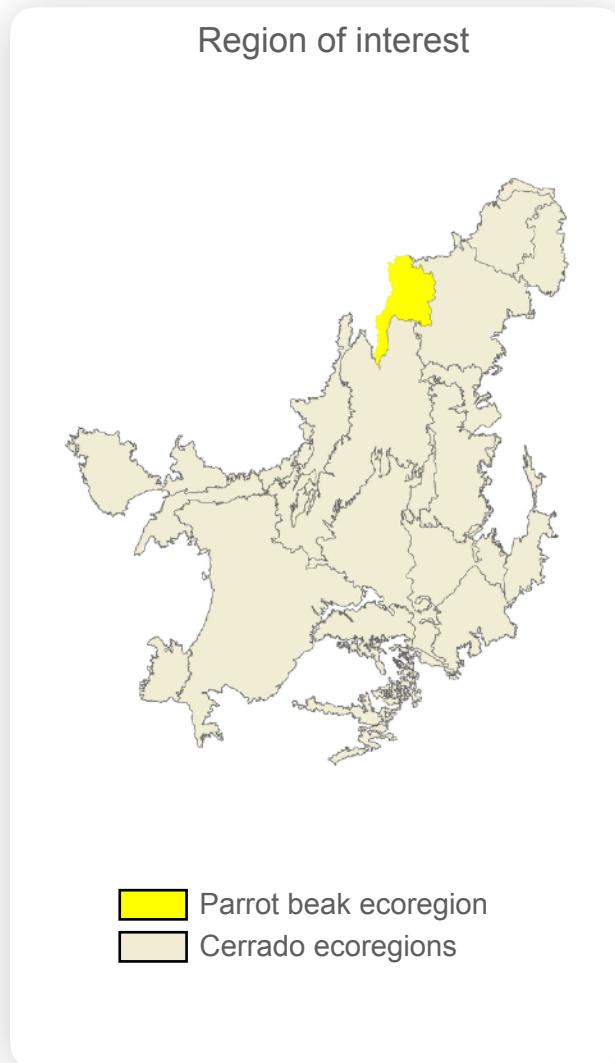


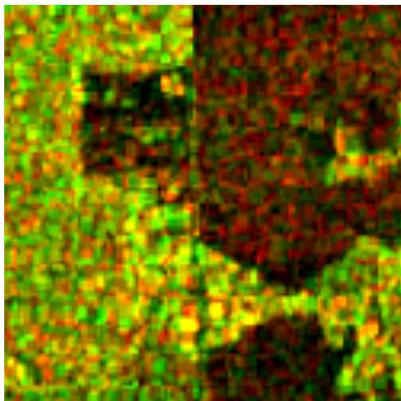
CerraData-3

- 80,000 hard-labeled
- For scene classification
- 8 classes of land use and land cover

- It encompasses 44% of Cerrado biome
- Wide Panchromatic and Multispectral Camera (WPM) from China-Brazil Earth Resources Satellite-4A (CBERS-4A)
- 2 meters of spatial resolution
- The images are composed with Panchromatic (2m), near infrared (NIR; 8m), green (G; 8m), and blue (B; 8m) spectral bands
- For land use and land cover classification

# CerraData-4MM





SAR image



Multi-spectral image



Edge information



Reference mask

## About the source

- Sentinel-1: 7 scenes considering both bands (VV and VH)
- Sentinel-2: 16 scenes considering 12 bands
- 10 meters of spatial resolution
- Reference masks are based on the TerraClass 2022 LULC map

## Number of patches

- 30,320 patches for each modality
- Patches of 128 x 128 pixels

# Experiment: set up



## Dataset

- First hierarchical level
- 90% used for training
  - 20% of the training subset was used for validation phase after training
- 10% for testing phase

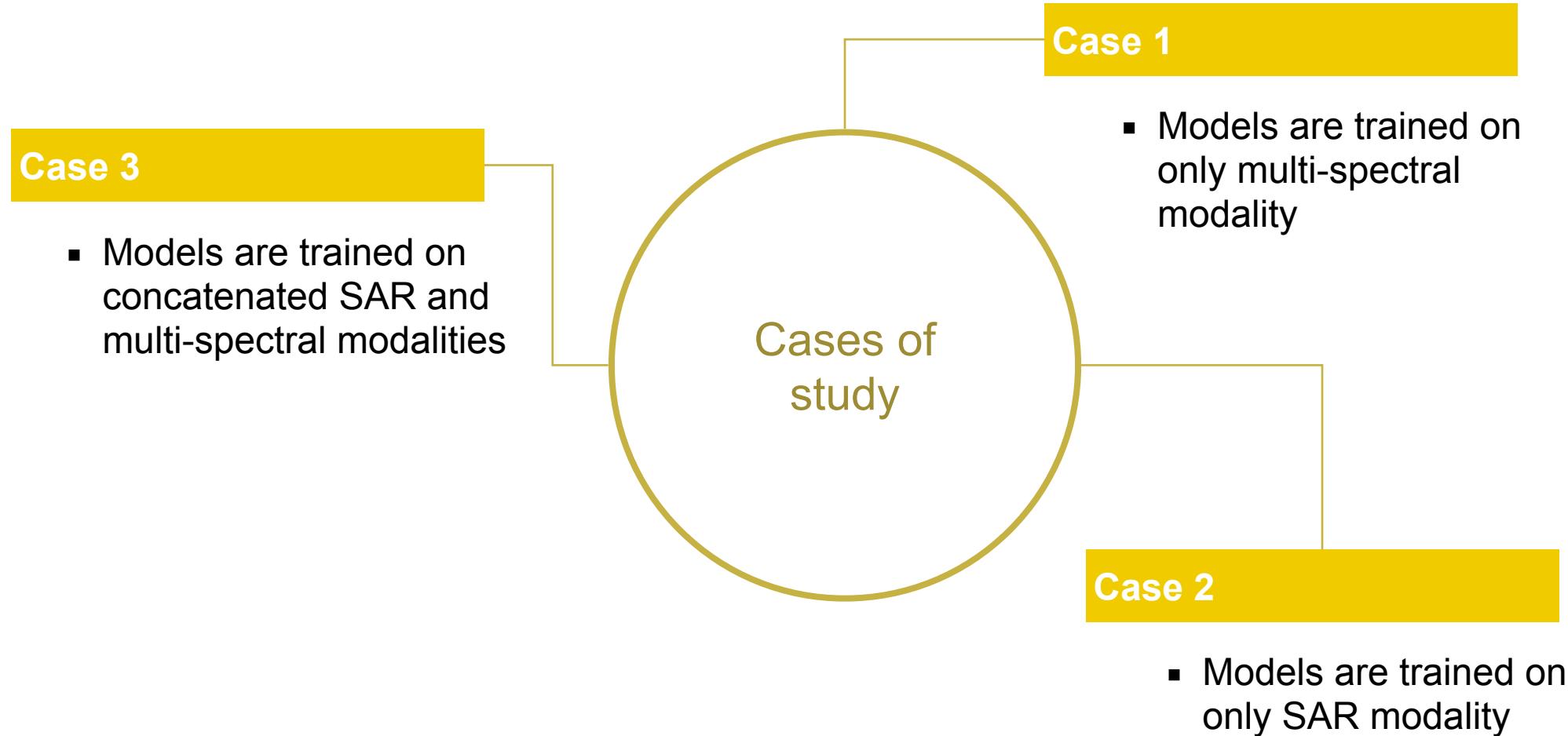
## Deep Learning models

- U-Net, a single task architecture (STL) built on convolution neural network
- TransNuSeg, a multi-task learning architecture (MTL) built on vision transform layers
  - Two tasks are considered: semantic and edge segmentation

## Metrics

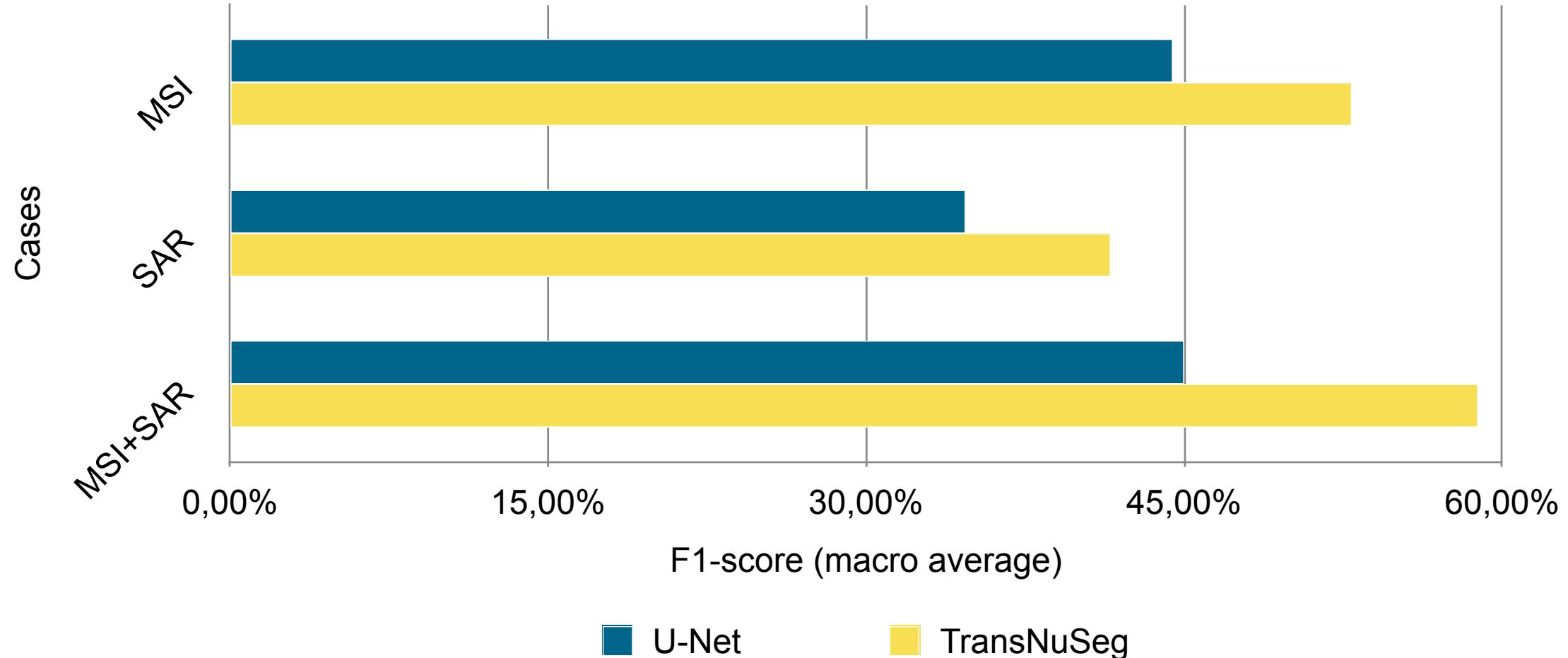
- F1-Score
- Confusion matrix

# Experiment



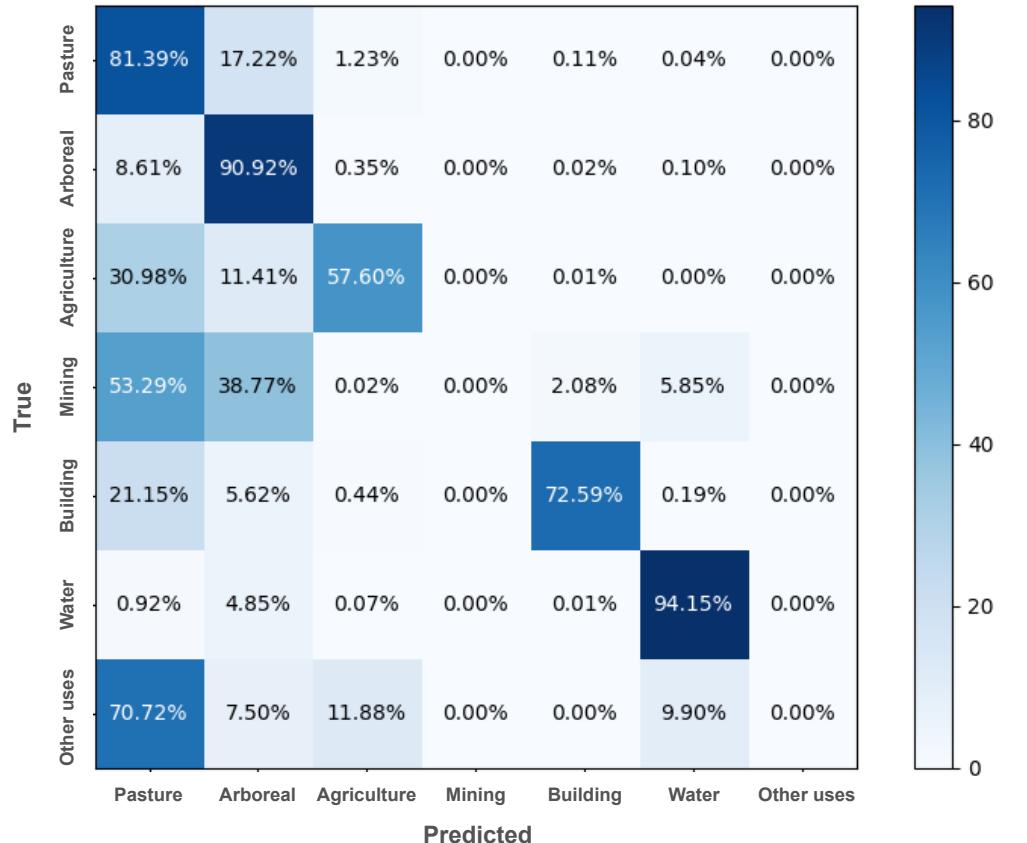
# Results

## Overall models' performance

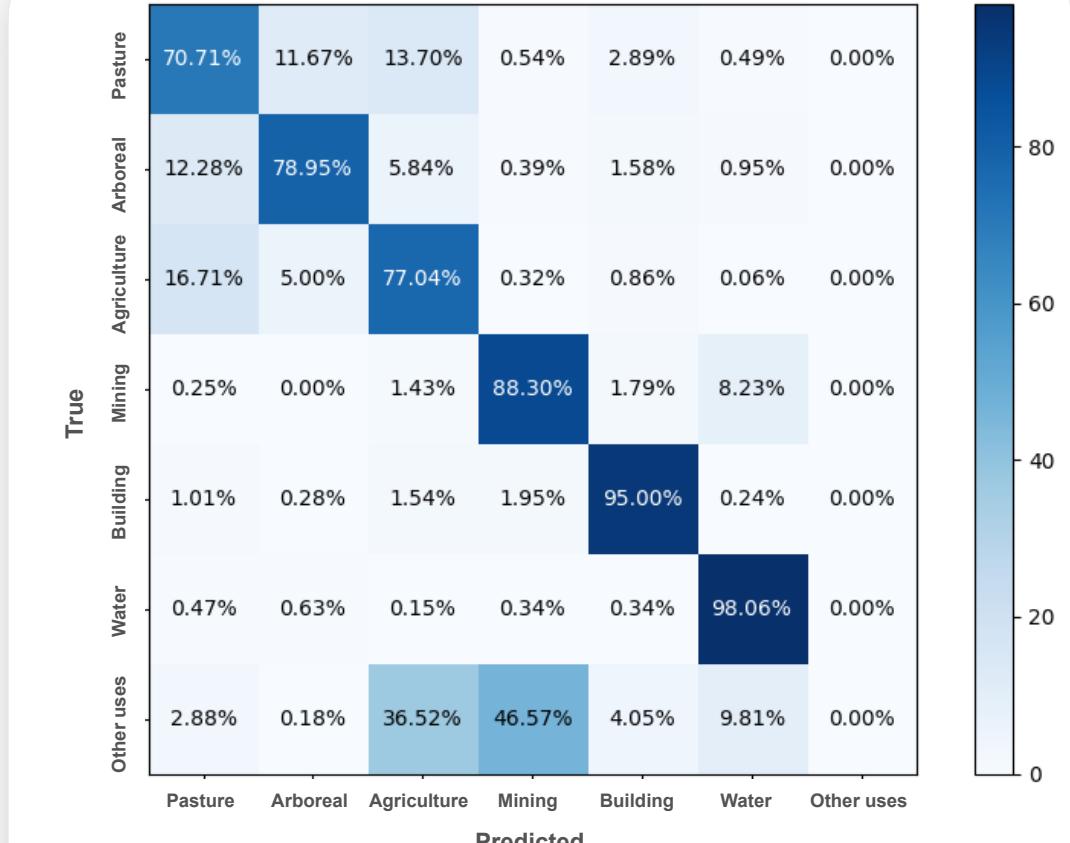


# Results

## Case 3: MSI+SAR data



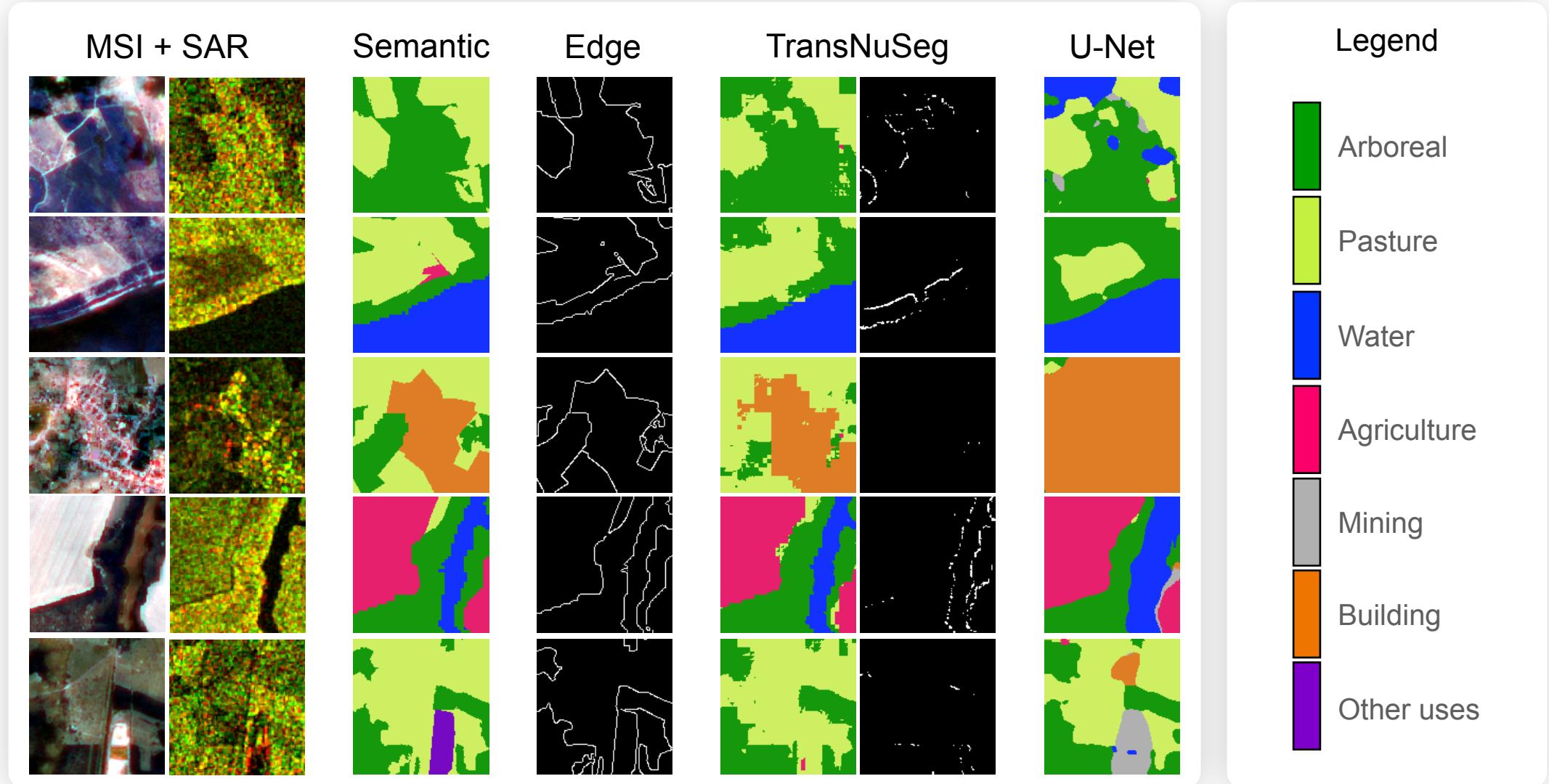
TransNuSeg



U-Net

# Results

## Case 3: MSI+SAR data



# Results

## Case 3: MSI+SAR data



### Data normalization

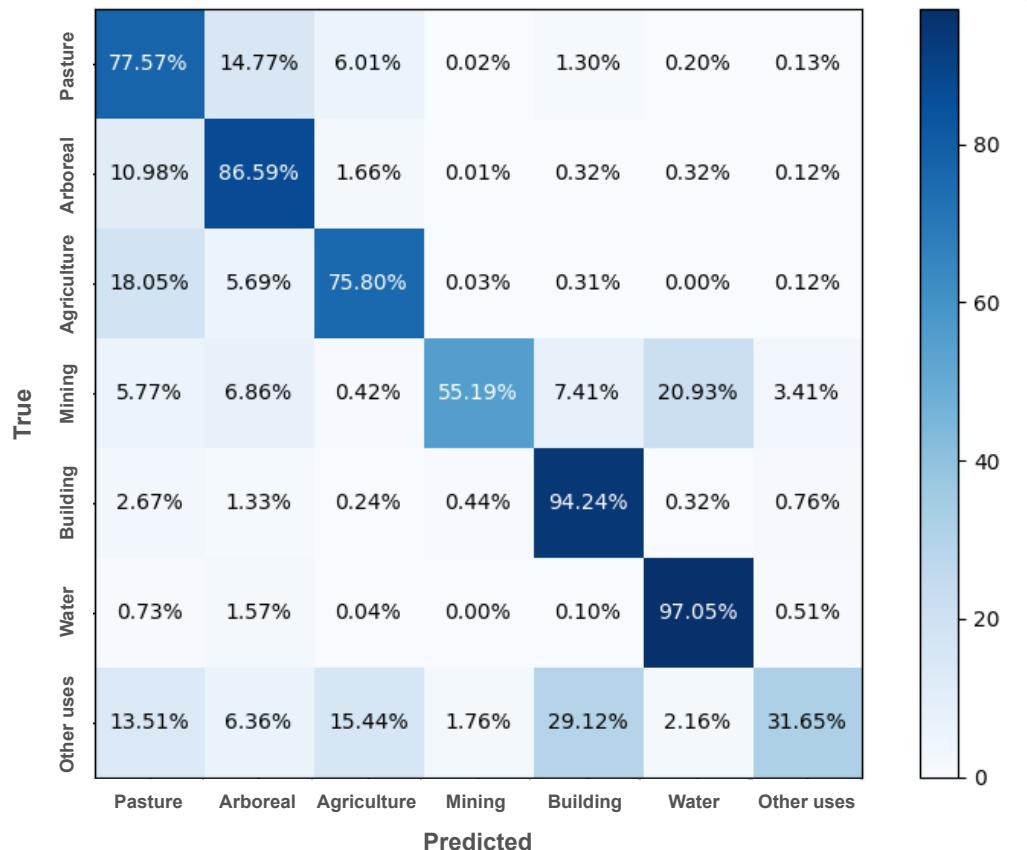
- The pixel values of each band were normalized between -1 and 1 on a log scale

### Weighted classes

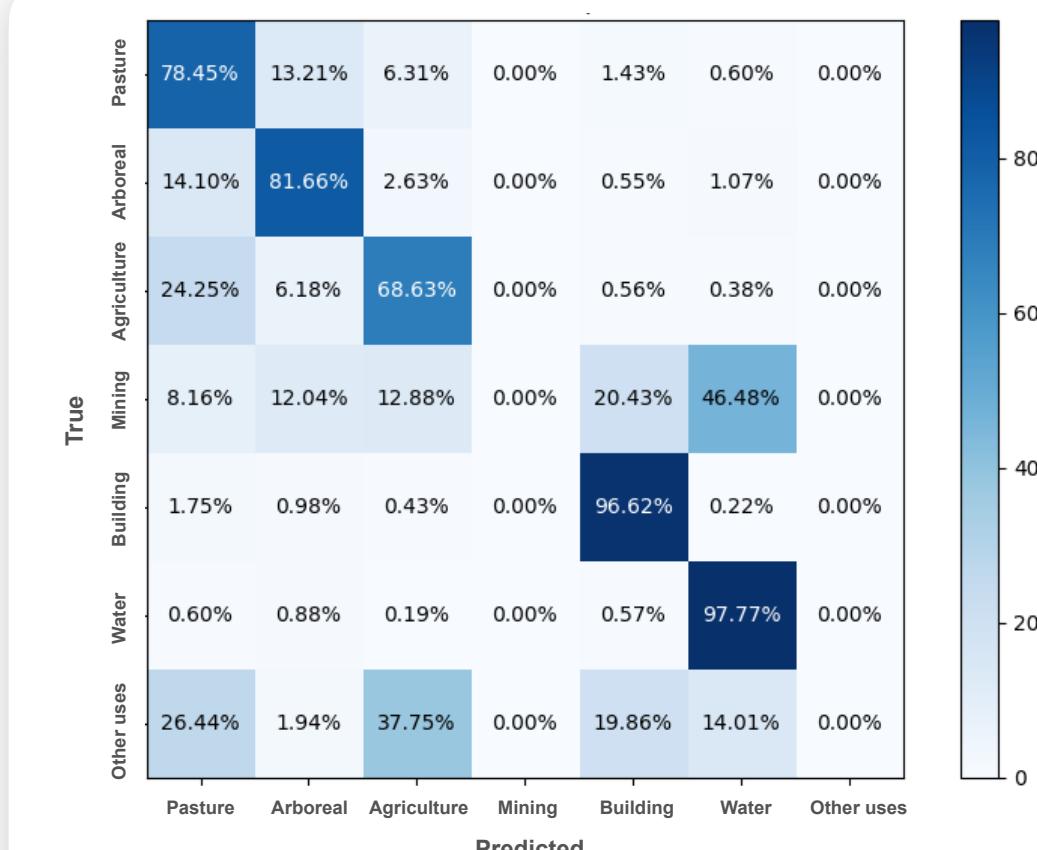
- Class distribution has been used as a parameter to assign weight to each class in order to balance them

# Results

## Case 3: MSI+SAR data



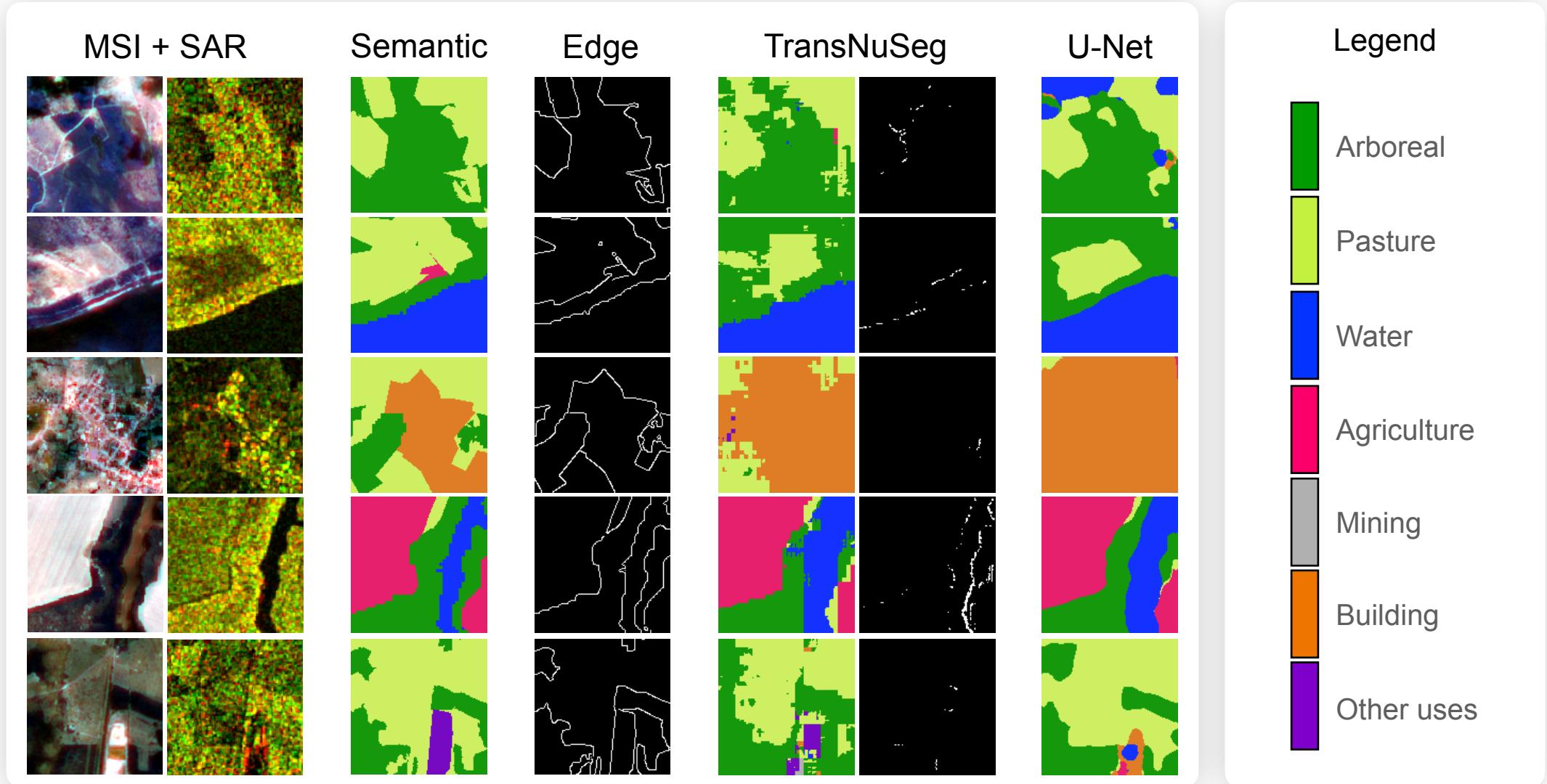
TransNuSeg



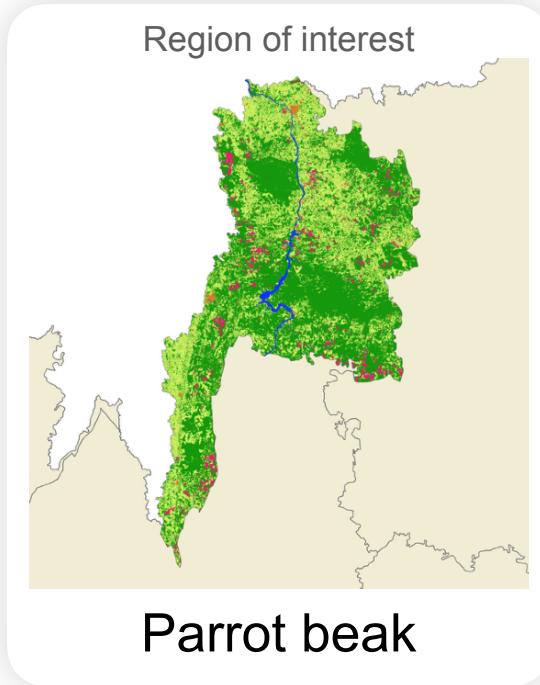
U-Net

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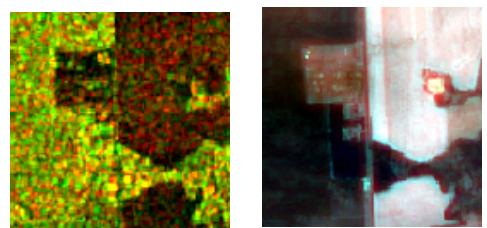
# Final Remarks



Semantic  
segmentation task

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2 hierarchical  
levels of classes



Multi-modal dataset



Deep learning approaches

TransNuSeg outperformed  
U-Net in all cases. Even  
better outcomes were  
achieved when they were  
trained on concatenated  
modalities.

# Final Remarks



## On going

- Experiments using this dataset are being performed
- Paper concerning CerraData-4MM dataset

## Future experiments

- A vision transformer-based multi-task learning (MTL) baseline architecture will be proposed
- A novel version of CerraData will be designed to include even more variables for MTL models.

**Thank you**  
*Obrigado*

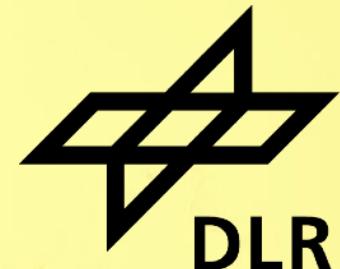
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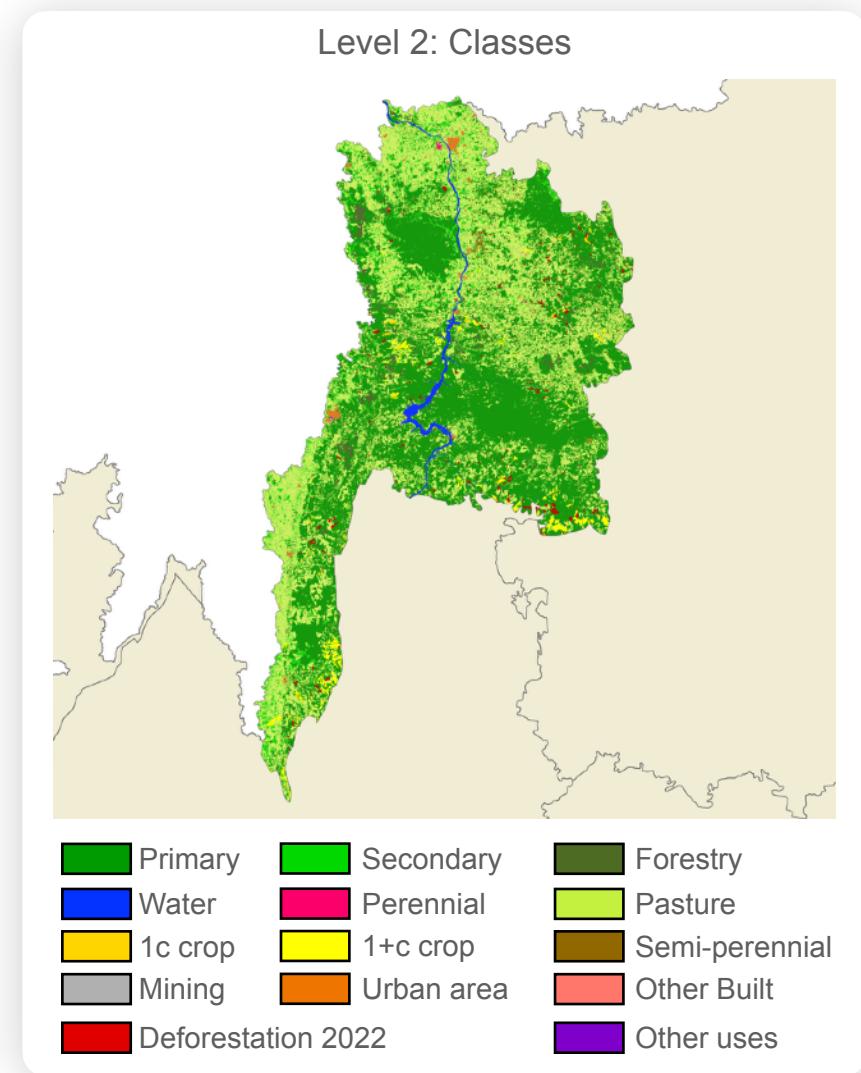
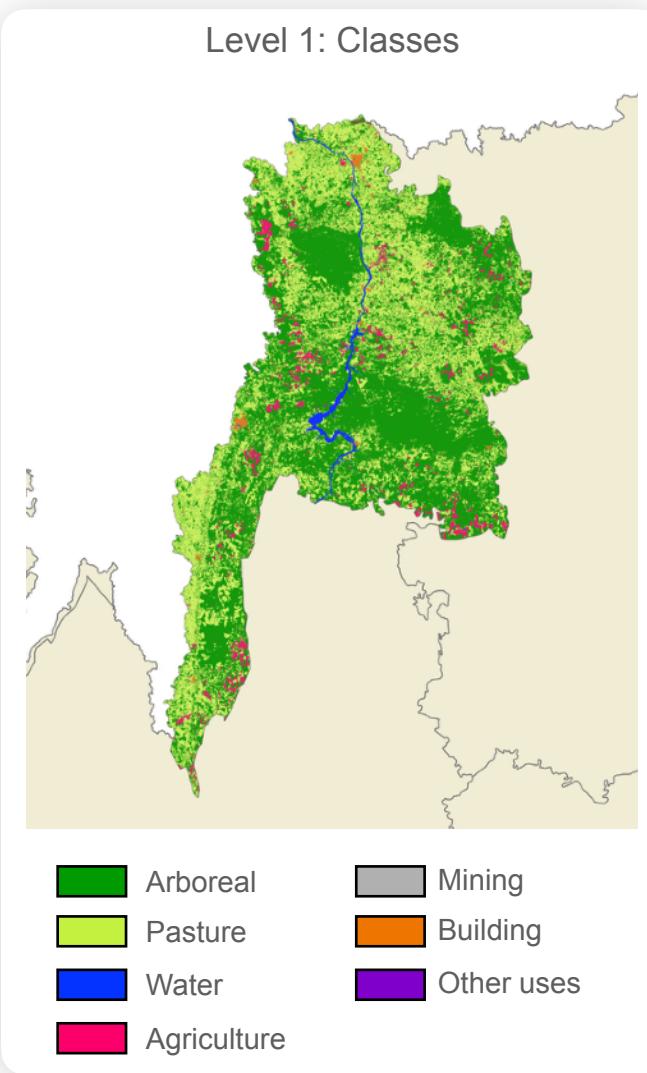
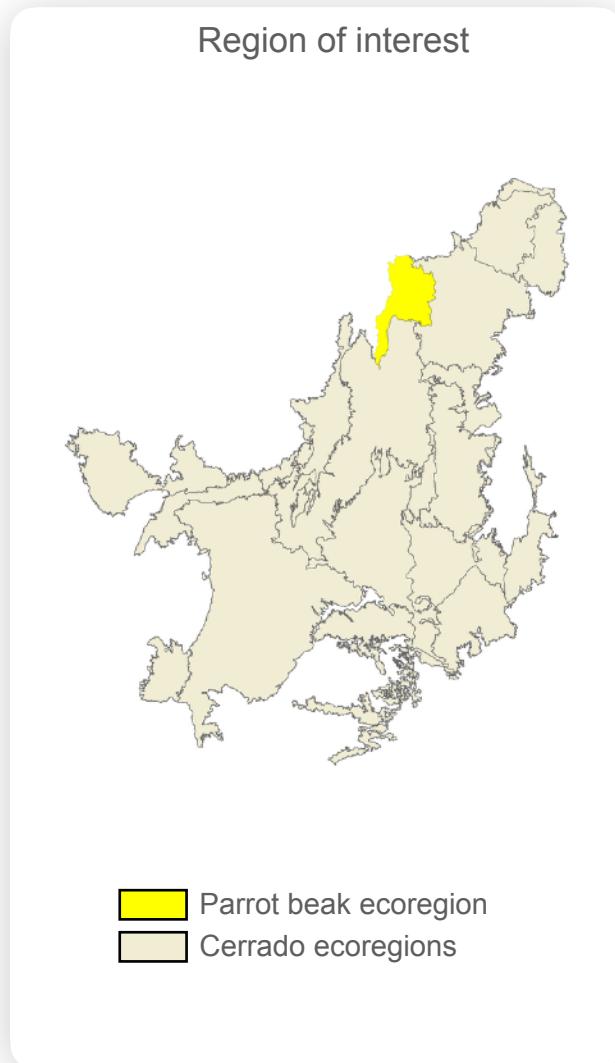
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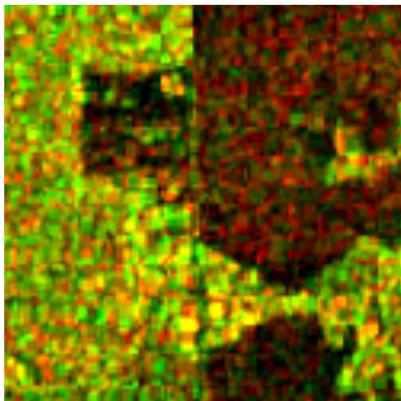
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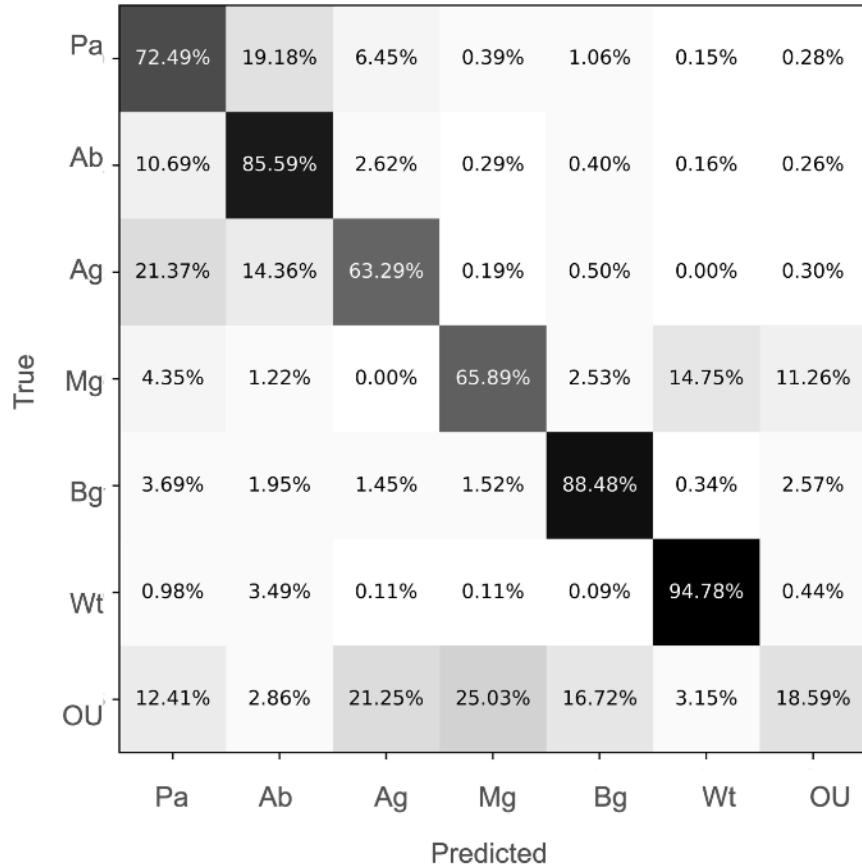
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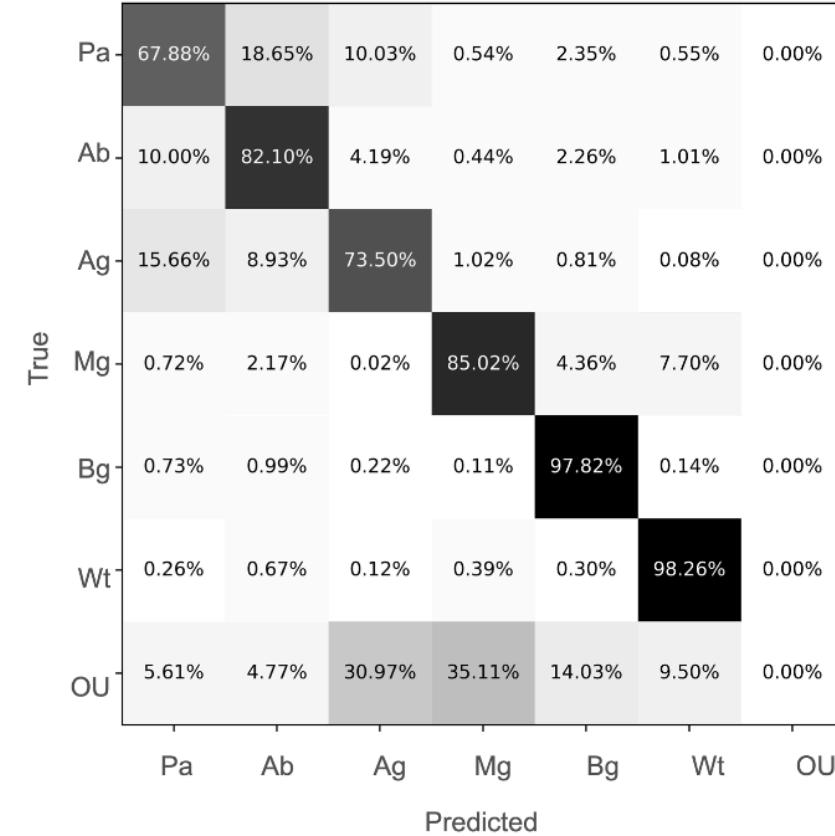
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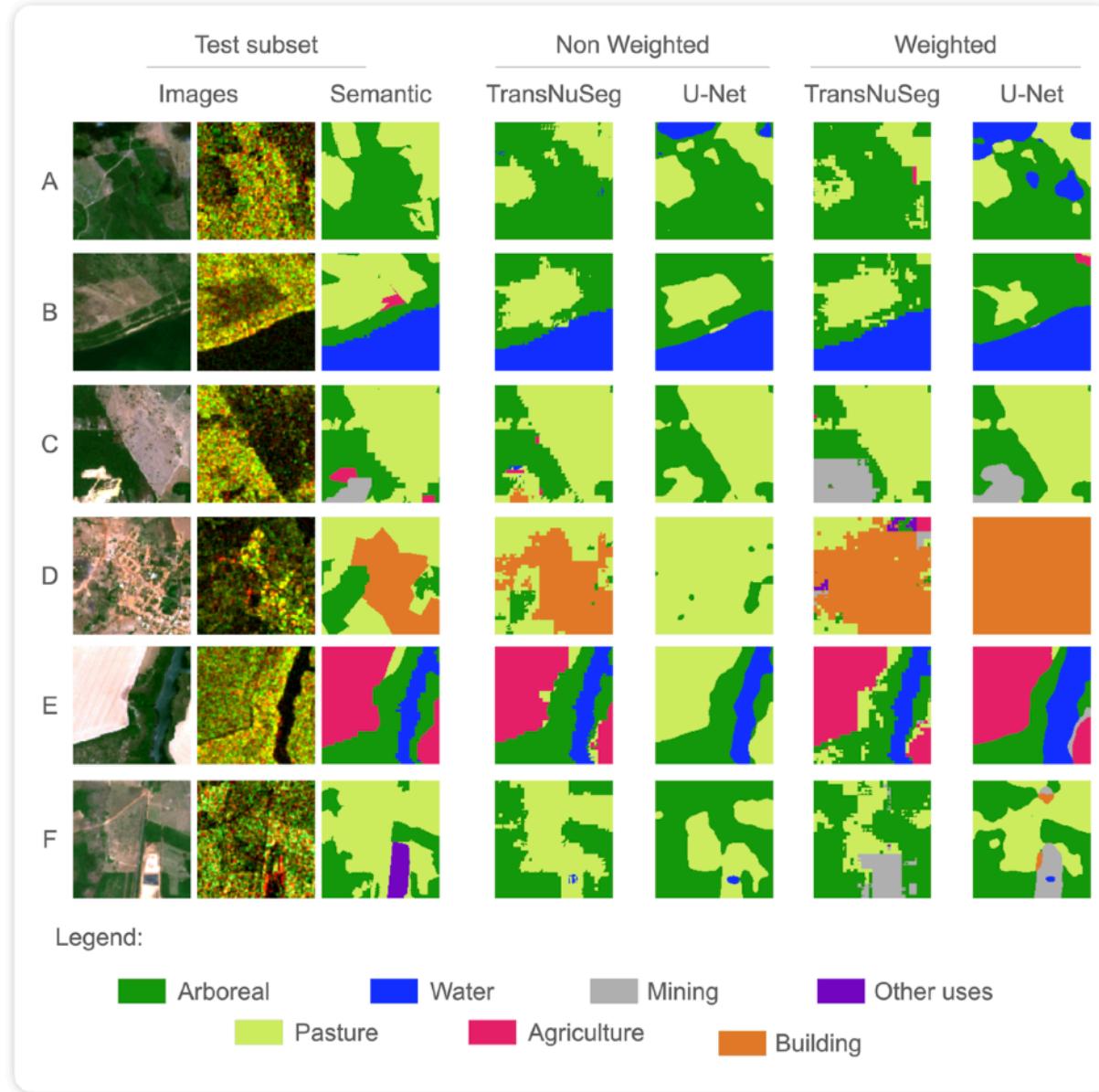
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TransNuSeg



U-Net



## Results Case 3: MSI+SAR data